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Titolo della tesi: CONTEXTUALIZING UKRAINIAN ROCK ART BY DEVELOPING AND APPLYING PHOTOGRAMMETRIC SOLUTIONS TO THE COMPLEX STUDY OF THE PORTABLE ROCK ART OBJECTS

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Preface

When two portable rock art specimens were discovered during the 2016 field season in the Mesolithic layers of the Kamyana Mohyla 1 settlement, they moved us to enter the much-neglected field of Ukrainian rock art research. By that time, discussions of Kamyana Mohyla and the attribution of artistic objects from the site had long since passed away, as well as those scholars who had previously explored this topic. Together with my colleagues from the Institute of Archaeology of the National Academy of Sciences of Ukraine (Kyiv), the National Historical and Archaeological Reserve "Kamyana Mohyla", and NGO the "New Archaeological School", we spent almost two years looking at engraved stones and considering how to study and present them to the public appropriately. To which topic would we contribute with these finds? What methods should we use? How can we best contextualize these objects? Instead of asking archaeological objects for answers, we were questioned by them.

Choosing microscopic examination and photogrammetric image-based 3D modeling to study and present our portable stones was instead a matter of accidence — a blend of our skills and expertise, potential methodological solutions, and the complete failure of different attempts. In addition, the approaching IFRAO 2018 Congress presented an excellent opportunity to exhibit Ukrainian rock art. That's how the photogrammetric study of Kamyana Mohyla first appeared. And this is how I started to address this topic — since photogrammetry was my responsibility in the project, consequently the digital study of rock art objects emerged.

Preliminary research on the topic and multiple dialogues with scholars worldwide led to a fantastic discovery. But, unfortunately, we know very little about Kamyana Mohyla's rock art with absolute certainty. Moreover, reliable knowledge about rock art in Ukraine needs to be improved. Even now, the phrase "Ukrainian rock art location" sounds peculiar to those who have encountered the few articles prepared since our first publication on the topic, dated back to the winter of 2018.

Even the very first meaningful attempt to digitize the petroglyphs from Ukrainian sites and compare the new data with the old interpretations and theories showed that our established knowledge of what the rock art objects of Kamyana Mohyla are is both incomplete and incorrect. Old interpretations appeared based on inaccurate drawings and obsolete contexts, new petroglyphs appeared one by one, and the chronological attribution was highly discussable. Moreover, all the previous efforts lacked digital solutions and were presented in Ukrainian or Russian, practically inaccessible to scholars worldwide.

This is not to say that the significant impact of M. Rudinskiy, V. Danilenko, and B. Mykhaikov on the complex process of studying the unique Ukrainian material was irrelevant. On the contrary, their research substantially influenced Ukrainian archaeology and rock art science, impacting our understanding of Eastern European prehistory. Their contribution alone represents the basis for robust rock art research in Ukraine today. Standing on their shoulders, a new generation of rock art researchers must re-examine and reconsider their legacy using new tools and approaches and developing alternative, modern theories on the objects themselves and their locations at Kamyana Mohyla.

This current research is a good starting point for a new episode in Ukrainian rock art research while proposing new data and solutions for the broader field of study. For this reason, I integrate technological aspects and seek new technical solutions for studying rock art within the more general framework of rock art research, aiming to counter typical approaches to the specialized study of portable rock art specimens. Above this is the objective to set the rock art Kamyana Mohyla in the Eurasian context and introduce it worldwide, carefully studying the objects from there.

To fulfill these tasks, I chose a small assemblage of portable rock art specimens from the site, desiring to analyze it entirely and extensively with photogrammetric tools and coming to limited conclusions regarding the portable art collection. However, life turned the process upside-down. First, the collection's number of portable art objects grew from 170 to almost 370 specimens during the first fieldwork season. Most of this data appeared to be unpublished. Moreover, the drawings and interpretations of the published ones were inaccurate and did not correspond with reality. Then, Kamyana Mohyla confirmed its uniqueness once again, revealing that the portable objects are distant from those recorded at European and Asian rock art locations nearby. Finally, COVID-19 and the war in Ukraine complicated data acquisition and processing, which put the whole rock art complex at risk of destruction. These considerations focused my research on the part of the collection gathered by V. Danilenko during the 1973 and 1974 field seasons. These 146 objects present two entities featured by two established hypotheses on their semantic, cultural, and chronological attribution. Testing these hypotheses required developing an appropriate technological solution to provide the relevant technical study of portable rock art specimens and a deep understanding of the context from which these specimens originated. Such requirements shaped the parameters and structure of my research, as they are presented below.

More than three years of this research project were enlighted with several noticeable discoveries, experiences, and analyses. The first year has been spent on gathering the available data on the Kamyana Mohyla rock art, its portable objects, and the overall categorization of the data. This consisted of visiting the reserve and many museums and examining the mobile rock art collection at the Institute of Archaeology in Kyiv for the first time since the 1970s. Compared to where we are now, this marked a very starting point of the research, when both materials and methods remained unclear and a subject of further investigation. Therefore, the first year of the study was full of surprises and concerns. This is why the thesis includes massive Annexes aimed at systematizing and representing the Kamyana Mohyla rock art in the best possible way. During the second year, I was mostly occupied with developing methodological concepts and digitizing V. Danilenko’s collection of portable stones. These actions led to the development of the specific metallic plate reference plate created by a computer numeric control machine and metrologically tested to ensure the comprehensive accuracy of 3D modeling. This developed solution proved accurate enough to extract additional data on the portable stones. The third year was devoted to the analyses and the application of their results to contextualize Ukrainian rock art using photogrammetric data. It brought new knowledge on almost everything we knew about the portable stones from Kamyana Mohyla — from the composition of engraved lines and the appearance of the symbolic imaginary on the Kamyana Mohyla rock art objects to the parameters of hardness and density of sandstone support as a typologically and technologically meaningful feature of Ukrainian rock art. Finally, these results allowed reevaluating of existing hypotheses and recontextualizing of Kamyana Mohyla rock art based on the knowledge extracted from photogrammetric analyses.

Taken together, all of the aspects mentioned above comprise this research. Though it reveals new dimensions in the Ukrainian rock art research field, and proposes a specific technological solution to address different questions, many important issues remain beyond the scope of this work. Indeed, additional questions have emerged during and as a result of this study. Throughout the final stage of this research, I was struck by the distinct lack of sound geological studies of Kamyana Mohyla and why it is unique in the European landscape. The unfortunate dearth of practical fieldwork on potential Upper Paleolithic sites in the vicinity of Kamyana Mohyla also impedes the work. The absence of any model of what's happening under the sand surface near the complex is disappointing. The study of ocher as a painting and the technology of rock art painting using ocher are also needed.

Moreover, questions around what exactly constitutes Mesolithic and Neolithic in the region in terms of chronological and cultural attribution are still the subject of debate. All these issues affected my research results and will hopefully be solved soon as research progresses. In addition, other requirements have emerged throughout this research. Among them is the urgent need for traceological and technological studies of Kamyana Mohyla engravings and Kamyana Mohyla sandstone, a more detailed examination of Central Asian rock art objects, and the search for clear connections with Kamyana Mohyla imaginary (though Borys Mykhailov, Victor Dzhos and myself narrowly explore this field). In addition, re-examining the whole corpus of petroglyphs from Wizards cave and many other objects from different locations, particularly those attributed as multilayered ones, would be beneficial. Finally, suitable digitization and preservation of the whole complex are awaited to prevent the constant risks and destruction of the complex.

Last, a thorough exploration of the Ukrainian Steppe must be carried out to search for additional rock art objects, especially in areas featured with petrographic anomalies. These issues are significant in and of themselves, but they are also parts of a wider field of rock art research in Ukraine that needs to be advanced going forward. New questions are emerging with every field season and with every publication. In this research, every attempt has been made to address and meaningfully answer essential questions about the site of Kamyana Mohyla. The first steps have been taken, and the way forward seems clear, so we should start.

However, this very first step took a lot of work. It would have been utterly impossible without the continuous efforts of many actors all around the world. My gratitude to all of them is boundless. Each of them spent part of their time, effort, and wisdom to make this happen and supported me when whenever called upon. My supervisors, Professors Vito Messina, Fulvio Rinaudo, and Paolo Biagi, managed and pushed me when required and left me to work independently when this was possible. I am incredibly grateful for their help and guidance. The whole team of "Technologies 4 Cultural Heritage" PhD school took care of many technical issues. At the same time, my co-fellows commented on different steps of work progress which inevitably led to the improvement of final results. My Ukrainian colleagues and senior advisors — Nadiia Kotova, Dmytro Kiosak, and Dmytro Nykonenko — survived through billions of complex discussions of the nature of archaeological processes on Kamyana Mohyla and around. Together we co-authored several substantial pieces of research on the site's prehistory. Many scholars worldwide supported me in different stages of my research — there are too many of them to name everybody, but special thanks come to Trond Lødøen and Sevinc Shirinli for their boundless kindness. The awesome collectives of Alta Museum (Norway) and Gobustan reserve (Azerbaijan) are to be mentioned together with colleagues from the Institute of Archaeology in Kyiv, Cemmo National Park in Darfo Boario Terme (Italy), and Regional Historical Museum in Zaporizhzhya (Ukraine). The fantastic teams of "Maibutni" and the "New Archaeological School" have supported me in my field trips and shielded my mental health during the research. Finally, many thanks to Anna Radchenko and Yevhenii Pohribniy, who spent night after night listening to long narratives about the portable rock art of Kamyana Mohyla — which is rarely the desired way to spend your time.

It is imperative to mention Victor Dzhos, Yuriy Ratskevich, and other Kamyana Mohyla National Reserve workers who are trying to protect the unique site from the constant risks of Russian occupation. Though their lives are endangered by the unjustified aggression of a terrorist state, they are standing to protect their workplace. I am honored to know them. Similarly, I am in tremendous debt to my colleagues who are fighting on a frontline of freedom, allowing me to conduct my research. Dmytro Kobaliia, Denys Grechko, Dmytro Romanchuk, Oleksandr Malyshev, Denys Bondarenko, Oleksiy Kryutchenko, Andrew Kobaliia, Mykola Belenko, Pavlo Vasyliev, Oleksandr Nezdoliy, Andriy Petrauskas, Ihor Starenkiy and many others. These are the real heroes protecting our country and the unique place I have described and studied in this research.

1. INTRODUCTION. THE FUNDAMENT OF THE RESEARCH

1.1. Fundament of the research

This research project **aims** to develop technological solutions for the photogrammetric study of portable rock art objects that will be applicable to provide technical interpretation and contribute to the contextualization of portable rock art specimens.

The **object** of this research is the assemblage of portable specimens from two caves on Kamyana Mohyla — the most prominent rock art location in Ukraine and the only one in the European part of the Eurasian Steppe belt. This assemblage counts 146 specimens in general. The research **subject** is the engravings on the objects' surface, their shape, metric parameters, and general composition. The interpretation and understanding of these parameters lead to a valid interpretation and contextualization of the specimens.

The **actuality** of the research is based on three different concepts. First, an affordable, cheap and straightforward solution for the accurate technological study of rock art objects is needed to make such a study accessible for museums and rock art sites worldwide. Second, Kamyana Mohyla, as a rock art location, fills the gap between the Central European rock art sites and those in the Eurasian Steppes or Ural mountains. Therefore, it is imperative to study this unique site as a distinct source of information about the prehistoric imagination of the region. Third, the site of Kamyana Mohyla is currently threatened by continuing unjustified Russian military aggression in Ukraine. With this in mind, it is vital to preserve the archaeology as far as possible and appropriately introduce the site to wider audiences.

Moreover, this topical research addresses and considers a bunch of **novel** concepts: it is the first time that the complex technological study of rock art collection has been performed by image-based 3D modeling with submillimeter accuracy; the developed hardware solution allows the scaling and referencing of the models with the submillimeter accuracy without any additional hardware solutions; most of the materials published in the research were entirely or partially invisible for scholars worldwide. Finally, as is the case with the study in general, each chapter aims to add something new to the current state of the art.

These research parameters lead to the formulation of particular **questions** that frame the research into the way it is produced:

1. What are the accuracy assessment strategies for the photogrammetric study of portable rock art? How to calculate and achieve the required accuracy throughout the data acquisition procedures?

2. What technological solutions are needed for comprehensive image-based 3D modeling and the following study of portable rock art?

3. What information can be obtained from studying image-based 3D-models of portable rock art objects regarding the engravings production, composition, relative chronology, and relation to the specific stone support?

4. How can photogrammetry be used to provide sensible conclusions for the study of Kamyana Mohyla's rock art?

5. What can image-based 3D modeling and an analysis of the Kamyana Mohyla portable rock art specimens' collection add to our understanding of their life cycle?

6. Is it possible to upgrade the old V. Danilenko and B. Mykhailov's hypotheses on the archaeological and chronological contexts of Kamyana Mohyla portable rock art or formulate new ones based on the information obtained from the results of the performed photogrammetric study? What are these updates and hypotheses?

These questions fostered the formulation of research **hypotheses** that guided me and my project from its very beginning to the desired result:

1. There is a clear and straightforward accuracy assessment strategy that leads to reliable 3D images of portable rock art specimens. It can be defined, structured, and applied to the relevant dataset. The calculations behind this strategy set specific requirements to make the procedure successful;

2. There are conceivable technological solutions to provide the referencing and scaling of the model at the desired accuracy without additional expensive hardware equipment;

3. The accurate 3D representation of the 3D objects' surface can provide required data on the engraving's composition, imagination, technology of the engraving's production, and their related chronology. Additional calculations performed on the data extracted from 3D models provide new information on the stone support about the engraving procedure;

4. Photogrammetric 3D modeling of the portable rock art specimens from the caves of Kamyana Mohyla allows for extracting the data on the engraved motifs and compositions, the engravings technology, and relative chronology. This will be a valuable addition to our understanding of Kamyana Mohyla's rock art;

5. The information extracted from these models and the observation of the portable specimens collection, in general, might give valuable data on the portable stones' life cycle;

6. All the data extracted from 3D models of the portable stones from Kamyana Mohyla will provide the basis for the reconsideration of the collection, confirming or rejecting established hypotheses on the interpretation and contextualization of portable rock art objects in general and those from Kamyana Mohyla in particular. The new data may lead to the formulation of new hypotheses.

The five chapters of this text follow these hypotheses, checking them one by one to answer the established research questions and come to general conclusions fulfilling the research aim. But, of course, the route has featured many twists and turns. Occasionally, additional detours were needed to arrive at the desired point of the intellectual journey — data were missed, concepts became confusing, and some pieces of knowledge required structuring before moving forward. These detours are presented in the text, which might be thought of as not simply moving linearly from question to answer, but rather as a report on the journey of "exploring the field".

Chapter 1 introduces the topic, outlining the main features of the research. Then, in a very brief and schematic way, it presents the Kamyana Mohyla and the rock art from the site. It aims to introduce the material under consideration, locate it on the map, and support it with visual representations. Furthermore, it outlines the specific issues regarding Kamyana Mohyla's rock art. It focuses on the division between parietal and portable art and the confusion it conveys to this particular study.

The second chapter is devoted to the general presentation of Kamyana Mohyla — the main case study of the research. The history of archaeological and rock art research on the site is presented through the prism of the scheme developed in the previous chapter. The main characters involved in the process — Mykola Rudinskiy, Valentin Danilenko, and Borys Mykhailov — are introduced through their key concepts, theories, and publications. Some information, such as archive data from field reports on the rock art research on Kamyana Mohyla, is obtained or gathered for the first time. Later this chapter highlights the archaeological context of the site and its surroundings from the Paleolithic through to the Medieval period. This work is supported by maps and brief descriptions, which have been gathered by our research team on-site since 2011. Finally, the third part of the chapter aimed to place the complex in a more general rock art context concerning European, Caucasian, and Central Asian sites and to represent the possible analogies and parallels related to parietal and portable art. None of these blocks have previously been presented in English at such a level of detail. Moreover, the site has never been considered in a broad Eurasian context. Regardless of whether or not this contextualization is exhaustive, it is sufficient for representing the site adequately and holistically.

Chapter three is the methodological heart of the research. It starts with a brief overview of the history of rock art recording methods focused on photogrammetry and image-based 3D modeling in particular. This part explores the criteria for the rock art recording results and the course to meet these criteria correctly. When this is done, the text presents the developed technological solution that I will apply to the portable rock art of Kamyana Mohyla. This task includes the accuracy calculation and determination of the desired camera parameters, the development and description of the metric polygon used for model referencing and scaling, accuracy tests, the description of the methodological workflow, etc. Finally, the presented workflow is described and illustrated with examples from the studied collection.

Furthermore, it is summarized in several diagrams from Annex A of the thesis. Finally, this chapter presents the application of the established technological solution and the workflow to the additional case study — the portable rock art specimens from the Gobustan Historic and Artistic Preserve in the Azerbaijan Republic. This case study aimed to evaluate the interoperability and reusability of the workflow and technological solution.

The processes and results of the research are documented in **chapters** three and **four**. The latter describes the process and results of the technological interpretation of 3D models obtained by image-based technology, including reflection on the specimens' portability, the calculation of rock density, comparison between different parts of the assemblage, analysis of the specimens' drawings, and the study of the engravings' relative chronology. This chapter also includes the typology of the engravings' cross-sections that appear to be relevant both for portable and parietal art specimens from Kamyana Mohyla and provides some basic conclusions regarding the technological interpretation of the specimens. Finally, it addresses a few researched and assessed parietal art objects to reveal the potential of digital solutions for re-examining and re-evaluating Kamyana Mohyla's rock art.

The final chapter of the research is **chapter five**. It gathers all the data acquired in previous stages to engage them with the established theories on the interpretation, cultural and chronological attribution of the examined portable art specimens. The different parts of the studied assemblage have been interpreted through two alternative hypotheses, and this chapter examines them individually. Additional supportive arguments were considered, developed, and presented when the hypothesis proved valid and relevant in light of new data. When the hypothesis proved misleading, the "pro" and "contra" arguments are examined, presented, and evaluated. Finally, a new hypothesis is proposed to replace the invalid one, taking into account the newly obtained data and the advances of contemporary rock art science, archaeological theory, and the concepts of ontological turn. This process marks the last point of the research — the production of new knowledge and new hypotheses from re-examining known and newly discovered data using modern digital methods.

Last but not least, the text is featured with five annexes that contain the results of data acquisition and processing but also introduce additional materials that deserve to be presented to the public. **Annex A** is a map and a complete list of the known Kamyana Mohyla locations. For the first time since 1947, they are coordinated and placed on the map. This data is featured with short descriptions after V. Danilenko and B. Mykhailov and a list of portable rock art objects related to particular locations I created and systematized. **Annex B** contains several IDEF0-diagrams and flowcharts that aim to explain the research and data acquisition workflow scheme. This section includes the workflow for accurate calculation and assessment, equipment selection, data acquisition procedures, and the general workflow for the whole research. **Annex C** presents the parameters of image processing and 3D-models creation used in the study, with the specific data on every processed portable rock art specimen from Kamyana Mohyla, including accuracy and processing time. **Annex D** is an extensive catalog that presents all of the portable rock art objects from the collection of Valentin Danilenko. Those of them that were 3D-modelled (71 out of 146) are presented with images, detailed drawings, legends, interpretations, cross-section lists, and Harris matrixes, where applicable. Others are featured with some images and descriptions after V. Danilenko and B. Mykhailov, with the source noted. Finally, **Annex E** presents the data acquired in the Gobustan Historical and Artistic Preserve (15 portable rock art specimens were modeled and analyzed), the parameters of the modeling, and the information about specimens. It is organized as a combination of Annexes C and D for smaller data. It is clear from this Annex that the proposed workflow is interoperable and reusable enough for its full-scale application not only on Kamyana Mohyla but elsewhere.

1.2. Kamyana Mohyla — to largest rock art location in the Southeastern Europe

Kamyana Mohyla, the primary study case of this research, is located in Southeastern Ukraine, near Melitopol in the Zaporizhzhya region. This place is close to the western border of the great Eurasian Steppe belt — a climatic zone that wastes from southern Moldova on the west to Mongolia on the east (fig. 1.1.). The European part of the Steppe belt is reached by archaeological sites, especially dozens of thousands of kurgans attributed from Eneolithic to Medieval age. However, the amount of rock art locations here is somewhat limited. Kamyana Mohyla is the only significant rock art locality in Ukraine. Moreover, there are no apparent signs of similar sites in the Steppe part of Russia. Such objects are also unknown in the space between the Carpathians and Dnipro. This makes Kamyana Mohyla a unique point on the map of European rock art locations — the westernmost among Steppe sites and the easternmost European one (except, probably, some caves in the Ural Mountains).

Kamyana Mohyla is an accumulation of sandstone blocks that creates a 19 m high hill filled with sand. This hill is well visible in the plain landscape of the Ukrainian Steppe and is different from the surrounding landscape (fig. 1.2). Some of these stones were washed by the Molochna River that flows right near the slopes of the hill. The hollow spaces between the large sandstone blocks create several remote locations, similar to caves or grottoes. Their walls and ceilings were considered suitable for creating parietal art objects — just like the exposed parts of the sandstone blocks that now introduce several rock art panels. Given the rarity of such stone accumulations in the steppe, it is rather evident why Kamyana Mohyla is considered a unique site suitable for rock art creation.

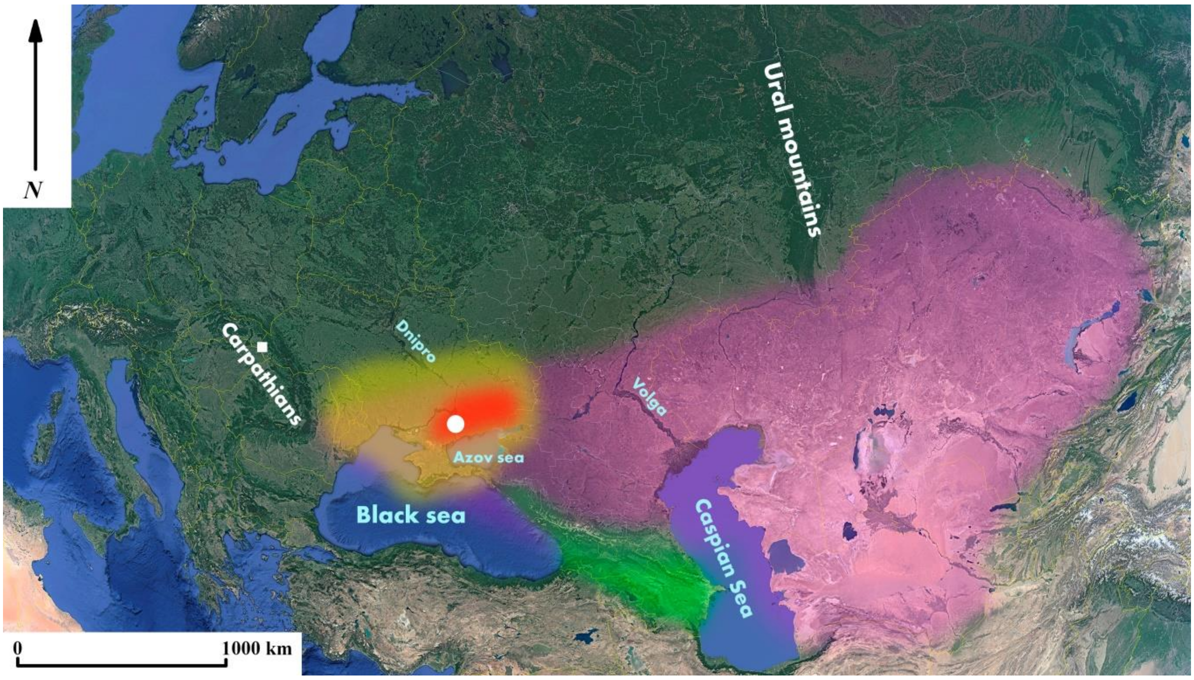


Fig. 1.1. The satellite image of Eurasia with the marked areals of Eurasian Steppe Belt (pink), Caucasus (green), North Black Sea region (yellow) and North Azov Sea region (red). White square marks the geographic midpont of Europe (Dilove, Ukraine). White circle indicates the location of Kamyana Mohyla

Fig. 1.2. Kamyana Mohyla in the landscape of Molochna River Valley

To day, 68 locations of the rock art specimens are known in the Hill (fig. 1.3). Most of them are exposed panels, featured with engravings in the sandstone; others are caves (i.e., No. 52, 54, and 55) or the excavated areas where portable art specimens were found (e.g., location No. 65).

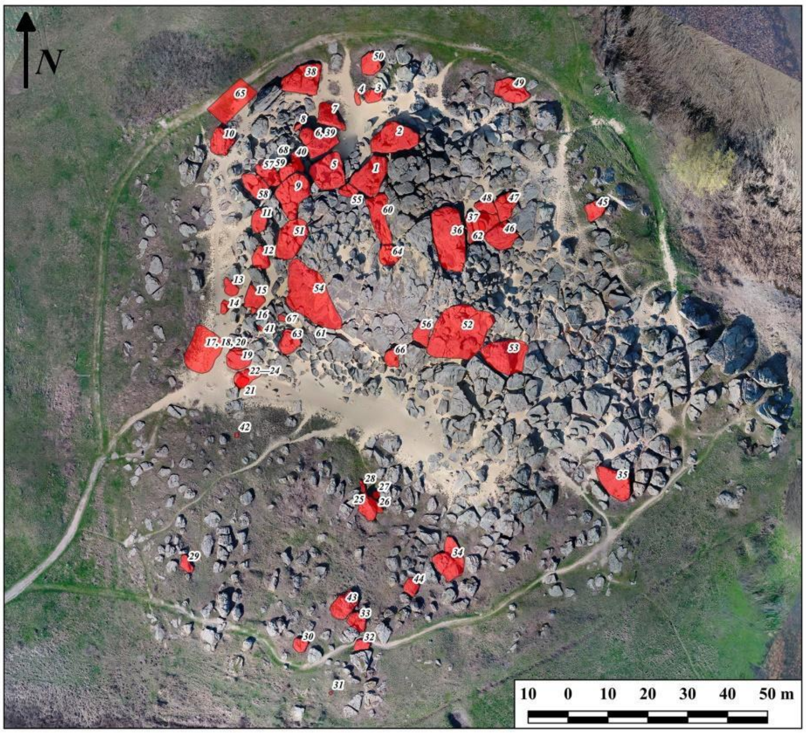


Fig. 1.3. The locations of rock art sites on Kamyana Mohyla hill, mapped during the current research

These locations are featured with engraved sandstone panels. Sometimes the images are figurative and naturalistic (see fig. 1.4); sometimes, they are somewhat schematic and non-figurative. They might be covered with liches and desert varnish that prevent them from being detected, especially in the dark spaces of the caves. Rarely engraved lines or cutmarks are covered with red ocher like in the case of Bull's cave (fig. 1.4:1). Some of the locations (e.g., Nos 52, 54, 60, etc.) contained several portable rock art objects that were discovered during the archaeological investigations of the site from 1973 onwards. The list of all these locations and the drawing available at the moment are presented in Annex A of the current research.

Fig. 1.4. Some of the most iconic figurative engravings from Kamyana Mohyla. 1 — the engraving of "Bulls in defensive position" in the Bull's cave. QR-code leads to the 3D model of the scene; 2 — parietal image of a goat (images by O.Tuboltsev)

Some of the rock art specimens of Kamyana Mohyla have been studied since the late 19th when the site was first recognized as a rock art location. The Bull's Cave (cave No. 9) was first introduced and described in the reports of Nikolay Veselovskiy to the Emperor Archaeological Committee in 1893 (Report 1890). He provided several expeditions to the site, reported a few rock art locations, and pointed out their scientific values that the Russian Empire historians did not recognize. After that, this cave was investigated by O. Bader, V. Danilenko, M. Rudinskiy, B. Gladilin, and B. Mykhailov. They all provided their interpretations regarding the chronology and semantics of the Kamyana Mohyla rock art objects, their style, and specific features. However, the lack of a comprehensive recording or visual representation and the Iron Curtain and language barrier influence prevented their conclusion from becoming widely known or accepted. Moreover, the variety of versions of the chronological and semantic attribution of the rock art objects from Kamyana Mohyla brought numerous discussions and uncertainties, struggling to provide reliable data on the rock art species context. This process is summarized in Chapter 2 of the following research.

Novel methodological approaches of the 21st century brought new possibilities to studying Kamyana Mohyla rock art. The methods and tools of digital recording enabled the representation of the walls and ceilings of the cave despite the lack of space in the narrow and shallow caves (fig. 1.5, 1.6) of Kamyana Mohyla.

Fig. 1.5. A view from the Bull's cave. The total heighs of the entrance does not exceed 50 cm

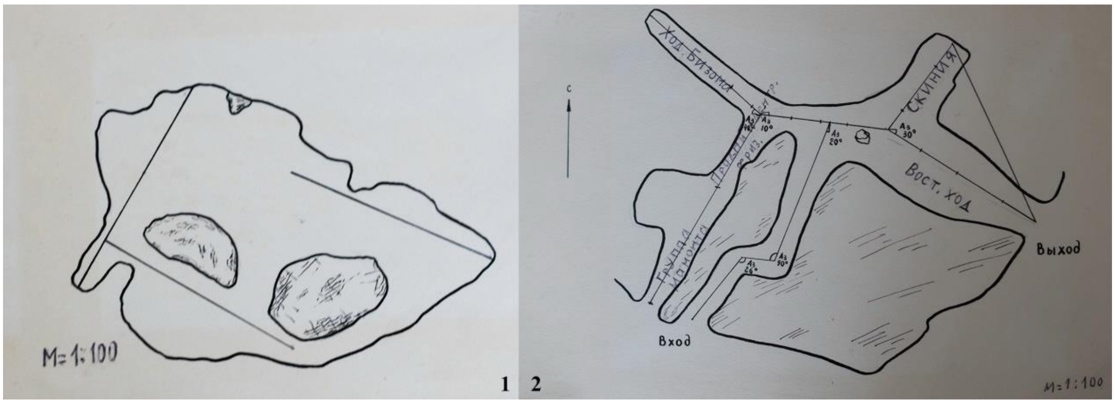


Fig. 1.6. 1 — The drawings of churingas from Churingas cave from V. Danilenko's field diary (Danilenko 1973, diary); 2 — Plan of a Wizard's cave (after Danilenko 1973, fig. 10)

The application of the digital recording and analysis instruments revealed an inconsistency and non-reliability of the previously produced data and theories regarding the rock art of Kamyana Mohyla. For instance, the photogrammetric study of the petroglyphs in the Bull's Cave revealed previously unknown figures. It clarified the semantic interpretations and chronological attribution of the panels from the cave. Last, digital traces show the non-reliability of drawings produced by V. Danilenko and B. Mykhailov in the late 20th century (Radchenko & Nykonenko 2019). The same result was achieved during the image-based 3D modeling and archaeological study of the panel in cave No. 55 (Radchenko et al. 2020). The digital study of the protrusion in the so-called Dragon's Cave (fig. 1.7) showed crucial nuances to be addressed in the interpretations and visual representations produced by B. Mykhailov.

In general, the digital evaluation of previous contributions to the study of Kamyana Mohyla rock art emphasized the need to get back to the rock art objects of the site, reconsider them through accurate and precise recording and reconsider the sufficiency and reliability of the existent theories regarding the context and chronology of Kamyana Mohyla engravings. This brought up the formulation of the final research question — "Is it possible to upgrade the old V. Danilenko and B. Mykhailov's hypotheses or formulate new ones based on the information obtained from the results of the performed photogrammetric study? What are these updates and hypotheses?"

Fig. 1.7. Placement of the 'Dragon's' figure inside the narrow cave

Even though the first experiments with the photogrammetric recording of the rock art specimens from Kamyana Mohyla proved successful, they required an essential methodological update to produce new knowledge of Ukrainian rock art. Developing and testing this methodology is one of the aims of current research.

However, an additional complication in studying the Kamyana Mohyla rock art complex is caused by the vastness of archaeological and cultural contexts to which the site is related. It is claimed to bear the rock art images from the Upper Paleolithic to the Modern Age. Moreover, the analogies and contexts that previous researchers relied on vary from Western Europe (i.e., Danilenko 1986) to Eastern Kazakhstan (i.e., Mykhailov 2005). As the site is rich with diverse examples of presumably Eneolithic cave art (fig. 1.8), parietal Iron Age rock art (fig. 1.9), and an asset of Stone Age portable objects (fig. 1.10), its study requires including multiple different contexts and concepts.

Fig. 1.8. Petroglyphs from the Bull's cave

Therefore, studying Kamyana Mohyla requires considering the waste archaeological and cultural context from Europe and Central Asia. This is needed to soberly evaluate the existing hypotheses on the Kamyana Mohyla rock art contextualization and attribution and to study this complex and multifaceted monument in a broad context. These issues are attempted to be covered in Chapter 2 of the research, where archaeological contexts and relevant analogies are put in place.

As these issues are simply too significant to be addressed in the Ph.D. thesis and require multiple diverse methodological and conceptual frames, this research will focus on the portable rock art specimens from Kamyana Mohyla, namely those instances that were discovered by V. Danilenko during 1973—1974 field seasons. These objects introduce the important dataset of great relevance for the Kamyana Mohyla rock art study: the central pillar of the Upper Paleolithic and the Mesolithic hypotheses on the Kamyana Mohyla rock art objects. Therefore, studying it through modern digital methods will shed light on the most distant part of the Kamyana Mohyla rock art timeline.

Fig. 1.9. Horses and raiders from location No. 25. 1 — image by V. Dzhos; 2, 3 — image by B. Mykhailov (archive of Kamyana Mohyla National Reserve)

Focusing on the photogrammetric study of the portable rock art objects from Kamyana Mohyla will not only contribute to the overall contextualizing of Ukrainian rock art. Still, it will foster the development of technological and methodological solutions for analyzing portable objects through image-based 3D modeling. As this digital tool has already proved its efficiency for studying the Kamyana Mohyla rock art, it is reasonable to assume that it might be successfully applied to collecting portable objects from the site. However, as the practical application of the method remain unclear, it leads to the postulation of the following questions: What information can be obtained from the study of image-based 3D models of portable rock art objects regarding the engravings production, composition, relative chronology, and relation to the specific stone support? Furthermore, what can image-based 3D modeling and an analysis of the Kamyana Mohyla portable rock art specimens' collection add to our understanding of their life cycle?

Fig. 1.10. Portable engraved stones from Wizard's cave (cave No. 54) *that are presumably attributed to Upper Paleolithic (according to V. Danilenko). 1 — No. 315; 2 — No. 318; 3 — No. 319; 4 — No. 322; 5 — No. 323; 6 — No. 325; 7 — No. 326; 8 — No. 327; 9 — No. 334; 10 — No. 337; 11 — No. 339; 12 — No. 340.*

All these pieces of portable rock art objects' understanding are valuable to properly contextualizing the Kamyana Mohyla rock art. To begin with, the non-reliability of the V. Danilenko and B. Mykhailov drawings and traces forces us to seek more elaborated tools for visualizing the Kamyana Mohyla rock art specimens. The spatial relation of particular engraved lines and their overall composition should be traced and analyzed with the best possible accuracy to avoid misleading hypotheses, as was the case for Bull's Cave and Dragon's Cave. Additionally, this is how to check the relevance of B. Mykhailov's and V. Danilenko's datasets and evaluate their results from the beginning — from the data acquisition process. Furthermore, this spatial relationship between different lines, their intersections, and interconnections might reveal additional clues on the relative chronology of the engraved stones, which would be a great addition to the contextualization of the portable objects.

Similarly, the details of engravings' shape and arrangement, studied from 3D models, might provide data on engraving technology. Worth noticing that this can be done through the instruments that are unavailable without the digital study of the portable stones — the submillimeter analysis of the engravings cross-sections and the artificial light simulation. Moreover, 3D modeling of portable stones can add more parameters to their study, especially those that reveal the features of stone support, such as its hardness and density. Last but not least, all these features might contribute to the reconstruction of the portable rock art objects' life cycle, showing the characteristics of their interaction with the Kamayna Mohyla rock art complex and the inhabitants of the site's vicinity (fig. 1.11). This might bring further understanding of the function and role of these objects in everyday life of Kamyana Mohyla inhabitants beyond the contextualization or interpretation. It is specifically important considering the lack of archaeological context for the portable rock art objects' direct archaeological or chronological attribution (not saying about dating) — such a limited amount of potential information sources forces us to seek additional data that can be extracted from the objects themselves. In this regard, approaching the reconstruction of their life cycle would be a great result in evaluating their role in the cultural landscape of Kamyana Mohyla.

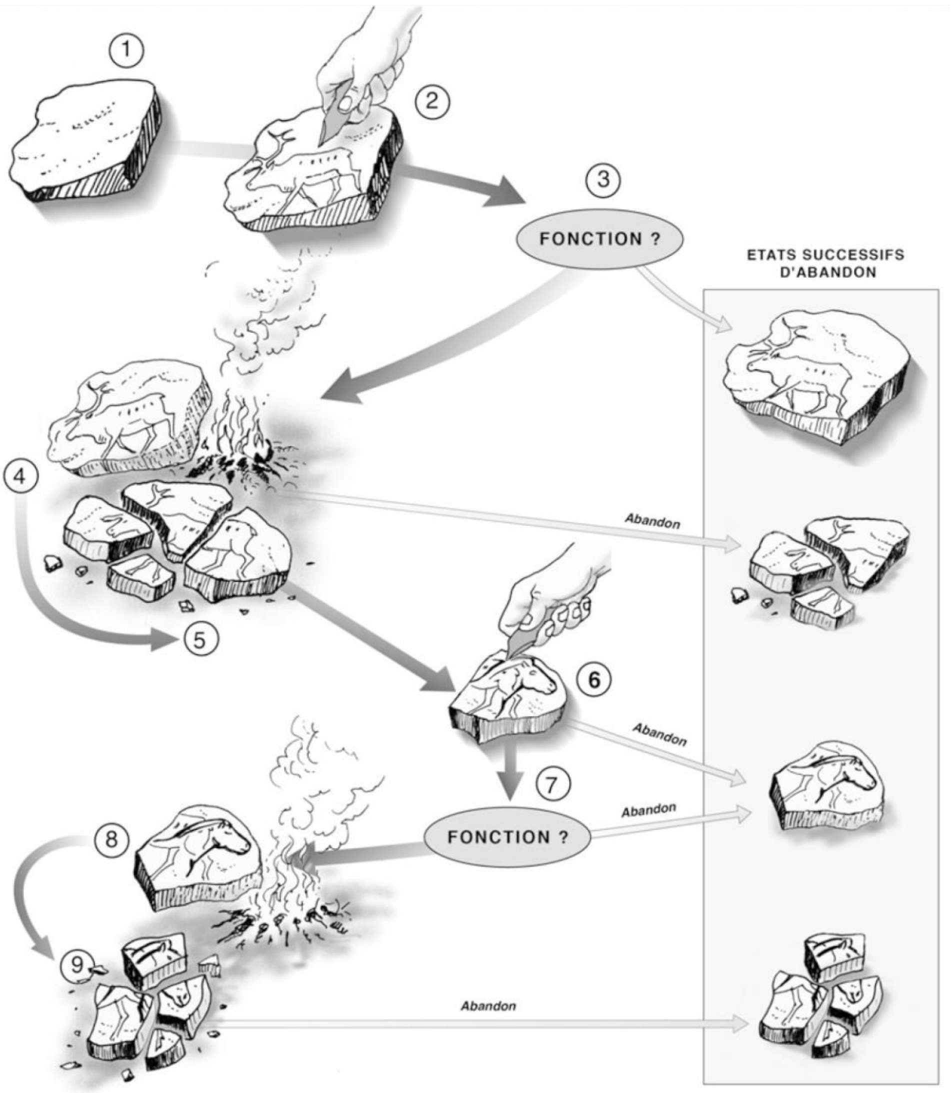


Fig. 1.11. Theoretical scenario of the engravings life cycle which helps explain the high level of fracturing that affects the engraved plaquettes in Europe, particularly in the Upper Magdalenian (G. Tosello scheme based on site data from Limeuil) (after Tosello & Villaverde 2014: 6031, fig. 5)

To answer these questions, one should seek to apply the most reliable methodology for data acquisition and accuracy assessment. At the same time, modeling portable objects requires considering the features and details of their shape. Searching for the technological solutions for the accuracy assessment and the creation of reliable 3D models is the fundamental issue of this research that brings up three research questions that are the first ones to be solved: What are the accuracy assessment strategies for the photogrammetric study of the portable rock art? How to calculate and achieve the required accuracy throughout the data acquisition procedures? What technological solutions are needed to perform a comprehensive image-based 3D modeling and the following study of portable rock art?

Proposing a particular solution to the issue of the image-based 3D modeling of portable rock art objects will contribute not only to the contextualization of Ukrainian rock art but to the overall methodology of digital rock art research. To ensure that the introduced technological solutions are applicable beyond the specific case of Kamyana Mohyla, this research presents the workflow evaluation on a different dataset — barely published portable rock art objects from Gobustan National Reserve in Azerbaijan. Applying the same questions to an entirely different dataset aimed to prove chosen research methodology is correct, applicable, and able to contribute to the fundamental methodological issues of digital rock art research.

1.3. What is defined as 'portable art'?

The defined objects under study force me to emphasize and accentuate the core category of the research specimens — namely portable art. Defining the portable art of Kamyana Mohyla is crucial for establishing the relevant methodological and technological solution for image-based 3D modeling. Therefore, determining the accuracy assessment strategies and the specific workflow requires specifying the research objects — portable art specimens from Kamyana Mohyla.

The classification attempts regarding the general technical parameters of rock art objects forced the emergence of several different classification models long ago. They were different, non-exhaustive, and sometimes complementary. For instance, prehistoric art has been divided into paintings, engravings (petroglyphs), and sculptures (Capitan 1902; Reinach 1913: 7). Such classification has a long tradition though it is far from being logical in the first place due to the possible existence of painted or engraved sculptures (or both). Another mode of classification (a complementary one that is still in use in research) is to divide motifs into figurative (recognizable figures) and non-figurative (abstractions) art (Breuil 1906: 1; Luquet 1926). Some of these taxonomic variations have been used simultaneously and proved their emergent efficiency (i.e. Goury 1927: 264—268). However, the most long-lived and effective taxonomy is, perhaps, the oddest one — the parietal / portable dichotomy that was proposed at the beginning of 20th century (Carthailhac and Breuil 1906: 123—143) and is still in active use, though also the subject of constant criticism (Forge 1991; Lorblanchet 1995: 13). It was very popular throughout the whole century (Raphaël 1945; Breuil and Lantier 1951; Leroi-Gourhan 1970), though may be compared to Jose Luis Borges's classification of strange creatures (1996: 85—86; Abadia & Moralez 2013: 270) for its dubious usefulness. Indeed, both classification systems are somehow absurd as they do not really classify these instances of art. Besides, important discoveries over recent decades have transformed our understanding of both parietal and portable art and raised questions about whether extant examples of cave art are truly representative of parietal art as a whole (Abadia & Moralez 2004: 322).

As the definition of whether a rock art specimen is "portable" or not is crucial to this particular research, I'll dwell on it, specifying the accepted approach. Noticeable, portable art might in fact be non-portable — too heavy to be carried out, static by its function, etc. Some of the blocks that may be considered portable art could be crushed parts of former parietal art objects. The division between Scythian stelae and portable tokens is much more radical than between these stelae and the parietal rock art —the latter two do not imply any transportation, while mobiliary art must be mobile. However, the dichotomy is so deeply rooted that it does not make any sense to argue or reject it. Even the recent development of rock art taxonomy takes this for granted (Bahn 2001) so it is reasonable to consider new data within this rooted paradigm. Therefore, it is important to clarify the boundaries of research subjects and use the term accordingly, trying to keep to a strict methodological approach.

Following H. Breuil and R. Lantier (1951: 82), portable art is “the art of small objects, easily transported, in contrast to cave art and such pieces which admittedly may have been transported but in principle were not moved, such as stelae and blocks of stone”. Armed with this definition, Plonka leaves the collection of Iron Gates sculptures (Srejovic 1969, 1989) out of his analysis of Mesolithic portable art: “Formally speaking they could have been moved about and as such may be understood to represent portable art, but their size and context of occurrence indicate that they were a permanent fixture in the dwellings” (Plonka 2003: 10). Following this approach I am not considering the North Azov Sea region stelae as portable, though there are some bright examples of prehistoric rock art among them (see Heyd 2017). They do not belong to the parietal art cluster and are theoretically moveable, but transportability is not their characteristic feature. Furthermore, they are simply too heavy to be carried. Meanwhile, the official glossary of the International Federation of Rock Art Organizations defines mobiliary art as “a form of palaeoart consisting of or made on objects small enough to be easily carried by humans” (IFRAO 2021) which means the opportunity to carry the artifact is the only crucial aspect that defines the object as a portable art one. Such transportability is an evident component of recognized cultural and social significance of portable materials (Conard 2003; D’Errico et al. 2003; Farbstein 2006; Farbstein and Svoboda 2007; Nowell 2006; Taborin 2004; Vanhaeren and D’Errico 2006; White 1992, 1997, 2006, 2007). Indeed, portable objects sometimes cover great distances (Farbstein 2011; Joyce 2005; Vanhaeren 2005; Vanhaeren and D’Errico 2006; White 2003), indicate different identities (White 1999; Zilhao 2007), economic networks (Alvarez Fernandez 2002; Kuhn and Stiner 2007) and technological choices (Vanhaeren and D’Errico 2006; White 1993, 1995. For a detailed overview see Abadia & Gonzalez-Moralez (2013). Therefore, in this research I will follow the approach which considers portability as the crucial characteristic feature of mobiliary art — the only features considered portable here are those that can be easily carried by humans.

Considering the stone object from Kamyana Mohyla to be a real portable rock art specimen requires it to fit additional parameters:

1. The stone must be portable, e.g., small enough to be carried.
2. It must not be a part of a parietal art object (i.e., a part of a cave wall or ceiling). This might usually be defined by the intensity and location of so-called “desert varnish” on the stone’s surface (an orange-yellow to black coating found on exposed rock surfaces in arid environments (Krinsley et al. 1995).
3. The stone must be ***engraved*** or have a ***worked*** and ***meaningful shape***.

The appearance of the artificial processing traces is necessary to consider the stone from the collection of “churingas” as a portable rock art specimen.

The collection of portable rock art objects from Kamyana Mohyla is traditionally referred to as “churingas.” According to V. Danilenko (1986: 118), the word “churinga” was chosen accidentally due to the shape similarity with the Australian sacral objects described by Emil Durkheim ([1912]2018: 206). Later this word was used to describe every specimen of non-parietal art from Kamyana Mohyla. That made the term “churinga” a confusing buzzword that reflects neither these objects’ lifecycle nor physical parameters. Initially, tjuringas were considered stone or wooden decorated objects of a particular shape and religious significance by Australian aboriginal people. Some used to have their “voice” and were used as an instrument to make a mysterious sound during the rituals. Most tjuringas also have some symbolic meaning hidden in their decoration. The word itself means an object that is “hidden” (tju) but also “that which is personal to me” (runga) (Strehlow 1947: 85—86).

Several crucial differences exist between the portable art specimens from Kamyana Mohyla and Australian tjuringas. To begin, churingas from Kamyana Mohyla were silent, and we think they were not employed for any rituals (Danilenko 1986: 118). Furthermore, their symbolic meaning (according to the interpretations of V. Danilenko (1986) and B. Mykhailov (2005)) is not always linked with the way of decoration or engravings. Researchers use this term also to describe figures and figurines (objects that have a meaningful shape and are not necessarily decorated). Besides, they use this word to describe every portable art object from the caves of Kamyana Mohyla and its surroundings, disregarding their size, shape, the existence of decoration, etc.

Both V. Danilenko and B. Mykhailov use the general term "churingas" to describe the portable art of Kamyana Mohyla, avoiding the direct analogies with the Australian specimens and focusing on the references from Central European pre-Historic ones (Danilenko 1986: 95—96, 118). Besides, the researchers use different terms to describe the artifacts' shape and spatial parameters (size and proportions). V. Danilenko usually used several terms, among which are "figure," "stone block," "concretion," "tile," etc. (Danilenko 1986: 95—103; 118—125), while B. Mykhailov (Mykhailov 2005: 43—99) — "tile," "block-tile," "figure," "figurine," "sculpture," or "churinga." Such stochastic terms complicate any classification and make their use almost meaningless. Both researchers later added more categories to the shape description but did not organize a system to structure the whole entity. Therefore, the entire collection of "churingas" needs to be re-sorted and re-considered to distinguish the natural portable art specimens from those previously considered churingas by mistake.

This tradition of calling these stones "churingas" is so rooted in the Ukrainian archaeological community that there is no need to fight it. Therefore, I use this term in the possible general meaning, e.g., as synonymous with "the portable rock art specimen from Kamyana Mohyla." On the one hand, this will keep the tradition in Ukrainian archaeological practice; on the other hand, this term provides the most basic generalization of the whole portable rock art collection under study (fig. 1.12). However, the stones from Gobustan National Reserve in Azerbaijan are referred to as "portable engraved stones." The term "figurine" will be in use for those artifacts that were worked from more than two sides to be shaped and has been interpreted by rock art researchers as instances with meaningful shape (i.e., female figurines or fish figurines, which shape has its meaning) (i.e., Danilenko 1986: 118—131; Mykhailov 2005).

Furthermore, the term “stone block” is used for the engraved stones. Sometimes these stones contain a manufactured surface, but the shape does not have any meaning according to the existent hypothesis. Later specification and shape description is possible but not crucial during this technological study.

Fig. 1.12. A variety of churingas discovered in the Churinga’s cave (No. 52). 1 — No. 246; 2 — No. 246a; 3 — No. 250; 4 — No. 251; 5 — No. 253; 6 — No. 255; 7 — No. 256; 8 — No. 262; 9 — No. 264; 10 — No. 266; 11 — 272.

Unlike many objects that can be considered portable art having an additional function (e.g. ornamented tools, necklaces, rings etc.), portable rock art from the case study for this research, the Kamyana Mohyla site in South-Eastern Ukraine, are considered to have only those functions that are connected to the non-material world, symbolism and rituals. Such functions are quite unclear and hard to reveal; however, this means that the stones from Kamyana Mohyla have at least two common features: transportability and engraveability. The latter also refers to the whole complex of Kamyana Mohyla, while the former is the exclusive characteristic of portable art (at least those examples from the collection that can be easily carried by humans). Taking all these factors into account, it is possible to avoid any complications with the classification background and analyze the portable art of Kamyana Mohyla in a comprehensive manner. Therefore, these two important issues are considered following the results of the technological study and the analysis of image-based 3D models, provided in the research.

Determining the correct technological and methodological approach and the overall contextualization of the Kamyana Mohyla and the portable rock art objects from the site requires revealing the site's historiographical, archaeological, and rock art context and its nearest vicinity. It is necessary, therefore, to outline the complex 130-year-long history of archaeological research on Kamyana Mohyla together with describing and systematizing the archaeological data on the North Azov Sea region in general and the rock art complex in particular. The efforts to put Kamyana Mohyla into the broad archaeological and rock art context form the central part of Chapter 2.

2. THE KAMYANA MOHYLA COMPLEX IN ITS HISTORICAL AND ARCHAEOLOGICAL CONTEXT

2.1. The history of research on Kamyana Mohyla

The whole complex of Kamyana Mohyla together with its rock art objects, examples of portable art, and marvelous archaeological sites has a long history of contextualization in Ukrainian archaeology. It is known as a historically important location for more than 130 years, though has rarely been paid the proper attention (Reports 1890). The biggest impact on the dissemination and preservation of the complex belongs to Boris Mykhailov — the first Head of National Historical and Archaeological "Kamyana Mohyla" reserve. He wrote dozens of scientific and popular papers concerning Kamyana Mohyla rock art and made a significant impact on the creation of the reserve in the first place. Nevertheless, Mykhailov's approach to rock art interpretation was far from scientific and his ideas concerning past processes were repeatedly challenged (Kotova et. al. 2017; Radchenko & Nykonenko 2019). Unfortunately, due to the politics of the USSR and the state of soviet archaeology in general, there are few papers on Kamyana Mohyla rock art that are not written in Russian or Ukrainian. Most of these appeared recently and a few were known from the last century (Gladilin 1969). This is the reason why Kamyana Mohyla remains unknown abroad. Although there is a lot of information available in Slavic languages, the site still waits for systematization and data gathering before being presented to the international community. Thus, I decided to make the first attempt here, as a background to this research. Besides, a holistic understanding of the cultural and archaeological complex is necessary for the interpretation of art from here and thus must be provided within the framework of current research.

Fig. 2.1. The Hill of Kamyana Mohyla

No doubt, the unique state of Kamyana Mohyla as a rock art complex is related to the specific geological nature of this place. The mound of sandstone (Fig. 2.1) is quite distinguishable from the landscape of the Ukrainian Steppe and attracted people since their appearance in the North Azov Sea region (Fig. 2.2).

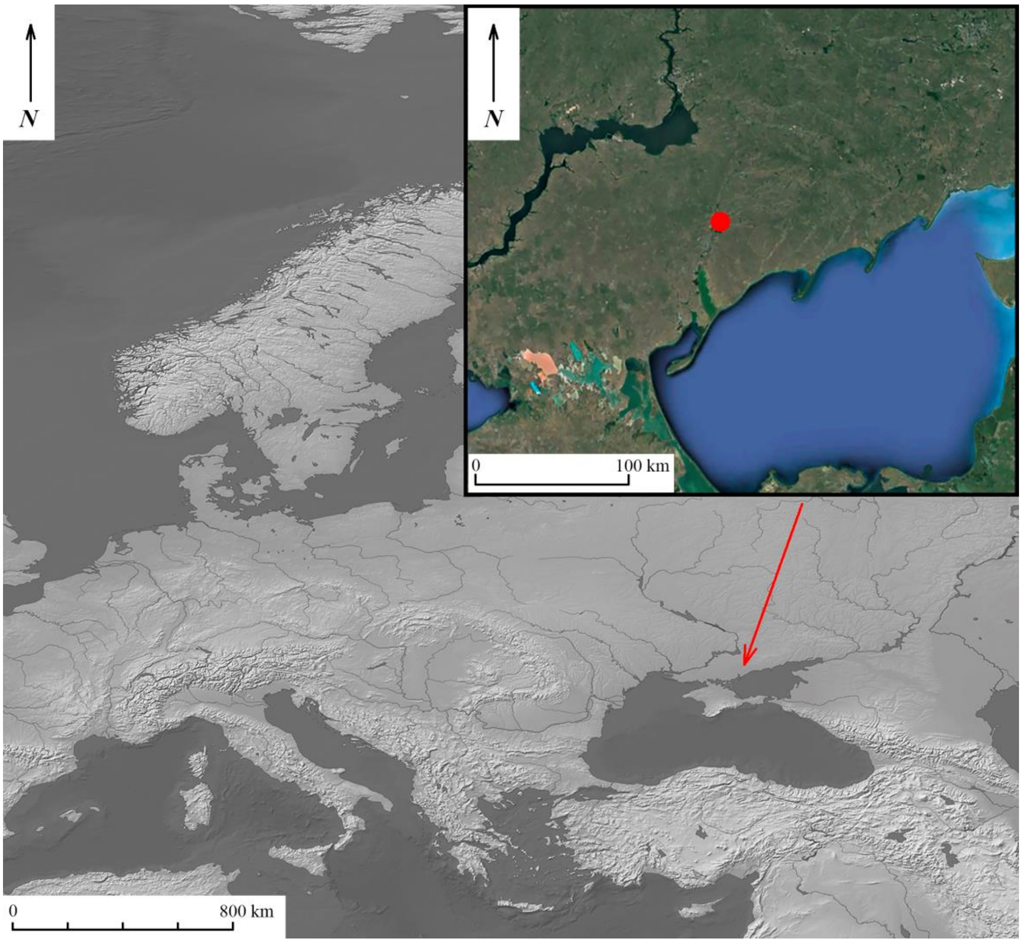


Fig. 2.2. The location of Kamyana Mohyla Hill in the North Azov Sea region (after Radchenko 2020: fig. 1)

When people arrived in this region, they considered the green and fresh Molochnaya river banks as comfortable for them (one should also note the flint locations nearby). Caves and grottoes of Kamyana Mohyla were quite unusual for the landscape and became sacred places for millennia. The images were mostly created on the walls and ceilings of the grottoes, rarely outside of them. Later the hill started to crumble and collapse, hiding some blocks and revealing the others. To date, 68 petroglyph locations are recorded here (Mykhailov 2017). Besides, quite recognizable stones from the hill were used to create burials nearby (Makhortykh et al. 2020). People lived here for more than 10 000 years, inhabiting this unique cultural landscape.

The first mentions of Kamyana Mohyla in written sources refer to the Russian-Turkish wars. The war doctor Lerhe mentions a place where the Russian army camped twice during the campaign of 1739: “It is not high … full of clefts, consisting of pure yellow sandstone. … Numerous clefts are filled with yellow sand…” (Dzhos 2018; Tarasenko 2019). Afterwards A.V. Suvorov ordered the garrison of 14 Cossacks to protect the post route. The first ethnic title we know of for this place is “Yuyun’-Tash”, which means “The Gathering Stone” the in Tatar language. The name “Kamyana Mohyla” first appeared later, in 1837, when P.I. Keppen mentions it among a list of ancient sites of the North Black Sea Region. According to his statements, local people “saw the writings on the stone blocks… created the line or separate words” (Isvestiya Tavricheskoy uchetnoy archivnoy kimisii 1908, 47). It is also known from local tales that one of the German Mennonites from Melitopol cared about the Kamyana Mohyla and knew a lot of petroglyphs from there. He even managed to engrave his name (“Peter S.”) onto one of the sandstone blocks.

The first archaeological reference concerning Kamyana Mohyla belongs to the surveys of N.I. Veselovskiy in 1890. According to the Reports of the Archeological Committee (Reports… 1890), “*the reason to check the hill was the accidental discovery of five silver coins of the Moscow period near one of the caves, that were bigger than the others. The rumors spread fast and the peasants started to dig the sand in search of the money. They exploded the gunpowder and destroyed the site while one of them was nearly dead because of an accident. Meanwhile, the rumors appeared that there are frescoes in this cave. During the excavations nearby in 1889, professor of Sankt-Petersburg University N.I. Veselovskiy visited the place. From the conversation with the local priest who used to visit the caves they found out that the images are not frescoes but engravings of some bird or an animal. The cave was covered by sand, so he started the excavations there only next year*”.

N.I. Veselovskiy studied this place for a few years during 1890—1919, dealing with the risk of collapse and the destruction of some blocks and caves. It was during that time that he discovered the “Bull’s cave” and some other locations and engravings of Kamyana Mohyla. However, his reports were not considered important during the last years of the Russian Empire, so the excavations here were halted for a time. It is notable that Ukrainian rock art research during that time developed within a general European framework, e.g. passing the Age of *consciousness* simultaneously to the most iconic discoveries.

Proper archaeological research started here when Valentin Danilenko discovered a multilayer settlement dating from the Mesolithic to the Iron Age near (180 m) the Kamyana Mohyla hill (fig. 2.3). In 1938 Otto Bader excavated this settlement for the first time, creating a trench of 22 m^2 (Bader 1950). While his main objective was the settlement excavation, he also discovered some crucial petroglyphs, such as “Rain Bull” in the Bull’s cave, the Footsteps’ block, The Horses blocks, the Dog’s cave etc (Bader 1941; 1947). The “Rain bull” image was considered as a depiction of a mammoth, therefore most of the Kamyana Mohyla engravings were associated with the Upper Paleolithic period. Some of these interpretations were already proved to be wrong (Mykhailov 2005; Radchenko & Nykonenko 2019). Not long since the site discovery, the first papers on rock art interpretation from Kamyana Mohyla appeared. For instance, Zemlyakov (1939) began the discussion of considering the “mammoth” as the “Bull”. This discussion lasted for 80 years and was only finalized recently. Remarkably, the common European trend to ‘Paleolithize’ rock art due to it’s stylistic qualities is also revealed in the study of Kamyana Mohyla. Though the time of *self-consciousness* came much later, during the next stage of the complex excavation.

After World War II the excavation of the settlement was continued by V. Danilenko in person. He correctly considered the inhabitants of the settlement as the ancient artists directly connected to the petroglyphs of Kamyana Mohyla (Danilenko 1950a). Thus, he studied both sites simultaneously. Despite the investigations of the hill, Danilenko failed to find new engravings at that time. Instead he concentrated on conducting a detailed study of the settlement. During 1947 the team excavated 113 m^2 trying to establish the stratigraphic conditions of the site (Danilenko 1947).

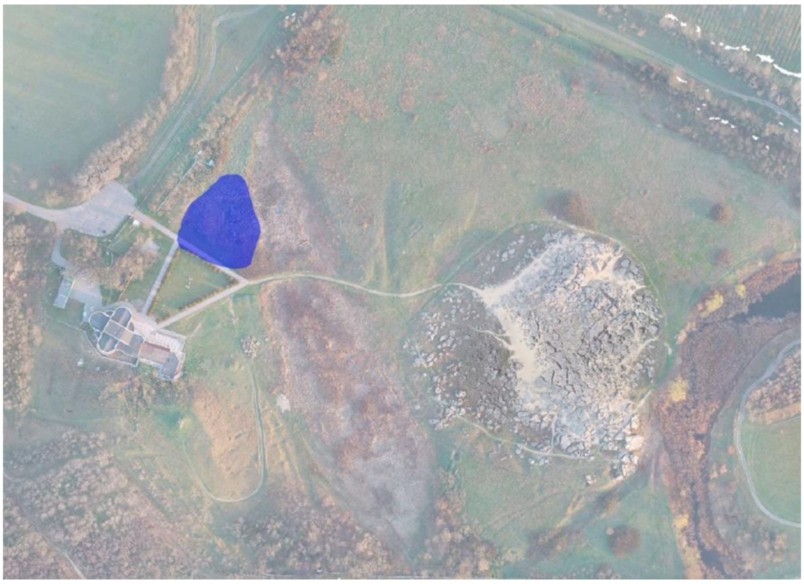


Fig. 2.3. The settlement of Kamyana Mohyla 1 located close to the hill (after Radchenko et al. 2020a, fig. 1)

In 1950, the government of the USSR decided to develop a channel and waterpower station providing energy and water supply to the North Azov Sea region and Crimea. One of the dams was planned to go right through the Kamyana Mohyla hill. Due to the importance of the location from an archaeological point of view, the authorities decided to provide financial support and finalize the archaeological research in all its complexity until 1954 (Tarasenko 2017, 130).

For this reason, excavations and investigations of the hill were continued by M. Rudinskiy (Rudinskiy 1951). He was very eager to study the petroglyphs of Kamyana Mohyla personally and continued this research for five years (1951, 1952, 1954, 1956 and 1957). During this time numerous different rock art locations were recorded (Rudinskiy 1952; 1953; 1956; 1957) despite a persistent lack of financial support (Tarasenko 2017, 135). After M. Rudinskiy sudden death, V. Gladilin published the first collection of Kamyana Mohyla rock art images and their preliminary interpretation (Rudinskiy 1961). During this work, in 1952, M. Rudinskiy discovered the first 'churinga' — portable rock art objects from Kamyana Mohyla (Danilenko 1986, 65) near the location where Churinga's grotto was discovered 20 years later (fig. 2.4).

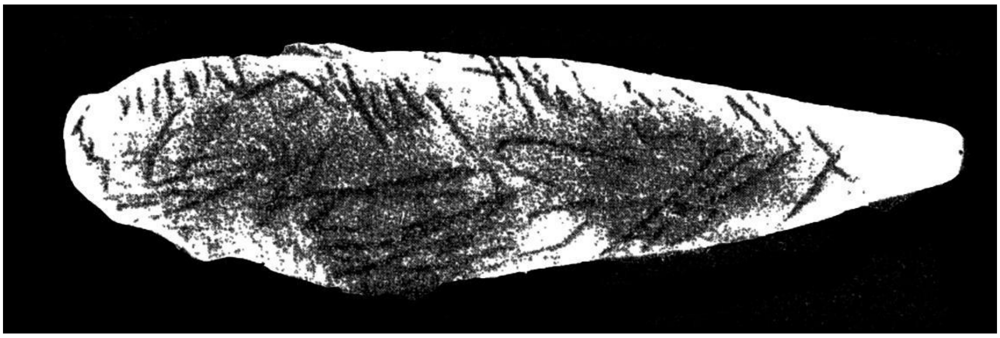


Fig. 2.4. The portable rock art object found in 1952 by M. Rudinsliy (after Danilenko 1986, fig. 20)

These years were also the first (and the last until 2018, when new topographic plan and 3D model of entire hill was done, see fig. 2.5) when the topographic scheme or any other kind of accurate representation of the Kamyana Mohyla hill was created alongside a description of the rock art locations and tourist guidelines. Thanks to the detailed mapping and descriptions, provided by M. Rudinskiy, we can estimate changes to the Kamyana Mohyla hill across several decades. Obviously the quantity of sand beneath the blocks is less than it used to be. This has occasionally caused movement of the blocks and was the reason for several collapse events. Some grottos became inaccessible, while others are just damaged. The process continues to threaten the site on an ongoing basis. Indeed, the question of preservation is extremely topical here. Finally, the situation remains critical because of tourists jumping and running on the hill. Despite restrictions they attempt to reach grottos and move the sand, which are dangerous and destructive actions — “as soon as we make the site available to the public — we sacrifice it”.

Until his death in the late 1950s, M. Rudinskiy was concerned about the condition of Kamyana Mohyla hill. He initiated the creation of the reserve here and even paid some of his own money to a local person to guard the site (Tarasenko 2017, 138—140). His diaries and letters remain very precise and informative for understanding of the site. He also tried to avoid preliminary dating of the petroglyphs, especially through the analysis of ancient techniques. Unfortunately, his research halted before he systematized the rock art collection of Kamyana Mohyla or at least found more of it.

Fig. 2.5. 3D-model of Kamyana Mohyla Hill

Rudinskiy was concerned that the most interesting analogies to Kamyana Mohyla rock art complexes are to be found in the South-East, within the territory of the Eurasian Steppe Belt. However, he also considered some references with the rock art of United Kingdom and Scandinavia (see also Otroschenko 2012).

After 1957 the site was sporadically investigated by V. Gladilin and B. Mykhailov (Gladilin 1964; Gladilin & Mykhailov 1970) and briefly described in a number of monographs (see, for instance Formozov 1969). However, the next chapter in the investigation of Kamyana Mohyla was opened in 1973, when V. Danilenko returned to excavate the settlement of Kamyana Mohyla 1 and search for new petroglyphs (Danilenko 1986; Radchenko et. al. 2020a). This expedition uncovered many new images and two caves that were previously unknown — the Churinga's cave and the Wizard's cave. Both are quite important as they contained collections of portable rock art and numerous petroglyphs that appeared to be Upper Paleolithic in date, according to V. Danilenko (1986: 9). Danilenko attempted to collect and interpret all of the Kamyana Mohyla artifacts that were excavated at that time, but did not manage to finish the research due to his death.

His method relied on technique as well as on the context of the rock art. Despite the complete absence of stratigraphy in the grottoes, he managed to find a number of Eneolithic artifacts in location No. 9 that allows us to estimate the date of this complex. A book published after his demise by his relatives contains only preliminary considerations. Some of them are still a matter of ongoing discussion. Unfortunately, V. Danilenko maintained his research notes in a much more chaotic way then M. Rudinskiy. For this reason, we don't have any persuasive records on the research during 1970 and 1971, though it is known that some research was conducted in those years (Kotova 2006: 33).

In 1973 Danilenko decided to investigate the area where the first churinga was found by Rudinskiy in 1952 (fig. 2.6). Digging the dark Aeolian sand, they found a new cave — Churingas' cave (fig. 1.6:1) and numerous examples of portable rock art. "Churinga's have the dimensions from 5 to 70 cm and were similar to different types of fish … Once upon a time these instances were found, shaped, and brought to the grotto … in an area of 40 m^2 approximately 40 churingas with linear engravings were found. Some of them were painted with red or black paint (Danilenko 1986, 74). There were no additional materials, only portable stones were found in situ on the top of the white sand. Danilenko distinguishes the 'dolphin-like', 'fish-like', 'spindle-like' (with or without fins), 'flander-like' and 'catfish-like' churingas (Danilenko 1986, 118). In his book, he describes most of them mentioning the archive number and shape according to his classification system sometimes adding the photo or drawing. However, he does not provide any chronological interpretation or at least a holistic classification of the art objects, just mentioning the similarity of some of them to the Paleolithic Venus from Kostenki (Danilenko 1986, 130). Although he calls the Wizard grotto "an Upper Paleolithic one" and refers to the Churingas' cave as being "related to Mesolithic or Neolithic Age", any specific considerations for these supposed dates were never published. Besides, Danilenko distinguished the churingas from the left and right part of Churinga's cave, sometimes drawing comparison with the instances from the Wizard's cave.

The Wizard's cave was also discovered during the campaign of 1973 (fig. 1.6:2). Searching for new grottoes, V. Danilenko attempted to reach the largest blocks located on the South-Eastern slope of the hill. Digging the sand out of the space under this block, scholars finally reached the long and complex cave. Attempting to excavate it in different directions, archaeologists were forced to stop several times to prevent an accident. At the same time, they managed to connect it with the Eastern grotto and discover some new hollows. On September 11th, 1973, researchers found the Wizard's engraving that was immediately assumed to be Paleolithic. Later, in the exact location V. Danilenko called "Skynia", they found more than 50 engraved stones that were considered as "archaic predecessors of churinga's" (Danilenko 1986, 76—77). These portable objects were found lying on a so-called "shelf". Danilenko assumed this place was their *in-situ* location, which is, unfortunately, quite non-informative.

Fig. 2.6. V. Danilenko and B. Mykhailov during the Kamyana Mohyla excavation in the early 1970s (after Radchenko & Nykonenko 2019, fig. 3)

Danilenko notes that the interpretation of these stones is not finished yet and points to their Early Stone Age origin because of the technique used to manufacture them. The most difficult part of their contextualization, in his opinion (and I agree), was the interpretation of the images' semantic meaning. Like the previous collection, Danilenko mentions the ID and size of the stones adding his own interpretation based on the understanding of the engraved lines. He also added images and drawings of the churingas and described what kinds of paleofauna are engraved, assuming all of the images to be related to Pleistocene time. Although the Pleistocene interpretation may be partially true, most of V. Danilenko’s ideas should be taken critically because of the lack of supporting evidence.

To increase the visibility of his interpretations, V. Danilenko drew what he considered engravings on the sandstone surface with black pastel coal. Though these drawings spoil the surface of portable stones and impact the objectivity of any other interpretations, they provide valuable data on V. Danilenko's views on the iconography of the rock art objects from Kamyana Mohyla. However, as the reliability of the researcher's drawings is questionable, it would be relevant to check them with the methods that provide a high level of graphic abstraction, allowing them to ignore the coal lines on the yellow sandstone surface.

V. Danilenko’s research started between 1970—1974 and was completed after the lab work between 1975—1978 clarified what the portable rock art of Kamyana Mohyla is in a daring and original way. Besides, this was the only attempt to consider all of the available data on Kamyana Mohyla’s portable art and interpret them archaeologically. However, further research added new examples to the collection and led to a reconsideration of some of V. Danilenko’s material, while classification and interpretation of the portable rock art as a collection still wasn’t complete. The collection of all the materials excavated by O. Bader, M. Rudinskiy and V. Danilenko together with the collection of portable rock art objects is currently stored in the Institute of Archaeology of NAS of Ukraine and the Archaeological Museum of the Institute of Archaeology of NAS of Ukraine in Kyiv. Because of the scholars’ endeavors to continue rock art research in the lab and to present the churingas to the community, they removed the artifacts from their cultural landscape they belong to. This is not a crucial issue for further investigations of the portable art because these objects were, in any case, very quickly decontextualized soon after being recovered during the original excavations.

The death of V. Danilenko in 1982 marks the end of the second stage of Kamyana Mohyla research. The interpretative endeavors of V. Danilenko, M. Rudinskiy, and B. Gladilin primarily relate to the style, typical during the phase of *self-consciousness* in European archaeology. However, the latter ceased during the development of the Leroi-Gourhan structuralism-based approach. Unlike most European scholars in the late 1970s, Ukrainian archaeologists tried to avoid social, cultural and semiotic interpretations and classified rock art due to its graphical style. The only exception is the book of V. Danilenko (1986) where some interpretative attempts were made, although this hasn't been systematized into a complex cultural or social framework.

Since V. Danilenko had died before the publication of his research and there was no sapid discussion, the hypothesis on the Pleistocene origin of some Kamyana Mohyla rock art remains to be evaluated and adequately examined in the future. This leads to the slightly schizophrenic state of the art: the site of Kamyana Mohyla is generally acknowledged to contain Upper Paleolithic depictions (Stanko et al. 1997: 99—102). However, Ukrainian scholars avoid discussing them as such, probably due to the lack of persuasive evidence (cf. Iakovleva 2010, Smyntyna 1999, Stanko, Gladkykh, Segeda 1999: 168—170). Proper contextualization of the portable rock art specimens from Wizard's Cave is one of the research aims of this thesis.

After V. Danilenko's death, excavation of the settlement nearby was conducted by D. Telegin (Telegin 1983; 1987; 1990; Telegin, Yanevich & Koyen 1987). He opened a discussion concerning the Mesolithic and Neolithic layers of the Kamyana Mohyla 1 settlement that also continued until quite recently. Meanwhile, the rock art of this complex was primarily studied by B. Mikhailov with the rare intrusion of other researchers (for instance, Titova 1982). Between 1983—2004, Mykhailov discovered more than fifteen caves (fig. 2.7). Thanks to his efforts Kamyana Mohyla was preserved as a National Reserve. Since then, the cultural landscape of Kamyana Mohyla has obtained its own protected territory, staff and museum. From that point until now the artifacts from the reserve-related sites came to the funds of Kamyana Mohyla Reserve. More than 200 objects that considered being portable art from Kamyana Mohyla are today housed there together with the most recently excavated artifacts and some rock art panels that were cut off the block.

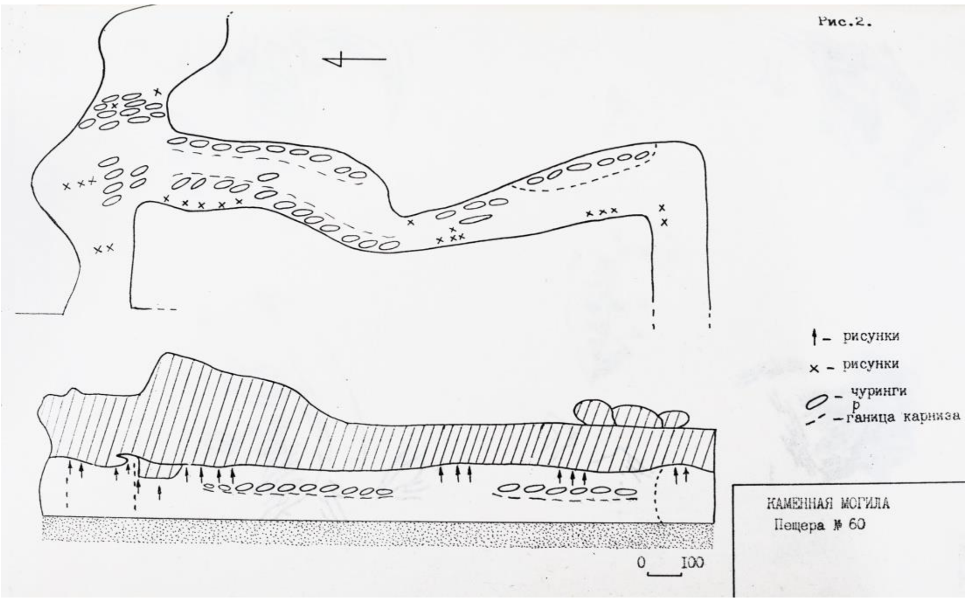


Fig. 2.7. Plan and profile of the Goat cave (after Mykhailov 1993c, fig. 2)

B. Mykhailov published a book where he attempted to provide a systematic interpretation of the Kamyana Mohyla engravings and his recent finds (Mykhailov 2005). This is the last major work on the rock art of Kamyana Mohyla that introduced the interpretation or at least a description of almost every object from the site. Mykhailov followed the interpretative trends of the second half of the 20th century and cogently presented a set of daring interpretations of Ukrainian rock art. His semiotic, semantic, and culture-based approach should be considered in the framework of the *interpretative self-conscious* stage during the development of rock art science. Although his interpretations were challenged many times, they still remain relevant as a significant publication of the Kamyana Mohyla rock art collection. This also contains a list of churingas (87 of them) that were found by B. Mykhailov and the reserve staff after 1980. However, Mykhailov provides only the drawings and short interpretation notes of the stones, making scientific interpretation impossible. He also does not explain his conclusions about the churingas semantics with any arguments. Thus, this part of the collection should be studied once again utilizing the capacities of modern techniques. Besides, the funds of Kamyana Mohyla contain 223 objects considered to be portable art, so more than half of the collection has never been published or studied in any systematic manner.

Mykhailov wrote several papers on his interpretation of the Kamyana Mohyla engravings that should be noted as the only pillar of Ukrainian rock art research during that time. Not only his dissemination efforts (Mykhailov 1998; 2003) but also his research results (Mykhailov 1987a; 1987b; 2000a; 2000b; 2004) and new finds publication (Mykhailov 1990; 1991; 1992a; 1992b; 1993; 1994; 1996) are among them. However, the churingas have never been a subject of his focused study. Besides, one should mention that all these efforts were still printed in the Russian and Ukrainian languages, which prevents widespread dissemination of the Kamyana Mohyla rock art even today.

After the death of B. Mykhailov, the museum staff continued his work on Kamyana Mohyla. Victor Dzhos, the senior researcher of the reserve, published several papers on Kamyana Mohyla rock art, archaeological and historical context (Dzhos 2011a; 2011b; 2014; 2015a; 2015b; 2015c; 2016a; 2016b; 2019; 2021; Dzhos et al. 2013). His recent discoveries make the total number of known rock art locations on Kamyana Mohyla to be 68. B. Mykhailov's son, Yaroslav, has been assigned as the new Head of the National Reserve. He published several papers on Kamyana Mohyla rock art and its place in the pan-Eurasian context (Mykhailov 2016; 2017) and several sci-pop products (e.g., Mykhailov & Zamataieva 2018).

In 2017 the Kamyana Mohyla reserve published a sci-pop catalog of (some) portable stones from the reserve funds. It presents numerous drawings (made by B. Mykhailov) and interpretations. However, both are dubious. The explanation contains the approximate size, rough interpretation, and dating of each stone. An example is as follows: "*No. 3851. Churinga is made of sandstone. Height — 13.5 cm, weight — 17.5 cm. Block in the shape of an animal-like creature's head.*

Contains deep notches. Eneolithic, III millennia BC. Location: the Hill of Kamyana Mohyla”.

During the excavation led by V. Danilenko and M. Rudinskiy the most important objective which scholars wanted to achieve was the preservation and discovery of Kamyana Mohyla and its cultural landscape. Alternatively, after the attempts of V. Danilenko and B. Mykhailov to collect and interpret the studied materials, archaeologists began to analyze the available data and tried to integrate it into a global rock art context. There are no examples of complex approaches to the site; however, single engravings or locations started to be studied, interpreted, and contextualized in comparison with European or Asian sites. Scholars also attempted to use Kamyana Mohyla to reach an understanding of the ancient artistic mindset and better understand the place of Ukrainian prehistory in relation European or even global prehistory.

Apparently, the next stage of rock art research at Kamyana Mohyla began in 2016, when fieldwork studies revealed new portable rock art objects in the archaeological context of the Mesolithic Kukrek cultural layer. This fostered a study of rock art from the whole complex using the latest technological and methodological advances of rock art science. During this last five years of research, the methodology for the photogrammetric study of ancient art was developed and tested. The complex of actions that includes some methodological ideas of N. Melard, A. Marshak, O. Harris, C. Chippindale and R. Bednarik have proven previous interpretations to be mistaken due to the recently obtained data. This data has intiated the slow rejection of the unprovable Paleolithic nature of some engravings (Radchenko & Nykonenko 2019; Radchenko & Kiosak 2022), the disadvantages of indirect ethnological sources (Radchenko et al. 2020b), and the advances of the comprehensive interdisciplinary approach to the complex rock art heritage of Kamyana Mohyla.

This new stage in the study of the Kamyana Mohyla rock art is mainly conducted by the reserve staff, primarily V. Dzhos, the “New Archaeological

School” research team and the participants of SNF SCOPES project which was held on the Kamyana Mohyla 1 settlement since 2011.

During the SNF project and my current Ph.D. project, we performed the aerial survey and cartography of the Kamyana Mohyla rock art locations first time since the topographic survey was done by M. Rudinskiy in 1951. All 68 locations were mapped and connected to the relevant descriptions from the published results, including the drawings of the parietal art objects. For the first time, this was summarized and presented as a catalog in Annex A of the current thesis. The data from caves No. 9, 52, 54, and 55 are updated according to the results of the recent digital study. However, most of the drawings are provided by B. Mykhailov and V. Danilenko (as the only available versions) and therefore are non-reliable and require future reexamination.

As there were no confirmed cases when the drawings of rock art objects provided by these scholars corresponded to the results of the recent investigations, the analysis of Kamyana Mohyla's rock art from these drawings is impossible. In the same way, a double check of the engravings in the unavailable caves is impossible, too — accessing them requires large-scale excavation after the de-occupation of the North Azov Sea region.

The non-reliability of the traces produced by V. Danilenko and B. Mykhailov leads to ambivalent consequences. On the one hand, their drawings should be excluded from analysis — that's why the thesis does not discuss the iconographical expressions contained in the Annexes A and D of the thesis — most probably, these expressions do not exist. Even if they do, it is unreasonable to discuss them before we are sure they are accurate. On the other hand, it is reasonable to check the reliability of the data provided by V. Danilenko and B. Mykhailov for the available dataset, which is the collection of portable rock art specimens. Therefore, focusing on portable rock art objects, this thesis performs the crucial reexamination of the previously produced data on the rock art of Kamyana Mohyla. The reliability of these data will indicate whether we can trust others' drawings of rock art panels discovered in the late 20th century.

Last but not least, once again, this raises the question of establishing the workflow for the accurate digital study of the portable and parietal rock art objects of Kamyana Mohyla and its role in the contextualization of rock art from the complex. Since digital recording can provide a sufficient level of reliability and abstraction on what is engraved on the stones, it is a relevant tool for the accurate examination of the rock art objects from Kamyana Mohya that will allow avoiding the previous interpretations and influence of the V. Danilenko's marks on the sandstone surface. Moreover, as the portable things from Kamyana Mohyla are decontextualized and are generally lacking the archaeological context, the digital study aims to acquire as much information relevant to these objects' contextualization as possible. Defining what information can be extracted and how to use it to contextualize Ukrainian rock art is within the determined research questions of the current research,

Therefore, the whole our research group tried to introduce a digital approach to rock art research on Kamyana Mohyla while simultaneously reconsidering the dubious interpretations provided by our predecessors (see Kotova et.al 2018; Radchenko et. al 2018; Radchenko & Nykonenko 2019). This work marks the first endeavors to disseminate Ukrainian rock art research abroad, making the publications accessible to the wide audience of the English-speaking community. This long and tedious process began recently and still requires a lot of time, effort, and scientific research to be carried out.

Thus, the current phase of the Kamyana Mohyla research process, which has just begun, might be described as a "*critical self-consciousness in a continuous process*". Despite the small lag at the beginning of this phase in the Ukrainian tradition as compared to global rock art research, this local study is in keeping with the global research framework.

During various historical ages, different populations in the vicinity of Kamyana Mohyla were impacted by many ideas that were reflected on the rock art panels. Of course, this complex must be contextualized both on the local level and within the general framework of Eurasian prehistory. Understanding that, Ukrainian archaeologists attempted to consider Kamyana Mohyla by searching for analogies in different countries and cultures to present it in the correct historical and geographical context. This, however, was complicated due to the frontier location of the site. Finally, the abundance of archaeological contexts and the vastness of geographical and chronological connections in the contextualization of Kamyana Mohyla make any attribution of the rock art specimens tedious and challenging. The following overview will endeavor to schematize the context and emphasize several features of Kamyana Mohyla's rock art.

2.2. The archaeological context of Kamyana Mohyla and its surroundings

2.2.1. The origin of the site

The first question to be raised about the site would be about the origin of Kamyana Mohyla as a geological location. Such accumulation of sandstone is weird and unusual for the region and remains a matter of discussion. Even Nikolay Veselovskiy, the first discoverer of Kamyana Mohyla as an archaeological and rock art location, who conducted the survey here during 1889—1890, assumed the artificial nature of the site (Veselovskiy 1893).

The most popular and scientific-looking version of the origin of sandstone slabs on the bottom of the Sarmatian Sea was lauded by V. Danilenko (1986: 5) and repeated several times afterward (Mykhailov 2005; Radchenko 2019; Radchenko 2020). The monadnock remained in its place after the sea had dried up. After that, the Hill performed as a bank of the Molochna River, and the stones were breaking. This caused the origination of several caves. Since “more than 10 000 years ago” (Danilenko 1986: 5), human beings started to inhabit the surroundings of Kamyana Mohyla. Then the caves were used as locations for ritual practices and rock art creation. Nowadays, 68 locations containing rock art or portable rock art objects have been discovered in the Hill, and its closest vicinity (Mykhailov 2017: 13, one more has been found during 2018—2020 surveys), and fewer are recorded or published.

However, geological surveys or studies do not support this “14-million” version. On the contrary, scholars emphasize that “there were no fundamental geological surveys or studies of Kamyana Mohyla ever” (Zamoriy, Malyavko 1946). The situation has not changed since 1946 (Manyuk 2015: 76). Therefore, any idea on the geological origin of the site will remain hypothetical before the profound geological study of the region. Though the age of origination of small-grained (the core diameter is between 0.1 mm and 0.5 mm) and iron-rich sandstone from Kamyana Mohyla might correspond to that of sandstones nearby Taromske village in the neighboring region (Manyuk 2015, 78), this matter still requires additional investigation. Whatever the site's origin, there are no severe arguments to consider it artificial.

In the broader context, the closest geological analogy that might be given to get a general notion of the Kamyana Mohyla rocks to a person non-familiar with the geology of the Ukrainian Steppe would be the reference to the complex of Fontainebleau rock art (Bénard & Guére 2014; Guére & Bénard 2017). The latter looks similar regarding the geology of the support and the chronological attribution of non-figurative and geometric rock art specimens.

The unusual appearance of Kamyana Mohyla in the surrounding landscape drew the attention of numerous populations through the ages. Therefore, the closest vicinity of Kamyana Mohyla is abundant distant in time archaeological sites (see fig. 2.8 and tables 2.1, 2.2). This includes presumably Upper Paleolithic camps of Sekiz 1 (Mykhailov 2006a: 26) and Kamyana Mohyla 5 (Dzhos & Mykhailov 2014; Dzhos 2015c) and multilayered preliminary studied settlements of Sekiz 2, Sekiz 3, Sekiz 4, Sekiz 5, Kamyana Mohyla 3, Kamyana Mohyla 5, and Kamyana Mohyla 6 (Dzhos 2019). These also featured a complex history, including Neolithic, Eneolithic, Bronze Age, Iron Age, and Medieval materials. The sites of Kamyana Mohyla 1 (Kotova et al. 2017a), Kamyana Mohyla 2 (Dzhos 2016a), and Kamyana Mohyla 4 (Dzhos et al. 2013; 2016b) are known relatively better since they had been excavated and published, featured with well-attributed data and sometimes even radiocarbon dates.

Table 2.1. Summarized data on the settlement sites in the nearest vicinity of Kamyana Mohyla

No.	Archaeological periodization	Rough chronological identification	Cultural attribution	Site	References
1	Upper Paleolithic	XVII—XIII millennia BCE	Kamennobalkovskaya culture (variant of Epigravettian)	Kashtaeva Balka	Mykhailov 1987b
2				Sekiz I	Mykhailov 1992a
3				Novopavlivka	Mykhailov 1982
4	Mesolithic	IX—VII millennia BCE	Kukrek sensu stricto	Kamyana Mohyla 1, layers A, B	Kiosak et al. 2022
5	Late Mesolithic	7000—6100 BCE	Kukrek cultural tradition	Kamyana Mohyla 1, layer C	Kiosak et al. 2022
6	Para-Neolithic	6300—4700 BCE	Sursky culture	Kamyana Mohyla 1, layer D	Kiosak et al. 2022
7		5900—4700 BCE	Azov-Dnipro culture	Kamyana Mohyla 1, layer D	Kiosak et al. 2022
8			Azov-Dnipro culture	Sekiz 2	Dzhos 2019
9		Circa V millennia BCE	Sursky or Azov-Dnipro culture	Sekiz 4	Dzhos 2019
10	Eneolithic	V—IV millennia BCE	Seredniy Stih culture, Dereïvka culture	Sekiz 2	Dzhos 2019
11			Dereïvka culture	Sekiz 3	Dzhos 2019
12			Seredniy Stih culture, Dereïvka culture	Sekiz 4	Dzhos 2019
13			Dereïvka culture	Sekiz 5	Dzhos 2019
14			Dereïvka culture	Kamyana Mohyla 1	Kotova et al. 2017a
15			Second period of Azov-Dnipro culture	Kamyana Mohyla 2	Dzhos 2019
16			Dereïvka culture	Kamyana Mohyla 3	Dzhos 2019
17			unclear	Kamyana Mohyla 5	Dzhos 2019
18			unclear	Kamyana Mohyla 6	Dzhos 2019
19	Early Bronze Age	Late IV — III millennia BCE	Yamna culture	Kamyana Mohyla 1	Kotova et al. 2017a
20				Sekiz 3	Dzhos 2019
21				Sekiz 4	Dzhos 2019
22				Sekiz 5	Dzhos 2019
23				Kamyana	Dzhos 2019

				Mohyla 5	
24	Middle Bronze Age	II millennia BCE	Babyno culture	Kamyana Mohyla 2	Dzhos 2016a
25	Late Bronze Age	II millennia BCE	Bilozerska culture	Kamyana Mohyla 3	Dzhos 2019
26			Srubna culture or Sabatynivska culture	Kamyana Mohyla 4	Dzhos 2019
27			Unclear	Kamyana Mohyla 6	Dzhos 2019
28	Iron Age	I millennia BCE	Scythian	Sekiz 4	Dzhos 2019
29				Sekiz 5	Dzhos 2019
30				Kamyana Mohyla 1	Kotova et al. 2017a
31				Kamyana Mohyla 6	Dzhos 2019
32		II century BCE — III century AD	Sarmatian	Kamyana Mohyla 2	Dzhos 2019
33				Kamyana Mohyla 5	Dzhos 2019
34				Kamyana Mohyla 6	Dzhos 2019
35				Sekiz 4	Dzhos 2019
36		V century AD	Hunnic	Kamyana Mohyla 6	Dzhos 2019

Numerous burial sites (table 2.2) are mainly featured with kurgans, preliminary attributed to the time lap from Eneolithic to Iron Age. The excavated complexes show multilayered structures and are rich with Bronze Age data (Obolduyeva 1952; Viazmitina 1960). This includes several kurgan groups in the surroundings of Novopylypivka village, 1 km to the East of Kamyana Mohyla, and ground burials in the field nearby. The Hill is also featured with medieval burial made inside the Wizards cave and attributed to the Hunnic presence in the area (Mykhailov 2005: 296). These sites are studied sporadically depending on the specific research interests and are barely placed in a broader context. However, the particular researches of the last decades allow us to overlook the archaeological context of Kamyana Mohyla and the North Azov Sea region on an appropriate level.

Table 2.2. Summarized burial sites in the nearest vicinity of Kamyana Mohyla

No.	Archaeological periodization	Rough chronological identification	Cultural attribution	Site	References

1	Eneolithic	V—IV millennia BCE	unclear	Kourgan on the Southern Edge of Terpinnya	Dzhos 2021
2		IV—beginning of III millennia BCE	Maykop	Burial mound near Melitopol	Mykhailov 2006b
3				Burial mound near Melitopol	Mykhailov 2006c
4	Early Bronze Age	2800—2600	Yamna culture	Surface grave near Kamyana Mohyla	Makhortykh et al. 2020
5		III millennia BCE		Kourgan in the Molochna river basin	Viazmitina et al. 1960
6				Kourgan group in the Northeastern part of Chervona Hora	Danilenko 1947
7				Kourgans near Novopylypivka	Oboldueva 1952
8				Two burials in the Bronze Age layers of Kamyana Mohyla 1	Danilenko 1947
9	Middle Bronze Age	III millennia BCE	Katakombna culture, Babyno culture	Kourgan group in the Northeastern part of Chervona Hora	Danilenko 1947
10				Kourgans near Novopylypivka	Oboldueva 1952
11	Late Bronze Age	II millennia BCE		Kourgans near Novopylypivka	Oboldueva 1952
12	Iron Age	II century BCE — III century AD	Sarmatian	Kourgans near Novopylypivka	Oboldueva 1952
13				Kamyana Mohyla Hill	Rudinski 1952
14		V century AD	Hunnic	Wizard's cave	Mykhailov 2005
15				Burial to the North from Kamyana Mohyla Hill	Makhortykh et al. 2020

Despite the abundance of archaeological sites in the nearest vicinity of the rock art location, there are no signs of inhabiting the Hill or any of its caves. Some assemblages were found occasionally, adding direct archaeological evidence to the rock art attribution of particular engravings (i.e., while interpreting the engravings from the Bull's Cave). However, they are rare, and most rock art objects lack direct archaeological contextualization. Moreover, archaeological assemblages in the cave do not give a hundred percent clue anyway since the artifacts are buried in the sand and are not featured with precise stratigraphic sequences (if any). Finally, these objects were extracted long before the current digital study started. The reports often lack details and clarity and do not lucidly reconstruct the situation. Therefore, revealing the archaeological context of Kamyana Mohyla's rock art objects mostly means describing the archaeological landscape of its surroundings. Further, I'll describe what happened here from the Paleolithic up to the 19th century.

Fig. 2.8. The location of archaeological sites in the Kamyana Mohyla nearest surrounding. Circles — settlements and camps; squares — burial sites. Multiple squares mark kurgan groups. Red circle marks the Hill of Kamyana Mohyla. 1 — Sekiz 1; 2 — Sekiz 2; 3 — Sekiz 3; 4 — Sekiz 4; 5 — Sekiz 5; 6 —

Kamyana Mohyla 1; 7 — Kamyana Mohyla 2; 8 — Kamyana Mohyla 3; 9 — Kamyana Mohyla 4; 10 — Kamyana Mohyla 5; 11 — Kamyana Mohyla 6; 12 — kurgan group in the northwestern part of the Chervona Hora; 13 — kurgan group in the northeastern part of Chervona Hora; 14 — kurgan group to the North from Kamyana Mohyla (partially excavated in 2017, see Makhortykh et al. 2020; Kotova et al. 2020); 15 — kurgan on the southeastern edge of Terpinnya village; 16 — kurgan group to the west from the western part of Novopylypivka; 17, 24 — kurgan group in the western part of Novopylypivka; 18 — ground burial in the horseshoe tract; 19, 22, 23 — stone constructions on the top of Chervona Hora; 20 — ground burial on the territory of Kamyana Mohyla 1 settlement; 21 — Medieval burial inside the Wizard's cave of Kamyana Mohyla. 1—11 — after Dzhos 2019; 12—24 — after Dzhos 2021.

2.2.2. Pleistocene occupation of Kamyana Mohyla surroundings

In his book published in 1986, V. Danilenko states that Upper Paleolithic sites are being discovered in the area surrounding Kamyana Mohyla from time to time, emphasizing that a proper understanding of the situation requires further research. He mentions, that "probably, the same cultural group includes also a destroyed camp near Novopavlivka that was discovered by B. Mykhailov a few kilometers down by the Molochna river from Kamyana Mohyla … One should remember the old discovery of the author [V. Danilenko] which contained a number of late Paleolithic flints found in the boundary of Sekiz on the southern part of Terpinnya village (a few kilometers to the north of Kamyana Mohyla). There were also two Upper Paleolithic flint tools found in the surroundings of the Kamyana Mohyla hill itself" (Danilenko 1986: 135—136). However, since those lines were written, the situation has changed.

The earliest signs of the Kamyana Mohyla surroundings inhabitation belong to the Upper Paleolithic age. They are introduced as flint tools extracted from nearby camps and supported by a small series of radiocarbon dates. Meanwhile, the situation in the North Azov Sea region, in general, is somewhat different.

Recent discoveries introduced evidence of the Early Paleolithic (Pryaslov 1968; Stepanchuk et al. 2010) and Neanderthal presence in the Ukrainian Steppe (Chabai 2007). The latter appears intense in the adjacent Donetsk region and Dnipro River rapids. However, the Upper Paleolithic is the best-represented period of the Stone Age, especially its later part after the Last Glacial Maximum (Kitagawa *et al.* 2018; Krotova 2019). Most finds belong to Epigravettian technocomplex, sometimes with evident differences that enabled some authors to propose regional groupings of the sites (Olenkovskiy 2001; Gorelik 2005; Zaliznyak 2005; Krotova 2019) (fig. 2.9).

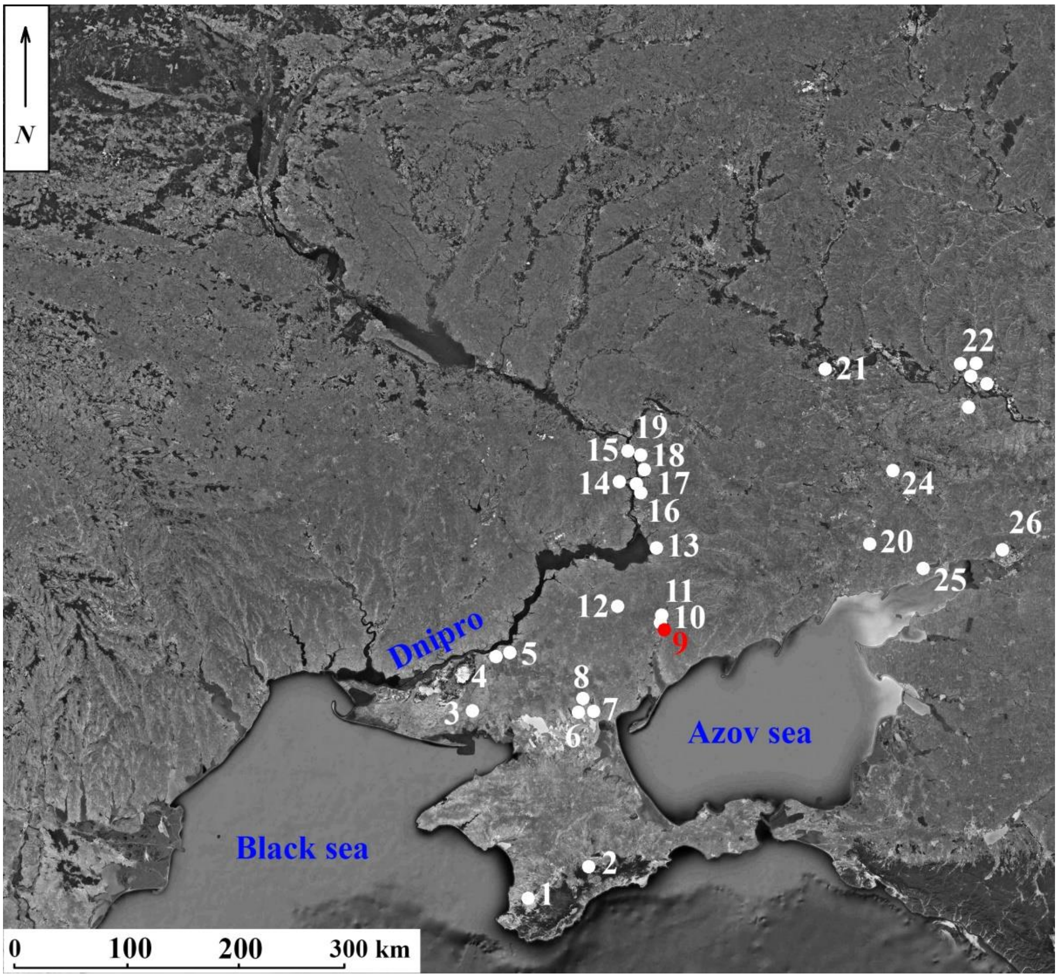


Fig. 2.9. Distribution of the Upper Paleolithic sites across North Azov sea region. 1 — Suren I; 2 — Agy-Koba I; 3 — Hatki; 4 — Somova balka; 5 — Velivalska balka; 6 — Solone Ozero IXa; 7 — Solone Ozero; 8 — Solone Ozero Ia; 9 — Kamyana Mohyla; 10 — Sekiz I; 11 — Novopavlivka; 12 — Kashtaeva

balka; 13 — Lysa Hora; 14 — Kantcerka II; 15 — Yamburg; 16 —Kapustiana balka; 17 — Kaistrova balka; 18 — Dubova balka; 19 — Vorona I; 20 — Fedorivka; 21 — Visla balka; 22 — Rogalyk V, VI, VII, IX; 23 — Hovorukha; 24 — Amvrosiivka; 25 — Muralovka; 26 — Kamennaya Balka I—II. 1—8, 12—22 after Olenkovskiy 2010; 9 — after Radchenko 2022; 10 — after Mykhailov 1992; 11 — after Mykhailov 1982; 23—26 — after Leonova 2015.

Three Upper Paleolithic locations are near Kamyana Mohyla: Kashtaeva Balka, Sekiz I, and Novopavlivka. Only Kashtaeva Balka has been excavated, studied, and published in detail (Mykhailov 1987b). "There were 174 sq. m. excavated on the site. The collection (4061 items, incl. 493 tools) consisted of cores, blades, and flakes. Tools comprise burins, end-scrapers, side-scrapers, engravers, etc. The non-geometric microlithic assemblage includes points of "gravitation outlook" (Mykhailov, 1987b: 51) (according to Dmytro Kiosak, the "gravitation outlook" in Mykhailov's publication means typically backed points, see Radchenko & Kiosak 2022), oblique truncations and points with arched back as well as a single, double truncation on a blade resembling a trapezoid. Kashtaeva Balka likely introduces the evidence of a direct connection to the Hill of Kamyana Mohyla since 23 sandstone pieces typical only to this unique geological formation have been found there (Mykhailov 1987b, 48). Kashtaeva Balka is compared to the sites of Fedorivka, Solone Ozero I, Ia, IX, IXa and either attributed to so-called North Azov Culture — a particular regional aspect of Epigravettian technocomplex (Olenkovskiy, 2001, 2010) or is treated as a local variant of Epigravettian Kamennobalkovskaya culture, known further in the east (Krotova, 2019: 212–213). The peculiarities of these sites are: a high percentage of double burins and double end-scrapers, the constant presence of Federmesser type curved backed points and a high percentage of backed blades and bladelets with retouched ends that make the collections look somewhat "geometric". Kashtaeva Balka fits well into this description (Olenkovskiy, 2010: 8).

Among them, Sekiz I (96 m2) is known from the collection of surface materials and 398 excavated flint objects (Mykhailov 1992b). Their attribution remains preliminary as only one point tool has been extracted from the excavation (Olenkovskiy, 1992: 57—58). Borys Mykhailov reported additional Aurignacian tools from the closest vicinity of the site (no more than 200 meters), but this statement requires further revision (Mykhailov 2005: 100).

The excavations at Novopavlivka (41 m2) yielded 81 flint implements and several sandstone blocks originating from the Kamyana Mohyla hill (Mykhailov 1982). The collection included some backed points and backed bladelets, thus making it likely a part of local Epigravettian. A single incomplete curved back point (Mykhailov, 1982: Fig. 2:5) resembles the tools from the Fedorivka, Kashtaeva Balka, Solone Ozero I and IX (Olenkovskiy, 2010, Fig. 2:16; 4:3 etc.).

Previously, at first glance, these sites were assessed as redeposited and destroyed locations that are far from being representative of the Upper Paleolithic of the region (Mykhailov, 1982: 91; Olenkovskiy, 1992: 57). However, our recent discoveries proved this consideration to be unreasonable. The sites are located in the low topographic position in the floodplain of the Molochna River and used to be thought to occupy the geomorphological forms of the Holocene Age. This consideration, however, was led by the poor geomorphological and geological knowledge of the region that has been recently updated. Since the Late Glacial Age pro-terraces were detected near the small rivers in the Ukrainian Steppe, the appearance of Pleistocene sites on those terraces was just a matter of discovery. Some of these sites are being revealed (Chepalyga and Kiosak, 2014). A similar geomorphological description can be applied to the sites in the Kamyana Mohyla surroundings.

Moreover, the North Azov Epigravettian sites are also not new to Ukrainian archaeology — more than two dozen of them are known by now in the region. Some were systematically excavated and presented in several publications (such as Olenkovskiy 2010 and Krotova 2019). A small and sparse set of radiocarbon dates belonged to these publications and was obtained in the Kyiv radiocarbon facility during the turn of the century (table 2.3). However, this adaptation must be further supported with materials extracted from precise contexts. One of the crucial reasons for that would be that the ultrafiltration procedure is highly demanded (Higham et al., 2006), especially for Pleistocene bone samples, but can also have an effect even on the Holocene samples (Steuri et al., 2019). Kyiv laboratory did not use ultrafiltration during the pre-treatment of samples (Pinhasi et al., 2011, 2012), so the dates can be younger than the "real ages" of the samples.

Table 2.3. Radiocarbon dates for Epigravettian sites of North Azov Sea region

No	Site	Lab N	Age, BP	+/-	Material	Reference
1	Fedorivka, l2	Ki-10354	15200	110	Animal bone	Krotova 2019
2	Fedorivka, l1	Ki-10355	14600	110	Animal bone	Krotova 2019
3	Solone Ozero Ixa	Ki-6360	14800	80	Animal bone	Olenkovskiy 2010
4	Solone Ozero Vi	Ki-6206	13030	70	Animal bone	Olenkovskiy 2010
5	Solone Ozero Vi	Ki-6202	12890	100	Animal bone	Olenkovskiy 2010
6	Solone Ozero IX	Ki-5825	13460	80	Animal bone	Olenkovskiy 2010
7	Solone Ozero Ia	Ki-6357	12700	60	Animal bone	Olenkovskiy 2010

The recent assessment of Kamyana Mohyla's rock art collection in connection to the local Upper Paleolithic (see Radchenko & Kiosak 2022) fosters the reshaping of these dates in light of calibration and further analysis. Unless the other is not specified directly, the calibration rules are as follows: calibration with OxCal 4.4.4 (Bronk Ramsey & Lee, 2013) using the calibration curve IntCal20 and atmospheric data from Reimer et al. (2020). The results introduce two sets of dates: the older encompasses 18730–17462 calBP (2σ), while the younger cluster is around 16498–14962 calBP (2σ).

The ups and downs of the calibration curve add up to uncertainty about the actual age of North Azov Culture sites (Fig. 2.10, see also Biagi et al., 2014). On typological grounds, Kashtaeva Balka was attributed to the older phase of this cultural aspect and compared to the site of Fedorivka with two XIX—XVIII mills. calBP radiocarbon dates. So we can suppose that the Upper Paleolithic people were near the Kamyana Mohyla hill during GS2-1b (Rasmussen et al., 2014) and probably later.

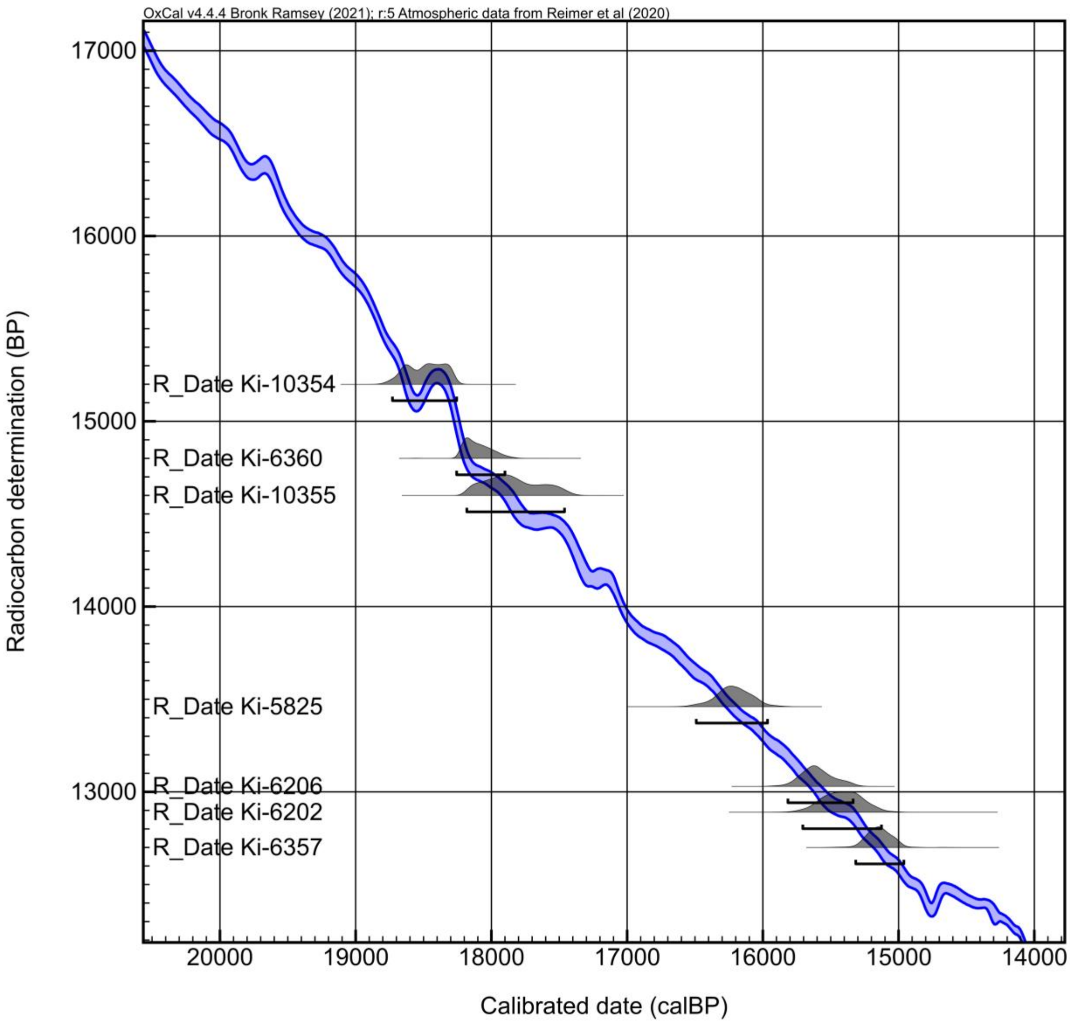


Fig. 2.10. Radiocarbon dates for the Upper Paleolithic sites of North Meotic region (after Olenkovskiy 2010, Krotova 2019)

Whatever the exact attribution of these sites and the whole set of locations would be, it links the Upper Paleolithic of Kamyana Mohyla's closest vicinity with the local (and broader East European) Epigravettian context. Therefore, assessing the possibly related rock art objects should fit into that frame.

However, the Upper Paleolithic rock art objects are rare in the landscapes of Eastern Europe. Images from Kapova cave (Ruiz-Redondo, Yanovskaya & Zhitenev 2020) are incredibly distant from Kamyana Mohyla in space and time (fig. 2.11). Moreover, their archaeological, technological, and rock art context differs from the Ukrainian case. The only one, though still quite iconic portable rock art object from Eastern Ukraine is the female engraving on the schist plaquette from the Rogalik site (Gorelik, Tarasenko 1993: 28—34; Gorelik 2001: 208—209). However, other pieces of evidence of Epigravettian art from Ukraine and Southwestern Russia are pretty known. The figures and engravings are often made on mammoth bone (Iakovleva 2009) and ivory (Yakovleva 1987; Stupak 2011). Among them — are female and bird figures from Mezhyrich, Mizyn, and other Upper Paleolithic camps in Ukrainian forest and forest-steppe zones (Rudinskiy 1931; Iakovleva 1992; 2009). The mammoth's bone bracelets (Shovkoplyas 1963; Bibikov 1965) and a complex of musical instruments (Bibikov 1978) from Myzin are the objects of international fame and interest. Decorated bone objects from Ukraine mainly featured geometric ornamentation — lattices, so-called meanders, zigzags, etc. (Iakovleva 2010). The finds of engraved mammoth bone are abundant in the Northern part of the country but somewhat absent in its steppe zone. However, there are some signs of the mammoth presence in the region (Mykhailov 2005, 101—102), so the discovery of Upper Paleolithic art objects might happen if any intense excavations are done in the future. The mammoth figures and the examples of engraved bone are also known in Kostenki and Avdeevo Upper Paleolithic sites (Iakovleva 1999). The images of so-called Paleolithic Venuses from Kostenki are understood and considered in the common context with Kamyana Mohyla rock art though no further analysis of that context was done (Fradkin 1975; Danilenko 1986: 117).

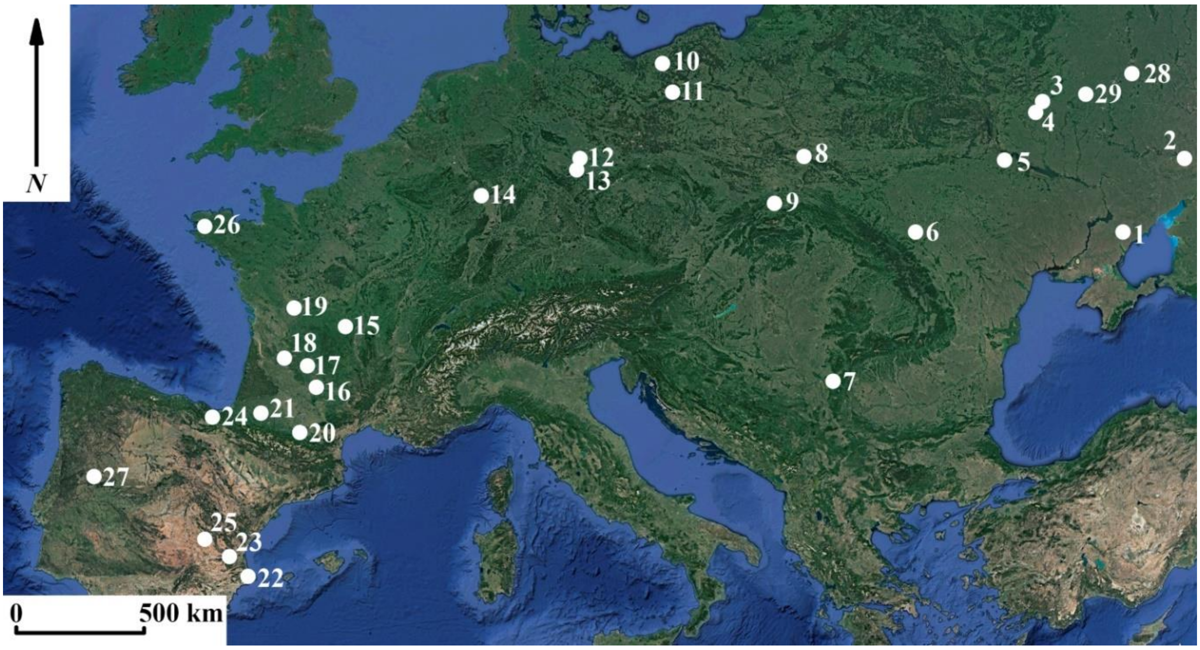


Fig. 2.11. Location map of the sites related to the 'Upper Paleolithic hypothesis' on the Kamyana Mohyla rock art. 1 — Kamyana Mohyla; 2 — Rogalik (after Gorelik 2005); 3 — Mizyn (after Iakovleva 2009); 4 — Obolonnya (after Stupak & Khlopachev 2014); 5 — Mezhyrich (after Iakovleva 2009); 6 — Balamutivska cave (Chernysh 1959); 7 — Cuina Turcului (after Cárciumaru, Niţu 2018); 8 — Ćmielów (Paczkowski & Przeździecki 2021); 9 — Obłazowa cave (after Valde-Nowak, Kraszewska & Cieśla 2017); 10 — Świdwin (Płonka et al. 2011); 11 — Rusinowo (after Płonka & Kowalski 2017); 12 — Saalek (after Bosinski 1982); 13 — Ölknitz (after Feustel 1970); 14 — Gönnersdorf (after Bosinski 1991); 15 — Combarelles cave (after Archambeau and Archambeau 1991); 16 — Carriot cave (after Lorblanchet 2010); 17 — Lascaux (after Lommel 1966); 18 — Gabillou cave (after Gaussens 1964); 19 — La Marche (Lwoff 1941); 20 — Les Trois-Freres (after Bégouën 2014); 21 — Les Espelugues (after Capitan et al. 1924); 22 — Parpalló (Villaverde 1994); 23 — Parellada IV (after Viñas and Sarriá 2010); 24 — Altxerri cave (Ruiz-Redondo, 2014); 25 — Cañada de Marco (after Ruiz et al. 2022); 26 — Rocher de l'Impératrice (after Naudinot et al. 2018); 27 — Foz do Medal; (after Soares de Figueiredo et al. 2020); 28 — Kostenki (after Iakovleva 1999); 29 — Avdeevka (after Iakovleva 1999).

However, these artifacts are barely insightful for the understanding and interpretation of Kamyana Mohyla art specimens as they have nothing in common with the objects that used to be considered as Pleistocene imaginary here. Moreover, searching for analogies in the Eurasian Steppe belt seems rather fruitless. There is no reliable and recognized evidence of Paleolithic imagination in Kazakhstan (Samashev 2003) and Central Asia (Clottes 2011). The rock art imaginary of Caucasus, though sometimes considered in relation to Kamyana Mohyla rock art (for instance, Mykhailov 2005; Aliev 2009), is instead barely related to what used to be regarded as Upper Paleolithic rock art of Ukraine or Epigravettian sites from here. Though the Pleistocene imaginary is known and studied in the notable rock art locations of the region, such as Gobustan National Historic and Artistic Preserve in Azerbaijan (Muradova 2003; Rustamov 2003; Azərbaycan Arxeologiyasi 2008), it is barely relevant to the Ukrainian case — they belong to different geological, climatic, archaeological and technological context.

Following these concepts, Valentin Danilenko and Borys Mykhailov (who were the most passionate scholars proving the Upper Paleolithic origin of Kamyana Mohyla rock art) referred either to Northern Europe and Russia, including Siberia or to the Western and Central European rock art traditions, primarily applying the examples of Late Magdalenian sites. Borys Mykhailov uses the term "Magdalenian" to describe the time lap when the Upper Paleolithic rock art of Kamyana Mohyla (Mykhailov 2005: 100—102) might have been created, possibly to refer to the European models. However, it is clear by now that the case of Ukraine is different, and it requires to be considered in our own, Epigravettian manner.

The "Upper Paleolithic" hypothesis of the Kamyana Mohyla rock art interpretation was first published in V. Danilenko's book (1986). Besides numerous considerations about paleofauna (cave lions, rhinoceroses, and mammoths), he refers to the images of elks, elk-horned humans, and anthropomorphic. Following Tokarev (1964, 308—313), he considers the elk cult very important to the Final Paleolithic societies. The same may be stated about the interpretation of boat pictograms (Ivanov 1936; 1954). In both cases, V. Danilenko refers to the rock art of North Europe and Asia, even Siberia. The only published solution was this Paleolithic interpretation of parietal and portable rock art specimens from the Wizard's Cave of Kamyana Mohyla (see Fig. 10). Since V. Danilenko had died before the publication of his research. There was no sapid discussion; the hypothesis on the Pleistocene origin of some Kamyana Mohyla rock art instances waited 36 years to be re-examined and reconsidered.

One of the primary artifacts supporting the "Upper Paleolithic hypothesis" is the collection of portable rock art objects extracted from the Wizard's cave in 1973 and 1974. The group expanded through decades due to the research of Borys Mykhailov. This asset contains at least 70 plaquettes attributed to Upper Paleolithic and is comparable to other portable rock art assets from Central and Western Europe. Indeed, portable engraved stones, also known as stone plaquettes, are well-known from European Upper Paleolithic. Large assemblages are found in Western Europe and connected to the Magdalenian Upper Paleolithic art (Sieveking 1987a, 1987b), though they are not limited to the latter. The portable rock art collections of Parpalló (Villaverde 1994), Gonnersdorf (Bosinski 1991), Saalek (Bosinski 1982), La Marche (Lwoff 1941), Ćmielów (Paczkowski & Przeździecki 2021) and Foz do Medal introduce numerous examples of different Paleolithic rock art traditions. The largest of them, Parpalló, consists of painted and engraved plaquettes and covers the whole span from Gravettian to Upper Magdalenian (Roldán García et al. 2016). Similarly, Foz do Medal introduces more than 1500 fragments of Gravettian, Solutrean, and Magdalenian contexts with figurative depictions incised in slate and greywacke (Soares de Figueiredo et al. 2020: 65). The Gonnersdorf collection of the engraved slate stones is noticeable due to the specific style of depictions spread across Central and even Southern (Mussi & de Marco 2008) Europe. However, the portable stones from Kamyana Mohyla have the most significant similarity with the collections containing slate or sandstone and engraved by scratching their surface (i.e., La Marche collection, technologically considered in Mélard 2008, 2010 and Mélard et al. 2016). They present different aspects of the Upper Paleolithic imagination, including anthropomorphic forms (Bosinski 1991; Fuentes 2016), animals (Güth 2012; Bosinski & Bosinski 2009), abstract and geometric motifs (Sieveking 1987a), and sometimes even environmental depictions (Garcia-Diez & Vaquero 2015).

Though the plaquettes are primarily found in France, Spain, and Germany, their geography varies from Portugal in the west (Soares de Figueiredo et al. 2014) to Romania in the east (Cárciumaru, Niţu 2018; Anghelinu, Niţa & Cordoş 2020). Single finds of comparable age are sometimes present in Eastern Ukraine (Gorelik, Tarasenko 1993: 28—34; Gorelik 2001: 208—209).

Most of these collections (not all) are featured with archaeological context, so their functions and life cycle can be considered or suggested. The former included use in hearth constructions (Tosello 2003; Fritz & Tosello 2011), as a pavement (Bahn & Vertut 1988; Bosinski 1991; Arias 2013), or non-functional use connected to the light conditions (Needham et al. 2022). The latter suggests that many of them might have been broken (accidentally or intentionally) (see Arias 2009) and engraved again after the fragmentation (Soares de Figueiredo et al. 2014). Unlike European cases, the stones from Kamyana Mohyla lack archaeological context and can barely be framed into any contextual system. They, however, are similar in terms of shape, size, and the theories applied to provide their interpretation in the past.

Even without the broad context of portable rock art collections from Hamburgian, Azilian (Plonka & Kowalski 2017: 174), and Magdalenian (Sieveking 1987a) complexes, Danilenko and Mykhailov followed the "European" line of Kamyana Mohyla contextualization. Nowadays, this seems reasonable due to the appearance of dated Upper Paleolithic sites in the Ukrainian Steppe and the abundance of Epigravettian art both to the west and to the east from the site. The dates obtained for these sites also indicate that Kamyana Mohyla's integration into the broad European context is possible. Finally, finding a different context would be challenging due to the lack of Pleistocene rock art in the depth of the Eurasian Steppe belt.

On the other hand, the existence of the Upper Paleolithic rock art on portable stones and in the caves of Kamyana Mohyla remains debatable. Though this complicated topic is detailed below, further investigations are needed before we can state something.

2.2.3. The vicinity of Kamyana Mohyla during Mesolithic and para-Neolithic

The Mesolithic sites of the region are mostly assigned to one of two cultural aspects: Hrebenyky (Grebeniki) and Kukrek (Kozlowski & Kozlowski 1979; Stanko 1967; Telegin 1982). While the former is analogous to the Late Mesolithic complexes of the Balkans (Tardenoisian pontique, Boroneanţ 2005; Gatsov 1989; Păunescu 1979) and the southern Europe (Castelnovian, Perrin & Defranould 2016), the latter finds no direct parallels in the archaeological record of western or southern Europe. Kukrek is a technocomplex defined by the presence of bone and antler "spear-/dart-heads", probably also armed with backed bladelets and back and truncated flint points (Telegin 1982). Contrary to common practice, the definition of the Kukrek technocomplex is based upon functional tools (*l'ouuntilage du fonds commun*, G.E.E.M. 1975), not types of microlithic projectiles. When defined in such a manner, this cultural aspect seems to last from the early Holocene up until the Middle Neolithic. The Kukrek sites are also widely distributed encompassing various environmental zones (fig. 2.12). Nowadays, it is regarded in Ukrainian archaeology as a "super-culture" spanning from the Epigravettian well into the developed Neolithic (Zaliznyak 2005).

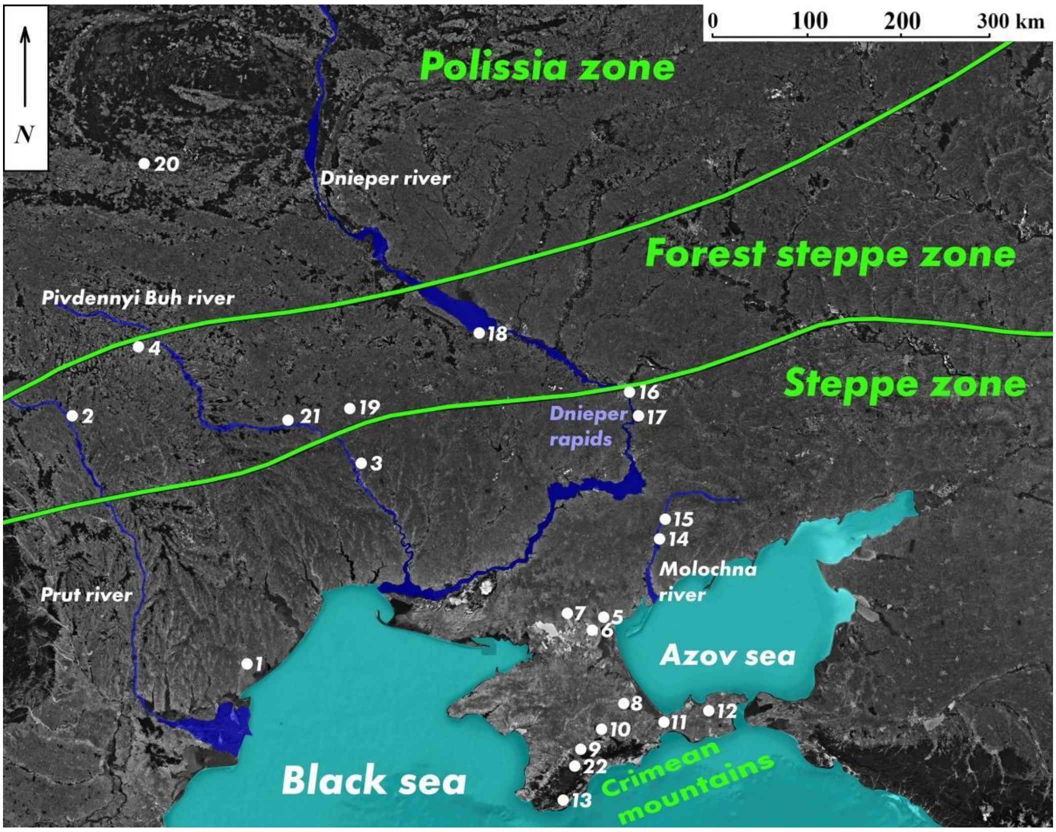


Fig. 2.12. Sites in the south of Eastern Europe which were assigned to "Kukrek" sensu lato: 1 — Trapivka, 2 — Badragii Vechi, 3 — Abuzova Balka, 4 — Mykolaivka, 5 — Liublinka II, 6 — Vesnianka V, 7 — Serhiivka I, 8 — Olexiivska Zasukha, 9 — Kukrek, 10 — Vyshenne 1, 11 — Frontove, 12 — Tasunove, 13 — Balin-Kosh, 14 — Kamyana Mohyla 1, 15 — Prylukivka, 16 — Ihren VIII, 17 — Sursky ostriv, 18 — Velyka Andrusivka, 19 — Dobrianka III, 20 — Lazorivka, 21 — Melnychna Krucha, 22 — Domchi-Kaia (after Kiosak et al. 2020).

The Mesolithic complexes of the North Azov Sea region are explicitly designated as Kukrek and are usually considered within that framework. Therefore, the sites in the Kamyana Mohyla surroundings are generally considered as Kukrek as soon as they are assigned to the Mesolithic (Kiosak et al. 2020: 86—88). Moreover, they are associated with fishing oriented societies that inhabited riverbeds of the big rivers in the region, like Don, Donets, Dnipro and Molochna river (as it is in case of Kamyana Mohyla) (Bodyanskiy 1949: 255; Danilenko 1950: 129; Belanovskaya 1975: 107; Telegin 2000: 70; Radchenko et al. 2020, see fig. 2.13).

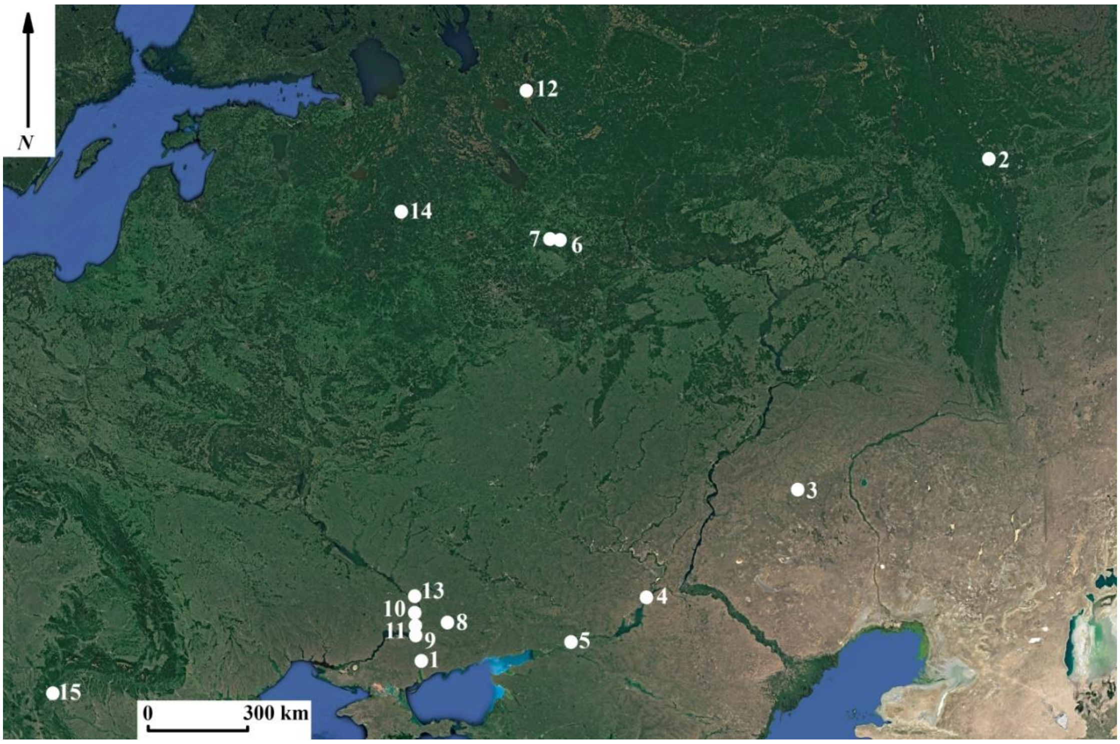


Fig. 2.13. Location of the sites, relevant to the contextualization of the Mesolithic river-oriented societies of Kamyana Mohyla that are mentioned in the thesis. 1 — Kamyana Mohyla; 2 — Shigir idol (Zhilin et al. 2018); 3 — Varfolomeevka; 4 — Razdorskaya 2 (after Tsybrij 2004); 5 — Rakushechniy Yar; 6 — Zamostye 2 camp (after Sidorov & Engovatova 1998); 7 — Ronskoe, Sinyaya Gora (after Oshibkina et al. 1992); 8 — Poltavka (after Telegin 1968); 9 — Vasylivka (after Kotova 2018); 10 — Sursky 1 (after Danilenko 1950b); 11 — Kizleviy 5 (after Kotova & Tuboltsev 2013); 12 — Sukhoe, Nizhnee Veretie (after Oshibkina et al. 1992); 13 — Igren' 8 (after Tlegin 2000); 14 — Sakhtysh 1, Sakhtysh 2 (after Oshibkina et al. 1992); 15 — Lepenski Vir, Icoana (after Srejovych 1972; Plonka 2003).

One of the reference sites for Kukrek culture in the region is the above mentioned settlement of Kamyana Mohyla 1 (and its layer B in particular), excavated sporadically since the first half of last century. This multilayered settlement is not only rich with archaeological materials, typical of the Kukrek cultural tradition (see Kotova et al. 2017; Kiosak et al. 2020), but also contains portable rock art objects in the excavated Mesolithic layers of the site (Kotova et al. 2018). A series of radiocarbon dates from mammal bones and coal fragments at the site reveals the approximate chronology of the Mesolithic inhabitation of Kamyana Mohyla and its closest surroundings (fig. 2.14). The general scheme of this settlement in the Mesolithic chronology of Europe is outlined below.

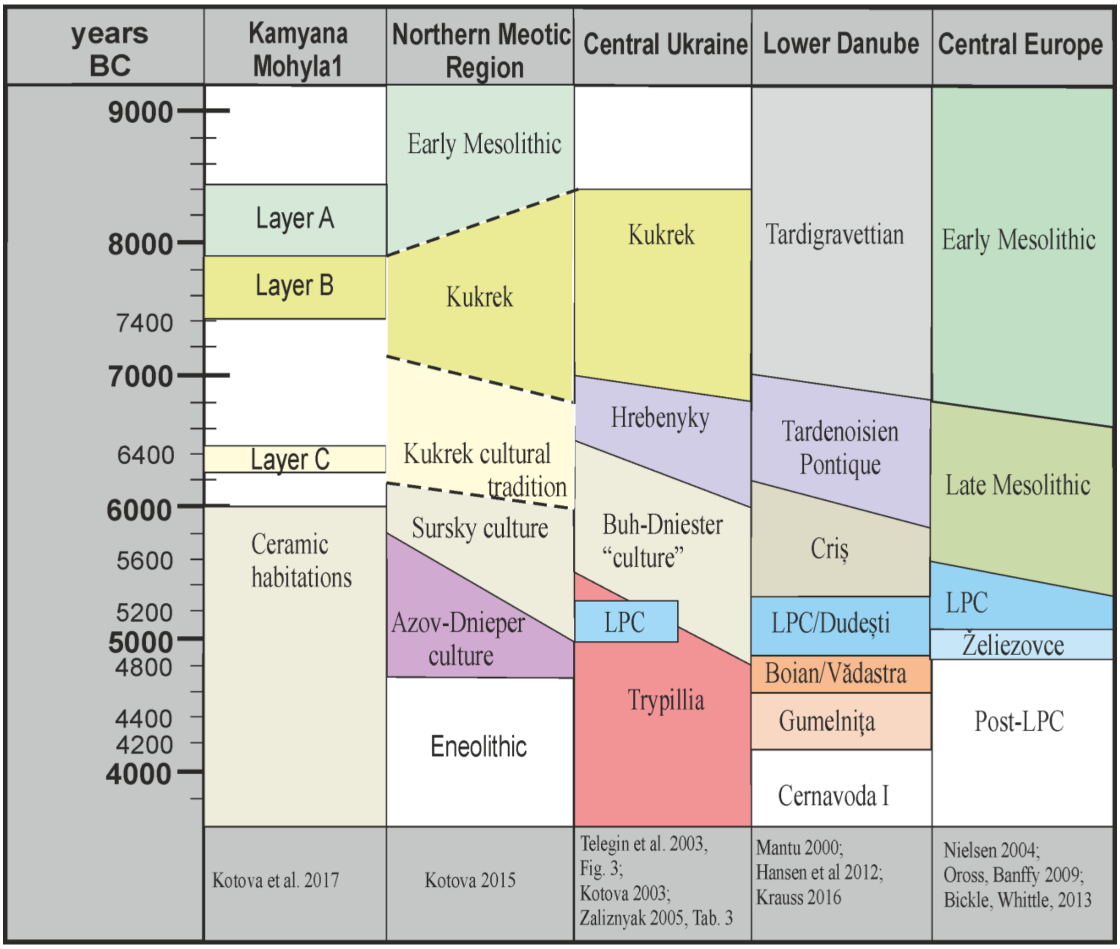


Fig. 2.14. Chronological table for the Kamyana Mohyla 1 site in context (after Kiosak et al. 2022: fig. 14)

This complex has been known and studied since 1947 and partially published by Danilenko under the term “Archaic Neolithic” (Danilenko 1952: 68). D. Telegin was the first to define the layers beneath the oldest pottery as Mesolithic (this includes layer B and probably layer C) (Telegin 1990; 2002). He also considered these assemblages as representing the Kukrek cultural entity (Telegin 1982: 101—104). Numerical and typological descriptions for part of the

Kamyana Mohyla 1 Kukrek assemblages were presented recently together with a new attempt to provide a radiocarbon framework for the dating of the Mesolithic and para-Neolithic layers of Kamyana Mohyla 1 (see Kiosak et al. 2022). D. Kiosak et al. follow M. Nowak in suggesting that communities who "still successfully carried on traditional lifestyle, gradually supplementing it with pottery" are para-Neolithic (Nowak 2021: 1582; Kiosak et al. 2020). This definition is applicable to layer C of Kamyana Mohyla 1, where the lowest potsherds on the site were found (Kiosak et al. 2022). The layer which underlies the latter clearly represents a Mesolithic assemblage that belongs to the "classic" Kukrek (*Kukrek sensu stricto*), while layer C is considered to belong to *Kukrek sensu lato* or the "Kukrek cultural tradition" (see fig. 5.4). Both layers (C and B) contained portable rock art specimens that can be associated to the churingas from Churinga's cave (fig. 2.15) and also represent what Danilenko used to call the "Archaic Neolithic" (1986: 17) or "Meso / Neolithic" (1986: 135) assemblages.

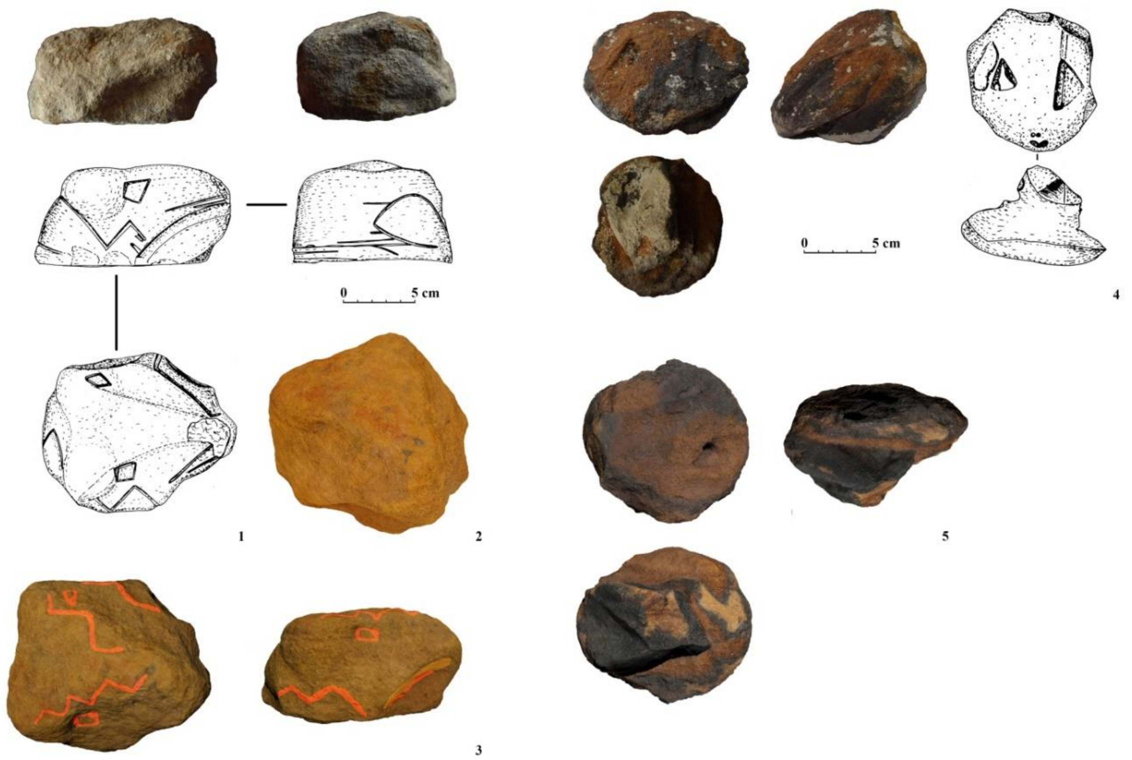


Fig. 2.15. Engraved stones from the Mesolithic layers of Kamyana Mohyla 1. 1 — bigger ("older") stone images and tracings (after Kotova et al. 2018, fig.

2); 2 — bigger stone after cleaning; 3 — 3D model of the bigger stone with the reconstructed engraved parts; 4 — smaller ("younger") stone images and tracings (after Kotova et al. 2018, fig. 3); 5 — smaller stone after cleaning.

By now the Mesolithic assemblage of Kamyana Mohyla 1 contains three layers divided by sterile lenses. These were conditionally called A, B and C (from earliest to latest) and represent different phases of the local Neolithic. Recent attempts at radiocarbon dating these layers returned 13 dates that clarify the depositional sequence of the assemblage (fig. 2.16).

Layer A of Kamyana Mohyla 1, which underlies layer B, contained fireplaces, shell middens, and pits. It was deposited between 8420–7910 calBC, based on Bayesian modeling (Figure 2.16). The results of radiocarbon dating have been calibrated with OxCal 4.4.2 (Ramsey, 2009) using atmospheric data from Reimer et al. (2020). Some of the lenses of layer C return ^{14}C dates of 6430—6230 calBC and 6380–6084 calBC. Comparable dates were obtained during previous efforts to date the site using the application of conventional radiocarbon analysis.

Thus, the time span for formation of the layer B falls between 7910 and 6430 BC. Layer B returned eight dates in total. The earlier one (Poz-51419 8730 ± 50) is 7944–7600 calBC and the later date (Poz-51304, 7980 ± 40 BP) is 7047–6700 calBC (fig. 2.17).

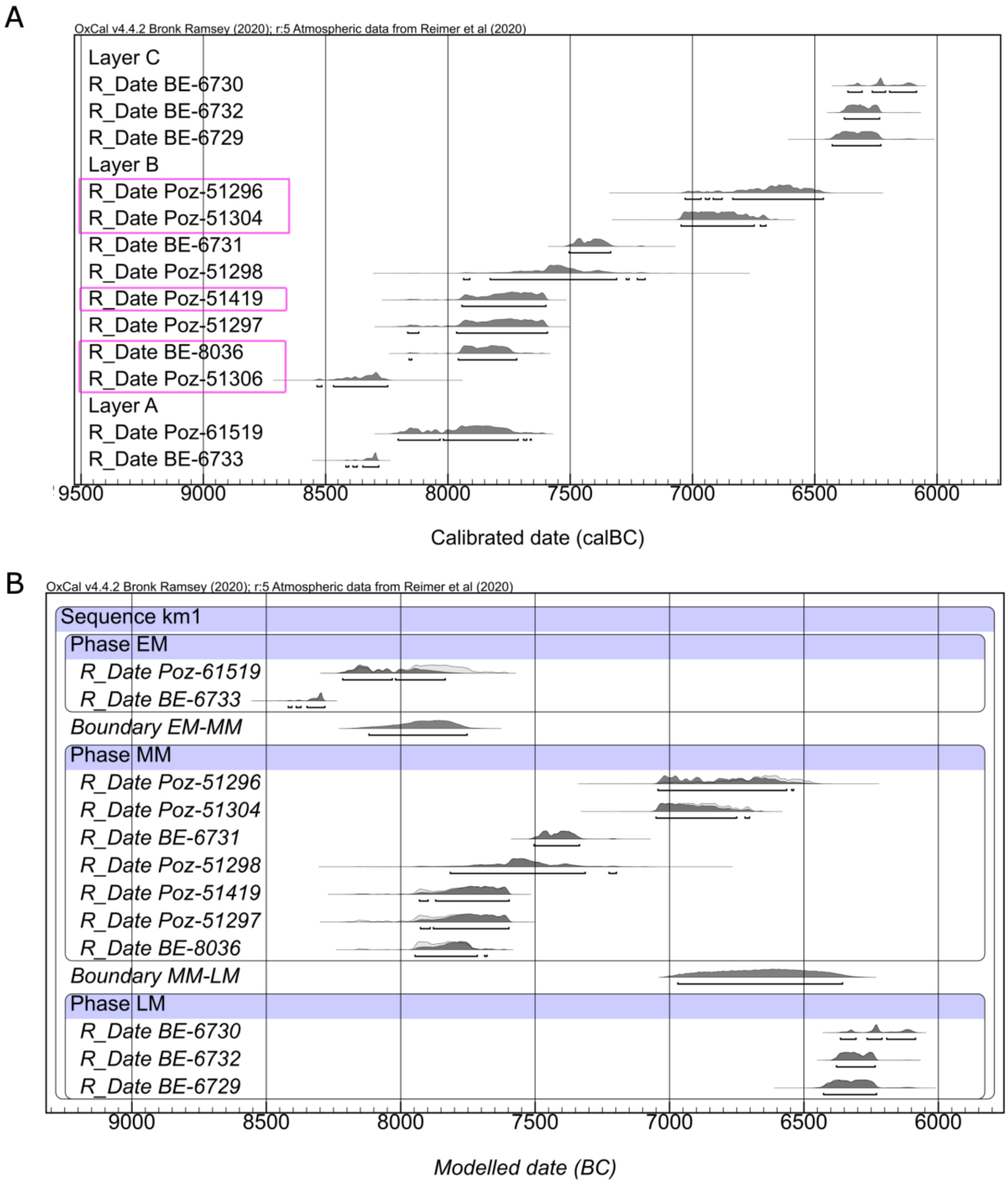


Fig. 2.16. (a) Calibration of AMS dates for the Kamyana Mohyla 1 site (in the order of appearance). Dates on animal bones are in purple rectangles. Other dates are on charcoal. (b) Modeled calibration of AMS dates for the Kamyana Mohyla 1 site. EM – Early Mesolithic (layer A), MM– Middle Mesolithic (layer B), LM– Late Mesolithic (layer C) (after Kiosak et al. 2022: fig. 7).

Provenance	Lab. number	Date BP	SD	Material	CalBC (2 s)
Tr. 2 – sq. 17, depth 50–63 cm, fireplace, layer C	BE-6730	7369	23	Charcoal	6364–6083
Tr. 2 – sq. 17, depth 76 cm, fireplace, layer C	BE-6732	7429	23	Charcoal	6378–6234
Tr. 2 – sq. 14, depth 48–60 cm, fireplace, layer C	BE-6729	7461	54	Charcoal	6248–6229
Tr. 2 – sq. 1, depth 91–93 cm, layer B	Poz-51296	7810	80	Animal bone	7029–6464
Tr. I – sq. 5, Depth 140 cm, layer B	Poz-51304	7980	40	Animal bone	7046–6699
Tr. 2 – sq. 13, depth 73 cm, charcoal scatter, layer B	BE-6731	8340	24	Charcoal	7504–7334
Tr. 2 – sq. 9, layer B	Poz-51298	8510	110	Charcoal	7935–7193
Tr. I – sq. 3, 140 cm, layer B	Poz-51419	8730	50	Bone of a large ungulate	7942–7598
Tr. 2 – sq. 6, depth 85–94 cm, fireplace, layer B	Poz-51297	8740	60	Charcoal	8164–7592
Tr. 2 – sq. 15, Pit 1, depth 79 cm, layer B	BE-8036	8783	25	Animal bone	8158–7718
Tr. 2 – sq. 4, depth 92 cm, layer B	Poz-51306	9120	50	Animal bone	8534–8245
Tr. 1 – sq. 9, depth 206 cm, layer A, fireplace	Poz-61519	8810	50	Charcoal	8203–7659
Tr. 2 – sq. 15, depth 126 cm, fireplace, layer A	BE-6733	9134	13	Charcoal	8416–8282

Fig. 2.17. Relevant radiocarbon dates for the Kamyana Mohyla 1 site (after Kiosak et al. 2022: table 1)

The findings of fish bones and *Unio* shell middens (fig. 2.18) on Kamyana Mohyla 1 (as well as on other Kukrek sites, e.g., Melnychna Krucha, Kiosak 2019) allow considering it in the general frame of the current archaeological record concerning the inhabitants of the large rivers banks. It is reasonable to assume that the North Meotic (Pontic) region had been habituated by the complex river-oriented societies by the first part of the Atlantic period (see Radchenko et al. 2020a; Radchenko 2022). These societies have drawn reasonable attention during the last 50 years, both in European studies (Tringham 2018; Kitagawa et al. 2018) and Ukrainian ones (Zaliznyak 1998). Similar river-oriented cultures inhabited the shores of large European rivers — the Schela Cladovei-Lepenski Vir culture on the Danube (Bartosiewicz and Bonsall 2004; Bonsall et al. 2004), Buh-Dniester culture in the Dniester and Southern Buh valleys (Danilenko 1969; Markevich 1974; Kiosak, 2014; Kiosak and Salavert 2018) the Sursky culture on the Dnipro (Demchenko 2016), and the Rakushechny Yar on the Don (Gorelik et al. 2016; Dolbunova et al. 2020). They share several material characteristics, most likely due to their shared tendency to exploit river resources. Their role in regional Neolithisation was probably different from that of mobile hunter-gatherers.

Fig. 2.18. A part of Unio cluster, found in the Mesolithic layer (B) of the Kamyana Mohyla 1 settlement during excavations in 2017 (image by N. Kotova)

Some Lower Dnipro and Donets region settlements of this period were catfish-oriented (Bodyanskiy 1949: 255; Danilenko 1950b: 129; Belanovskaya 1975: 107; Telegin 2000: 70). Consequently, this fish had the importance of being a primary source of food. This might have impacted the appearance of water- and fish-related religious beliefs in the life of these Mesolithic and Neolithic populations (Neprina 1988; 1991; Kryzhevskaya 1991; Tsybrij 2004, see fig. 2.15). Such hypothesis is confirmed utilizing diet analysis — recent advances showed the significant contribution of freshwater resources, including fish, to the diet of human beings buried at the Meso-Neolithic cemetery of Vasylivka III (Lillie, Richards & Jacobs 2003: 747—748).

The Mesolithic trend to picture fishes is well-known in Eastern Europe and even the Asian part of Russia (fig. 2.19; Kungurova, 2004; Oshibkina et al. 1992). Some fish-resembling portable objects are known among Khakassian stone figures. One figure near Styra Lake is shaped like a massive cigar with an oval cross-section. One end is wider and flattened, so it resembles a broad head of a fish (Okladnikov 1975: 59, Fig. 1). Small stone fish figures are also typical for the

Mesolithic of Yenisey (Kyzlasov 1986: fig. 1.16) and Baikal (Studzinskaya 2011: 42) regions. In the latter case, the image of a fish is related to the Underworld in the folklore of Siberian tribes (Studzinskaya 2011: 47).

The appearance of fish cults during the Late Mesolithic has been reported even for distant locations, such as the surroundings of the Gobustan rock art site (Parajova 2009: 164—165).

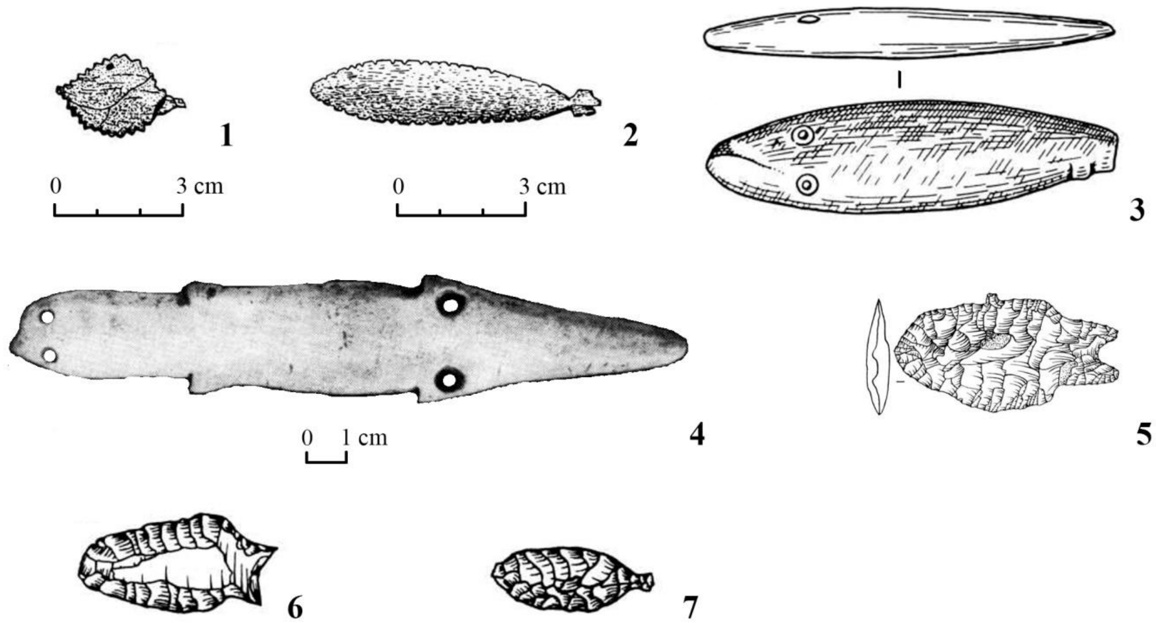


Fig. 2.19. Fish figurines dated to Mesolithic (1, 2) and Neolithic (3—7): (1, 2) Nizhnee Veretie; (3, 4) Sakhtysh 1; (5) Sakhtysh 2; (6) Ronskoe 1; (7) Sinyaya Gora; (1–4) bone; (5–7) flint; Nos 3, 5, 6, 7 not to scale (1–7 after Oshibkina et al. 1992)

This might also be the case for the inhabitants of Kamyana Mohyla 1. Danilenko considers the Mesolithic population of the region to be catfish oriented (1950: 119) and interprets some of the fish figurines from Churinga’s cave as representing a catfish (Danilenko 1986: 118). Though there are other types of fish, spotted in the stone’s shape and described by Danilenko, the main idea remains the same — the dependence of the inhabitants of the settlement in the Hill’s surroundings led to the ritualization of the fish and caused the creation of the fish depictions in the Kamyana Mohyla sandstone or even from a flint blade (fig. 2.20). Therefore it would be reasonable to expect the appearance of fish and water among the Mesolithic art of Kamyana Mohyla. These considerations formed one of the most sustainable and coherent hypotheses on the interpretation and attribution of Kamyana Mohyla rock art. The idea that some rock art specimens from Kamyana Mohyla represent fish images and are attributed to Late Mesolithic has been developed by V. Danilenko (1986) and then supported by B. Mykhailov (2005) and our researchers (Radchenko et al. 2018).

Fig. 2.20. Fish figurine from Kamyana Mohyla 1 settlement (Kotova et al. 2017)

Examples of Mesolithic rock art in Ukraine are outnumbered. Apart from one location in the Carpathian Mountains (Chernysh 1959), only Kamyana Mohyla shares similar potential to bear examples of Mesolithic rock art. More or less solid attribution might be considered for an object in cave No. 55 (fig. 2.21). Danilenko also considers the portable art specimens he found in Churinga's cave in 1973 as Mesolithic. He considered the portable rock art specimens from that cave to represent fish. The contrasting interpretation of churingas from Wizard's cave and those found in Churingas' cave is worth noticing as Danilenko refers to these stones as engraved in different styles and resembling the generally distinct type of portable objects. As he claims these stones bear differences in the way they were manufactured, he concludes the existence of two different episodes of the portable rock art specimens' creation. Confirming this hypothesis requires searching for the evidence of two different styles of presence — the difference in the morphology of engraved lines, which Danilenko describes by their shape — width, and depth. Therefore, further analysis of these engravings requires analyzing these principal parameters to define whether they belong to different engraving traditions.

A fish head from location No. 55 of Kamyana Mohyla is decorated with a double-line zigzag with interesting analogies. While singular and multilinear zigzags have broad expansion and dating ranges, zigzags of two lines are rarer. The double zigzag is known on European Mesolithic bone tools, stone and bone pendants, and a unique wooden idol from Shygyr peat bog (Ural, Russia). This large sculpture is dated to 9600–9000 calBC (Zhilin et al. 2018: Fig. 1). The double zigzag is also known in the Mesolithic forest of Russia, namely in the Veretye culture that is rich in ornamented bone products (Oshibkina et al. 1992: Fig. 16.10). This zigzag is also found on small, decorated stones (churingas) from Zamostye 2 camp near Zablolotskoye Lake in Sergievo-Posadkiy district of Moscow oblast (Sidorov and Engovatova 1998: Fig. 1.26, 32). Double zigzags are among the ornaments found on Mesolithic and Early Neolithic bone figures from this camp (Sidorov and Engovatova 1998, Fig. 3.2; 4.1). This zigzag was used to decorate stone pendants and bone figures dated to 7000 cal BCE, found on Late Mesolithic sites of the lower Don River (Gorelik et al. 2016). This element is also found on a bone tool from the Mesolithic level of the Icoana settlement in the Iron Gates on the river Danube (Plonka 2003: Fig. 28.2, after Boroneant 1973).

Fig. 2.21. Mesolithic rock art from "Location No. 55" of Kamyana Mohyla (after Radchenko et al. 2020b, fig. 4)

Double-zigzagged bone and stone finds are known from the late Mesolithic and Neolithic sites of the Dnipro region. Fragments of spear/dagger bone tips from Sursky Island 1 and Igren' 8 settlements have engraved double parallel and crossed zigzag ornament compositions on them. Double zigzag compositions are known on Poltavka and Kizleviy 5 talc tools and a bone bracelet fragment from the Vasilyievskiy II burial site (Fig. 2.22).

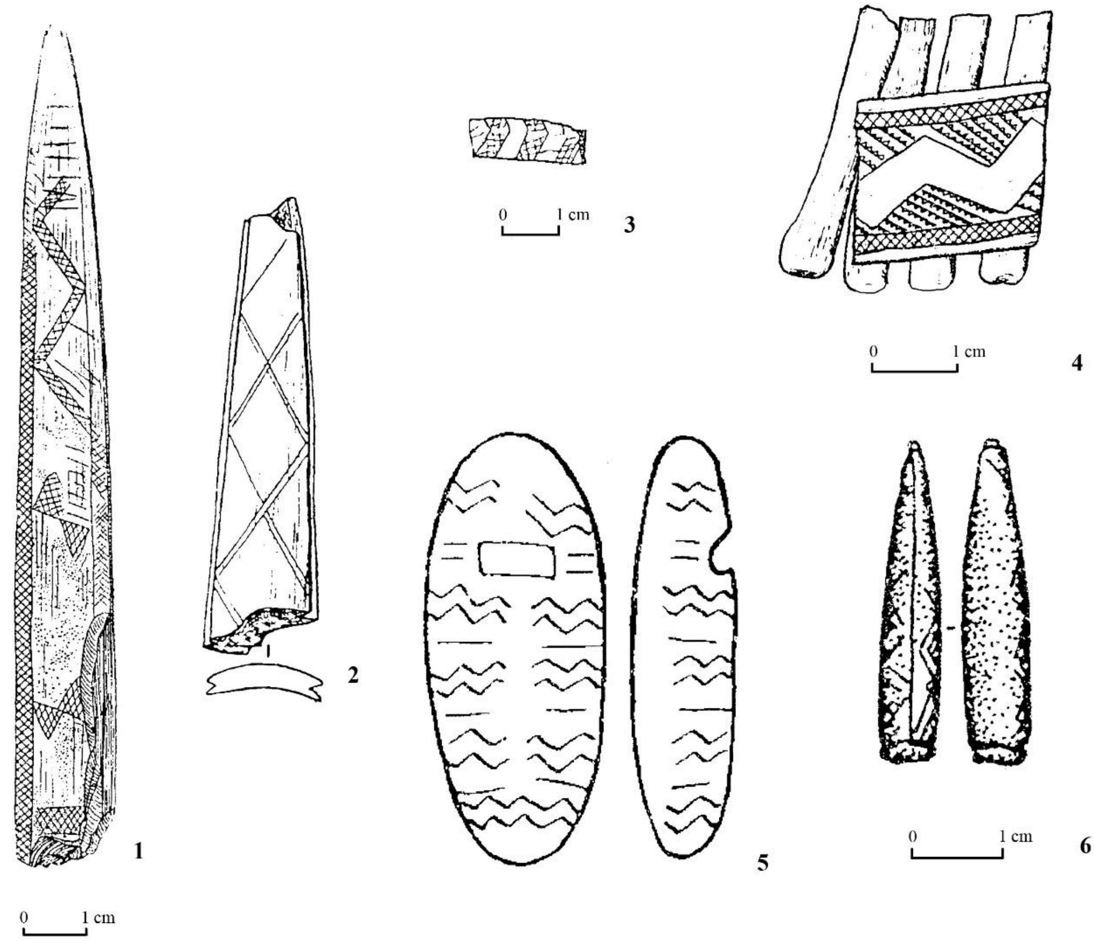


Fig. 2.22. Double zigzag ornamentation from the territory of Dnipro region: (1) Sursky Island 1 (after Danilenko 1950b: Fig. 1. 1); (2, 3) Igren' 8 (after Telegin 2000: Fig. 20.15, 41); (4) Vasylievka (after Telegin 1991: Fig. 15); (5) Poltavka (after Telegin 1968: Fig. 50.1); (6) Kizleviy 5 (after Tuboltsev 2005: Fig. 7.15). Nos 2 and 5 are not to scale

During Neolithic and early Eneolithic times, the double zigzag was used on pottery ornaments in the very same regions where it was used to decorate Mesolithic bone and stone finds, lower Don (Kotova 2003: Fig. 72.5; 73.5; 78.10) and forests near the river Volga (Sidorov and Engovatova 1998: Fig. 7.6, 11; see fig. 2.23). Previously unknown double horizontal or numerous vertical zigzag ornaments appeared on the pottery of that period within Dnipro and Azov Sea regions (Telegin 1991: Fig. 55.1, 2; Kotova 2015: Fig. 11.1; 14.4).

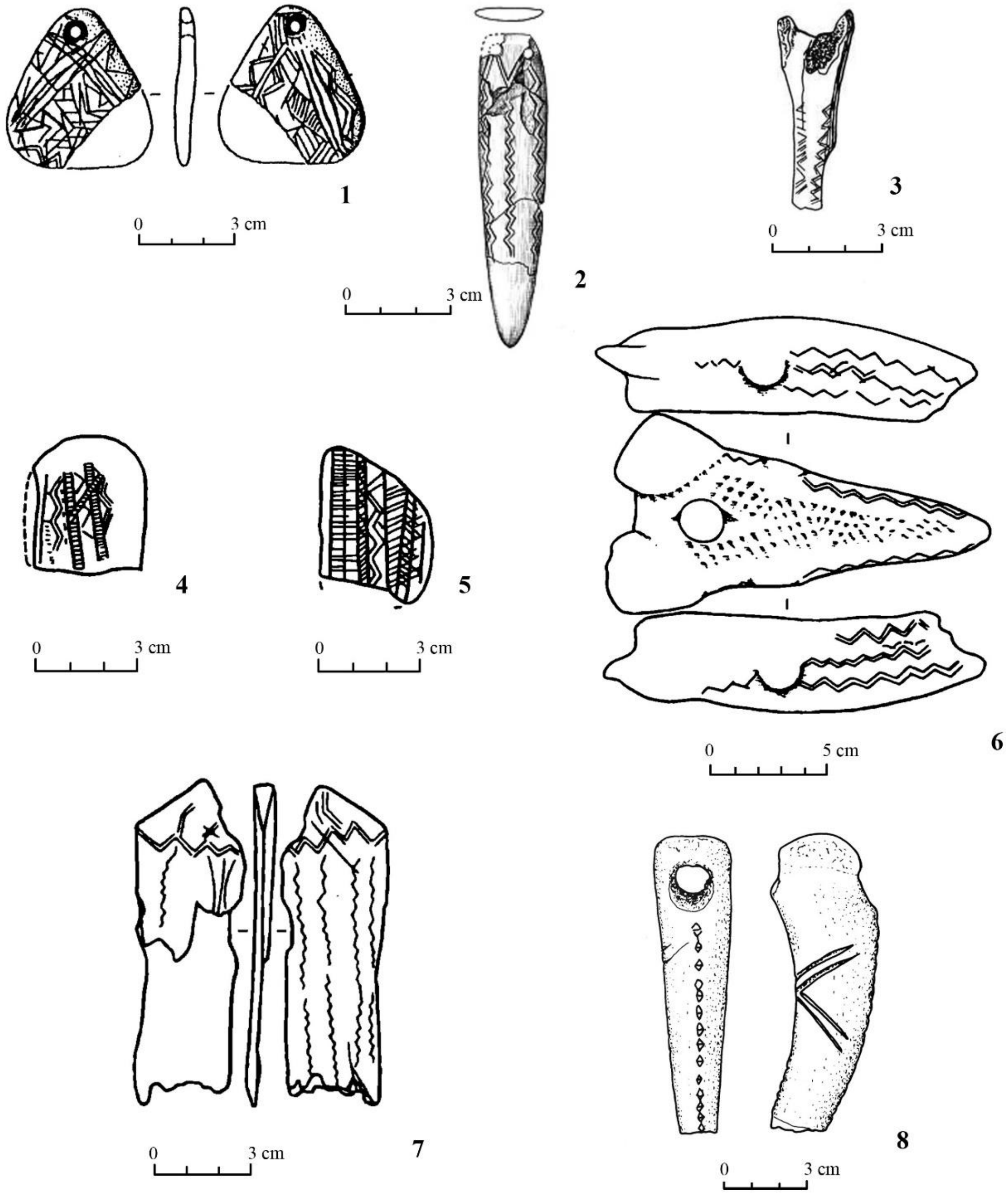


Fig. 2.23. Double zigzag ornamentation: (1, 2) Razdorskaya 2 (after Tsybrij 2004); (3) Sukhoe camp (after Oshibkina et al. 1992); (4–7) Zamostye 2 camp (after Sidorov and Engovatova 1998); (8) Icoana, level 1 (after Plonka 2003).

Large stone fish / human hybrids stone figures (Radovanivic 1996: Fig. 3.55, 3.60) are known within Late Neolithic–Early Mesolithic sites in Iron Gates on the river Danube from about 6300 cal BCE. Palaeodietary data indicates a strong reliance on fish throughout the Mesolithic period. Stable isotope data suggests that during the Early Neolithic period, at least a part of the population abandoned the reliance on fish that characterized the Mesolithic diet. This might be connected with an incoming Neolithic population who brought with them a manufacturing economy. Since this change coincides with the appearance of ‘fish/human hybrid’ depictions, this dietary change was interpreted, although not entirely, as a consequence of specific prohibitions, including taboos against eating at least certain types of fish (Borić 2007). Figures could picture the stages of metamorphosis, from a dead person to a ‘fish ancestor’ (Borić 2005). Remarkably, these figures were found only in the Lepenski Vir settlement. 29 of them were reported as fish like stones after the first discovery (Srejovic 1969: 95; Srejović 1972), now at least 94 of them are known (Borić et al. 2018). Its dwellers specialized in catching Huso huso, the largest of sturgeons in the Danube. The figures within the site resemble this very species (Živaljević 2012: Fig. 5.6). People elsewhere at the same time, from Vlasac (specialization in catching carp [*Cyprinus carpio*]) and Padina (specialization in catching catfish [*Silurus glanis*]), did not make such figures (Živaljević 2012). Lepenski Vir sculptures are stylistically different from the Kamyana Mohyla ‘catfish’ figure. It was discovered recently that the migration process from the prehistoric Danube river banks towards the Ukrainian Steppe may have occurred during the Late Mesolithic or the Early Neolithic periods (Haskevich 2020). Apart from that the portable rock art of Mesolithic Europe is well-published and represented in the academic literature (see mainly Plonka 2003), though remains outnumbered compared to the engraved wood and bone artefacts assigned to that period.

However, the context of portable art of Mesolithic Europe is much broader than this and parallels the findings on Kamyana Mohyla. It includes various specimens, from amber pendants, flints, stone pebbles, and engraved pieces of bone and wood (Plonka 2003: 19—20). The similarities to the local context of ornamented objects from the Ukrainian steppe might be found both in the stone pieces from Mesolithic settlements on Don (polished or featured with non-figurative engravings) (Fedyunin et al. 2021: 168, fig. 2.17) and engraved bone of the Mesolithic of Northern Europe (Plonka, Adamchyk & Diakowski 2022, fig. 2, fig. 8).

This abundance of data from the site itself, the settlement nearby, and its local and global contexts, together with a relatively large quantity of radiocarbon dates and discovered connection between the rock art site and the settlement, make the Mesolithic assemblage of Kamyana Mohyla rock art an incredibly pleasurable and hospital to work with. Its attribution and interpretation are among the most secure compared to other engravings from the site.

Last but not least, the abundance of non-figurative and geometric engravings on the soft sandstone of Kamyana Mohyla Hill makes it reasonable to compare some of the site contexts with the Fontainebleau rock art in France (Bénard & Guéret 2014; Guéret & Bénard 2017) that has been attributed to the Early Mesolithic times. Though the sites look similar in many aspects, additional research is needed to hypothesize that they share similar chronological or technological features.

The beginning of Ukrainian Steppe Neolithization and ceramization brings up an abundance of other complex contexts. Though some rock art objects have been attributed to the Neolithic on Kamyana Mohyla, this remains questionable. First of all, when applied (by Valentin Danilenko or Borys Mykhailov) to the rock art of Kamyana Mohyla, the term “Neolithic” basically means “produced by representatives of Sursky or Azov-Dnipro cultures during VI—IV millennia BC. However, chronological attribution of rock art specimens to that time lap is usually poorly supported by reliable evidence (if any). Moreover, the semantic interpretation of “Neolithic” parietal art objects from the site is connected with the fishing economy, e.g., introducing several engravings as fishing tools (fig. 2.24). Such interpretation is dubious and might indicate rather Late Mesolithic than Neolithic chronological attribution, as in the case of Late Mesolithic engraved antler and bone fishing tools from southern Scandinavia (David 2017).

However, the settlement of Kamyana Mohyla 1 remain of crucial importance to the Neolithic and Neolithization of the region (Kotova 2003; Kotova et al. 2017a). The fieldwork revealed the cultural layers attributed to Sursky and Azov-Dnipro cultures. After the recent observations, Nadiia Kotova (2018) determined two Neolithic layers on the site. One belongs to the second period of Azov-Dnipro culture (5300—4900 calBC), and the other — to Sursky culture (6100—5900 calBC).

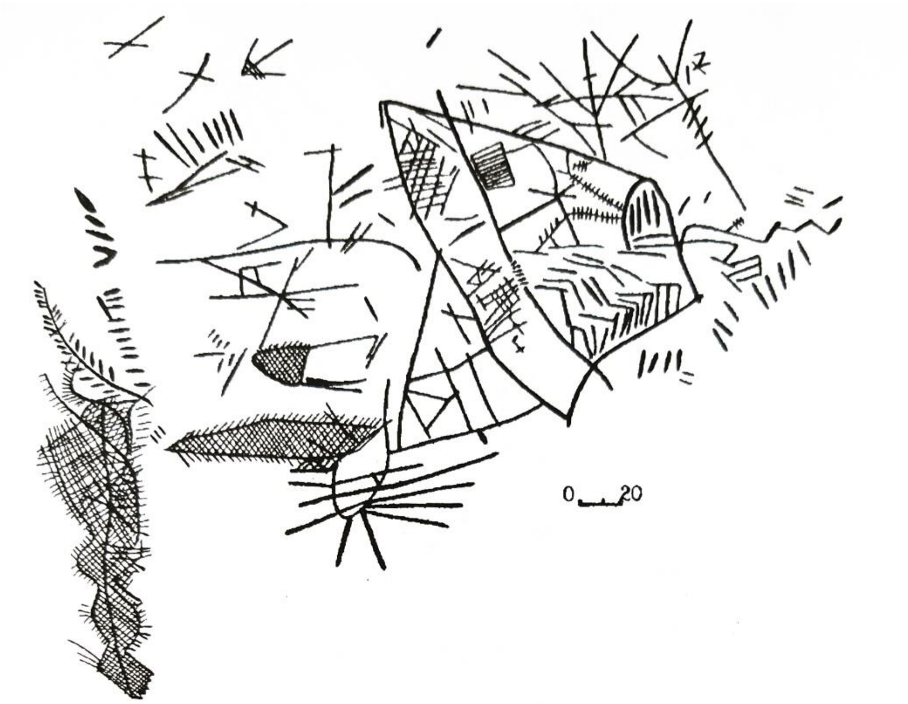


Fig. 2.24. Engravings on the block No. 4 that has been (too daringly) interpreted as an "image of fishing tools" (Mykhailov 2005: 199, fig. 4)

The situation regarding the Neolithic occupation of Kamyana Mohyla 1 was determined during the excavations that began in 2011 (Kotova et al. 2017a). "They showed that the materials of the second period of the Azov-Dnipro Culture lie directly over the materials of the second period of the Sursky Culture. The Azov-Dnipro materials are confined to the upper horizon of the brown soil with large carbonates, and the Surska materials are found in the lower horizon of this soil layer. The bones obtained by D. Ya. Telegin from this soil layer date to about 5300—4900 calBC” (table 2.5) (Kotova 2018: 62).

Table 2.5. Radiocarbon dates for the animal bones of the Sursky culture (after Kotova 2018, table 1).

Monument	Material	Index	BP	quickcal2007 ver.1.5, calPal_2007_HULU
First period				
Surskoy island 2, lower layer	Animal bone	Ki-6691	7245±60	6113±70
Surskoy island 2, lower layer	Animal bone	Ki-6690	7195±55	6065±53
Semenovka 1, lower layer	Animal bone	Ki-7679	7285±70	6140±67
Semenovka 1, lower layer	Animal bone	Ki-6689	7125±60	5979±57
Kamyana Mohyla 1, first ceramics layer	Animal bone	Ki-4022	7250±95	6116±89
Kamyana Mohyla 1, first ceramics layer	Animal bone	Ki-4226	7170±70	6028±69
Kamyana Mohyla 1, first ceramics layer	Animal bone	Ki-7667	7055±60	5920±58
Kamyana Mohyla 1, 2011, trench 1, sq.3, 98-107 cm	Cattle bone	Poz-513020.8%N 4.0%C	7075±35	5960±36
Second period				
Kizlevy 5	Animal bone	Ki-7999	6740±90	5641±74
Kamyana Mohyla 1, brown soil with abundant carbonates	Animal bone	Ki-4025	6376±60	5378±64
Kamyana Mohyla 1, brown soil with abundant carbonates	Animal bone	Ki-4024	6180±90	5130±115
Kamyana Mohyla 1, brown soil with abundant carbonates	Animal bone	Ki-4023	6120±80	5069±115
Strilcha Skelja, sq. 8, shtyk 9, 509	Animal bone	Ki-8174	6290±65	5254±80
Vilnyanka cemetery, burial 40	Tooth of red deer	Ki-14874	6290±60	5233±85
Vilnyanka cemetery, burial 32	Animal bone	OxA-17497	6252±36	5206 ±74
Vovnigi 3 cemetery	Tooth of red deer	Poz-61517	6230±35	5195±83
Yasinovatka 1 cemetery, burial 54	Tooth of red deer	OxA-17500	6121±34	5061±76
Vovnigi 1, burial 25	Tooth of red deer	Poz-51301	6170±40	5129±62

Back in the middle of the 20th century, Kamyana Mohyla 1 was considered one of the main sites that represent the Steppe Neolithic of the region, featured with evidence of the local origin of cattle domestication and pastoralism. From the zooarchaeological study, mammals here were considered by researchers as domestic ones (Pidoplichko 1959: 54—55; Danilenko 1969: 12, 178). However, recent studies showed no signs of the reproductive economy or pastoralist habitation here. The only classical "Neolithic marker" presented here is the pottery's appearance (fig. 2.25). However, only several potsherds were extracted from "Neolithic" layers of Kamyana Mohyla. They alone are not generally indicative of this occupation as a Neolithic one.

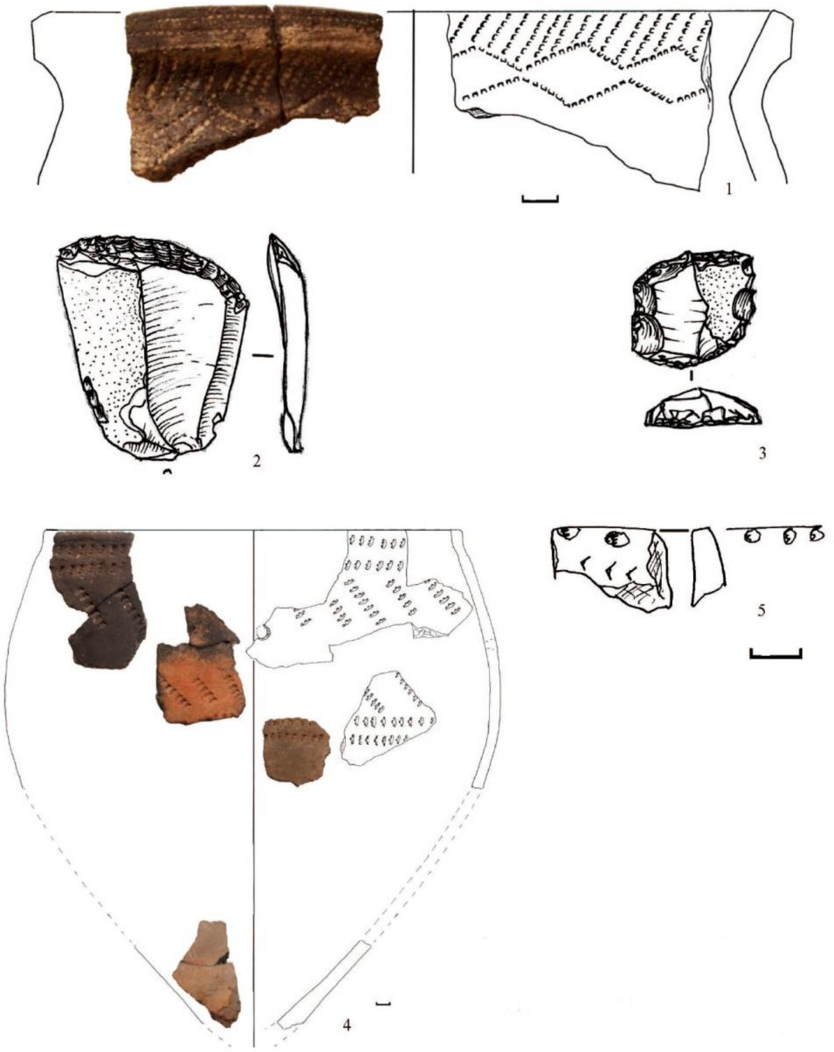


Fig. 2.25. Kamyana Mohyla 1. Finds, attributed to Azov-Dnipro culture (1—3) and Sursky culture (4—5) (after Kotova et al. 2017a: fig. 10)

The issue of defining the Neolithic here is complicated because "none of the complexes combining pottery and tools of "Kukrek cultural tradition" is homogenous. Each can be doubted on taphonomic grounds. So, the exact relation of "Kukrek cultural tradition" and the earliest pottery in the Meotic region is still to be clarified. Hopefully, further work on the layer C of the Kamyana Mohyla 1 site will shed additional light on the issue" (Kiosak et al. 2022: 108). Such heterogeneity is also a case of layer C of Kamyana Mohyla 1 — the lithic assemblage might be considered a "Kukrek cultural tradition" and Sursky culture one (fig. 2.26). On the one hand, this makes it a perfect representative of the overall situation in the region; on the other hand, the issue of its attribution remains complicated.

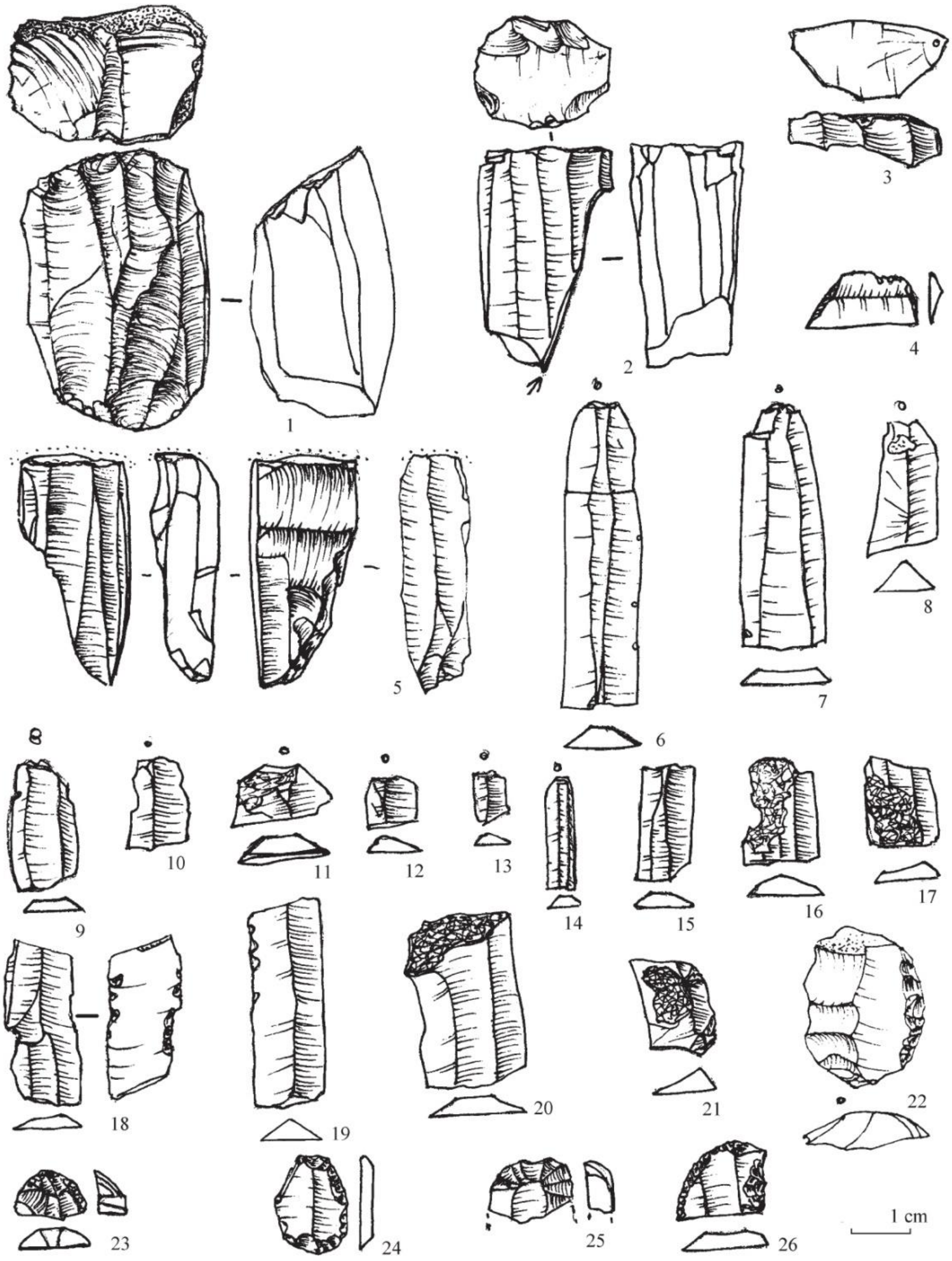


Fig. 2.26. Kamyana Mohyla 1. Finds, attributed to Sursky culture (after Kotova et al. 2017a: fig. 11)

Kamyana Mohyla 1 is not the only Neolithic site in the nearest surroundings of Kamyana Mohyla. The surface survey and sporadic excavations of the other sites nearby also yielded traces of Neolithic occupation. I.e., the settlement of Sekiz 2 has been attributed to Azov-Dnipro culture based on the observation of 159 flint tools and pottery fragments (Dzhos 2019: 15). Similarly, one of the layers of Sekiz 4 might be considered as Late Neolithic one based on the observation of 45 flint tools (Dzhos 2019: 16).

In general, Neolithic sites of the region are concentrated on the banks of large rivers. While the Molochna River is comparatively small (though in the 18th it was reported as navigable), the Dnipro River is one of the largest in Europe. Therefore most of the Neolithic sites of the region are gathered along Dnipro rapids (fig. 2.27). They are attributed to one of the two 'Neolithic' cultures of the Dnipro steppe region. At present, three chronological groups of sites are distinguished (Kotova 2018: 48) for each of these cultures. Their chronology has been recently examined and re-established by N. Kotova based on multiple dates received in Kyiv, Poznan, and Oxford facilities (see table 2.6).

Moreover, the abundance of Mesolithic and Neolithic cemeteries near Dnipro rapids provides many essential data sources for analyzing ancient DNA and studying population dynamics. The chronologically attributed Ukrainian Mesolithic population indicates intermediating between the Eastern Hunter-Gatherers population and Mesolithic hunter-gatherers from Scandinavia (Mathieson et al. 2018: 198). Though this population experiences some admixture with Western hunter-gatherers during 6200—4600 BCE, the dominant component of their ancestry remains local. "In the lower Dnipro Valley region in Ukraine, the direct descendants of the Mesolithic population continued being the dominant group for thousands of years after the start of the European Neolithization, and the end of this continuity was associated with the Eneolithic/Bronze Age migration wave from the East. Hence, we conclude that the Dnipro Valley region's Neolithic cultural innovations, such as the adoption of pottery (further from pointed-bottom vessels to flat-bottomed ones), pioneer animal husbandry (cattle, pig, sheep & goat, agriculture, e.g., barley) and the changes from contracted to extended supine burials were not associated with gene flow from Anatolia, as was the case for most the regions located further west" (Matilla et al. 2022).

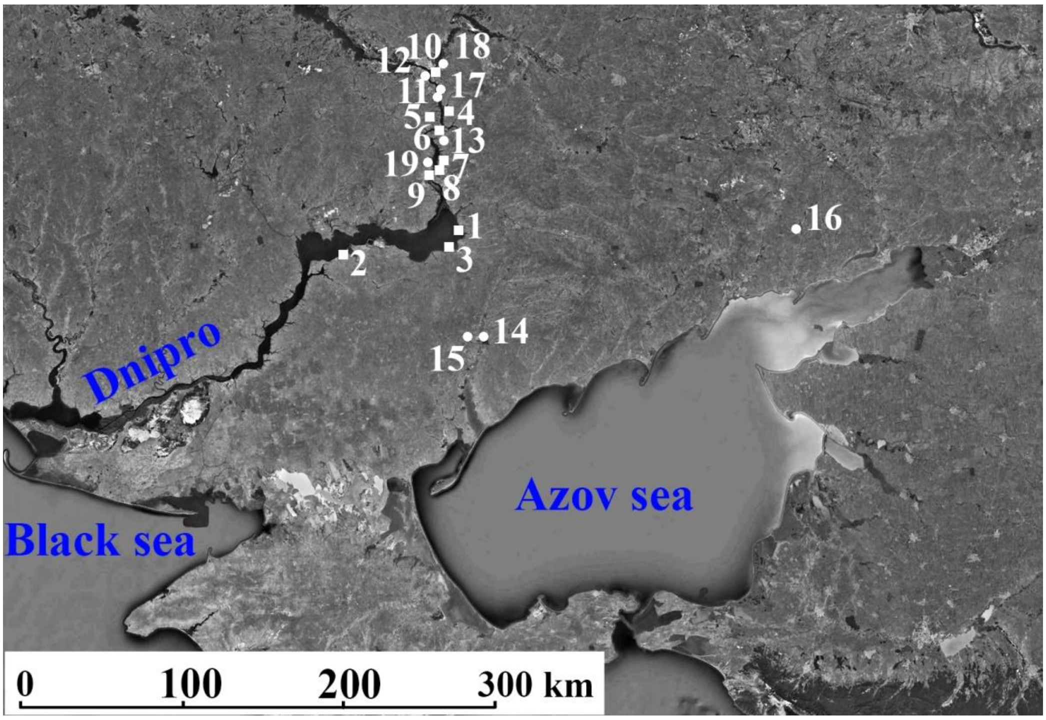


Fig. 2.27. Neolithic sites of Sursky and Azov-Dnipro culture in Ukrainian Steppe. Burial sites marked with squares, while settlements — with circles. 1 — Vasylivka; 2 — Mamai Gora; 3 — Lysa Gora; 4 — Kizleviy; 5 — Mykilskiy; 6 — Vovnygy; 7 — Yasinovatovka; 8 — Vilnyanka; 9 — Sobachki; 10 — Chapli; 11 — Sursky island; 12 — Kodachok; 13 — Vynogradny; 14 — Kamyana Mohyla; 15 — Semenivka; 16 — Razdolnoe; 17 — Strilcha Skelya; 18 — Igren-Gorodok; 19 — Vovchok (1—3 — after Kotova 2018; 4 — after Kotova & Tuboltsev 2013; 5—9 — after Haskevych 2020, fig. 1; 10—12 —after Kotova 2009; 13—15 — after Telegin 1968, fig. 1; 16 — after Kotova et al. 2017b; 17—19 — after Kotova 2018).

Table 2.6. Old and adjusted dates for the Azov-Dnipro and Sursky culture (after Kotova 2018: table 6)

Azov-Dnieper Culture	Surskoy Culture	CalBC	
		Old dates	Dates adjusted for the reservoir effect
	Period 1	6300/6200-5900	6300/6200-5900
Period 1a	Period 2a	5900-5750	5900-5750
Period 1b	Period 2b	5750-5200	5750-4900
Period 2	Period 3	5200-4750	4900-4700

Though these cultures are classically considered as 'Neolithic' and linked to the early appearance of agriculture and pastoralism (VII millennia BC) with "ceramization" of the region (Kotova 2003; Kotova 2004), there is general concern about the reliability of evidence for that. D. Kiosak considered the relevant evidence regarding the neighboring Bug-Dniester culture (Kiosak 2019: 106—118). The latter used to be considered an Early Neolithic society in Southern and Southwestern Ukraine. However, recent zooarchaeological studies have not found signs of domesticated animals on Bug-Dniester sites (Benecke 1997; Wechsler 2001). The same might be stated in the evidence of agricultural practices. Probably, the statement of G. Motuzaite-Matuzeviciute on the emergence of domesticated plants in Ukraine together with the bearers of Linear Pottery Culture is correct (Motuzaite-Matuzeviciute 2012; Motuzaite Matuzeviciute 2014; Motuzaite Matuzevi-ciute et al. 2015; Motuzaite-Matuzeviciute, Telizhenko 2016). This idea emphasizes the absence of clear evidence of the reproductive economy of Sursky and Azov-Dnipro culture sites and Kamyana Mohyla 1 in particular.

Considering the issue of the Ukrainian Steppe Neolithic, Dmytro Kiosak reasonably argues that the "Neolithic way of living is not only domesticated animals and plants" (Kiosak 2019: 117). It is instead a complex of interconnected features — a settled way of living, sustainable houses and constructions, settlements, and the considerable evidence of religious beliefs of a particular type (Whittle 1996). These features are somewhat absent (or not yet discovered) in the Ukrainian Steppe Neolithic. Furthermore, ceramic complexes there are instead left by mobile hunter-gatherers and fishers, whose way of life was sufficiently different from the early farmers who inhabited neighboring territories (Kiosak 2019: 117—118).

Dmytro Kiosak suggests describing their life mode through the term "para-Neolithic," which has been used for the societies of Northern Europe and the Baltic Sea basin (Kempisty 1982; Kobusiewich 1999; Nowak 2007). He considers para-Neolithic an excellent term to describe the societies of hunter-gatherers that are familiar with pottery and co-exist with classical Neolithic societies. Viewed this way, the representatives of Sursky and Azov-Dnipro cultures that inhabit the vicinity of Kamyana Mohyla should be instead called para-Neolithic than Neolithic (Kiosak 2019: 118).

This would also explain the absence of clear signs of Neolithic inhabitation of the region, significant and long-existing settlements, and rock art specimens that might be attributed to the Neolithic "way of living," "Neolithic worldview," or "Neolithic artistic manifestations." According to Emmanuel Anati's postulates on the typology of rock art, "universal reflections conditioned by way of life influence behavior, thought, ideology, associative processes, and consequently artistic manifestations" (Anati 2019: 19). Therefore, the absence of Neolithic rock art might be reasoned with the lack of the societies of pastoralists, farmers and groups with a complex economy. Instead of them, the surroundings of Kamyana Mohyla were inhabited and featured by para-Neolithic societies, so their artistic manifestations are what we can expect to find in the caves of Kamyana Mohyla. However, determining what these manifestations would look like requires further archaeological and rock art research.

2.2.4. Kamyana Mohyla during Eneolithic and the Bronze Age

The next abrupt change in the prehistory of Kamyana Mohyla is related to the beginning of the Eneolithic. At that time, a new set of archaeological cultures emerged between Dnipro and Don based on Surska and Dnipro-Donets Neolithic cultures. The largest entity, Seredniy Stih culture, is considered to be a part of the bigger Khvalynsko-Srednestogovslaya cultural entity (Klejn 2015; Kotova 2016:

121). At this point, the massive Eastern impacts appear in the archaeological landscape of the region. The representatives of the Early Eneolithic Seredniy Stih culture as well as its descendants (namely Dereïvka, Skelyanska, and Kvityana cultures), are considered to be pastoralists, hunters and partially farmers (Telegin 1973; Kotova 2006). The population of this culture is considered to be mixed and connected to local 'Neolithic' (Sursky) and Nizhnedonskaya cultures (Kotova 2006). Sometimes they are discussed as related to the origination of Indoeuropeans (Rassokha 2007).

Innovations brought by Seredniy Stih culture include the spread of the first metallic tools, the crouched posture of the buried, and the use of stones in the burial constructions (Kotova 2014: 66). At this point, the first kurgan burials are also appearing.

The Middle Eneolithic occupation is presented by the sites of the Dereïvka culture sites, which is considered a descendant of Seredniy Stih (Kotova 2013).

To sum up, the Eneolithic map of the region has featured the settlements and burials of Seredniy Stih culture and the second period of Azov-Dnipro culture (fig. 2.28) during Early Eneolithic and multiple sites, mainly of Dereïvka culture (fig. 2.29) during the Middle Eneolithic. These have been analyzed, described, and published in detail by N. Kotova (2008 and 2013, respectively).

The Eneolithic period marked the first signs of agricultural practices brought to the region by the representatives of the so-called "Steppe Trypillia" (Zaliznyak 2017: 20). They are associated with the burials of Zhyvotylivsko-Vovchanskiy type and dated back to the IV millennia BC. These burials are found in the North Azov and North Black Sea regions and featured with Trypillian pottery. According to Yu. Rassamakin (2004a) states they were constructed by late trillions, who were forced to migrate under the pressure of the arrival of new agricultural societies to Western Ukraine. When they appeared in the Steppe zone, they were forced to practice transhumance and farming, transferring their knowledge to representatives of the Mariupol, Skelya, and Kvityanka cultures (Zaliznyak 2017: 20).

Artifacts and sites attributed to other contexts are noticed from time to time with the attribution to Lower Mylhailivka culture, Repino culture, Rogachyk culture, etc., but none of them were found in the Kamyana Mohyla nearest surroundings (see Kotova 2013; Kotova et al. 2017b).

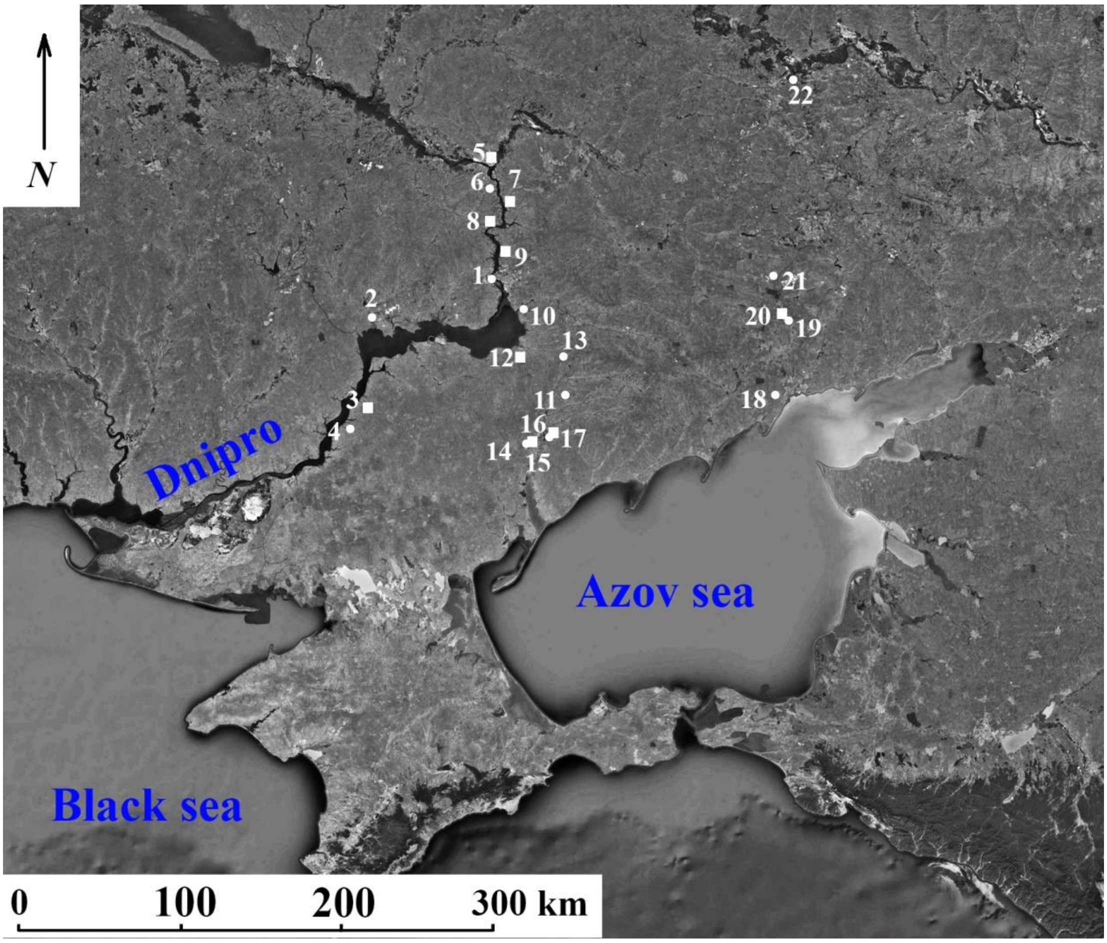


Fig. 2.28. Early Eneolithic sites of the region. Circles mark Seredniy Stih sites, while squares — the sites of the second period of Azov-Dnipro culture. 1 — Seredniy Stih, Sobachki, Vovchok; 2 — Kut, Zolota Balka; 3 — Kairy; 4 — Nizhniy Rogachyk; 5 — Igren and Capli cemeteries; 6 — Kodachok; 7 — Strilcha Skelya; 8 — Vovnygy and Yasinovatovka sites; 9 — Vynogradny; 10 — Petro-Svitsunovo; 11 — Vynogradne, kurgan 3; 12 — Lysa Gora cemetery; 13 — Novodanilovka cemetery; 14, 15 — Semenovka; 16, 17 — Kamyana Mohyla; 18 — Mariupol cemetery; 19, 20 — Rasdolnoe; 21 — Donetsk; 22 — Yama cemetery (after Kotova 2008: fig. 1)

These cultures remain numerous signs of presence near Kamyana Mohyla. Though most sites here are known from the preliminary surficial survey, they might provide a basis for some preliminary conclusions. Several settlements nearby the Hill sites contained traces of Eneolithic occupation: Sekiz 2, Sekiz 3, Sekiz 4, Sekiz 5, Kamyana Mohyla 1, Kamyana Mohyla 2, Kamyana Mohyla 3, Kamyana Mohyla 5, Kamyana Mohyla 6 (fig. 2.8).

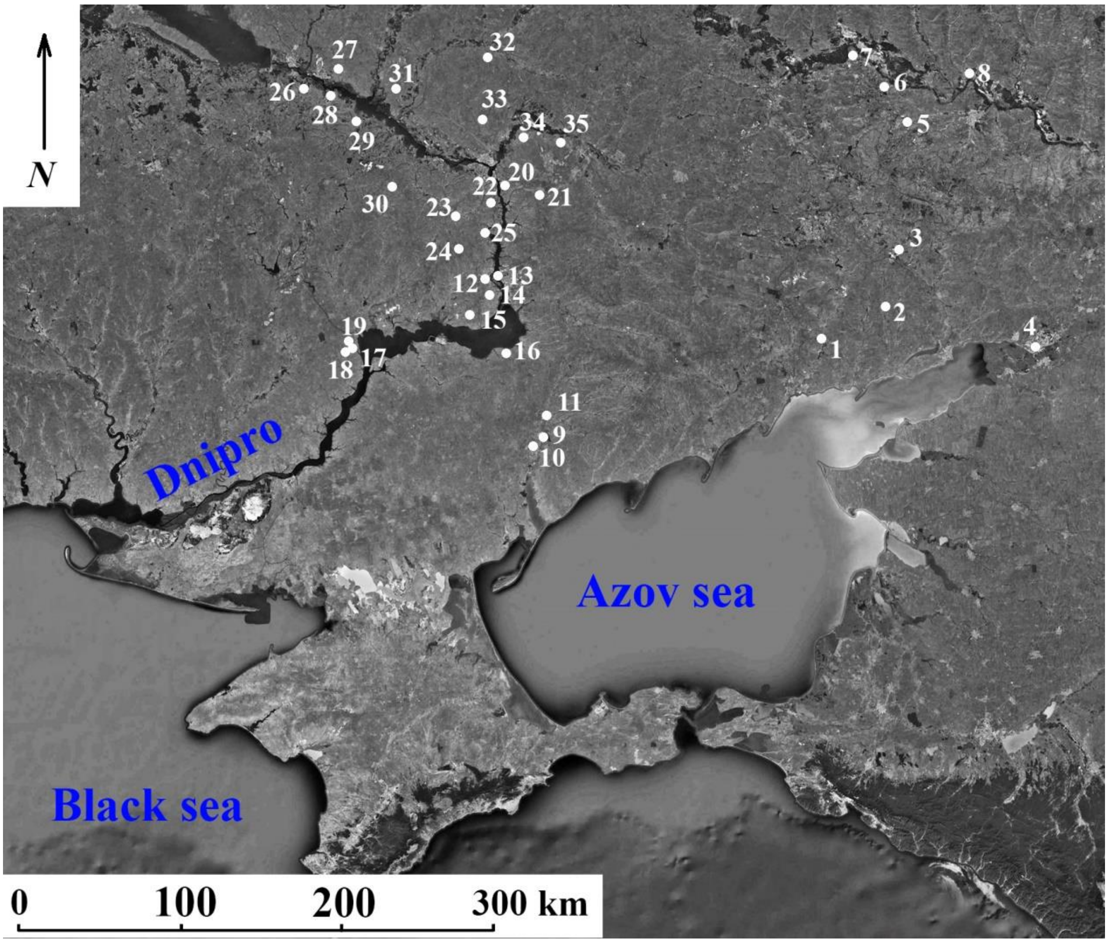


Fig. 2.29. The Middle and Late Eneolithic sites of North Azov Sea region. 1 — Bugaevo, Chereshnevoe; 2 — Razdolnoe; 3 — Vysokoe; 4 — Leventsovka; 5 — Oktyabrskoe; 6 — Minevsliy Yar; 7 — Verevkinsie hutora 14; 8 — Aleshyn ruchei, Nadterassnoe, Podpesochnoe, Serebryanskoe, Sosnovaya roscha, Chernikovo ozero 1—3; 9 — Kamyana Mohyla 1 and 3; 10 — Semenivka 1; 11 — Vynogradne; 12 — Pohyliy, Vynohradniy, Vovnyzhske pravoberezhne; 13 — Yasynovativske cemetery; 14 — Vilno-Hrushevka; 15 — Avgustinovka, Hortytsia, Kichkas, Soloviina roscha, Sobachki; 16 — Kamyanka Dniprovska; 17 — Zolota

balka; 18 — Mykhailovka; 19 — Osokorovka; 20 — Ihren cemetery; 21 — Bohuslav; 22 — Mayorka; 23 — Novooleksandrivskiy; 24 — Ust-Kamenka; 25 — balka Kvityana; 26 — Kamyani potoky; 27 — Pidlyzhne; 28 — Uspenka; 29 — Dereïvka; 30 — Mlynok; 31 — Orlyk; 32 — Buzovka; 33 — Verkhnya Maivka and Spasske; 34 — Kabaky; 35 — Bulakhovka. (after Kotova 2013: fig. 1)

The materials from the settlements nearby are mainly collected from the surface and studied in a separate study. The assemblage from Sekiz 2 is considered to belong to the Seredniy Stih culture. The excavations in Sekiz 3 and Sekiz 5 presented a set of materials that were considered as ones from the Dereïvka Eneolithic culture (Dzhos 2019: 15—16), while Sekiz 4 yielded the assemblage from both cultures in different planigraphic positions.

Same as for the Mesolithic and Neolithic occupations, the most informative and reliable results are received from the excavation of Kamyana Mohyla 1. The layer of Seredniy Stih culture presents the Early Eneolithic occupation of Kamyana Mohyla 1. The radiocarbon analysis of the cattle jaw returned the date 4044—3801 cal BC with 95.4 % probability (Poz-51305). The Middle Eneolithic layer is considered to belong to the Dereïvka culture (Kotova et al. 2017a: 24; Dzhos 2019: 18). These materials from layers included "fragments of unornamented pottery, in which shell had been added to the clay, a few flint tools, and animal bones. An assembly of bones in square 4, mostly domestic horse bones, appeared to belong to this layer (fig. 9: 6). the upper horizon of the layer, containing middle Eneolithic material, has been dated by a radiocarbon date, obtained on a fragment from the jawbone of a domestic ox, to around 4000—3900 calBc" (Kotova et al. 2017: 33).

The assemblage from the settlement of Kamyana Mohyla 2 has been attributed to Early Eneolithic during the excavation made by V. Danilenko. He considers them to belong to the second period of Azov-Dnipro culture (1986: 44).

After the excavations on the multilayered settlement of Kamyana Mohyla 3, the Eneolithic layer there has been attributed to Dereïvka culture (Dzhos 2019: 19). The materials from Kamyana Mohyla 5 and Kamyana Mohyla 6 is provided from the surface materials. It remains unclear, though Dzhos (2019: 20) describes them as settlements that yielded some traces of Eneolithic occupation.

The burial sites in the surroundings of the Hill are excavated sporadically, so their chronological and cultural attribution is to be defined in the future. Similarly to the small area around the rock art location, the whole vastness of the Ukrainian steppe is featured with many kurgan sites. The detailed survey in two districts of Zaporizhzhya oblast (North Azov Sea region) indicated more than 8000 kurgans spread across the land (Tuboltsev 2020, personal communication). These might be attributed to the extended time from the early Eneolithic to the Late Medieval Age. Moreover, most of these sites are usually multilayered and feature burials made by distant cultural groups.

While the minority of kurgans nearby the Hill were excavated and studied, some are considered Eneolithic. The kurgan on the southern edge of Terpinnya village revealed the cenotaph that is regarded as an Eneolithic (fig. 2.8: 15, Dzhos 2021: 27) due to the flint point found in a grave. In the same way, B. Mykhailov attributed one of the burials nearby Melitopol (20 km from Kamyana Mohyla) to Eneolithic Maykop culture based on the flint assemblage (Mykhailov 2006b). The relation to Maykop points out one more line of connection between the region and the Eurasian Steppe belt. Moreover, it is noticeable due to the sandstone blocks that were probably transferred more than 25 km from Kamyana Mohyla to create the burial. Stone blocks from Kamyana Mohyla have also featured the ground burial, studied by B. Mykhailov in 1997 (Mykhailov 2006c). This one included three burials attributed to the III mill's beginning. BC.

The eastern line of interpretation arises not only due to the connection of the local archaeological context with the Maykop material culture but also due to the pastoralist and nomad migrations from the east. Eneolithic groups (Eneolithic of Kamyana Mohyla vicinity is generally presented by artifacts of the Dereivka culture) of that time originate mainly on a regional basis, although they are strongly linked with the Eneolithic of the North Caspian Sea region (the

Khvalynskaya culture or Khvalynsko-Srednestogovskaya cultural group) (see Telegin 1973; Kotova 2013; Klejn 2015).

The Eneolithic inhabitation of Kamyana Mohyla's surroundings is of particular interest for the rock art research of the site as it is the only case of archaeological assemblage being discovered and recorded right in the rock art location. A group of flint, stone, and ceramic materials was found during the excavation of the Bull's cave (Danilenko 1986: 71—73). Unfortunately, no stratigraphic context was reported. However, this asset of flint and stone tools and a few pottery fragments were attributed to Eneolithic Seredniy Stih culture and formed strong evidence for the attribution of the petroglyphs from the cave to the Eneolithic (fig. 2.30). Though this does not indicate the inhabitation of the site, it provides the connection between the particular archaeological artifacts and rock art objects that are missing for many caves on the site.

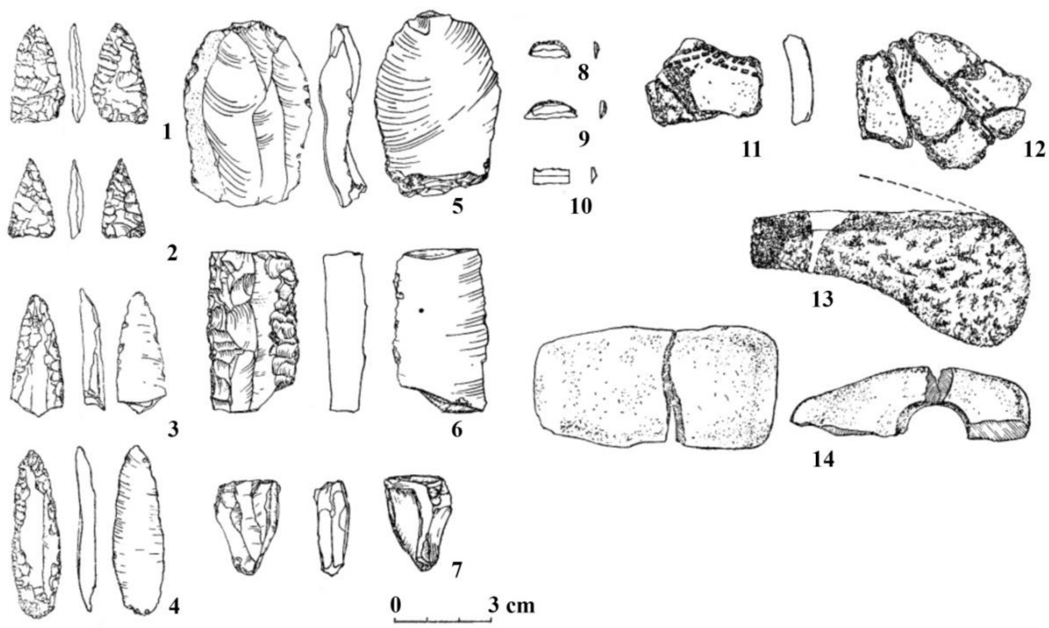


Fig. 2.30. The flint tools (1—10), pottery fragments (11—12) and stone tools (13—14) found inside the Bull cave (after Danilenko 1986: fig. 22, 24)

Despite Eneolithic materials in the Bull’s cave, the attribution of rock art remained a long discussion that lasted since the 1930ies. In the 21st century, the demise of main rock art scholars involved in the topic naturally prevented its prolongation. Still, new data and concepts were recently provided by the digital study of main rock art objects from the cave and the archaeological contexts from the Ukrainian Steppe. The photogrammetric survey of the so-called “Rain Bull” (fig. 2.31) image allowed its possible reconsideration as a hunting scene (Radchenko & Nykonenko 2019: 56).

This work was an additional reminder of the digital recording relevance compared to the old rock art records provided by V. Danilenko and B. Mykhailov. Neither could they identify the natural cracks in the stone surface nor produce reliable drawings of the image. Moreover, the ocher painting of the block was, according to the information provided by the museum workers, renovated to correspond to the pictures made by V. Danilenko, which means the relief of the block is the only reliable source of information regarding the rock art object and digital recording — the best way to receive the abstract and accurate image of this block.

As presented by the engravings from the Bull’s Cave (see Radchenko & Nykonenko 2019), the rock art of Kamyana Mohyla meets numerous analogies in the Caucasian region and Central Asia (see Clottes 2011), including Kazakhstan (Baypakov et al. 2005; Maksimova, Ermolayeva and Maryashev 1985; Herman 2011), Uzbekistan (Khuzhanazarov 1995), etc. B. Mykhailov frequently refers to the rock art of these regions (fig. 2.32 and Fig. 2.33). The most famous of the Kamyana Mohyla engravings of Eneolithic — Early Bronze Age date is the abovementioned “Rain Bull.” This petroglyph, as well as the others from the Bull Grotto, was produced by the abrasion of the whole surface of the image, which is characteristic for this group and period but shouldn’t be the sole line of evidence relied upon for dating and requires additional proof. According to B. Mykhailov and our recent studies, these bulls belong to Eneolithic and find numerous analogies in the rock art of Kazakhstan (for details, see Radchenko & Nykonenko 2019) and Central Asia in general. Recently one more bull’s engraving, similar in terms of engraving technology and the creature’s general appearance, has been contextualized in Ukrainian Steppe to the west from Kamyana Mohyla (Daragan, Polin & Svoyski 2021).

Fig. 2.31. An image of so-called "Rain Bull", considered by V. Danilenko as one depicting a mammoth

Describing the rock art of Kazakhstan in general and its most exciting locations (namely Tamgaly, Eshkiolmes, Akbaur, Karasay, etc.) in particular, Z. Samashev refers to Kamyana Mohyla noting the technical and functional similarities of some rock art examples with the rock art of Toleubulak (Samashev 2006, 22). Indeed, among the rock art collection, he interprets, there are a lot of similar engravings — primarily the long-horned bulls or horses, wagons dated to the period from Early Bronze Age to Iron Age, etc. Some linear ornaments and lattices can be considered similar, too (Samashev 2006, 34—95). Further on, Samashev points out the similarities between Iron Age Sarmatian tamgas from Kamyana Mohyla with the ones from Kazakhstan. However, while the rock art of the Eneolithic — Bronze Age period has much in common in these locations, the rock art of the historic age appears to be quite different. In addition, Kamyana Mohyla seems to be relatively poor for the engravings of the Late Iron Age.

Fig. 2.32. Location map of the Bulls' analogous to the Rain Bull engraving from Kamyana Mohyla. 1 — Kamyana Mohyla; 2 — Velikaya Aleksandrovka; 3 — Maykop mound; 4 — Sauyskandyk; 5 — Terekty-Auliye; 6 — Arpa-Uzen'; 7 — Kuljabasi; 8 — Karasay; 9 — Chokpar; 10 — Karakyr; 11 — Tamgaly; 12 — Akkaynar; 13 — Eshkiolmes (after Radchenko & Nykonenko 2019).

Following B. Mykhailov, Z. Samashev refers to ethnographical and mythological sources of Central Asia (Gryaznov 1977; Butyan 2003; Meletynskiy 1975; Mykhailov 2002; Rigveda 1974; Toporov 1979) to provide the interpretation of Kazakhstan petroglyphs. While his book remains the most complete collection of Kazakhstan rock art sites, there is other research on that topic. Unfortunately, Samashev, nor any other Central Asian rock art researchers, did not mention any sign of portable rock art collections (the only stone that could be portable is not described as an example of mobile art). Elena Miklashevich (2011, 128) reports on 'quite a few small slabs taken to the museums' from Oglakhty VI, though she does not mention the initial portability of these objects.

Taking into account the poor level of dissemination and publication of the portable art from Kamyana Mohyla, Olgahty VI, and Gobustan, one might assume that the mobile rock art collection is presented in Eurasian Steppe rock art but remains unknown, unpublished, or still waiting for their discovery.

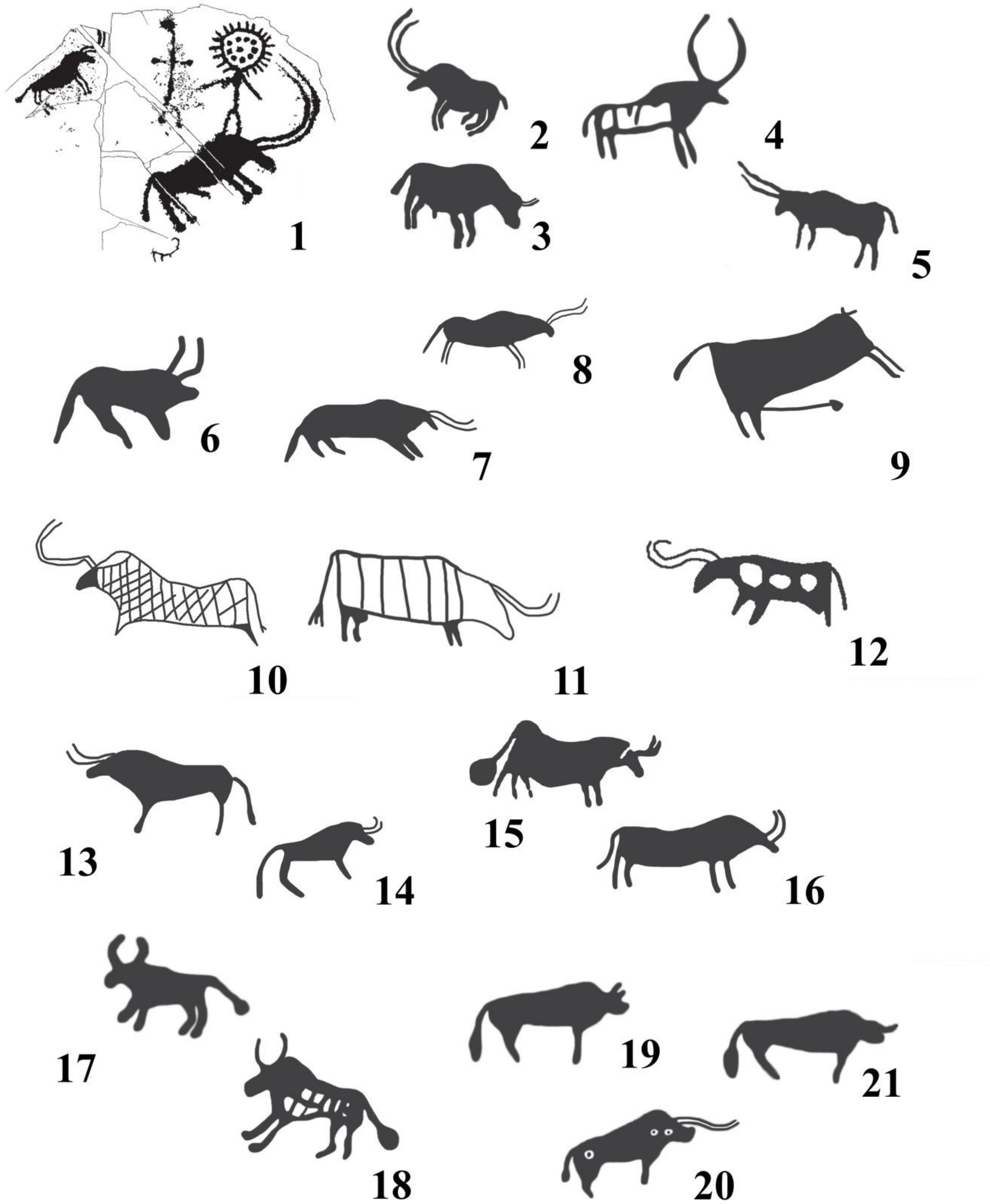


Fig. 2.33. Bull images in Central Asian rock art. 1 — Image of Bull together with "solar-head" deity, Tamgaly (after Rogozhynsky 2011: 188, fig. 151: 7); 2, 3 — after Rogozhynsky 2011: 301, fig. 251); 4, 5 — Eshkiolmes (after Baypakov et al. 2005); 6 — Arpa-Uzen (after Avanesova, Sajdullaev & Erkulov 2001); 7, 8 —

Akkaynar; 9 — Karakyr; 10—12 — Kuljabasi; 13—14 — Terekty-Auliye; 15—16 — Chokpar; 17, 18 — Karasay; 19—21 — Sauyskandyk (7—21 — after Radchenko & Nykonenko 2019, fig. 13)

During the Early and Middle Bronze edge, large groups of semi-nomad pastoralists of Yamna, Katakombna, and Babyno cultures inhabited the North Azov Sea region. At the same time, the Late Bronze Age featured an abundance of settlements, mostly belonging to the Srubna and Sabatynivska cultures. Due to this abundance of sites and the absence of their direct connection to the rock art of Kamyana Mohyla, further, I describe only those in the nearest surroundings of the sites and particularly affecting its archaeological context.

There are several settlement sites of Yamna culture on the rapids of the Dnipro River (Kaiser et al. 2020). However, in general, they are relatively rare in the archaeological landscape of the region and are a complicated phenomenon overall (Radchenko & Tuboltsev 2019). Moreover, the settlements of Yamna culture are relatively rare archaeological sites. Based on radiocarbon dating, Elke Kaiser considers Early Yamna culture to occupy the time lap of 3400—3000 calBC (Kaiser 2019: 34) and be synchronic with Late Maykop, while classical Yamna culture is attributed to 3000—2350 calBC. Surprisingly enough, the results she obtained from 14C radiocarbon dating contradict the established periodization of the Bronze Age of the Ukrainian Steppe (fig. 2.34) and attributes Katakobna culture presence in the same time lap as Yamna (Kaiser 2019: 58). The situation in the vicinity of Kamyana Mohyla fits both to that attribution and periodization. The sparse assemblage of the Early Bronze Age of Kamyana Mohyla 1 included "featureless ceramic fragments, without ornamentation … bones of cattle, domestic horses, pigs and sheep, and bones which may be those of either sheep or goats. The bones of red deer represented wild animals. Fragments of tortoiseshell were also found" (Kotova et al. 2017a: 31—32). Radiocarbon dating returned the date 3502—3105 calBC with 95.4 % probability (pig bone, Poz-51466).

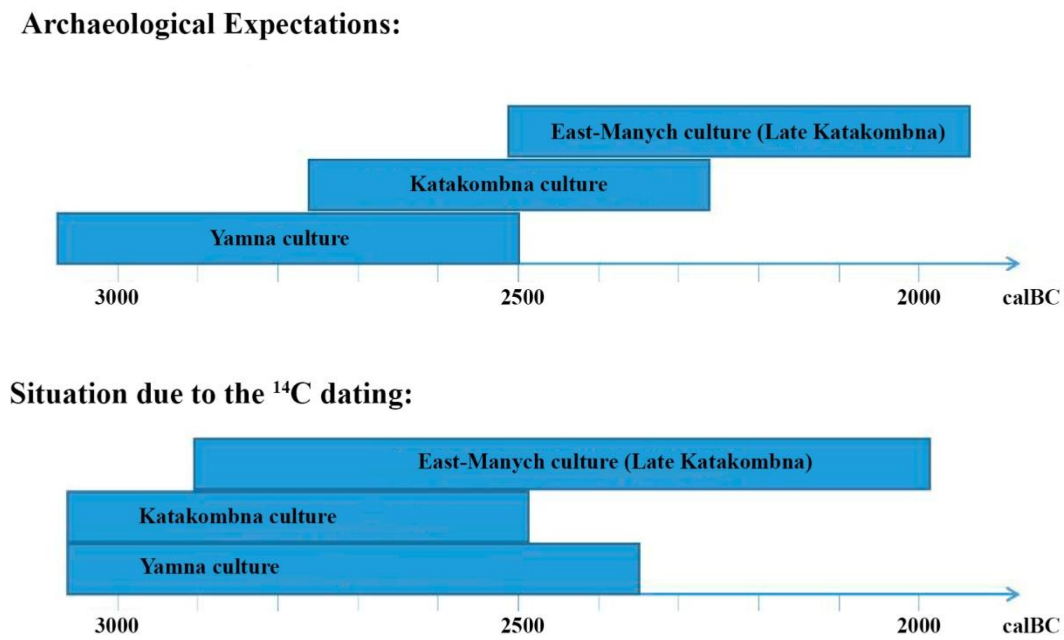


Fig. 2.34. The difference between archaeological and radiocarbon dating of the Early Bronze Age cultures in South-eastern Europe (after Kaiser 2019: 58, fig. 26)

The collection of surface materials on the Sekiz 3, Sekiz 4, Sekiz 5, and Kamyana Mohyla 5 sites yielded several flint tools and pottery fragments attributed to Yamna culture (Dzhos 2019: 16).

The burial sites of this culture are much more abundant here. This includes the unique surface grave excavated during the 2017 field season (Kotova et al. 2020; Makhortykh et al. 2020). The grave was featured by two ritual complexes that include the cattle skull and bones and an upside-down vessel, considered to belong to Yamna or Katakombna cultures (the Yamna-Katakombna type used to be considered as transitional between these two, which is peculiar considering the divergence in archaeological and radiocarbon dating). The artifacts from this complex were dated in the Bern radiocarbon facility and returned the interval of 2831—2675 cal BC based on two dates (Makhortykh et al. 2020: 233). Similar stone burials were found in the Molochna river basin before (Rudinskiy 1954: 15; Viazmitina et al. 1960: 116—117; Mykhailov & Mykhailova 1990: 63; 2006: 89). The ritual objects (the vessel and the cattle skull) are also meeting analogies in the region, particularly in the burials of Akkermen' kurgan and the kurgan near the Ushanly River (Viazmitina et al. 1960). Constructions of this kind are known in the North Azov Sea and North Black Sea regions. Typically, to the stone construction on Kamyana Mohyla, the local sandstone from the rock art location was used to create the burial.

Apart from those sites, the surroundings of Kamyana Mohyla are featured with the number of previously excavated kurgans. V. Danilenko reports on excavating the kurgan group in the northeastern part of Chervona Hora that contained all kinds of Bronze Age burials except for Katakombna culture (Danilenko 1947). Kurgans to the west from Novopylypivka were also featured with Bronze Age burials, attributed to the different phases of the Bronze Age (Obolduyeva 1952). Moreover, V. Danilenko reports that the Early Bronze Age horizons of Kamyana Mohyla 1 featured two burials (Danilenko 1947: 68).

Several rock art objects from Kamyana Mohyla were attributed to the Early Bronze Age ones. Sometimes, like in the case of the "Dragon" from the cave No. 55 or the composite being on the block No. 10, this was done through the dubious interpretation of the particular images and motifs through the stories and plots from Rigveda (Mykhailov 2005: 115—139). Some of these interpretations were re-examined and dismounted; others are still waiting for the relevant study. In other cases, the Early Bronze Age attribution might be supported by the analogies from the Yamna culture's artistic manifestation from the region. This has been done for the engravings of wagons from different locations on Kamyana Mohyla and the petroglyph of the sandal (Radchenko et al. 2020). The latter finds several analogies in the stones and stelae of the region (fig. 2.35) and in the parietal art objects from the Rostov region in Russia (fig. 2.36).

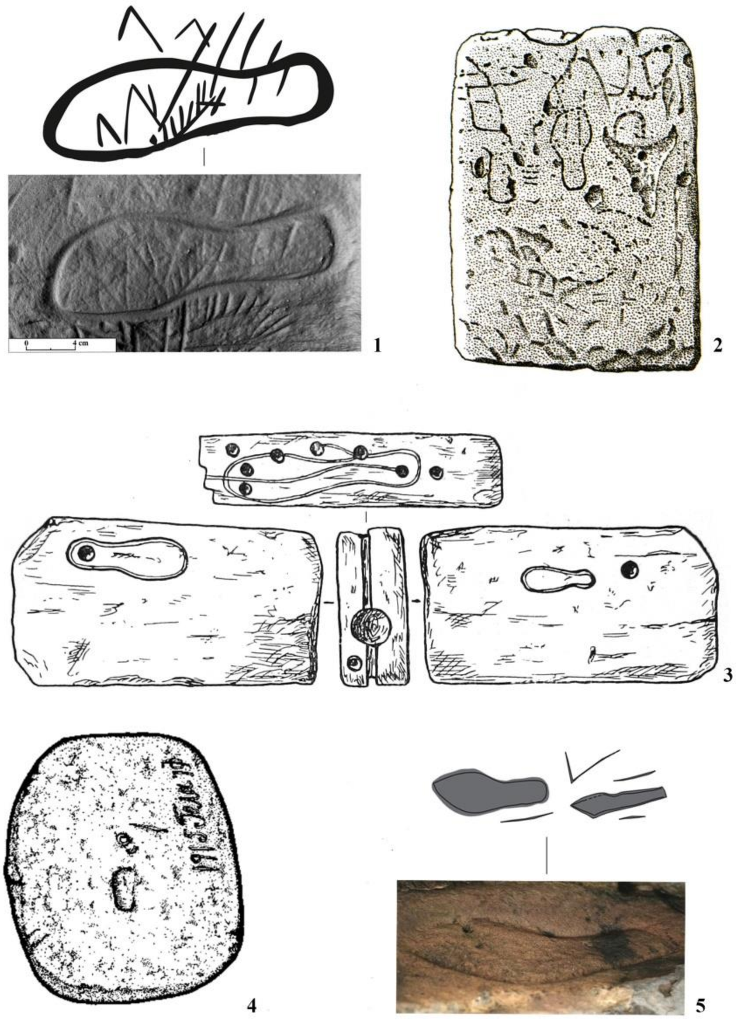


Fig. 2.35. Singular ‘sandals’: 1 — Vishap figure from location No. 55 of Kamyana Mohyla (after Radchenko et al. 2020, fig. 15:1); 2 — burial No. 2 of kurgan 8 near Khrystoforovka, Mykolayivska region (Ukraine) (after Dovzhenko 2009); 3 — kurgan near the Maryino settlement (Crimea) (after Formozov 1969); 4 — kurgan group No. V near the Petrashevka village, Poltavska region (Ukraine) (after Suprunenko 2010); 5 — grotto near the Skelnovskiy village, Rostov region (Russia) (after Kiyashko et al. 2010)

The Middle Bronze Age period nearby Kamyana Mohyla is featured with several burials in the site's surroundings, mainly excavated in 1952 and described by Viazmitina et al. (1960). Apart from that, the settlement of Kamyana Mohyla 2 contained a layer that has been attributed to this period (Danilenko 1986: 12).

Recent excavations performed in 2015—2016 enabled the cultural attribution of that layer to Babyno culture (Dzhos 2016a: 44).

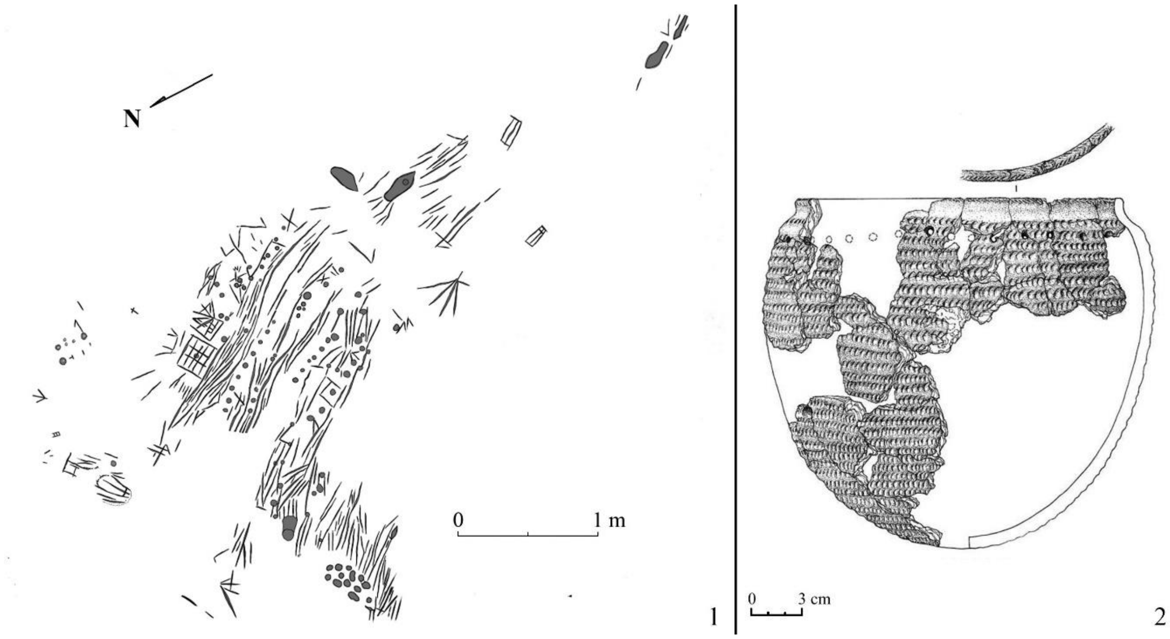


Fig. 2.36. Materials from the Lower Don region: 1 — petroglyphs near Skelnovskiy village; 2 — Yamna culture vessel from grotto near Skelnovskiy village (after Kiyashko et al. 2010).

Besides the burials of the Late Bronze Age found in the kurgans nearby Novopylypivka, the surroundings of Kamyana Mohyla reserve are featured with several settlements of that period. Namely, Late Bronze Age layer was discovered on the site of Kamyana Mohyla 3 by B. Mykhailov in 1989 (Dzhos 2019: 18). The site has been excavated by B. Mykhailov (Mykhailov and Tuboltsev 1991), O. Tuboltsev (1995) and N. Kotova (Kotova et al. 2011). The site has been attributed to Bilozerska culture (Mykhailov & Tuboltsev 1991: 38).

The settlement of Kamyana Mohyla 4 also yielded the Late Bronze Age assemblage attributed to Srubna or Sabatynisvka cultures (Dzhos 2019: 19) and Kamyana Mohyla 6. However, the cultural attribution of the latter is questionable. Sites of this kind are incredibly abundant in the region. Sometimes, we encountered ceramic fragments that probably belonged to the Late Bronze Age when digging household pits for our archaeological fieldwork camps. It is noticeable, though, that the Late Bronze Age was never discussed as a possible attribution for Kamyana Mohyla rock art specimens.

The stone stelae provide the largest asset of artistic manifestations and rock art specimens of the region's Bronze Age and Iron Age. The latter are being discovered in different contexts, but often as a part of burial construction or burial rite, on tops of kurgans, etc. Engravings on them are interpreted and contextualized intensively through the last decades (see Schepynskiy 1973; Telegin 1971; Tonceva 1981; Telegin & Mallory 1994; Smirnov 2004; Vasylenko, Blum & Vetrov 2007; Dovzhenko 2009; Suprunenko 2010; Heyd 2017). The most famous Kernosivsky idol has probably been considered a representation of the Yamna worldview and an essential cultural indicator (Romanchuk 2015). However, the divergence in chronological attribution remains a matter of discussion (Heyd 2017). Borys Mykhailov intensively applies to the Bronze Age stelae in his interpretation and contextualization of Kamyana Mohyla rock art (Mykhailov 2005: 284—287), which seems to be reasonable, taking into account their rich and informative ornamentation and the vast territory of their spread both in Ukraine and beyond (fig. 2.37, 2.38).

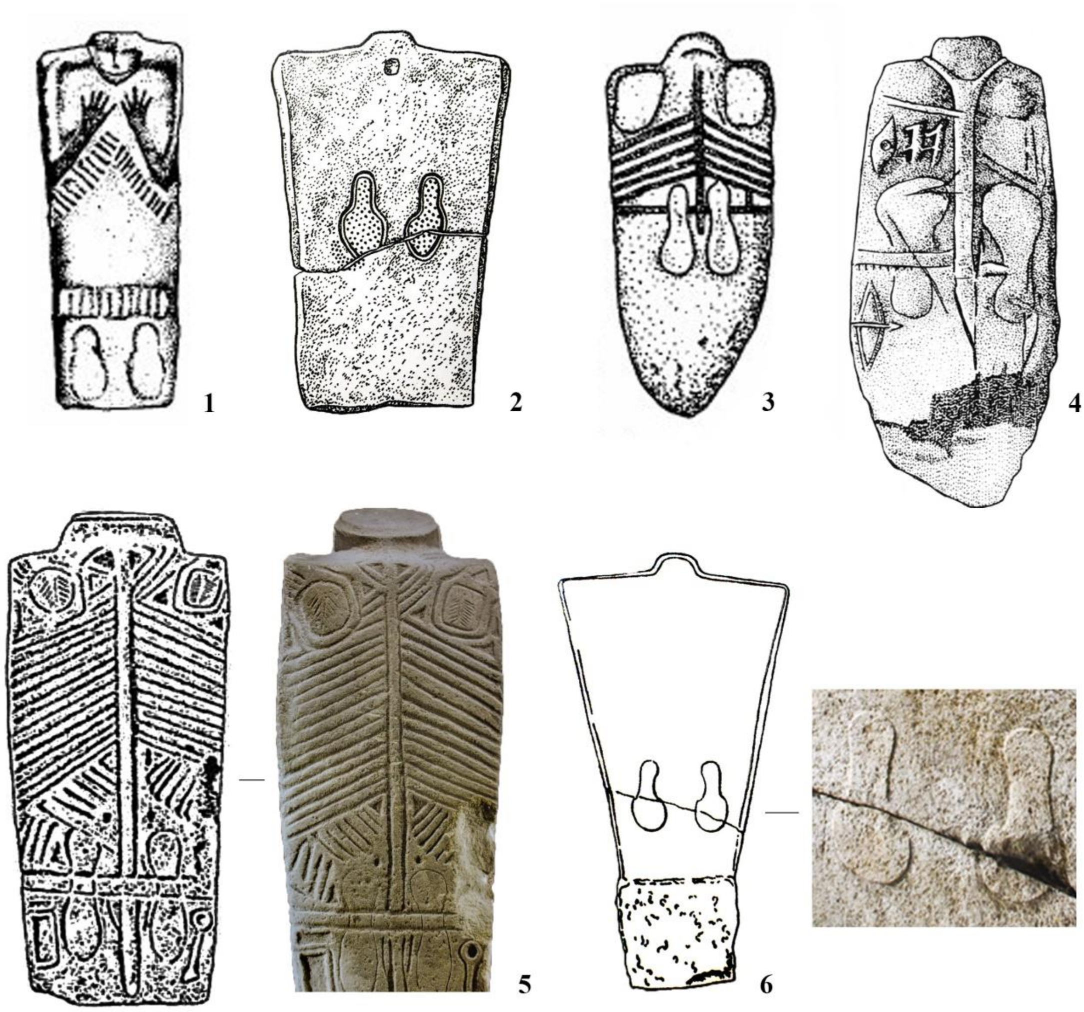


Fig. 2.37. Bronze Age stelaes from Ukrainian Steppe. 1 — Belogrudovka I (after Telegin and Mallory 1994); 2 — tomb 2 of a kurgan 11 near Konstantinovka village, Mykolayivska region (after Dovzhenko 2009); 3 — Novoselovka (after Telegin and Mallory 1994); 4 — Svatovo (after Korenevskiy 1999); 5 — Kernosovo (after Dovzhenko 2009); 6 — burial 18 of a kurgan 4 near Pryshyb village, Mykolayivska region (after Dovzhenko 2009)

Fig. 2.38. Bronze Age stelaes of North Pontic region. 1 — Natalyivka; 2 — Verkhnyoricchya; 3 — Svatovo; 4 — Fedorivka; 5 — Myshkoltz-Fyut'khaz; 6 — Dobrudzha; 7 — Nadezhdino; 8 — Spasske (after Mykhailov 2005, fig. 126, 128, 129)

Last but not least, B. Mykhailov often refers to the Vishap stelae and the rock art of ancient Caucasus when he drew the Eneolithic and Bronze Age chronological attribution to the rock art specimens from Kamyana Mohyla. Indeed, Vishaps from there can be considered both as a reference to fish-connected rituals and Bronze Age myths (Mykhailov 1992; Mykhailov 1993), both depending on the interpretations of the stela itself (Abrahamian 2015; Maar & Smirnov 1931; Narimanishvili, Shanshashvili & Narimanishvili 2015; Piotrovskiy 1939; Petrosyan 2015). However, there are no relevant connections between the rock art images from Kamyana Mohyla and Caucasian sites.

Nevertheless, the region is rich with unique rock art locations which ought to be considered. The largest is the World Heritage Complex of Gobustan in Azerbaijan, including Boyukdash, Kichikdash, and Jingirdash mountains (fig. 2.31). The complex contains abundant imaginary, assigned to an extended period from the Upper Paleolithic to the Medieval period, including anthropomorphic images (Alok, Edmonds & Akgun 2011), faunistic (Dzhafaradze 1999; Schachner 2001; Farajova 2017) and non-figurative depictions (Abdullayev, Shirinli 2020), and has been excavated and studied for a long time (Muradova 2003; Rustamov 2003; Azərbaycan Arxeologiyasi 2008). Similar to the area surrounding Kamyana Mohyla, Parajova reports on the fish cults in the regions surrounding Gobustan's rock art locations (2009: 164—165). The Mesolithic and Neolithic artifacts and rock art complexes here are assigned comparatively well due to the abundant archaeological material in front of the rock art complexes (Rustamov & Muradova 2008). An assemblage of portable rock art objects, i.e., anthropomorphic figures, have been recorded from that complex since the 1970s (Rustamov 1986).

What is much more critical for the current research is that the Gobustan complex and Azerbaijan rock art tradition generally featured portable rock art artifacts — engraved stones. These remain poorly reported in foreign literature, though they are sporadically published by local researchers (see Faradgayeva 2009, 367—368; Muradova 2010). Some of them are found in kurgans and are well-assigned to the Bronze Age (Muradova 2011), while others are in the context of Mesolithic and Neolithic processes in the region (Rustamov & Muradova 2008) or even considered as Upper Paleolithic examples (Rustamov 1990). Portable rock art specimens are also known from archaeological sites in the Absheron Peninsula (see Fig. 2.39: 1). These artifacts are of particular interest as they can provide the comparable dataset for the technological solutions on the photogrammetric modeling of the portable rock art specimens. Though they probably don't share any specific archaeological context with Kamyana Mohyla ones, these stones are the closest portable rock art collection from Asian rock art sites ever reported.

Other rock art sites from Azerbaijan (see, for instance, Aliev 2009), in some cases, refer to the Neolithic and Bronze Age examples of Kamyana Mohyla; however, due to the poor level of visibility, these materials are still to be studied with modern methods and approaches.

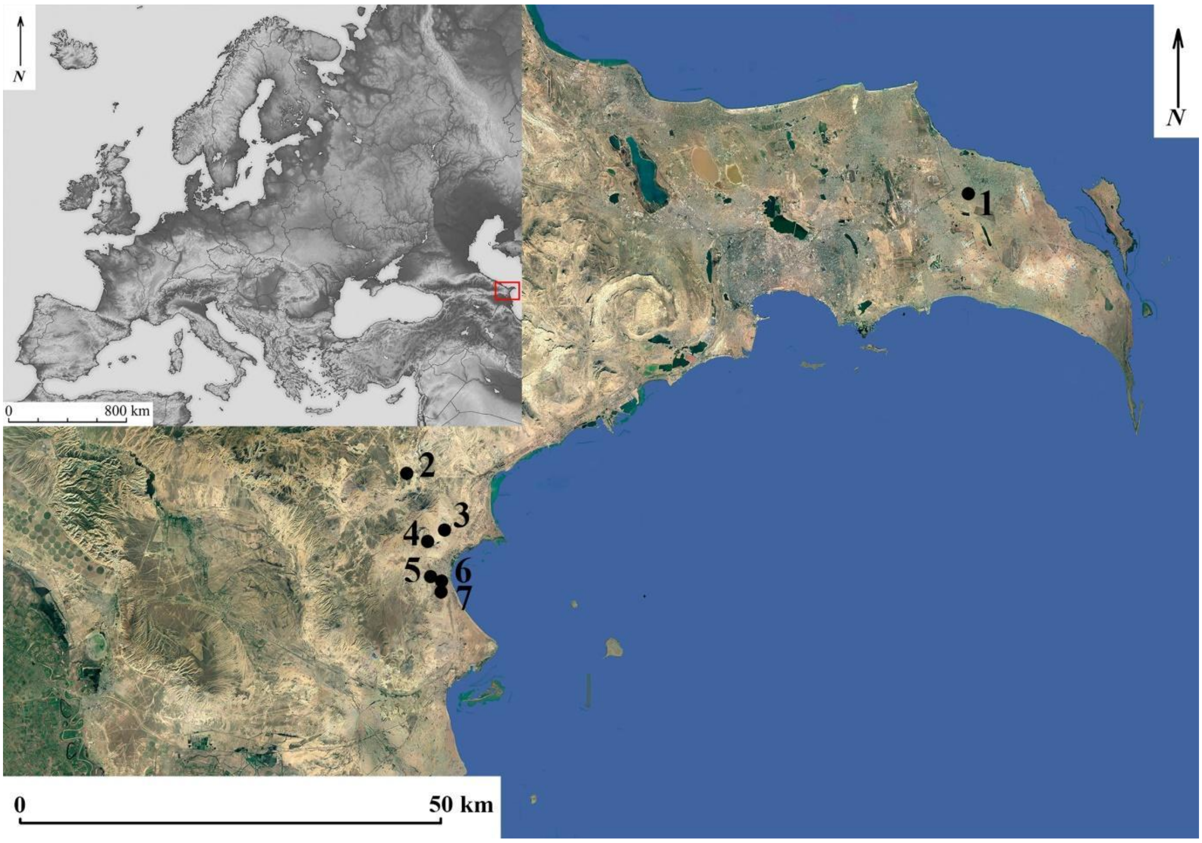


Fig. 2.39. Location map of rock art and portable rock art locations in Azerbaijan, mentioned in the research. 1 — Bendustu settlement, Apsheron (after Schachner 2001: fig. 31); 2 — Jingirdag Mountain (after Farajova 2017: fig. 1); 3 — kurgan 3 in Boyukdash complex (after Muradova 2011: 145); 4 — Boyukdash mountain, Ana Zaga and Kenize sites (after Farajova 2017: fig. 1); 5 — Kichikdash mountain (after Farajova 2017: fig. 1); 6 — Firuz 1 shelter (after Farajova 2017: fig. 1); 7 — Firuz 2 shelter (after Farajova 2017: fig. 1).

2.2.5. Kamyana Mohyla and the Iron Age nomads

Similar to the Bronze Age, the rock art of the Iron Age on Kamyana Mohyla featured impacts and analogies from the Asian part of the steppe belt. This is because the cultural and ethnic groups that are considered to habituate the region are mostly related to the nomadic population of the Eurasian Steppe belt and entered Ukraine from the East. Cymmerians, Scythians, and Sarmatians are among them.

The descriptions of these cultural groups are featured both by archaeological and historical sources — it shows that during most of the I millennia BC the Pontic region (Including the North Azov Sea region) “was inhabited by farmers and pastoralists, as well as Scythian warriors and ‘Royal’ Scythians” (Herodotus [1987]; Melyukova 1995; Mozolevskiy 2005; Rolle 2011; Johnson 2023). While “the persistence of the idea of ‘nomadic’ Scythians in popular and academic thought, in the face of these growing datasets, lies in the fact that open steppe-lands are frequently seen as key crossroads for population movement, with the spread of animal style motifs lending support to narratives of mobile nomad warriors engaging in long-distance east-west interactions” (Simpson & Pankova 2017), Ventresca Miller et al. (2022: 3) notice that “recent genetic studies suggest that extensive human migration was, in fact, higher in periods predating the Iron Age, and decreased during the Iron Age itself” (also see Juras et al. 2017, Nikitin et al. 2017b).

Being nomadic or not, the Iron Age Scythians were present in the landscape of Kamyana Mohyla. The vicinity of the site is featured not only with the sparse cultural layers of the multilayered settlements but also kurgans and ground burials.

The settlement of Sekiz 4, apart from Neolithic, Eneolithic, and Bronze Age artifacts, contained several pottery fragments attributed to Scythian and Sarmatian times and the Middle Ages. Similarly, Sekiz 5 surface survey provided the pottery fragments and two Bronze objects that can be attributed to Scythian time and Medieval (Dzhos 2019: 16—17).

N. Kotova reports that the settlement of Kamyana Mohyla 1 also yielded several non-characteristic materials that might be attributed to Scythian (Kotova et al. 2017: 22). Dzhos reports on some finds made during his excavations of Kamyana Mohyla 2 as connected to Sarmatian Age (Dzhos 2019: 18). Some Sarmatian materials also feature the site of Kamyana Mohyla 5, but also the Late Medieval ones (Dzhos 2019: 20), while Kamyana Mohyla 6 contains the materials of Early Iron Age, Scythian ones and those that can be attributed to Sarmatian and Hunnic time.

The signs of Scythian inhabitation are also known from the rock art of Kamyana Mohyla. Based on the stylistic analysis, E. Titova attributes the footsteps from the location No. 34 as Scythian ones (Titova 1982; fig. 2.40). Similarly, the engravings of riders and horses, mostly known from the location No. 25, are considered as produced by Scythian population and should be taken into account in the general frame of the rock art of the Central Asian nomadic and semi-nomadic people (Samashev 2003: 95—119).

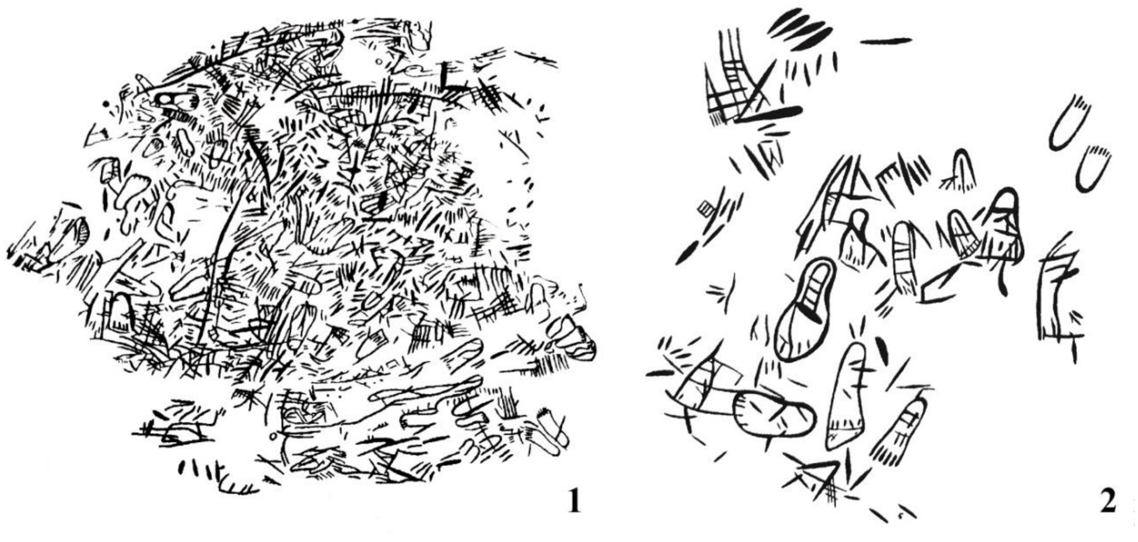


Fig. 2.40. The engravings of footsteps from Kamyana Mohyla. 1 — Location No. 34a (after Mykhailov 2005: 216, fig. 30); 2 — Location No. 34b (after Mykhailov 2005: 2016, fig. 31)

The Sarmatian inhabitation of the region that is considered to follow a Scythian one also might be traced both in the archaeological landscape of the area and the rock art objects from Kamyana Mohyla. The general description of Sarmatian archaeological assemblages in the region is provided by a series of studies during the last decades (Vyazmitina 1960; Abramova 1961; 1962; Kostenko 1983; Simonenko 2004; Simonenko 2008) and summarized by O. Symonenko (2019). Some materials were extracted from the settlements (Sekiz 4, Kamyana Mohyla 2, Kamyana Mohyla 5, and Kamyana Mohyla 6, fig. 11) and kurgans near Kamyana Mohyla.

The kurgans nearby Novopylypivka (fig. 2.8: 16, 17, 24) mainly contained Sarmatian burials and were excavated multiple times by V. Danilenko (Obolduyeva 1952: 43), who reports on the collective burial of Sarmatian times there, T. Obolduyeva (1952) and M. Rudinskiy (1954), who excavated a group of kurgans, mainly attributed as Sarmatian ones. M. Rudinskiy has discovered one more burial inside the Kamyana Mohyla Hill itself. It has been considered a cenotaph (Rudinskiy 1952; 1961: 112—113). Based on the vessel, bronze mirror, and carnelian bead, it was attributed to Sarmatian presence. The discovery of the half-dugout on the hill's southern slope was also important. Based on these two objects, M. Rudinskiy concluded that "Kamyana Mohyla draw the attention of the local Sarmatian population … [that created] complex scenes with the significant elements of vegetable elements without both faunistic depictions and geometric figures (Rudinskiy 1955: 70). In addition, the engravings of the tamgas on the location No. 62 (fig. 2.41) might be attributed to the Sarmatian presence here during II century BC — III century AD.

Fig. 2.41. Sarmatian tamgas from the location No. 62 of Kamyana Mohyla

Later on, the Hunnic population visited the vicinity of Kamyana Mohyla. The sparse signs of that might be encountered in the assemblage of the settlement of Kamyana Mohyla 6. Two burials of Hunnic time have been found there — one in the Wizard's cave inside Kamyana Mohyla Hill. It was discovered and described by V. Danilenko during his excavations there in 1973. The burial was made in a wooden coffin placed 6.2 m from the entrance to the cave (Mykhailov 2005: 73). Danilenko reports here about the presence of typical Hunnic Iron buckles, red clay oinochoe and typical V century AD glass cup (Danilenko 1986: 78).

One more Hunnic burial was found while excavating two small kurgans North of Kamyana Mohyla Hill (Makhotrykh et al. 2020; Kotova et al. 2022a). Following radiocarbon dating results, it received the date of 1611 ± 21 BP (BE-8042.2.1, human bone, calibrated to 415—535 AD) (Kotova et al. 2022a, table 1). This one can be related to a group of ground burials of the time of the Huns, found on the banks of rivers, in secluded places, or at the bottoms of ravines (Zasetskaya 1994: 16). Mostly, such nomadic burials had skeletons in a stretched-out position with their heads oriented to the north. This type of burial is known in the Molochna River basin, including the surroundings of Kamyana Mohyla and the site itself

(Mikhailov 1977; 1993; Vyazmitina et al. 1960). However, some non-typical burials with skeletons curved on their backs or eastern orientation occur (Zasetskaya 1994: 15, 19). A burial from the surroundings of Kamyana Mohyla precisely parallels the new dataset from Middle Don Basin. Flexed skeletons with a latitudinal orientation were recorded in a cemetery near Ksizovo village, Lipetsk region (Russia) (Oblomsky & Kozmirchuk 2015a; Oblomsky & Kozmirchuk 2015b: 136). The burials from there received radiocarbon dates close to the date from the grave nearby Kamyana Mohyla (1600±60 BP, IGAN-3771; 1690±100 BP, IGAN-3772; 1640±110 BP, IGAN-3767) (Oblomsky & Kozmirchuk 2015c).

The Hunnic presence and post-Hunnic occupation of the North-Azov Sea region are marked by the abrupt growth of different tribes and increasing dynamics of their migration, development, change, and demise (Bubenok 2016). The sites of that period are presented mainly by burials of different kinds and are noted by historical sources (Kazanski 2020). The traces of these processes in the rock art of Kamyana Mohyla, however, are yet to be recorded.

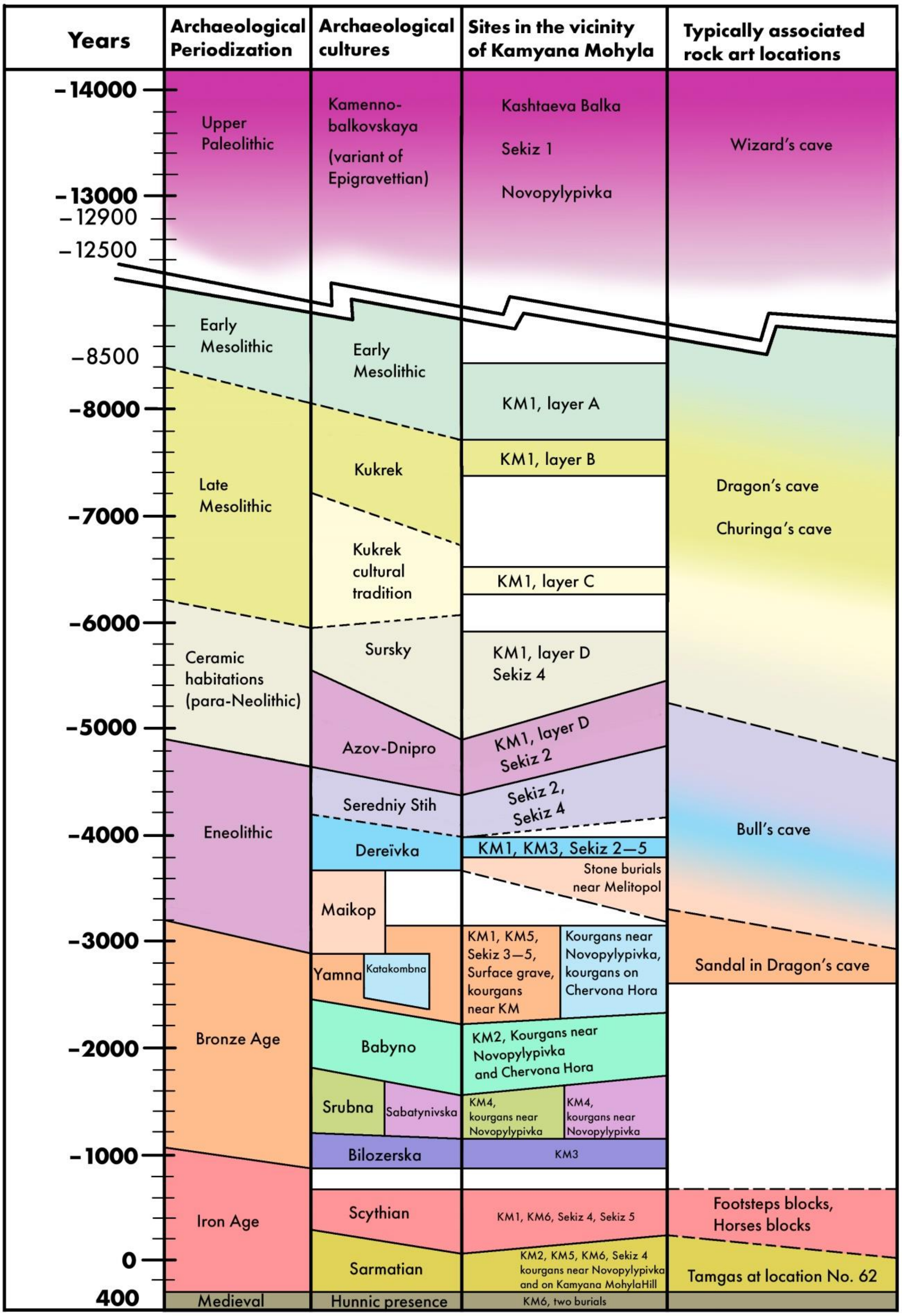


Fig. 2.42. Rough summarization of the archaeological context of Kamyana Mohyla and its surroundings through ages

2.3. Archaeological and historiographical contexts of Kamyana Mohyla in light of the formulated research questions

3. DIGITAL STUDY OF PORTABLE ROCK ART. AN APPROACH TO THE DATA

3.1. Rock art recording and study methods in their historical development

3.1.1. Rock art visualization from sketching to photogrammetry

The process of interaction with pre-Historic art is unavoidably connected with its documentation and visualization. Indeed, rock art is primarily visual art and visual data; thus, it requires visual methods to be represented. These methods are different, developed for over a century and under different conditions, and serve numerous purposes. Using different methods leads to producing data of different natures and types, so by rock art recording, we refer to "any form of visual documentation of the works of art and their spatial location" (Domingo Sanz 2014: 6352).

There are many different reasons why rock art recording projects are introduced. Brady et al. (2017) state that the most common ones of them include the following:

1. *The threat of destruction*. Indeed, many 20th-century rock art recording processes appeared due to dam construction projects that would cause the loss of rock art instances (Schaafsma 2013: 23). There are many examples of such projects worldwide. Even the first massive recording of the Kamyana Mohyla rock art complex was initiated due to planned dam construction in 1956 (Tarasenko 2017).

2. *Tourism*. The destructive influence of a crowd, artificial light, unstable environmental conditions, etc., caused by the touristic exploitation of rock art sites might lead to the complete extinction of an image, composition, or even entire site. Therefore, recording is needed to preserve and disseminate rock art instances without putting the artifacts at risk. Some such records are used to create highly accurate touristic facilities (Clottes & Chippindale 1999; Muzquiz & Saura 2002).

3. *Dissemination for the general audience and the scientific community*. Any communication concerning visual art requires it to be presented and visualized. It is a disadvantage to speak of rock art instances without any graphic expression.

Not only visual representation and communication is helpful to increase the attraction of a particular area for cultural tourism, but it also links the particular population with its cultural history and provides information to the grassroots and researchers worldwide. Following Domingo Sanz (2014: 6351), these records "are also significant as vehicles for scientific and, more importantly, public dissemination of the art, necessary to raise public awareness of the value of this heritage as a long-term conservation strategy to guarantee the preservation of this heritage resource for current and future generations." This inevitably leads to the recording of art instances and forces to choose a correct method to provide the record.

4. *Research*. "Given rock art'sart's ability to address a wide range of questions about the past and present, researchers need to tailor their recording strategies and target specific aspects of rock art assemblages in order to gather the required data to answer specific questions" (Brady et al. 2017: 3). Indeed, the scientific research of pre-Historic art is impossible without a comprehensive recording strategy. Such records should contain all required information concerning the art object'sobject's spatial, temporal, cultural, and conditional dimensions. Moreover, it usually contains a primary interpretation provided by the researcher who made it. Being mostly immovable, rock art demanded to development of reliable ways of transferring the information to the lab or publication unit. Such a transmitter is a vital data source for rock art analysis and interpretation. Therefore, the quality of the record and the level of correspondence to the demand of particular research is one of the most critical parameters of any research.

A visual recording plays a central part in the rock art research process. Though there is much spatial and contextual information to be presented in other ways, the artifact is introduced to the world community through the visual record. Therefore the latter requires accurate, objective, and precise, featuring with the highest possible precision. Following these requirements, one can conclude that rock art research'sresearch's most pressing needs might be *visibility*, *abstraction*, *accuracy, and objectivity* (Rondini 2018: 260). Unfortunately, it is impossible to reach all of these needs simultaneously using just one type of record, so researchers are again forced to search for the right balance between insufficient and too much.

Visibility corresponds to the need to see clearly, what is depicted and where. Approaching high visibility might be challenging due to erosion processes, the location of the rock art instances, or the nature of an image that might be hardly distinguishable.

Abstraction corresponds to the need to see the engraved figures free from distracting elements (Rondini 2018: 260). Indeed, the rock surface color and shape, the presence of vegetation, or natural cracks might affect our understanding of the artwork and thus should be excluded from the analysis. However, analyzing rock art instances should simultaneously consider the morphology of the irregular surface. "Once you try to reproduce these images on paper, with either a drawing or a photograph, you come up against these insoluble difficulties. Everything is stretched, twisted, and distorted in every sense. We are almost always obliged to isolate one image from the group it forms part because it occupies a concave, convex, or very irregular surface. Sometimes the photograph can only show a fragment of an image. Little by little, we have become accustomed to thinking of Paleolithic art in fragments, and we forget the whole" (Laming-Emperaire 1962). Thus, the level of abstraction introduced in the record is discussible and should also consider the specific features of a particular site.

Accuracy refers to the level of correspondence between the model (drawing, sketch, 3D model, etc.) and reality. The demands for the accuracy level usually depend on the requirements of specific research, mainly scale requirements. However, accuracy, similar to the sufficient *resolution* (the density of the data sampled (Jaillet et al. 2017: 5)), is necessary to provide a high-quality record.

Finally, *objectivity*, in this particular case, is the need to produce visual data that would correspond sufficiently with reality. The such level must fulfill the research requirements and allow further analysis using the record as a reliable data source. It has already been established that every type of documentation is subjective (Arca et al. 2008: 379). Even the objective nature of computer-aided image processing has already been questioned (Read & Chippindale 2000: 75). However, the publication of rock art instances visualization "as they are," without any kind of interpretative tracing is an error in method and in communication (Chollot 1964) as it is usually impossible for a reader to understand the direct record without the graphical assistance in interpretation. This means that while some kinds of rock art records should seek ultimate objectivity, others must be focused on clarity and comprehensibility.

Different methods of rock art recording that have developed over more than a century address these criteria differently. Some of them introduce limitations in abstraction and visibility production. However, the images of great accuracy and objectivity; others, and vice versa, make the artifact visible, though they are more-or-less subjective. Nowadays, the toolkit of rock art researchers contains all the methods developed from the beginning of the last century — contact tracing and drawing; photography; cataloging; 3D-digitalization; microscopic examination, etc.

The first recording methods that were primarily based on sketching and producing hand-made drawings and included the direct tracing on the rock surface were introduced at the beginning of the 20th century and intensively published by Henri Breuil (Fritz & Tosello 2007: 49). Staring from 1950 tracing were made on thin sheets of polyethylene plastic held close to the cave wall (Pleiner 1971). In Italy, in Camonica Valley, tracing on the paper included outlining engravings previously painted with chalk (Glob 1954; Rondini 2018: 262). Later, following the method introduced by Emmanuel Anati, the surface was prepared by coloring the carvings in white; then, the oil paper was traced. Later on, the "neutral method" by Anati consisted of painting a rock surface entirely in white and then rubbing a surface, creating a contrast monochrome effect. Though the method is highly invasive and has been later forbidden due to conservation issues (Poggiani Keller et al. 2005, 120), it made it possible to identify figures otherwise almost invisible

(Anati 1974, 15—18). Anyhow, rubbing and direct tracing — the most famous rock art surface contact tracing — are still often used by rock art researchers unless the surface is preserved too poorly to perform it. In some countries, however, scholars try to avoid direct contact with the rock surface as it can damage artwork. As an alternative option, indirect manual tracing is widely used among researchers worldwide as it assumes personal contact with the rock art object. "As with tracing, the advantage of manual drawing is that researchers are forced to look closely at the rock face and its motifs. In order to discern various details, there is often nothing better than the human eye carefully examining the art in the field" (Brady et al. 2017: 12). Such kind of tracing is highly subjective and affected by the cognitive biases of its author. The subjectivity of manual records leads to the constant debate concerning different rock art instances worldwide and the need for reconsideration of rock art instances with new methods and tools. For instance, in Ukraine, the subjective interpretation from different researchers led to the appearance of different drawings and interpretations of the same petroglyph. While V. Danilenko considered it an image of a mammoth, B. Mykhailov referred to it as an engraving of a Bull. Unfortunately, the restoration of the image made after one of V. Danilenko's drawings for the museum exhibition made it impossible to correctly distinguish pre-Historic ocher pigment from contemporary one, destroying the asset of information forever. The discussion on the meaning of the image lasted up to both researcher'sresearcher's death; new light was shed recently from the application of digital recording methods (Radchenko & Nykonenko 2019).

On the other hand, manual tracing is clear and easily understandable, shows a significant level of abstraction, and might theoretically produce an accurate record. A more accurate dataset is usually required to provide additional data and produce sufficient rock art research. Therefore, the appearance of digital technologies provoked their abrupt popularity among rock art researchers.

The first non-manual method of rock art recording ever applies the photography that has been in use for more than a century (for instance, Battaglia

1932; 1934; for an overview, see Brady 2006). Surprisingly, photography has been introduced as an invasive method quite often — artifacts have been poured with water, painted with paint or chalk, etc., to increase their visibility and a level of abstraction. This led to obvious destructive consequences, so such a practice is mostly frowned upon. Photos have also been widely used as a source of data for drawing creation — the sketching has been done not in contact with the surface but from its photograph (Aujoulat 1987; Lorblanchet 1995; Whitley 2001). However, this approach was criticized as it excludes the researcher's direct observation of the rock surface, which is considered sufficient. Anyway, photography is a popular way to produce fast, cheap, and objective records, and today is a necessary part of any rock art or archaeological research.

Both direct tracing and photography were widely used on the Kamyana Mohyla site. Unfortunately, that was connected to the invasive procedures — sketching on the rock surface, painting the engravings to provide sufficient contrast, etc. (Danilenko 1986). Therefore some of the rock art instances from Kamyana Mohyla have been heavily damaged during the past study.

The photography for rock art recording includes several instruments for modifying the images with computer processing to fulfill the research and documentation demands. This set of methodologies was, maybe, the first achievement of the digital revolution that has been applied to rock art science since the early 1980th (Brady et al. 2017: 15). The computer-based technologies were applied to improve a color quality of images and avoid the visual consequences of deterioration (Dickman 1984; Rip 1983). Following these advantages, new software solutions began to emerge to produce different ways of image enhancement, digital tracing workflows, etc. (Briot 1999; David, Brayer, McNiven, & Watchman 2001; Domingo & López-Montalvo 2002; Henderson 2002: 35). Advanced techniques of multispectral images enhancement includes multispectral analysis and use of multispectral cameras (Zainuddin et al. 2019), polynomial texture mapping and structure light-based instruments (Earl et al. 2010), principal component analysis, decorrelation stretch, reflectance transformation imaging or digital elevation models analysis. All of these techniques are of great use in nowadays rock art research. They provide a set of instruments for digital sketching and tracing in the manual or automatized way (Domingo Sanz 2014: 6355; for instance, see Domingo & Lopez-Montalvo 2002; Cassen & Robin 2010; Domingo et al. 2013). Some of them, like DStretch, PCA, or multispectral imaging, are pretty helpful in the definition of eroded motifs (e.g., Díaz-Andreu, Brooke, Rainsbury, & Rosser 2006; Rogerio-Candelera, Jurado, Laiz, & Saiz-Jimenez 2011; Quesada & Harman 2019), others allow to understand more of the panel superimpositions and a sequence of pictures (Arca 1999; Gunn et al. 2010; Domingo, Carrion, Blanco & Lerma 2015). The popularity of RTI is also growing as a tool to better understand rock art objects' shape (Díaz-Guardamino, García, Wheatley, & Rodríguez 2015). Recent developments also had shown the possibility of morphometric analysis from the spectral treatment of digital images (Alonso, Abadia & Dominguez Gomez 2016).

Besides photography, the digital revolution introduces numerous other techniques currently used in rock art recordings, such as video recording (Tacon 2012) or spherical imaging (Goldsmith 2011).

These methods do not fully reflect the 3-dimensional nature of rock art instances. The latter, however, appears to be of crucial importance due to the analytical and visual capacity of 3D modeling for rock art science. Therefore, the attempts to record the 3D forms were applied to cave art during the late 1920s. Lemozi's method (1929) consists of placing the dynamic greed close to the cave wall following the contours of the rock surface. The tracing created using this grid on paper allowed to introduce of the wall morphology as a network of warped quadrilaterals (Jaillet 2017: 5). Later, in the 1970s, the first real photogrammetric experience was introduced to create a contour-line map and decipher relations between the artwork and wall morphology (Lorblanchet 1982). However, the method appeared too exhausting and expertise-related back then, so only a few photogrammetric studies were known (Atkinson 1968; Clouten 1974; 1977).

The drastic improvement of automated image-based 3D modeling software observed during the last two decades, a result of the significant advancements in dense image matching and the improvements in camera manufacturing, popularized photogrammetric applications in archaeology and heritage science (Lowe 1999; 2004; Pierrot-Deseilligny & Clery 2011). That led to the creation of reliable, popular, and achievable software. Since then, photogrammetry has become of great use in rock art studies. To begin with, it introduced a new level of rock art visualization, allowing experiencing the interaction with rock art instances closer and comprehensively replicating the scenes that appeared in the ancient people's eyes. Moreover, the analysis of 3D surfaces brings numerous analytical procedures to the table.

Indeed, though 3D modeling reaches quite a low level of abstraction, the accuracy, resolution, and objectivity are very high and continue to increase. Last but not least, it shows an excellent level of visibility and allows recognition of the art instances that were unnoticed due to their size or a level of erosion. Finally, image-based modeling is a comparatively cheap and straightforward solution requiring limited costs and expertise.

Thanks to all the above, the number of photogrammetry applications in rock art science has increased tremendously. Some of them focused on visualization purposes and did not imply any kind of specific analysis (see, for instance, Chandler & Fryer 2005; Chandler, Fryer & Kniest 2005; Palonka 2017; Davis et al. 2005; Mannu, Mazzurana, Cavulli 2018; Rondini 2018; Wang et al. 2019, etc.;). Most 3D models produced for rock art recording purposes remain not metric. They can be used for visualization and documentation rather than for acquiring new data during the research. Others include a photogrammetric study of rock art instances to achieve additional information concerning their object — both in its archaeological and semantic dimensions (Alyilmaz, Yakar & Yilmaz 2010; Diaz-Guardamino & Wheatley 2013; Miles et al. 2014; Alexander, Pinz and Reinbacher 2015; Dessi et al. 2015; Lesvignes, Robert and Valentin 2019; Porter et al. 2016; Carrero-Pazos, Villas-Esteves & Vazquez-Martinez 2018; Jalandoni, Domingo &

Tacon 2018; Drabsch 2018). Such application methods are developing quite fast, constantly introducing new approaches.

It has already been proven that SfM-photogrammetry can be an efficient tool for the definition and description of barely visible engravings (Porter 2016; Likhachev 2018; Radchenko & Nykonenko 2019). Moreover, the analysis of rock art surfaces from 3D-model is good enough to replace RTI technology (Porter 2016; Graff 2018). This is also proven to help define the sequence of engravings creation, the features of the rock art production process (so-called "technological" ones), and the artistic nuances of the process (Melard 2010; Melard et al. 2016; Arca 2018; Radchenko et al. 2020b). Although technological analysis demands accuracy and precision and remains a significant challenge (Tosello & Villaverde 2014: 6034), it can introduce new knowledge concerning the technological aspect of rock art creation (Fritz & Tosello 2007). Such advantages are proven achievable through photogrammetry (Plisson & Zotkina 2015) and can even introduce accuracy comparable to the laser triangulation scanning results (MacDonald 2011).

Recently, several methods to combine image enhancement techniques and image-based 3D modeling has been introduced (Harman 2015) and applied to the rock art instances in Europe (Monney 2014) and America (Fouere et al. 2014).

An issue that prevented the rapid adoption of photogrammetric techniques for decades is the high requirements of accuracy and precision of 3D models surveyor needs to acquire the previously anonymous data from the studied object. Indeed, analyzing portable rock art instances by investigating their virtual surface sometimes requires a submillimeter or at least near-submillimeter density of acquired surface data (Tosello & Villaverde 2014: 6034). Nowadays, this obstacle seems to be slowly overcome, and the photogrammetric survey seems to be a more-or-less obvious winning strategy for cultural heritage and rock art study (Aicardi et al. 2017; Rahaman & Champion 2019). Computer systems' productive power is constantly growing according to the parameters of photographic equipment and the quality of final results.

Though rock art researchers are mainly focused on achieving cultural and historical data and rarely provide the accuracy protocols for photogrammetric surveys (except for those that assume the quality estimation due to the scope of research such as Messina, Rinaudo & Kian 2014; Plisson & Zotkina 2015; Melard et al. 2016), newest application of the technology to different cultural heritage instances prove that millimeter or even submillimeter accuracy for photogrammetric applications is possible and reachable (see Chiabrando, Donadio & Rinaudo 2015; Melard et al. 2016, etc.). Detailed and accurate modeling of historical wall painting and architectural instances through SfM-photogrammetry has shown to be quite efficient even on the mentioned scale (Fregonese et al. 2016; Markiewicz et al. 2018; Widerski & Daliga 2018). Since structurally, rock art instances are pretty close to the architectural elements (due to their morphology) and wall paintings (due to their nature), we assume that sufficient accuracy can be reached for pre-Historic art through the similar (however, adopted) workflow. Few available studies on the topic assure that the photogrammetry might provide the results of enough accuracy for rock art research that would be comparable to the accuracy of a laser scanner (MacDonald 2011) and allow the acquisition of all information required for pre-Historic artworks interpretation (Plisson & Zotkina 2015; Melard et al. 2016).

Unlike expected, numerous software packages available to process the data of photogrammetric surveys (3Df Zephyr, Colmap, MicMac, VisualSfM, Agisoft Metashape, Pix4D, to name a few) introduce a more-or-less comparable and comprehensive level of model quality in terms of accuracy and precision. The most comparable among them is Agisoft Metashape and Pix4D Mapper. The former introduces a comprehensive package of instruments for modeling portable objects, while the latter is known for the high quality of orthophoto image creation (Rusli 2018). Thus, if the data acquisition process has been performed correctly, the accuracy of models fits the requirements of the rock art research with minor differences depending on chosen software. Simultaneously, recent tests proved that some parameters of the data acquisition scenario do not affect the accuracy dramatically. The survey process, though it must be shaped carefully, provides some fresh air in decision-making (Zhongmin 2017: 25). The comparison of different workflows has been performed several times using test objects and cultural heritage instances (Barbasiewicz, Widerski & Daliga 2018; Firdaus & Rau 2017; Adamopoulous, Rinaudo & Ardissono 2021). However, the only software solution that introduces the option to create a closed 3D model of a small object is Agisoft Metashape software, which is also most popular due to the simplified workflow that allows its use with minor expertise in photogrammetry and 3D modeling. The latter is in wide use in rock art research and is quite popular among archaeologists all around the world, showing comprehensive, informative results of sufficiently high quality (Miles et al. 2014; Porter 2016; Palonka 2017; Arca 2018; Carrero-Pazos et al. 2018; Likhachev 2018; Rondini 2018; Radchenko et al. 2020b; etc.).

Laser scanning technology is a rapidly developing 3D technology that is quite effective in accurately analyzing a different scale (Robson et al. 2001, Lerma et al. 2010). This method was first applied to the 3D modeling of cave art at Vielmouly (France) in 1994 (Aujoulat et al. 2005). The survey was considered efficient, and since then, laser-scanning projects have started appearing in rock art science worldwide (Trinks et al. 2005). Despite the lack of mobility, high price, and expertise requirements, the laser scanner easily creates a detailed and accurate 3D model, reflecting the surface's morphology, structure, and shape. Thanks to that, terrestrial laser scanning has been applied to provide data for numerous pieces of rock art research so far (e.g., Diaz-Guardamino & Wheatley 2013; Messina, Rinaudo & Kian 2014; Messina 2016; etc.). Nowadays, it is becoming a standard practice to record cave features and rock shelters in 3D (Jaillet et al. 2017: 9). Laser scanning of portable cultural heritage instances is also becoming more popular these days due to the growing number of solutions for that procedure (MacDonald 2011). The high resolution of laser scanners allows for an additional investigation of rock art surfaces, achieving additional data on the art instances' production and use, the tools used for their creation, and tribological data (Melard et al. 2016; Hermon et al. 2018). The application of 3D scanning to investigate Upper Paleolithic portable rock art has shown excellent results in their visualization, analysis, and interpretation, even on a microscopic level (Güth 2012). This includes recent advantages in the use of structured light scanners that introduce a high level of accuracy (up to 25 microns) (Zedig 2022), low processing time, and high level of detail capturing (Kościuk et al. 2022; Lødøen 2022). Similarly to photogrammetry, laser scanning is a simple way to produce 3D models that "provide a unique approach to the 3D quality of rock art, which is key to understanding the art in context (location in the panels, use of the rock surface, and so forth) and to show the multiple perspectives from where the audience can visualize the art" (Domingo Sanz 2014: 6355).

The resolution of triangulation scanners might not be enough to fulfill the requirements of the rock art research. Besides, the improvement in the performance of optical instruments has also led to advances in the precision of information since the 1980s (D'Errico 1995). The application of scanning electron microscopes (SEM) at 20, 50, or more magnification reveals numerous microscopic marks invisible to the naked eye (Fritz 1999a; 1999b). These marks might contain additional technological information concerning the type of the tool, the movement direction of the tool, its inclination, etc. Such typological parameters might lead to conclusions on the features of specific technology and help to identify regional "know-how" of pre-Historic artists. Nowadays, 3D restoration of a small surface with a microscopic resolution based on using the confocal microscope is also developing as an efficient tool (Melard 2010).

The great diversity of rock art recording and research methods introduces an excellent capacity of science and technology to solve the mysteries of the human past. Among others, “photogrammetry is experiencing a revival, which is particularly promising for the study of portable art” (Tosello & Villaverde 2014: 6034). Indeed, the increasing accuracy and resolution, new software, technological and methodological decisions, and the constant steps in our humanistic understanding of portable art reveal great perspective in its study. The number of case studies and relevant projects shows that so far, photogrammetry is the most potentially effective rock art recording and visualization method. Not only is it capable of opening the sufficient perception of rock art from any distance, but it replaces some other research tools (such as RTI technology) and is the basement for the relative chronology of rock art and its classification, also taking into account the context of the object.

Moreover, the simplicity and data processing speed are adequate for processing portable art assets, which was almost impossible without the advances of the digital revolution. Besides, the 3D-recording techniques are pretty helpful for other purposes of rock art recording. Currently, it is the best way to *save the rock art sites under threat of destruction* (such destruction constantly happens even to the most noticeable sites, like Palmira) and to make them accessible for *tourists* despite the pandemic restrictions. Indeed, the opportunity to communicate with cultural heritage while staying home becomes one of the crucial needs of 21st-century man. Last but not least, 3D recording is the most comprehensive way to provide the *dissemination and outreach* to pre-Historic art and has great potential both for cultural studies and educational purposes. Together with its efficiency for scientific *research*, it fulfills the requirements of the record and addresses all the purposes of the rock art recording process.

However, and it has already been mentioned numerous times, all of these tools are yet supplementary instruments for the researcher. At the same time, direct observation, comprehensive analysis, and intellectual effort are the foundation of any rock art research (Tosello & Villaverde 2014: 6034).

3.1.2. Perspectives of photogrammetric study of Ukrainian portable rock art objects

Broad and complex international experience of applying photogrammetry for rock art research reveals its applicability to almost all the tasks that emerged while examining the Kamyana Mohyla portable rock art collection. It is clear from international experience that formulated research questions might be answered through the application of image-based 3D modeling and photogrammetry can provide sensible conclusions for the study of the Kamyana Mohyla rock art. The clear and strict determination of how exactly the contextualization can happen requires a clear accuracy assessment and data acquisition strategy, which is the main topic of the following chapters. The strategies and solutions for the photogrammetrical study of Kamyana Mohyla portable rock art objects require the consideration of all possible error sources and ways to mitigate their impact. This might require a specific technology solution that would provide valuable and transparent data on the quality of the resulting image-based 3D models and thus introduce the fundament for searching what kind of can be provided by this tool.

It is shown by many abovementioned types of research that photogrammetry and a closer look at the modeled objects' surface are capable of providing crucial data to the understanding and contextualization of rock art objects. It is even more transparent for engraved stones, where the surface shape is the primary source of information for further research. Analyzing these surfaces in the virtual environment with the use of artificial regulated light sources is a great tool to examine the tiny details of the engraving's shape and morphology, including the technical and technological details of the engraving process and the superimpositions of different lines, i.e., a relative chronology of the Kamyana Mohyla engravings. Studying 3D models with this tool forms the first step for determining the nuances of engraving. Moreover, this creates a multivariable way to visualize the engraved sandstone objectively, thus contributing to producing accurate and reliable drawings of the rock art specimens. This allows for checking the iconography reported by V. Danilenko and B. Mykhailov on the portable stones and analyzing it according to the obtained results.

Since 3D models are the source for extracting the engravings profiles with submillimeter accuracy (which is hardly obtainable by similar instruments), it is an additional source of statistical information on the engraving's size and shapes — their width, depth, symmetry, slope parameters, etc. Not only are these data needed to consider the style and technology concepts introduced by V. Danilenko, but they are also used to analyze the entity of engraved stones, distinguishing them by the types of engraving.

Moreover, 3D modeling appears to be the most accessible, non-invasive possibility to consider the parameters of the stone's volume and density, defining the hardness of the engraving support. Though the thickness of sandstone is highly variable, their mathematical calculations from the data obtained by photogrammetry provide a whole new dataset and help answer if there is any particular difference in the stones from different caves of Kamyana Mohyla.

Lastly, precisely determining the natural cracks, artificial engravings, their interconnection, and interrelation will help reconstruct these artifacts' biographies.' Together with the intensity of desert varnish and the depositional context (if any), these data help reconstruct the objects' life cycle, showing the nature of these objects beyond interpreting their cultural and semantic context.

All the information regarding the listed issues comes from the detailed investigation of the rock art surface, post-processed with relevant shaders and render features, and explored under the artificial light simulation conditions. From the information on the surface irregularities, one can obtain data on the engraving technology, relative chronology, and peculiarities of the stone support, as was shown numerous times by replicated digital experiments worldwide.

However, the analysis of the state-of-the-art photogrammetry application for rock art research shows that the accuracy assessment strategy is rarely correctly reported, evaluated, and mathematically proved. The same is true for the technological solutions for the portable rock art specimens' image-based 3D modeling — they are rarely discussed despite the obvious methodological challenges.

There are some critical issues to overcome indeed: the need to reconstruct the whole shape of the object and, thus, rotate it, applying masks to the images before the alignment; the need to balance the contradictory data acquisition parameters (such as aperture, exposure, ground sample distance and the focal length of the camera); the need to provide the universal technological solution for the accuracy assessment; the need to achieve the submillimeter accuracy and precision to make 3D models informative and relevant; the long and exhaustive procedure of data acquisition and processing is also to be mentioned. All these challenges are of a methodological kind and are solvable by developing specific solutions adjusted to the particular dataset. Last but not least, the visual 3D representations of engraved stones will not introduce any reliable data beyond the accuracy and precision of the model that is dependent on the applied methodological and technological solutions. However, these issues are compensated by the highest possible level of objectivity and abstraction from the destructive elements of the surface (such as V. Danilenko's painting on the stone surfaces), obtainable high accuracy of the visual representation of the rock art specimens, accessibility of the complex characteristics of the objects and the ways of their analysis (i.e., measurable cross-sections or the density of the stone support) and comparatively low price and thus the availability of photogrammetry as a 3D modeling tool.

3.2. An assessment of accuracy through the data acquisition process and 3D modeling procedure

3.2.1. The general description of the workflow

The image-based 3D modeling study of portable rock specimens needs to take all the details mentioned above into account to produce a comprehensive and efficient workflow for data acquisition and processing. The requirements of such a study derive from the research questions and the particular needs of a specific project. Thus, before answering any kind of contextual or interpretational questions, the workflow that would refer to the previous studies and contemporary standards and correspond to the requirements of *visibility*, *abstraction*, *accuracy*, and *objectivity* (Rondini 2018) should be established. However, providing the relevant image-based 3D modeling study requires the correct assessment of 3D models’ accuracy to give space for a specimen’s surface visual analysis.

This means that quite the usual and well-known data acquisition process should be preceded by the preparation stage, where the concepts of accuracy are considered and tested. In doing so, one must take into consideration the following questions:

1. Which data can be achieved through the surface analysis of portable rock art collection digital assets?

2. How to use them in the one analytical model?

3. How can this model contribute to interpreting portable rock art collections?

Finding the relevant answers to these questions means receiving the maximum amount of data from the image-based 3D modeling analysis and their later use for technological, spatial, and archaeological contextualization. Thus, the demands of photogrammetric study are addressed to the relevant technical expertise to provide the research process with the data acquisition and processing workflow while answering the archaeological questions is left for the archaeological interpretation. However, the data acquired during the image-based 3D modeling analysis will become the basis of this interpretation — a new, transdisciplinary and technological way to acquire new data from and test the old hypothesis on the portable rock art collection.

The process of image-based 3D modeling study from its beginning to the final archaeological conclusions may be considered as a sequence of four stages that includes several typical procedures (Annex B, IDEF0 diagram): *preparation stage*; *data acquisition and processing*; *data analysis*; *data interpretation*. The process of archeological interpretation and search for semantic meaning is left beyond this workflow as it is a task for independent research that will be grounded on the results of the technological study. However, the data interpretation stage will unavoidably provide new data on the spatial and archaeological context of portable rock art specimens — confronting old hypotheses with the new data and contributing to our understanding of these specimens' life cycle, the processes, and concepts of their creation and use.

The preparation stage consists of research questions, consideration, and analysis to set the accuracy and precision requirements. Many archive and storage investigations are required to understand the collection in terms of existent hypothesis, archaeological and spatial context, and objects physical parameters. This also includes calculating the data acquisition parameters, choosing equipment and software to use during the project, and providing several tests. Metric tests are necessary to check if the settled workflow provides the research with the desired accuracy and precision and how it can be modified to improve the further research stages.

Data acquisition and processing include the time-consuming process of the 3D model creation — from the specimens imaging to the export of a prepared 3D model to begin the analysis. The workflow here includes processing the rock art instances in the storages of Kamyana Mohyla National reserve and Institute of Archaeology of the National Academy of Sciences of Ukraine, image pre-processing and referencing, creation and cleaning of a point clouds, building the 3D-mesh and its texturing for the further analysis.

Data analysis consists of surface examination in a virtual environment, including its modification with shaders and filters, virtual lightning systems, etc. It leads to extracting specific incision profiles, creating a comprehensive drawing, and establishing the relative chronology for each portable rock art specimen. This is when a photogrammetric study provides additional data to allow further interpretation and reconsideration, considering the spatial, archaeological, and technological context.

Data interpretation is the last stage of the technological study, which means the analysis of the extracted profiles to assume their possible typological scheme. It also includes the analysis of the specimen’s relative chronologies to search for standard models and sequences for the instances from the collection. These processes allow testing and verifying the existent hypothesis on the portable rock art instances in terms of the technology, life cycle, spatial context, and (sometimes) their interpretation in general.

When these stages are overcome, new attempts for the semantic interpretation and cultural attribution of the portable rock art collection become possible. Archaeologists and rock art researchers should provide such attempts to assess the required expertise in the complicated process of rock art research. Though they would not be possible without comprehensive technological study, photogrammetry is just a tool to achieve additional information on rock art objects.

It is evident by now that the archaeological and rock art interpretation of any kind of portable art instance nowadays requires to be preceded by the study of the technology of rock art specimens' production. Thus, the rock art research process starts here, on the stage of technological preparation.

3.2.2. The preparation stage: determining accuracy requirements and redundant error sources

S1. Preparation stage. This research stage is devoted to creating the methodological workflow for data acquisition and determining the accuracy requirements for the images and the models (the whole process is schematized on the "S1" IDEF0 diagram, Annex B). However, all of these would be impossible without knowing the score of the portable rock art collection. Thus, the preparation stage includes an extensive survey of the archives and the storages of all the institutions that contain the Kamyana Mohyla portable rock art specimens. The results of these surveys connected with the archaeological context, history of the rock art research, and the current interpretation hypothesis were briefly described in Chapter 2. All rock art instances from Kamyana Mohyla have been cataloged together with their existent descriptions and physical parameters. Besides the current interpretation and the spatial data, the list consists of specimens' physical parameters — their weight and size. This is needed to address the portability of portable rock art objects, which is proven to be the most important one during the conceptualization of portable rock art specimens (IFRAO Glossary). Moreover, the particular size of the specimens is one of the important parameters that affect the choice of photogrammetric equipment, as it is connected to the scene sampling distance (SSD) and the image resolution.

While the concept of rock art instances' portability is to be addressed on a data analysis stage, and their spatial location will be in use during the data interpretation, the data on the portable art instances' size will be in use at the very beginning of the preparation stage to correctly define the data acquisition parameters (These processes are schematized on the "F1.1—1.5" flowchart in Annex B).

Besides, the direct examination of the collection is required to set up the accuracy demands. The Kamyana Mohyla rock art incisions are primarily shallow and small in size, with an approximate depth of 1 mm or sometimes less (Danilenko 1986: 79). Thus, measuring and examining the shape of these incisions needs to be entirely accurate. Indeed, sometimes the millimeter or submillimeter accuracy and precision are required (Messina, Rinaudo & Kian 2014; Chiabrando, Donadio & Rinaudo 2015). To fit these requirements, considering the shallowness of the rock art incisions from Kamyana Mohyla, the accuracy limitation for the 3D models was settled to be less than 1 mm. Aiming at 99.7 % probability requires a precision of 0.33 of accuracy, which is 0.33 mm maximum. Under these circumstances, the 3D model will provide sufficient data to contribute to the archaeological and rock art research of the complex with the sub-millimeter accuracy of the models and even higher precision value (Galantucci, Lavecchia, Percoco 2013; Galantucci, Pesce, Lavecchia 2015; Percoco et al. 2017).

Unfortunately, the rock art research process rarely includes the accuracy assessment protocol, so one should be invented to address the particular case of the portable rock art instances with shallow incisions on the soft sandstone. Most the papers on rock art research do not include the proper data on the metric quality of the models, assuming that the quality is enough (Miles et al. 2014; Porter 2016; Palonka 2017; Arca 2018; Carrero-Pazos et al. 2018; Likhachev 2018; Rondini 2018; Keller & Rondini 2021). Most of the research that provides exhaustive information on the models' accuracy is connected to the laser scanning procedures where the latter is scaled to dozens or at least hundreds of microns (Melard 2010; Melard 2016; Porter et al. 2016).

Therefore, the methodological workflow that will achieve the desired accuracy should be invented and checked. This requires taking into account the following considerations:

1. The accuracy of the modeling and measurement should be lower than 1 mm;

2. Thus, the triangle size of a triangulated mesh of a 3D model of a portable rock art specimen should be smaller than 1 / 3 of the required accuracy, i.e., 0.33 mm as a maximum;

3. The SSD is also required to be at least three times higher than the final texture resolution (which is 1 mm);

4. The shape of portable rock art instances in proven to be essential for their interpretation (Danilenko 1986: 118), so it must be reconstructed completely;

5. This requires the use of a rotation table and the images acquisition of all the specimens' facets, including the bottom ones;

6. Thus, the software chosen for preprocessing must allow image masking before the alignment stage to exclude the object's environment before reconstructing the scene.

Taking into account the effect that these considerations cause on the typical image-based 3D modeling data acquisition and processing workflow, we can specify the following stages and procedures: image acquisition on the rotation table; image masking and scene reconstruction; referencing of the scene to the local coordinate system; creation of the 3D model (Luhmann et al. 2006; Zheng, Yuan & QingHong 2008; Galantucci, Lavecchia, Percoco 2013; Brady, Hampson, Domingo Sanz 2017; Carrero-Pasoz, Vilas-Estévez, Vázquez-Martínez 2018; Rondini 2018; Agisoft Metashape Manual 2019; Guidi, Malik & Micoli 2020).

Each of these stages is connected to the possible errors of different sources that should be considered during the process of accuracy estimations. If possible, the impact of each error should be reduced to its minimal size or zero.

The image acquisition process might include the following errors: Human-caused error; error caused by the unstable camera; error caused by distortion; error caused by unstable environmental conditions.

Due to exclude the impact of **the unstable camera** and **human-caused errors**, the direct operator’s contact with the camera has been avoided during the data acquisition process: the imaging was made using the wi-fi module without touching the camera or tripod directly. The camera and the tripod were located in an isolated place, and the imaging was performed without any movements or activities around. The exposure time has been settled to 1 / 30 seconds, so any tiny fluctuations ruined the image entirely. In this case, the image has been thrown away from the dataset. Avoiding the impact of the human-caused errors also assumed the acquisition of additional images to create a space for excluding the lousy quality images from the dataset. The minimal number of images per 3D model was set to 96, though some datasets consist of more than 200 images.

To avoid the **changes in the environmental conditions** and the thermal expansion of the object and scale bar, the acquisition of images has been performed in a closed room with stable temperature and the artificial light system (that affects the accuracy minimally, according to Fau Cornette & Houssaye 2016). The light has been located to minimize the impact of shadows on the model (due to the recommendations given by software developers (Agisoft Metashape Manual 2019)).

The *image masking and scene reconstruction* process implies the impact of the alignment error and errors that appear during the masking procedure. As the masking process is entirely manual, the double-check procedure has been applied to exclude possible errors. In case the latter appear, they unavoidably affect the results of scene reconstruction and thus are detected at that stage.

However, the error that appears during the **camera alignment and scene reconstruction** remains uncertain (Lavecchia, Guerra, Galantucci 2017) and impacts the final results and thus must be considered during the final accuracy estimations. On the other hand, the value of this error fits the stated requirements and will not exceed the total RMSE of the model reference (as it is considered during the RMSE calculation) (Zheng, Yuan & QingHong 2008; Percoco & Sanchez Salmeron 2015; Percoco et al. 2017). Also, the impact of alignment and the length measuring error are proven to have a much smaller value than the reference error (Lavecchia, Guerra, Galantucci 2017; Rieke-Zapp et al. 2008).

The process of image referencing is under the influence of the following errors: the error caused by the inaccuracy of the metallic reference plate; the error caused by thermal expansion; the referencing error.

The **inaccuracy of the reference plate** might be taken into account by its calibration with a highly accurate calibration system such as a laser interferometer. The reference process should include the control and checkpoints' calibrated coordinates, and the calibration quality should be as high as possible.

The changes in the environmental conditions cause the **thermal expansion error**, so taking the stability of data acquisition conditions into account, this error can be counted close to zero. To ensure the absence of thermal expansion impact on the measurements, the material with the minimal thermal expansion coefficient must be chosen for the design of the metallic reference plate. While invar is the best solution, the small size of the portable rock art objects allows different, more available options.

Unlike the previous ones, the referencing error is unavoidable and should be considered during the accuracy estimations. The latter can be defined with the particular polygon and software during the accuracy tests. To ensure that the accuracy of the modeling is enough, this value must not exceed particular limits.

The *process of 3D model creation* is entirely artificial and implies the Poisson algorithm reconstructing the model shape. This reconstruction's accuracy is considered high enough due to the high quality of imaging, point cloud creation, and the high precision of the model — a high number of points and vertices. Therefore, the impact of any errors connected to 3D models is considered neglectable.

3.2.3. Defining the data acquisition and equipment parameters

Determining basic accuracy limitations and redundant errors allows us to define the specific methodological requirements of the data acquisition procedure that provides the comprehensive study of the Kamyana Mohyla portable rock art collection and acquire the desired information from image-based 3D models. This leads to determining the specific equipment setup that would satisfy the research aims. After being defined, the specific camera and data acquisition parameters are to be tested during the specific metric tests and then applied to several case studies — the main study case, which is a portable art collection from Kamyana Mohyla, will be followed by the additional one — the collection of portable rock art specimens from Gobustan National Historical Artistic preserve.

The scale of engravings on the portable art objects defines the desired accuracy. Since the model must be accurate enough to make them observable and visible, the accuracy must be higher than the metric parameters of the incisions on the specimens' surface. According to V. Danilenko, the estimated width of the engravings is "up to 2—3 mm", while their depth might be "sometimes up to 1 mm" (Danilenko 1986: 79). Therefore, to successfully catch the shape of these lines, the accuracy of the 3D model must also be up to 1 mm. 99.7 % of probability requires precision to be 0.33 accuracy. Therefore the desired precision (and thus, a size of a pixel length and width) is defined as follows:

$$\frac{1000}{3} = 333 \text{ microns.}$$

Thus, the scene sample distance value should not exceed 333 microns or 0.333 mm, preferably staying lower. These parameters, together with the knowledge of the portable rock art specimens' size, define the required camera resolution to specify the photogrammetric equipment.

Equipment selection. The calculation of image resolution operates two principal parameters: the maximum size of the portable rock art specimen that can be photographed using a rotation table (for the examined collection, this size is 1070 mm (stone No. 246, found by V. Danilenko in Churingas cave during his fieldwork in 1973)) and the maximum scene sample distance, that is calculated to be no more than 0.333 mm:

$$RES_{min} = \frac{1070}{0.333} = 3213 \text{ pixels},$$

where RES_{min} is the minimal resolution of the camera to fit this requirement.

However, to avoid the impact of distortion, which is higher and closer to the image edge, one should place the portable art object in the center of a scene, using no more than 60 % of the image space when producing a 3D model. Thus, the real resolution parameter is

$$RES = \frac{3213}{60} * 100 = 5355 \text{ pixels}.$$

Therefore, the camera resolution for the image-based 3D modeling study of portable rock art objects, parametrically similar to the Kamyana Mohyla ones, has to be more than 5355 pixels. Taking into account the metrical parameters of portable rock art specimens and the existing solutions for close-range photogrammetry (Arca 2018; Carrero-Pasoz, Vilas-Estévez & Vázquez-Martínez 2018; Rondini 2018; Keller & Rondini 2021), the focal length of the lens has been chosen to be 50 mm.

Taking all these factors into account, the camera chosen to fit the abovementioned requirements are Canon EOS 5DS R (fig. 3.1). It has been accompanied by the optical lens Zeiss Milvus 50 mm f / 1.4 ZE (fig. 3.2). Equipment has been operated through the Canon Camera Connect software for the distant imaging. The parameters of a selected setup are listed in table 1.

Fig. 3.1. The digital camera Canon EOS 5DS R

Fig. 3.2. Optical lens Zeiss Milvus 50 mm f/1.4 ZE

It is evident that the parameters of this setup correspond to the fixed requirements and fit the data acquisition paradigm. This is also important because of the CMOS sensor type on the Canon device and the known distortion model of the Zeiss lens (less than 2 % of distortion on the image edges according to the camera documentation) that will be taken into account during the image preprocessing to eliminate its impact on the image acquisition results.

Several procedures were applied to exclude the impact of the distortion: the desired object has been placed in the center of the image, where the impact of distortion is minimal, and the image sharpness is maximal. Besides, the distortion has been corrected according to the specific camera parameters in the image preprocessing stage. After the scene had been reconstructed and referenced to a local coordinate system, the "cameras optimization" was also performed to consider camera calibration parameters.

Table 3.1. Specifications of the equipment

Parameter	**Value**
Sensor type	36 x 24 mm CMOS
Effective pixels	50.6 Megapixels
Width, pix	8868
Height, pix	5792
Color depth, bit	24
Image processor	Dual “Digic 6”
ISO	50—12800
Shutter	1 / 8000—30 s
Focal length	50 mm
Lens Construction	10 Elements in 8 Groups
Maximum Aperture	f / 1.4
Minimum Aperture	f / 16
Focus Modes	Manual focus
Closest focus	45 cm

Ensuring a low level of lens distortion and including the estimated distortion parameters in the data processing procedure requires the camera calibration process to be performed. This is done through the Agisoft Lens software solution. This automated solution uses the pinhole camera model for lens calibration. The distortions are modeled using Brown’s distortion model (Agisoft Lens User Manual 2011: 5). The estimated parameters of the camera calibration are later to be included in the image processing stage during the image-based 3D modeling. The parameters of the calibration chessboard have been chosen to reflect the small details of the image acquisition scene in correspondence to the required accuracy of 3D models — pattern step of 50 pixels and frame border of 10. Based on ten images taken by the selected camera with the above-described *Zeiss Milvus* lens, the calibration showed a low level of distortion that fits the estimated requirements (table 2; figure 3.3). Moreover, as these parameters will be included in the processing stage, the accuracy of the modeling increase.

Table 3.2. The camera calibration parameters as calculated by Agisoft Lens software (50 / 10)

Parameter	Value	Std Error
Image width	8688	
Image height	5792	
Focal length (x)	13251.1	4.84284
Focal length (y)	13250	4.86678
Principal point (x)	4371.93	0.94886
Principal point (y)	2908.37	0.734885
Skew	–0.736304	0.655079
Radial K1	–0.158504	0.00156427
Radial K2	0.258367	0.0390597
Radial K3	–1.36164	0.384363
Radial K4	4.03552	1.66779
Tangential P1	–0.000478538	1.10271e–05
Tangential P2	–0.00015709	1.39629e–05

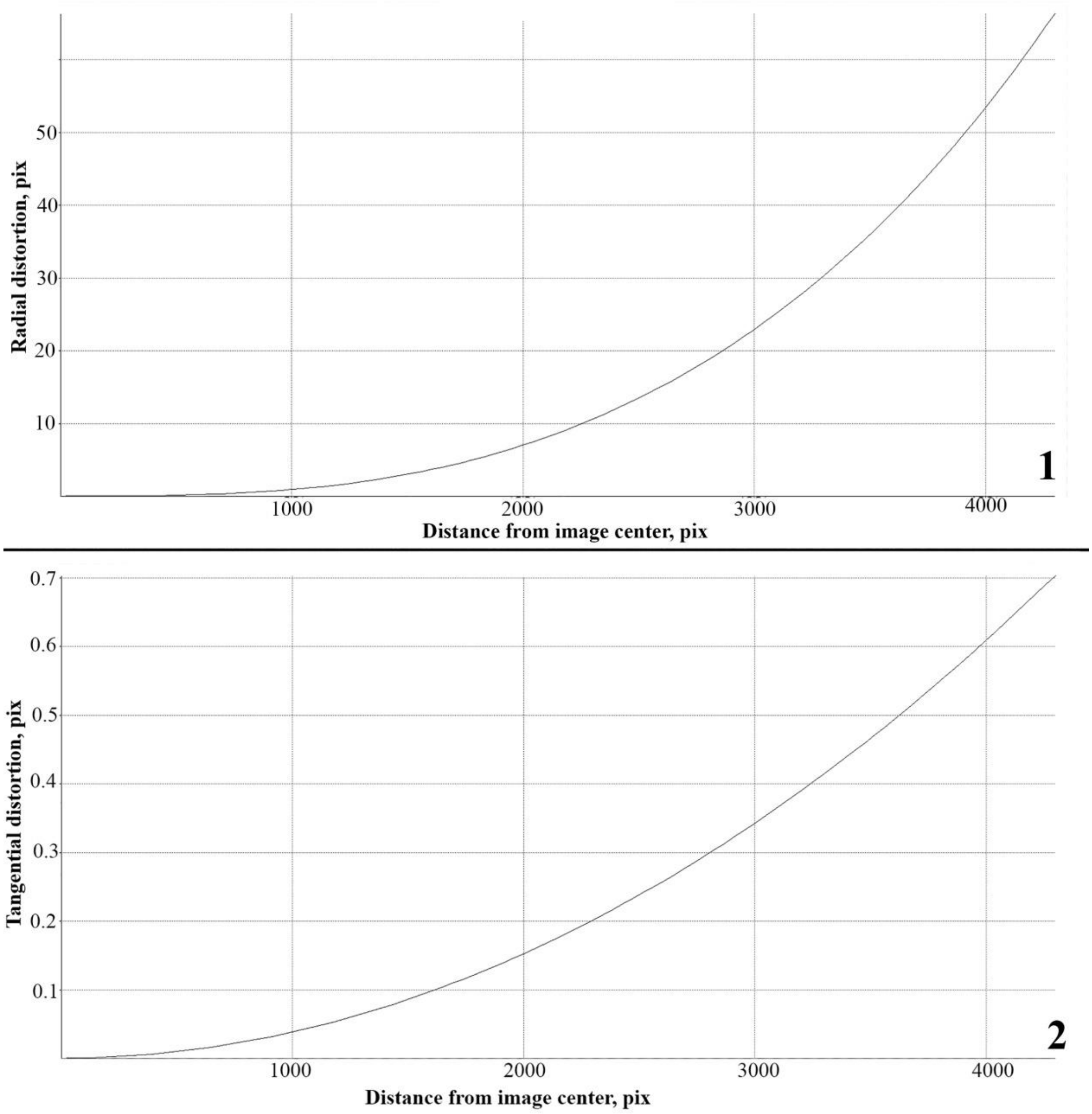


Fig. 3.3. Distortion profile for the selected camera, estimated through Agisoft Lens. 1 — Radial distortion; 2 — Tangential distortion

Image acquisition parameters calculation. Performing the metric tests requires calculating the parameters of future data acquisition. While the camera parameters are already known, imaging distance, shutter time, and aperture remain variable. Moreover, the imaging distance should not be too high due to software demands. While the radiometric qualities of an image taken from a high distance (up to 8 meters) remain valid (Zhongming 2017), the alignment of the images is complicated if it takes into account a small number of pixels. Besides, increasing the shooting distance also increases the value of the scene sample distance and, thus, decreases the quality of the final result.

Therefore, the required distance calculation has been performed considering the size of portable rock art objects. As the whole object must be imaged as sharply as possible, the biggest one of them needs to be smaller than the value of the field of depth. The latter can be calculated from the following formulas:

$$R_1 = \frac{R*f^2}{f^2-K*f*z+K*R*z}, R_2 = \frac{R*f^2}{f^2+K*f*z-K*R*z},$$

Where

R_1 — distance to the front edge of the depth field;

R_2 — distance to the back edge of the depth field;

R — focusing distance (to the center of the depth field);

f — focal distance of the camera (50 mm) taken in meters;

K — f-number of the optical system;

Z — the allowable scattering circle taken in meters. For the cameras 24 x 36 mm it is equal to 0.03—0.05 mm

Therefore, the depth field value (P) can be calculated as

$$P = R_2 - R_1 = \frac{R*f^2}{f^2+K*f*z-K*R*z} - \frac{R*f^2}{f^2-K*f*z+K*R*z},$$

The formula shows that increasing the f-number also increases the field of depth. Considering that, the f-number for the data acquisition procedure has been fixed as 16. To compensate for the decrease in brightness caused by the increasing f-number, the shooting time has been fixed as 1 / 30 s.

As the value of P is known (107 cm for the biggest portable rock art specimen from the collection and 20 cm for the minimal possible depth field needed (the size of the metallic reference plate)), the calculation allows determining the value of R — imaging distance:

$$107 = \frac{R*0.05^2}{0.05^2+16*0.05*0.00003-16*R*0.00003} - \frac{R*0.05^2}{0.05^2-16*0.05*0.0003+16*R*0.0003},$$

$$107 = \frac{0.0025R}{0.002524-0.00048R} - \frac{0.0025R}{0.002476+0.00048R},$$

Performing these calculations shows that to achieve the value of a depth field equal to 107 cm, the image taken distance has to be at least 1.62 m, while the 20 cm field of depth requires the distance to be fixed at 0.74 m.

Therefore the tests of the reference plate have been performed to assure the probable referencing accuracy during the image acquisition procedure from the four different distances: 0.5 m; 1 m; 1.5 m and 2 m.

The image acquisition parameters are shown in the table 5.

Table 3.3. The image acquisition parameters

Parameter	**Value**
Resolution	8868 x 5792
Focal length	50 mm
Image taken distance	0.5 — 2 m
Aperture	16
Exposure	1 / 30 s
ISO	200
Lightning	No

3.2.4. Designing of a reference plate

The metallic reference plate is to be designed considering the required reference accuracy, the demands of the material (thermal expansion coefficient), and the parameters of portable instances. Thus, its size must correspond to the size of the rotation table and the size of rock art instances and consider the technical opportunities. The size limitation for the devices made by laser computer numerical control machine is 20 cm, so the polygon size is less than this value. The expected accuracy of the coordinate system is about 0.1 mm. To increase the latter, the calibration of the polygon by a laser interferometer (RMSE is equal to 5 microns) has been performed.

Moreover, the accuracy of the polygon needs to be much higher than the required reference accuracy to avoid the errors caused by the inaccuracy of the coordinate system. The metallic plate is flat, unlike the portable art objects to be modeled. However, the main areas of interest in the rock art objects might be flat due to the low shallowness of the engravings and the general subrectangular shape of most specimens in the collection. Therefore, the results of metric and accuracy tests will be relevant for the proposed workflow and study case and capable of answering the questions asked.

A metallic reference plate has been designed and drawn to provide the orthogonal local coordinate system that allows the reference of different size objects — from a few millimeters to dozens of centimeters. The drawing of the coordinate lines on the polygon is presented in fig 3.4., while the list of the main crosses coordinates (fig. 3.5.) is in table 3.3.

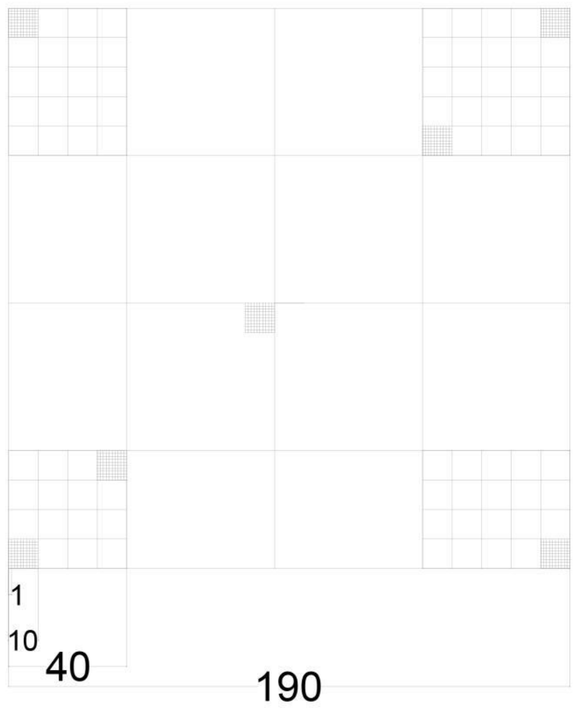


Fig. 3.4. Drawing of a metallic reference plate designed for the image-based 3D modeling *survey. Numerical parameters is given in millimeters (mm)*

To minimize the impact of thermal expansion accuracy, the polygon must be made of a material with a relevant coefficient of a relevant value. While invar is the best solution in terms of thermal expansion, other metals might be considered, especially for polygons of a small size. This is possible also taking into account that the survey will take place in the storage, where the environmental conditions are stable and will take a short period, so the temperature in the survey location is assumed to be stable.

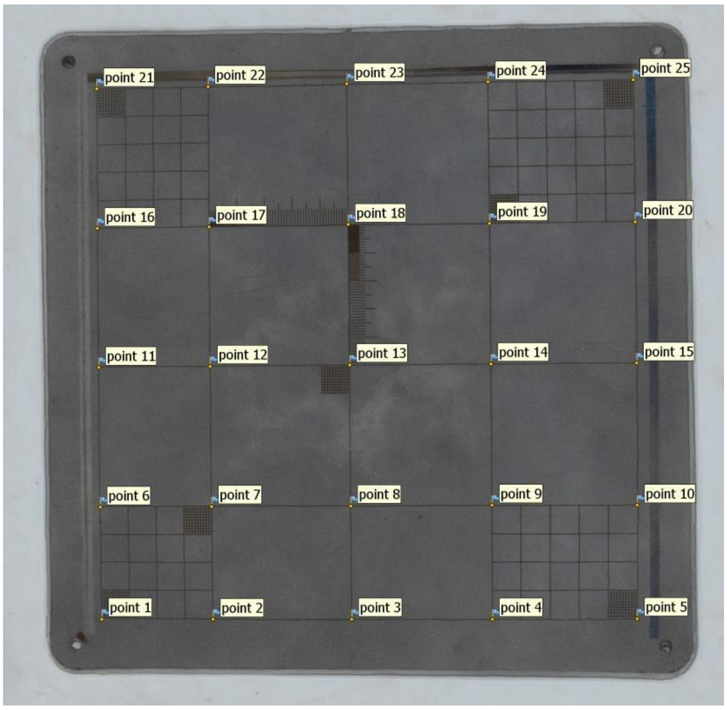


Fig. 3.5. The location of important points (coordinate lines crosses) on the metallic reference plate

The steel of ST3 mark has been chosen to create the metallic reference plate (fig. 3.6.) according to its availability and the small thermal expansion coefficient: 9.9 microns per 1 ^{o}C per meter. This means that for the 20-centimeter line, the thermal expansion will be no more than 2 microns per degree Celsius. Such an expansion can be ignored due to its small value, and the assumed stable conditions during the survey.

Fig. 3.6. The designed metallic reference plate made of ST3-mark stainless steel

Table 3.4. The planned coordinates of important points (coordinate lines crosses) of the metallic reference plate

Point No.	X, m	Y, m
1	0	0
2	0.04	0
3	0.09	0
4	0.14	0
5	0.191	0
6	0	0.04
7	0.04	0.04
8	0.09	0.04
9	0.14	0.04
10	0.191	0.04
11	0	0.09
12	0.04	0.09
13	0.09	0.09
14	0.14	0.09
15	0.191	0.09
16	0	0.14
17	0.04	0.14
18	0.09	0.14

19	0.14	0.14
20	0.191	0.14
21	0	0.19
22	0.04	0.19
23	0.09	0.19
24	0.14	0.19
25	0.191	0.19

Before metric tests, the polygon was examined with the laser interferometer to include the errors of the coordinate lines' location during the metric tests and scene referencing. This allows ignoring the metallic reference plate error, as the quality of interferometer measurements is relatively high (up to 5 microns). The results of this calibration are presented in table 5.

Table 3.5. The coordinates of important points (coordinate lines crosses), corrected after the calibration and high-quality measurements

Point No.	X, m	Y, m
1	0	0
2	0.040224	0
3	0.090019	0
4	0.140419	0
5	0.191478	0
6	0	0.04
7	0.040004	0.040389
8	0.09001	0.040500
9	0.140009	0.040488
10	0.191500	0.040353
11	0	0.090244
12	0.040268	0.090633
13	0.090185	0.090277
14	0.140332	0.090760
15	0.191498	0.905680
16	0	0.140221
17	0.040273	0.140610
18	0.090195	0.140785
19	0.140362	0.140769
20	0.190434	0.140533

21	0	0.190758
22	0.040245	0.191014
23	0.090051	0.190996
24	0.141230	0.190683
25	0.191071	0.190733

It is evident from table 3 that the liminal points of the polygon accumulate too much of errors caused by the laser CNC machine while producing the polygons. Therefore, the calibrated and refined coordinates must be considered during the scene referencing and the reference accuracy control.

Metric tests in different software should be included to prove that the required accuracy can be achieved using the designed polygon. This is also helpful in designing specific software solutions. The critical feature of the photogrammetric software to fit the requirements of a 3D modeling procedure with a rotation table is the capability to perform masking (one of the image preprocessing procedures) before the image alignment. This possibility allows aligning images considering only desired parts of the scene. It is vital to do the image-based 3D modeling of the small object's entire surface. Few software solutions can perform image masking before the alignment or bundle adjustment procedure. The most popular are the Agisoft Metashape (extremely popular among archaeologists and rock art researchers due to its simplicity and good visual results) and 3Df Zephyr software. These two have been chosen for the metallic reference plate accuracy tests.

3.2.5. Accuracy tests with Agisoft Metashape and 3Df Zephyr software

Metric tests. Settled data acquisition parameters and the accuracy requirements allow designing the test of the metallic reference plate. The test implies image acquisition of the metallic reference plate on the rotation table (the rotation angle of 15º has been chosen and operated manually; the exact angles to the object were established for each image acquisition distance), preprocessing of the images to remove distortion and apply the mask to the background (that is the condition of the correct scene reconstruction when using a rotation table), scene referencing accuracy check using the control and checkpoints, reconstruction of the model to compare radiometric parameters of the polygon reconstruction through different software solutions.

An amount of 133 points has been registered on the aligned images. Sixty-three of them have been settled as checkpoints while the rest remained the control ones (fig. 3.7).

When the background is removed and the image alignment performed, the reconstructed scene is formed, assuming that the camera has moved around the metallic reference plate (fig. 3.8).

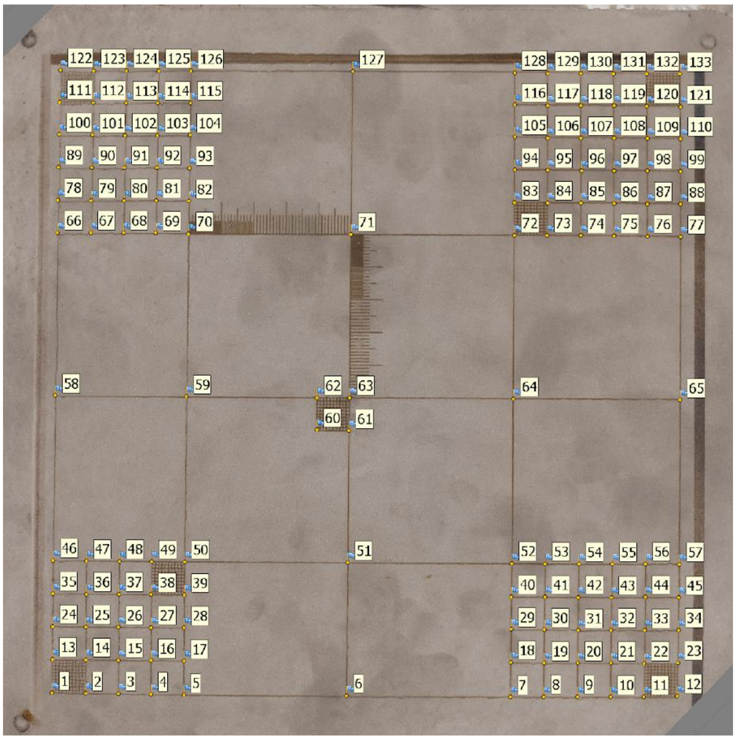


Fig. 3.8. The model of the metallic reference plate with marked marker points

The tests have been performed for Agisoft Metashape and 3Df Zephyr software solutions. Agisoft Metashape is a software solution provided by the

Russian-based company Agisoft LLC. It is available in Standard and Pro versions. Due to the simple pipeline and comparatively low price, the software became extremely popular among archaeologists and cultural heritage researchers (Guidi, Barsanti & Micoli 2014; Palonka 2017; Arca 2018; Carrero-Pasoz, Vilas-Estévez, Vázquez-Martínez, 2018; Likhachev 2018; Rondini 2018; Keller & Rondini 2021; Radchenko et al. 2020, etc.). Several times, it has already been shown that Metashape software provides relevant or higher accuracy than other software solutions while covering them with functional diversity and simplicity (Kingsland 2019; 2020; Duric et al. 2021).

3Df Zephyr is commercial software for photogrammetry and 3D modeling developed and marketed by the Italian company 3DFLOW. Only the "Pro" version allows point cloud reference to the coordinate systems. The software allows 3D reconstruction from both photos and videos.

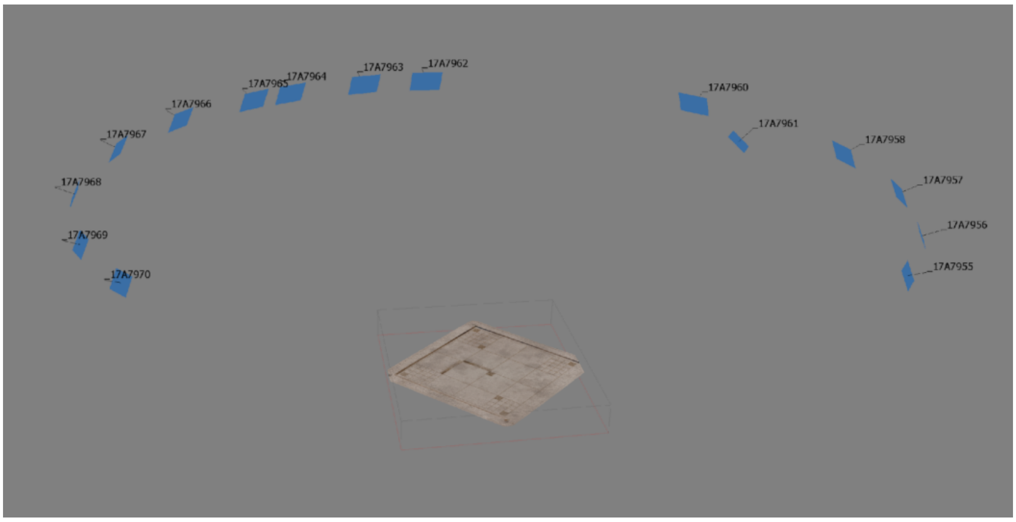


Fig. 3.7. The reconstructed scene of an image acquisition from the taken distance of 0.5 m (Agisoft Metashape software)

After the points have been marked and the camera optimization performed, the software automatically calculates the value of referencing root mean square error (RMSE). The results for different distances taken are shown in tables 3.6 and

3.7. The process has been repeated with the same dataset three times to ensure the results' stability and avoid sudden accuracy changes.

Table 3.6. The results of metric tests processed with the Agisoft Metashape software (v. 1.5.4.8885)

Taken distance, m	Number of images	Matching time, s	Alignment time, s	Points (Sparse cloud)	RMSE, control points, pix	RMSE, control points, mm	RMSE, check points, pix	RMSE, check points, mm	SSD, microns
0.5	15	90	9	1960	0.705	0.308	0.701	0.348	47,2
1	28	216	8	16167	0.743	0.480	0.659	0.478	76,9
1.5	24	442	3	6042	0.387	0.262	0.369	0.279	115.5
2	26	554	21	4704	0.313	0.541	0.335	0.550	155

For all the tests done in Agisoft, Metashape images have been aligned with the maximum possible quality (“Highest”) and camera preselection. All the markers have been pointed out on six images.

Table 3.7. The results of metric tests processed with the 3Df Zephyr software (v. 6.009)

Taken distance, m	Number of images	Running time, s	Points (Sparse cloud)	RMSE, check points, mm	SSD, microns
0.5	15	121	7004	0.388	47,2
1	28	452	17349	0.465	76,9
1.5	24	414	8138	0.182	115.5
2	26	230	4405	0.754	155

The bundle adjustment in Zephyr has been performed using the “General” preset category and the “Deep” quality that provides increased bundle adjustment iterations, number of critical points, and camera matches.

Both software solutions reveal the high accuracy of referencing that fits the required one. The differences are mostly not sufficient and require additional tests to be proven. The only exception is the RMSE of the two m-distant photosets processed in 3Df Zephyr software. While RMSE for the same image set processed in Metashape is higher than other results, it still fits the formal requirements for the reference error — to be below 1 mm. Worth noticing, the Agisoft Metashape presents a more comfortable solution in terms of mask application, increasing both the quality and speed of dataset processing. This makes it more desirable for the particular technological solution with rotation tables and masking procedures.

The scene sample distances for all the image sets are much lower than the limited ones, especially for distances below 1 m. This is one of the main reasons why the scene references show an unusually small value of RMSE. The second reason is the high accuracy of the metallic reference plate, and its calibration results were taken into account during the tests.

Another essential factor that should be considered when choosing software solutions is the visual quality of the final model and the quality of the surface reconstruction. Comparing the latter (Table 3.8), one should admit that Agisoft Metashape yielded better results than 3Df Zephyr even for the taken distance of 0.5 m and 2 m. In contrast, other results are similar same as the value of RMSE.

Due to the test results, the Agisoft Metashape has been chosen as an adequate software solution to provide the data processing for the image-based 3D modeling study of portable rock art specimens from Kamyana Mohyla. The final test was performed with the artificially damaged piece of sandstone. This is needed to check the efficiency of the chosen workflow and the relevancy of the modeling results to the specific research objectives. In this case, the accuracy of the modeling will be enough for the analysis, and the artificial incision will be recognizable. The proposed workflow, data acquisition parameters, and selected equipment will be proven to fit the planned research.

The images of the tested stone have been acquired in four different positions: front view (on the metallic reference plate), inverted, left, and correct views (without a polygon). The total amount of images is 76. All of them have been masked and aligned successfully (fig. 3.9). The parameters of test stone 3D modeling are shown in table 3.9.

A total of 64 markers were pointed to check the final accuracy of the model referencing. Thirty-two of them were used as checkpoints. As the final RMSE is far below 1 mm (and equal to 0.425 mm), the accuracy of 3D modeling fits the requirements of image-based 3D modeling research. Therefore, the data acquisition process performed with the selected workflow and equipment can provide the data to answer the announced research questions.

The experimental traces are apparent both on the textured mesh and on the 3D surface (fig. 3.10), even though their length and width are much smaller than the ones from the Kamyana Mohyla portable rock art collection.

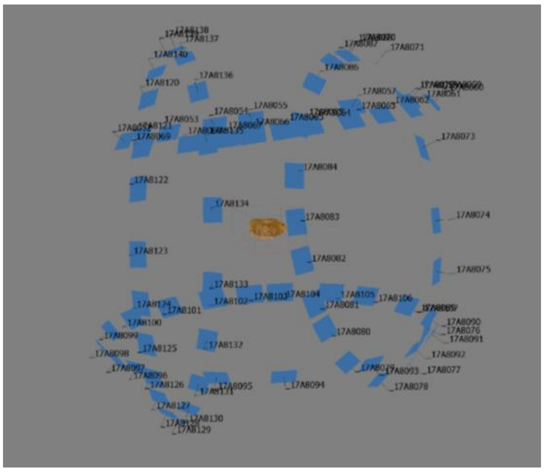
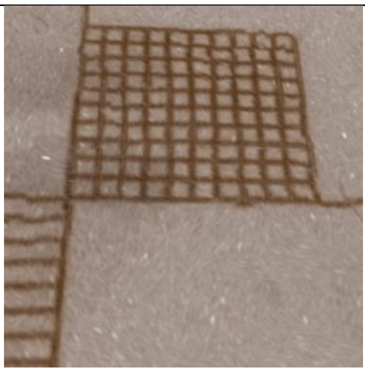
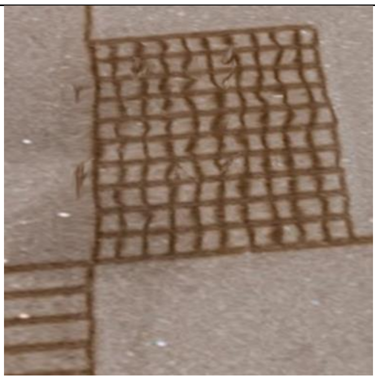
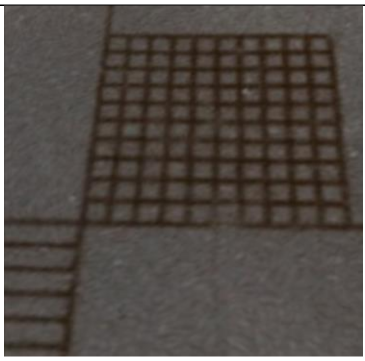
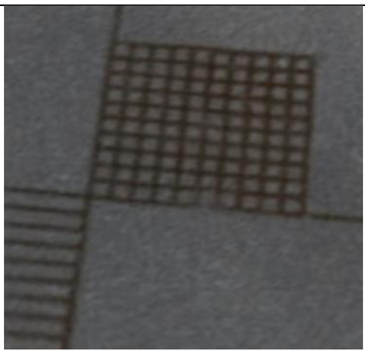
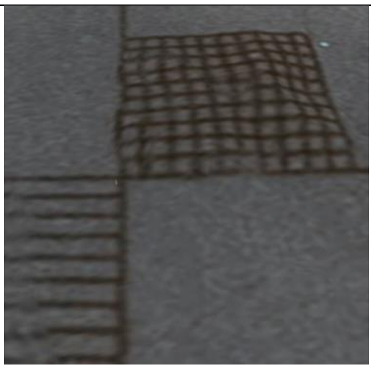
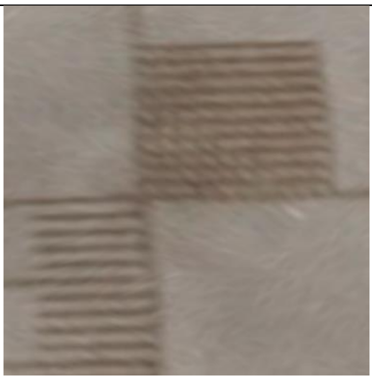


Fig. 3.9. The scene, reconstructed by Agisoft Metashape software

The provided tests show that the chosen equipment, designed polygon, and the proposed workflow are capable of fulfilling the requirements of current research and can be applied to acquire the datasets for future data analysis — several image sets that are to be transformed into 3D models of Kamyana Mohyla portable rock art instances.

Therefore, the data acquisition and processing workflow might be considered established and tested. After its formalization, it will be ready for its application to the specific collection pushing the research process forward to the data acquisition and processing stage (phase S2 of the general workflow).

Table 3.8. Comparison of the visual quality of the metallic reference plate reconstructed model

Distance, m	Agisoft Metashape	3Df Zephyr
0.5		
1		
1.5		
2		

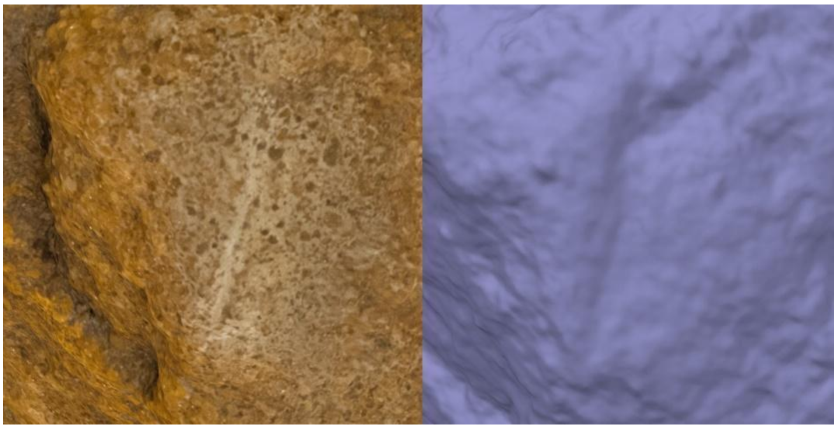


Fig. 3.10. The experimental engraving is visible on the 3D model of a test stone taken from the Kamyana Mohyla hill. Textured (left) and non-textured mesh (right)

Table 3.9. Parameter of the test stone 3D modeling

Parameter	**Value**
Sparse cloud	
Number of points	76 614
Accuracy	Highest
Generic preselection	No
Matching time	37 minutes 35 seconds
Alignment time	19 seconds
Referencing	
Number of control points	32
Number of check points	32
RMSE control points, pixels	0.958
RMSE control points, mm	0.522
RMSE check points, pixels	0.853
RMSE check points, mm	0.425
Dense cloud	
Number of points	4 473 875
Quality	High
Filtering mode	Mild
Processing time	37 minutes 23 seconds
3D model	
Number of faces	6 millions
Number of vertices	3 millions
Surface type	Arbitrary
Source data	Dense cloud
Interpolation	Enabled
Processing time	12 minutes 52 seconds

3.2.6. Data acquisition and processing. Portable art of Kamyana Mohyla as a main case study

S2. Data acquisition and processing. The main result of the preparation stage is the formulation of a specific data acquisition workflow that will be implied to provide the research with the 3D models of portable rock art specimens from the Kamyana Mohyla collection. This workflow is described and schematized before the implementation to the particular collection ("S2" IDEF0 diagram, Annex B) and consists of the following parts.

S2.1—2.2. Image acquisition (Flowchart 2.1—2.2, Annex B).

a) *Organization of the workspace* implies the construction of the white background and the rotation table; installing the camera on the tripod (taking into account the determined image taken the distance for the rock art instance of a particular size); locating the metallic reference plate and the specimen; connecting the camera with the software application for the remote operation; setting the particular image acquisition parameters.

b) *Acquisition of an image photoset of a portable art specimen with the metallic reference plate (front view)* is the first and essential part of the data acquisition process as it produces the images that will later be in use for referencing the scene to a local coordinate system. Thus, these images are the most valuable in the final accuracy of the model (fig. 3.11).

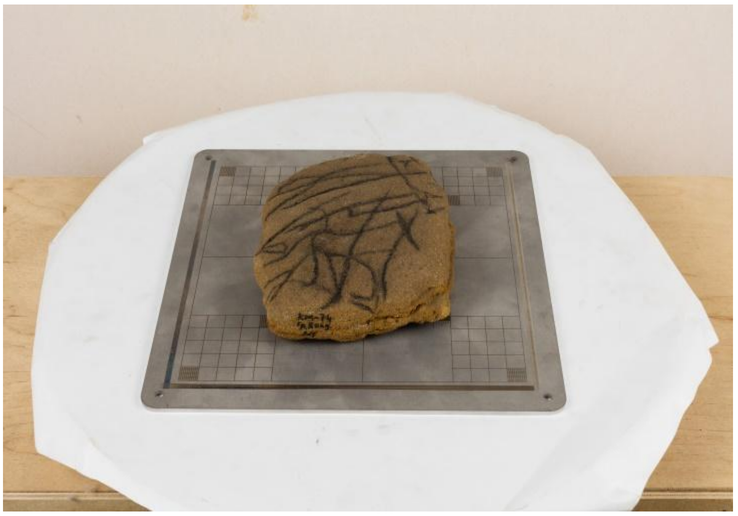


Fig. 3.11. The imaging scene with the first position of a portable art specimen

c) *An acquisition of a photoset without a polygon (inverted view)*. This part of the acquisition process (as well as the two following steps) is needed to capture the whole surface of the model. Some portable art specimens are processed in terms of their shape engraved from both sides of the stone, so the entire surface must be reconstructed (fig. 3.12).

Fig. 3.12. The imaging scene with the second position of a portable art specimen

d) *Acquisition of a photoset without a polygon (left view)*. The side views are needed to perform better camera alignment procedures and increase the chances for successful and accurate 3D modeling. Besides, it contains the necessary information to capture the narrow facets of the specimen (fig. 3.13).

Fig. 3.13. The imaging scene with the third position of a portable art specimen

e) *Acquisition of a photoset without a polygon (right view)*. Similar to the previous position, this view is required to improve the camera alignment procedure. In case when the shape of a specimen is too complex to capture with these four positions, additional images might be needed to fix the points that will later form numerous stone's edges (fig. 3.14).

Fig. 3.14. The imaging scene with the fourth position of a portable art specimen

f) *Transferring the data to the computer* marks the final stage of data acquisition and the beginning of the preprocessing procedure.

g) *Fixing the white balance and taking into account the radiometric parameters of the image using the known camera parameters* is an essential part of the workflow that affects both the accuracy of the image (allowing fixing the distortion and minimizing the impact of the distortion errors) and its radiometric properties, unifying the images to the one color scheme (following the request of the rock art recording objectivity) (fig. 3.15). These actions were performed in the Camera RAW plugin for Agisoft Photoshop software.

Fig. 3.15. The RAW image before the preprocessing stage (left) and the one after the preprocessing procedure (right)

h) *Converting images from RAW to JPG file format* is needed to begin the 3D modeling the specimen in Agisoft Metashape photogrammetric software. To avoid simplifying radiometric parameters and data losses, the level of compression has been set to a minimum — the quality of transformation up to 12 into CameraRAW software that corresponds to 0—5 % of data losses.

i) *Importing images to the photogrammetry processing software* marks the end of preprocessing and the beginning of the S2.3—2.8 stage — data processing.

S2.3—2.8. Data processing (Flowchart 2.3—2.8, Annex B).

a) *Applying masks to the images* is required to exclude the image acquisition background from the data processing. Under this condition, the software will perform camera alignment taking into account only the space of the model and the metallic reference plate, and thus, will reconstruct the whole surface of the model as requested. Both tested solutions, Agisoft Metashape and 3Df Zephyr, has different operation modules for image masking. Masking images before the camera alignment is crucial for correctly reconstructing the specimen's shape. This narrows the list of software solutions for such processing to a few. When masks are applied to the first position of the specimens, the metallic reference plate should be included in the zone that will be considered during the processing (to allow the scene referencing), while for the rest of the specimen positions, only the pixels of the stone must be included (fig. 3.16).

Fig. 3.16. The masked images with the first (up) and right (down) positions of the rock art specimen

b) *Image alignment* assumes the reconstruction of the scene to define the relative orientation of the cameras in the project and finally reconstruct the scene. The sparse cloud and alignment parameters are presented in table 10 during the final result of the scene — on the fig. 3.17. According to the established workflow, if the image does not align correctly, a re-acquisition of the dataset is needed to move the modeling process further.

Table 10. The parameters and results of camera alignment for the portable rock art object No. KM74—1

Parameter	**Value**
Number of images	139
Number of points	32 061
Accuracy	Highest
Generic preselection	Yes
Key point limit	50 000
Tie point limit	4 000
Filter points by mask	Yes
Mask tie points	Yes
Adaptive camera model fitting	Yes
Matching time	2 hours 42 minutes
Alignment time	16 seconds

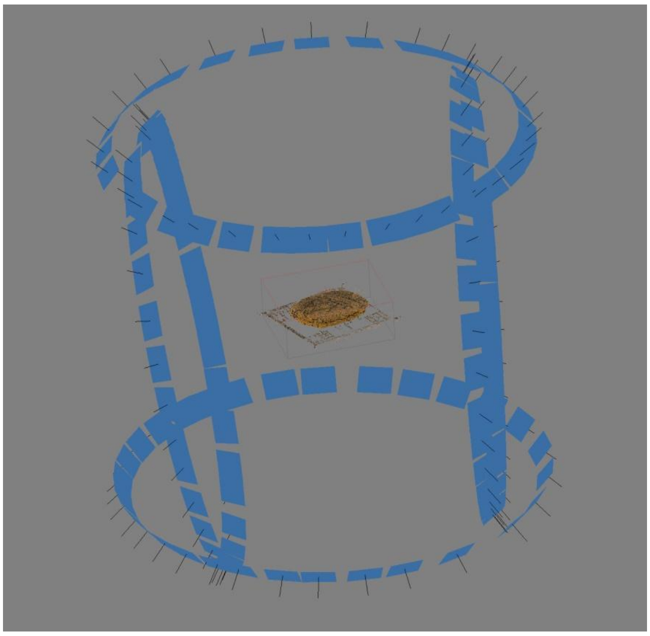


Fig. 3.17. The reconstructed data acquisition scheme (Agisoft Metashape)

c) *Referencing the scene to the local coordinate system with control and checkpoints*. This procedure implies picking the same marker points on different images to reconstruct their spatial location. As the coordinates of any point of the metallic reference plate are known, and their accuracy is high enough to provide sufficient quality of the 3D model (according to the performed tests), marking different points of the metallic reference plate as control and checkpoints for the further accuracy control has to show the relevant quality of the sparse cloud (and scene) referencing (fig. 3.18).

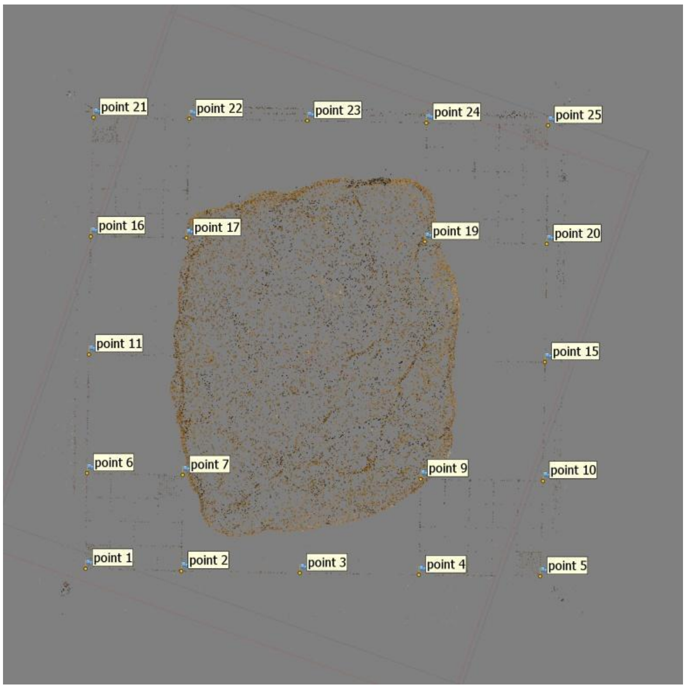


Fig. 3.18. The sparse point cloud with marked points that are to be listed as control and check ones (Agisoft Metashape software)

d) *Checking the root-mean-square error (RMSE) of the referenced point cloud* is the crucial and the last procedure of accuracy check for the specific model. The required accuracy of referencing remains below 1 mm. The example of the RMSE calculation results (for specimen No. KM74—1) is listed in table 3.11. Suppose the value of RMSE is too high. In that case, the accuracy should be increased by extra referencing of the scene to avoid existent errors or by the image re-acquisition procedure.

Table 3.11. The results of scene referencing for the portable rock art object No. KM74—1

Parameter	**Value**
Number of control points	13
Number of check points	12
Maximum number of projections	11
RMSE control points, pixels	0.601

RMSE control points, mm	0.427
RMSE check points, pixels	0.567
RMSE check points, mm	0.465

e) Creating a dense point cloud means extracting additional points to the portable rock art specimen model. These points will later be in use for the proper 3D mesh reconstruction. The parameters of dense point cloud reconstruction are shown in table 3.12, while the results of this reconstruction — are in figure 3.19.

Table 3.12. The parameters of dense point cloud creation for the portable rock art object No. KM74—1

Parameter	**Value**
Number of points	4 918 950
Quality	High
Filtering mode	Mild
Depth maps generation time	3 hours 12 minutes
Dense cloud generation time	1 hour 3 minutes

Fig. 3.19. The dense point cloud of a specimen No. KM74-1
(Agisoft Metashape software)

f) Cleaning of the dense point cloud from the noise sometimes required improving the geometry and the general view of the future 3D model (fig. 3.20).

Fig. 3.20. The noisy points the dense point cloud that are to be cleaned

g) Creating the mesh uses the Poisson algorithm to transform the dense point could into triangulated mesh — the primary data source that will be in use during the surface analysis to provide technical and technological conclusions on the portable rock art objects. The parameters of 3D mesh modeling for the specimen used as an example are shown in table 3.13, while the results — on the fig. 3.21.

Table 3.13. The parameters of 3D mesh modeling for the portable rock art object No. KM74—1

Parameter	**Value**
Number of faces	6 000 000
Number of vertices	3 000 050
Surface type	Arbitrary
Source data	Dense cloud
Interpolation	Enabled

Processing time	16 minutes 21 seconds

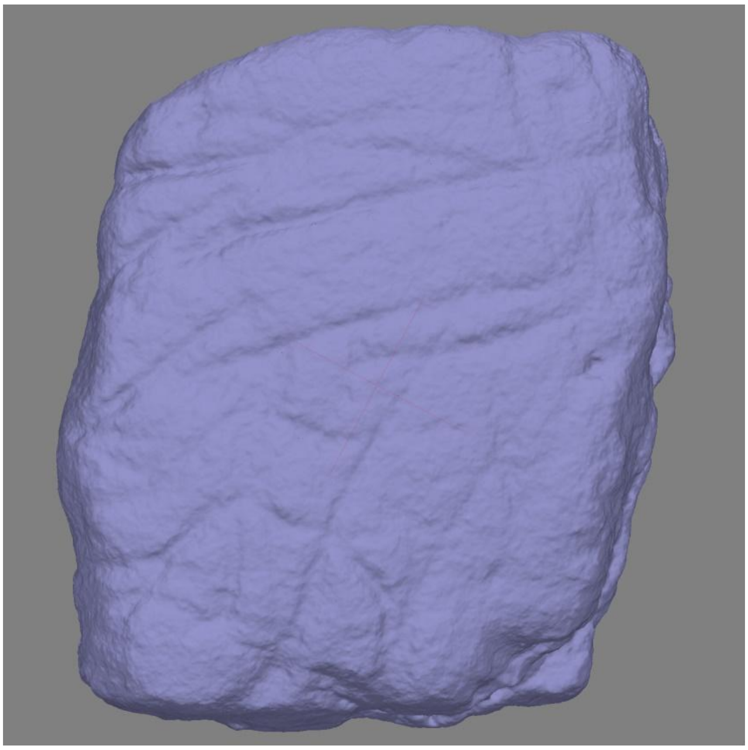


Fig. 3.21. 3D-mesh of a specimen No. KM74-1 that will be used for the surface analysis procedure (Agisoft Metashape software)

h) Texturing the 3D mesh uses the images from all the datasets to produce the textured 3D model of a high resolution. Unfortunately, in most cases, the parameters of color cannot be used during the Kamyana Mohyla portable rock art analysis due to the modifications made during the late 20th century. However, as this procedure can theoretically provide additional information, it has been performed. The parameters of 3D mesh texturing for the specimen used as an example are shown in table 3.14, while the results — on the fig. 3.22.

Table 3.14. The parameters of 3D mesh texturing for the portable rock art object No. KM74—1

Parameter	**Value**

Mapping mode	Generic
Blending mode	Mosaic
Texture size	16 384
Enable hole filling	Yes
UV mapping time	2 minutes 42 seconds
Blending time	41 minutes 59 seconds

Fig. 3.22. The colored (left) and the textured (right) 3D mesh of the portable rock art object No. KM74—1

When the mesh texturing is finished, the data acquisition and processing stage is to be over. This is the point, when the procedure of data analysis begins.

S3. Data analysis (IDEF0 Diagram "S3", Annex B).

The procedure of 3D model analysis — drawings creation, profile extraction, etc. should be preceded by the contextualization of each particular stone according to the frame of the previous research and the existent interpretations with the specified physical parameters. Most of the parameters have been measured by the researchers during the preparation for the publication and checked in the frame of this research or measured during the data acquisition in the storages of Kamyana Mohyla National Reserve or the Institute of Archaeology of National Academy of Sciences of Ukraine. This creates a special standardized card for each portable art specimen, like the one in table 3.15.

After the data analysis is performed, this basic information will be enriched with the analysis results, comprehensive and detailed drawings, and the relative chronology scheme.

S3.1. Importing the model to Meshlab. An important part of the data analysis is happening in the Meshlab software due to the wide variety of available filters and rendering options and the possibility of simulating the artificial light. Meshlab is a mesh processing system oriented to managing and processing unstructured large meshes for editing, cleaning, healing, inspecting, rendering, and converting these kinds of meshes. Thus, one of the initial actions for data analysis is importing the 3D model to the Meshlab (v. 2016) software.

S3.2. *Applying filters to the surface*. This process implies using *Ambient Occlusion* and *Radiance Scaling* tools to increase the visibility of relief features on the portable rock art instances 3D model. These filters appear to be the important part of the visual inspection procedures when analyzing shallow and barely visible incisions, like those on Kamyana Mohyla rock art instances (fig. 3.23).

Table 3.15. The information card for the portable rock art specimen No. KM74—1

Specimen's ID	KM74—1
Image	
Length, cm	11
Width, cm	15
Weight, g	696
Volume, m^3	0.000358
Density, kg / m^3	1944,134
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The lower third part of the block is occupied by an image of an animal with the long tail, probably the bull. His head is turned right. Four legs are engraved; no ears. The middle part of the bull has been crossed by the big lines that are probably marks the spears. Under the image of the bull linear notches are situated. Their meaning is undetermined. The upper quarter of the block is covered with the schematic image of an animal that moves right: its tail is elongated, the head is turned down. Following the analogies from the Wizard's cave one can assume that this creature is well-known character of a cave lion. Its breaths and hip are crossed with wide lines (the spears).
Description source	Danilenko 1986: 95—96

Fig. 3.23. The 3D mesh right after the data import (left) and after (right) the application of "Ambient Occlusion" and "Radiance Scaling" filters

S3.3. Surface examination with light simulation. The Meshlab software solution has a possibility to simulate the virtual lightning of a 3D model from the desired view point. From the technological point of view this tools appears to be capable to replace RTI technology (Porter 2016; Graff 2018) in terms of 3D model analysis. It also simplifies the process of the relative chronology determination for the particular engravings as brightens the tiny features of the different engraving's intersections. Therefore the virtual examination of a 3D model implies the definition of a number of different rock art specimens features such as engravings intersections (fig. 3.24), technological details, such as the direction of the incising (fig. 3.25), the details of the profile's shape (fig. 3.26). After this examination is done, the preliminary conclusions on the relative chronology and the rock art specimen creation process might be delivered. This is also the source of information for the accurate and clear drawing of the specimen.

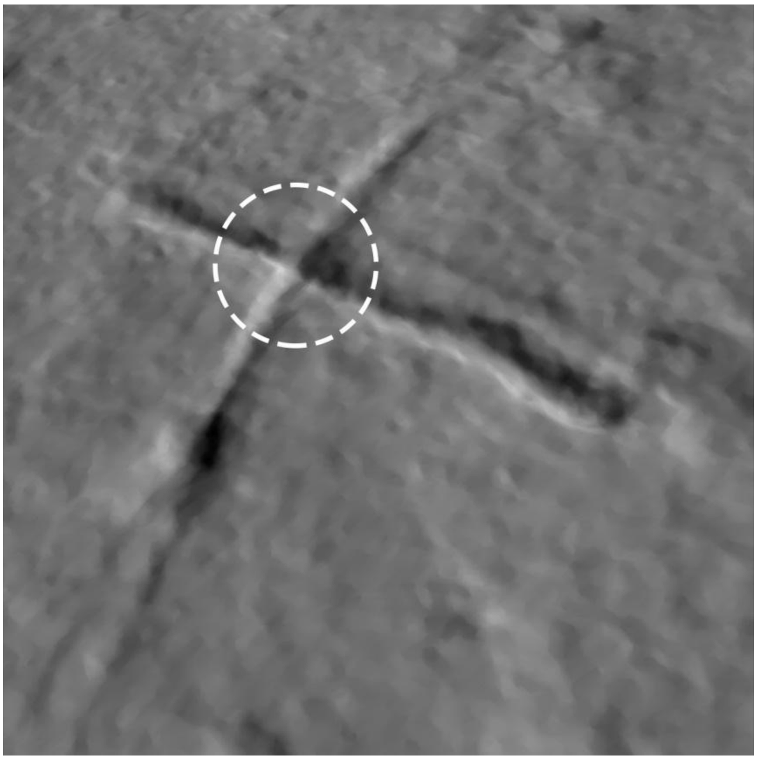


Fig. 3.24. The shape of the two different incisions crossing gives a clue about the marking direction and a relative chronology of the incisions

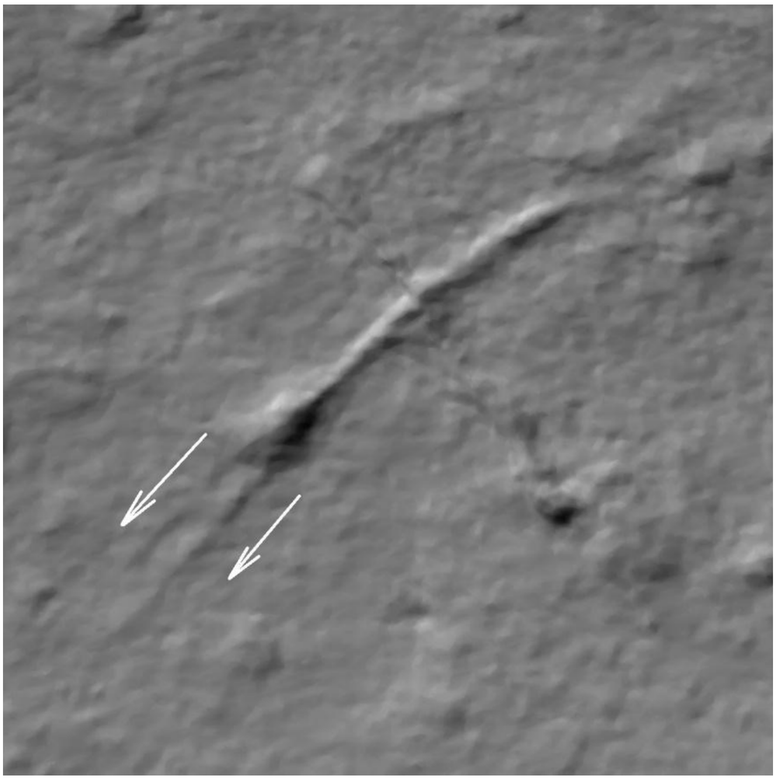


Fig. 3.25. The incisions on the engraved surface marks the direction of the stone's notching (experimental specimen)

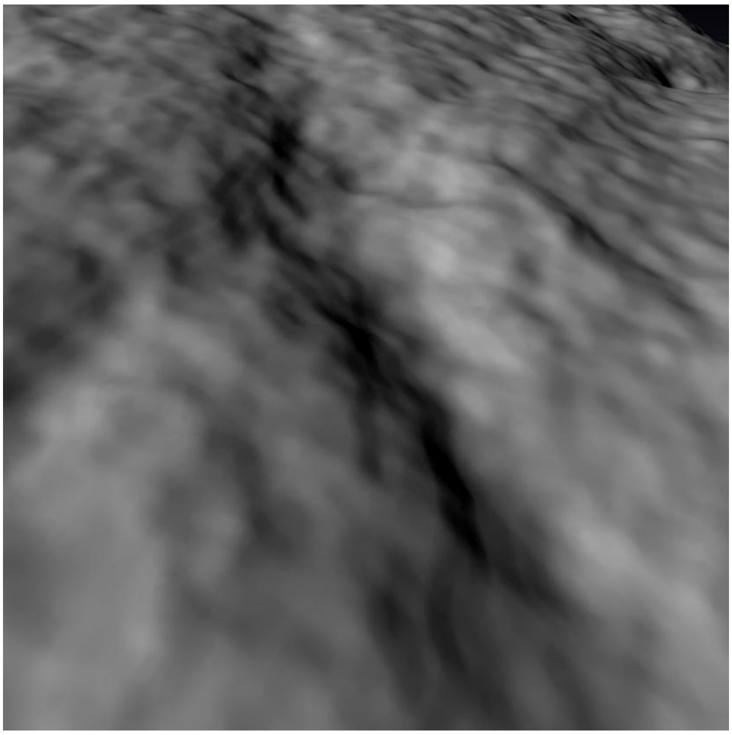


Fig. 3.26. The details of two shallow profiles shape is clearly visible on the surface, enlightened with the virtual light simulation

S3.4. Extracting and measuring the engravings profiles. This procedure implies the receiving of the profile's shapes and metric parameters for the engravings of each particular portable art specimen. This will later be used for the typologization of the profiles and further analysis of the portable rock art instances according to the types of inscriptions. Profiles are measured with the perpendicular crossing on the small part of its shape (fig. 3.27). The differences of the profiles shape is later used to provide the deeper understanding of the engraving process and present it through the drawing and the relative chronology of the specimen.

All the extracted profiles are drawn, measured and presented in a separate list for each analyzed portable rock art specimen (fig. 3.28). The lengths of the profiles are measured between the two closest relief extremums (turning points), while the depths — as a perpendicular to the length line.

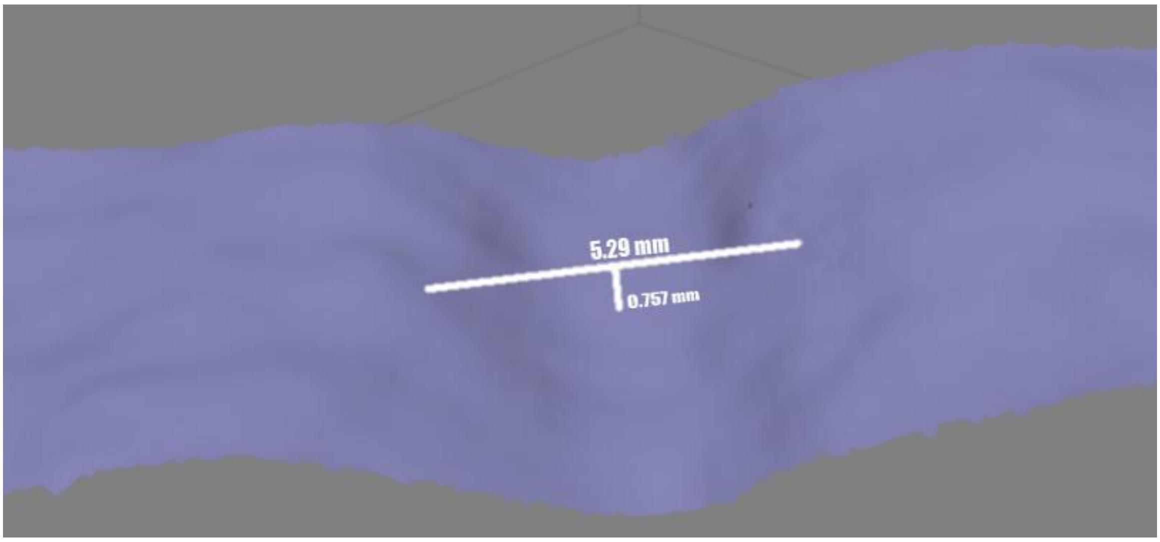


Fig. 3.27. The extracted engraving profile from the portable rock art instance No. KM74—1

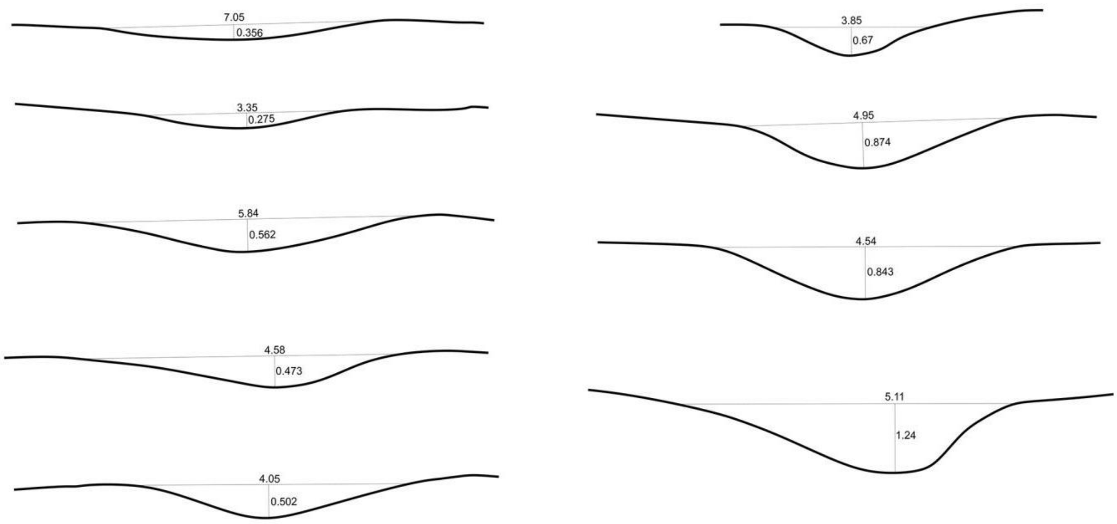


Fig. 3.28. The "cross-section list" with all types of profiles on the portable rock art specimen No. KM74—1

S3.5. Drawing of the specimen. All obtained data is required to provide the comprehensive drawing of the portable rock art specimen that is a required and established way of rock art recording (fig. 3.29). The drawing as well as the profile list in included into the card of a particular specimen.

Fig. 3.29. Drawing of the portable rock art object No. KM74—1. Different types of profiles are marked in black and grey

S3.6. Defining the relative chronology of engravings. The final stage of rock art specimen examination implies determining the incising sequence, e.g., the relative chronology of engravings. These data will be used later to consider the life cycle of particular specimens or specimen types. The relative chronology is to be presented in two different ways: as a drawing (fig. 3.30) included in the specimen's card and through the Harris matrix.

Harris matrix is a "diagrammatic way of representing how layers are superimposed … Where the patterning is complex … a graphic representation can greatly assist in visualizing the superimposition pattern, making the chronology easier to analyze. Harris Matrices provide such a method" (Harris & Gunn 2017: 1). This tool was invented back in the 1970s and applied for the analysis of soils stratigraphy and the general analysis of deposition processes since then as a stratigraphy as a source of archaeological information become more and more critical (Harris 1989). However, the examples of the Harris matrixes used for the rock art study remained few during the 20th century because painted "deposits" are a unique stratigraphic unit (Harris 2017: 2).

The idea to use Harris matrixes for rock art study has been first proposed for paintings in the 1990s (Chippindale & Taçon 1993; Loubser 1997). Though the Harris matrixes remain in occasional use for rock art study, several case studies from Africa (Russell 2000, 2012; Swart 2004) and elsewhere (Gunn, Ogleby, Lee, & Whear 2010; Keyser 2001; Magar & Davila 2004; Keller & Rondini 2021) appeared recent decades. Thus the distinction between the different Harris matrix phases can be grounded in technological, stylistic, or semantic differences. Researchers propose their solution for the matrix application in rock art studies.

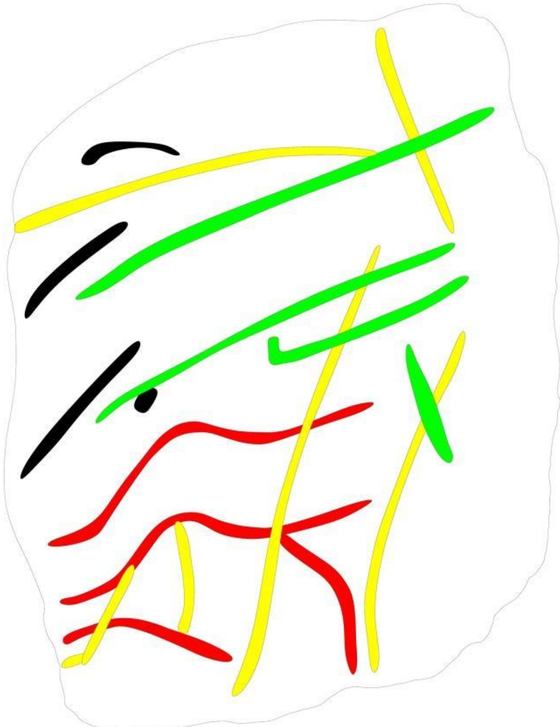


Fig. 3.30.Relative chronology drawing for the portable rock art object No. KM74—1. The oldest lines marked in red, the middle one's are yellow, the youngest are green, while the black ones are unidentified

The use of Harris Matrices to help visually structure and interpret rock art sequences should be considered a standard component of rock art research whenever complex superimpositions are involved (Harris & Gunn 2017: 16). Recent revival of the photogrammetry and its active use for the technological study and interpretation of the rock art petroglyphs sometimes allows the definition of the sequence for the creation of the particular engravings. Such an option gives a floor to the Harris matrix application as a tool for technological analysis of the petroglyphs when the semantic or chronological aspect is barely distinguishable. The capability to define the relative chronology of the engravings of the portable rock art instances has already been demonstrated through the means of 3D modeling by N. Melard (2010; Melard et al. 2016), while the application of Harris matrix to the motifs sequence determination showed great success on the Cemmo stones in Valcamonica, Italy (Keller & Rondini 2021).

The earlier experiment was performed for the Kamyana Mohyla rock art made on soft sandstone (Radchenko et al. 2020). This resulted in the reinterpretation and novel determination of the iconic rock art scene from the Ukrainian Steppe’s Late Mesolithic and Early Bronze Age. Though there are no specific features for the superimposition’s determination from 3D models and the clear, unified workflow for different sites cannot be established (due to different technics and technologies but also to different geological and archaeological contexts), numerous clues on the 3D model surface usually help determine the relative chronology of the rock art instances all around the world.

Considering the excellent capability of the relative chronology determination from the 3D models of portable rock art specimens and the high efficiency of its presenting and analysis using the Harris matrixes, I find the latter be a comprehensive way to acquire, analyze and interpret data on Kamyana Mohyla rock art. The systematic application of the Harris matrixes as a notation method for the stratigraphy of rock art instances simplifies the distinction of separate motifs (when possible at all) (Harris & Gunn 2017: 14—15) and fuzzification of engravings both on the separate portable art specimen and the collection as a whole.

Therefore, the established sequence of relative chronology for each portable rock art specimen from Kamyana Mohyla will be followed by its presentation in the Harris matrix (fig. 3.31) that is also added to the specimen's card. The amount of these matrixes might later be used for the analysis and reconstruction of the portable rock art instances' life cycle and the determination of the particular technological features of their creation.

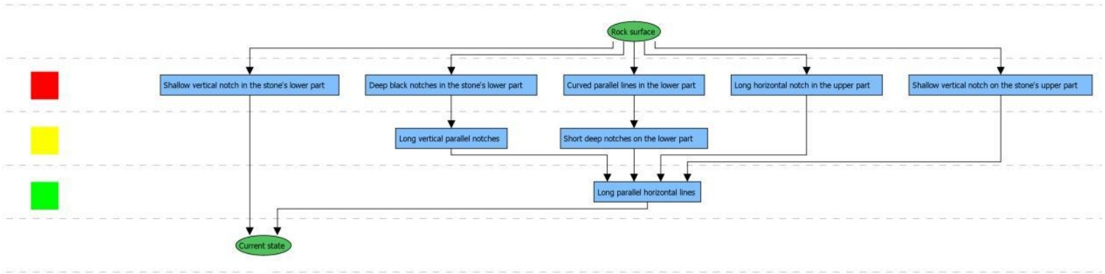


Fig. 3.31. Harris matrix for the portable rock art object No. KM74—1

After all, these procedures are completed, and the relevant information cards are created, the data concerning the portable rock art specimen's 3D models might be analyzed as one entity to provide the new technological data on the portable rock art of Kamyana Mohyla, validate the existent theories concerning the collection, reconstruct the technological life cycle of a particular specimen's or their types, etc. This implies the data interpretation procedures — the final stage of the portable rock art instances image-based 3D modeling study.

3.2.7. Data acquisition and processing. Portable objects from Gobustan National Historical Artistic preserve as an additional case study

The workflow presented in section 3.2. of this Chapter seeks to develop the correct and efficient accuracy assessment strategy and technological solution for the image-based 3D modeling of portable art specimens with submillimeter accuracy. This procedure is expected to be efficient beyond the narrow case of Kamyana Mohyla rock art and applicable to other mobile rock art cases. Therefore it is reasonable to test the developed technological solution (metallic reference plate) and the formulated workflow on the different datasets and check if the modeling result will be sufficient for answering the potential research questions. If the developed solutions can contribute to the rock art study and contextualization of the portable engraved stones beyond the case of Kamyana Mohyla, this would be a valuable result regarding the formulated research questions.

Therefore, the challenge is to apply the same methods to another collection of portable rock art objects and reach the same level of accuracy and relevance of the data, calculating the resulting accuracy and comparing it to the results from the Kamyana Mohyla case. A further step would be to check if these models might contribute to other research questions applied to the Gobustan collection instead of the Kamyana Mohyla one. However, the initial objective is to ensure the adequacy and relevance of the developed solution for datasets different from the Ukrainian one.

This procedure includes the application of the technological and workflow schemes defined and enlisted in Annex B to the specimens from Gobustan National Historic and Artistic Preserve and producing an additional dataset of portable rock art 3D models from Azerbaijan. These limestone objects are extracted from archaeological contexts and introduce different engraving technologies — mostly pecking and incising. Though B. Mykhailov drew some lines of analogies between Kamyana Mohyla and Azerbaijan, the preliminary study did not show any lines of evidence. However, the variability of portable stones is expected to present the possible limitations of the methods (if any). It might give a clue about the additional data that might be extracted from the photogrammetric study of the portable engraved stones. The detailed survey results are introduced in Annex E. In contrast, the data acquisition, modeling, and analysis results of a single object from the Bendyustyu site on the Apsheron peninsula are presented here.

S2.1—2.2. Image acquisition (Flowchart 2.1—2.2, Annex B).

a) Organization of the workspace. The data acquisition conditions in Gobustan National Historic and Artistic preserve differed from those in the Institute of Archaeology in Kyiv. Similarly to Ukrainian materials, the portable stones in Azerbaijan must remain in storage or not be removed from the museum's specific part. This limitation and the lack of space and light sources in the storage room brought several additional issues: the absence of single-color background and light sources. Therefore, during the data acquisition in Azerbaijan, the background was not created artificially, as the location could not be modified. The absence of light sources forced us to use the additional portative equipment — a macro LED ring mounted on the lens. This solution cannot provide the perfect light conditions but improves them to the appropriate level (fig. 3.32).

Fig. 3.32. The data acquisition conditions in the storage of Gobustan National Historic and Artistic Preserve

Furthermore, the portable rock art specimens from Azerbaijan are mostly larger than those from Kamyana Mohyla. Taking this into account, the image taken distance has been increased to an average of 1.1—1.5 m (screen sample distance of

80—115 microns) to provide the relevant field of depth and capture the whole object with enough sharpness.

b). Image acquisition. The image acquisition procedure has also changed. As there was only one chance to acquire the relevant images and the first attempt should have been successful, additional camera positions have been used. This has increased the number of images in each asset (24—48 more for one model). The main procedure, however, remained the same: one full circle (the rotation angle of 15 gives 24 images for each camera position) with the metallic reference plate, and others (four or five instead of three) were made without a reference plate. Sharp edges and complex shapes have been photographed to ensure they will be captured correctly.

c—h) Creation of the model. The parameters of 3D image-based modeling of the portable stones from Gobustan were equivalent to those of the churingas from Kamyana Mohyla. The image referencing returned the RMSE below 0.5 mm both for the Control points and Checkpoints (the data are listed in Annex E). The workflow is linear and consists of converting the images in Camera RAW and exporting them to Agisoft Metashape, applying masks to each image, referencing the metallic plate to the coordinate system, image alignment, building dense cloud and 3D-mesh and texturing the model (fig. 3.33).

Fig. 3.33. The model of the portable stone N12(A87) from Bendysty site of Apsheron peninsula

Further procedures include processing the model in MeshLab and applying a number of filters ('Ambient Occlusion' and 'Radiance Scaling') to define the relative chronology of the engravings on the stone surface (fig. 3.34). These data are reflected in the drawings made from the data extracted from the 3D model (fig. 3.35).

Fig. 3.34. The 3D mesh of the stone N12(A87) from Bendysty after the application of "Ambient Occlusion" and "Radiance Scaling" filters in MeshLab

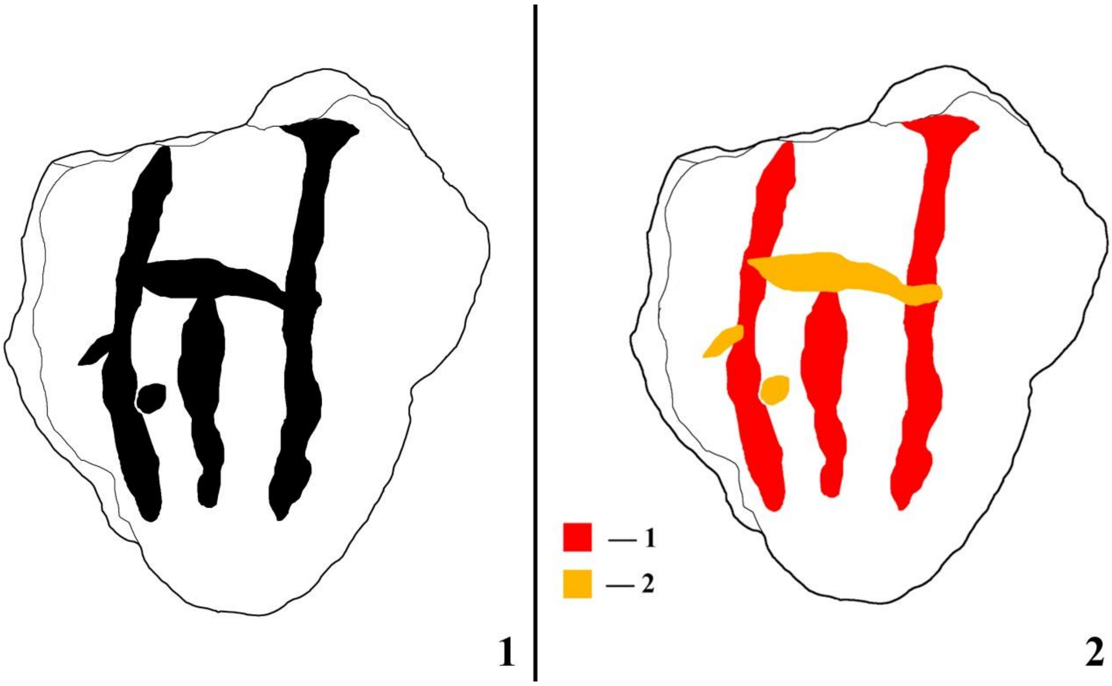


Fig. 3.35. Stone N12(A87) from Bendysty site. 1 — drawing; 2 — drawing of engraving sequence as determined after the examination of 3D model

The cross-section extraction and measuring are performed the same way as for the churingas of Kamyana Mohyla (fig. 3.36). The similar shape and configuration of cross-sections support the assumptions of Bendysty discoverers that the primary way of engraving the portable stones from there is the scratching technique. Finally, the general data on the stone has been grouped in the card (table 15). The cards of all the stones that have been 3D modeled and investigated during this survey are found in Annex E. As most of the stones from that survey have not been published before (and none of them have ever been 3D modeled and published in English), they represent an asset of new material to be introduced to the scientific circles and interpret further, together with the specialists from Gobustan and taking into account the local context.

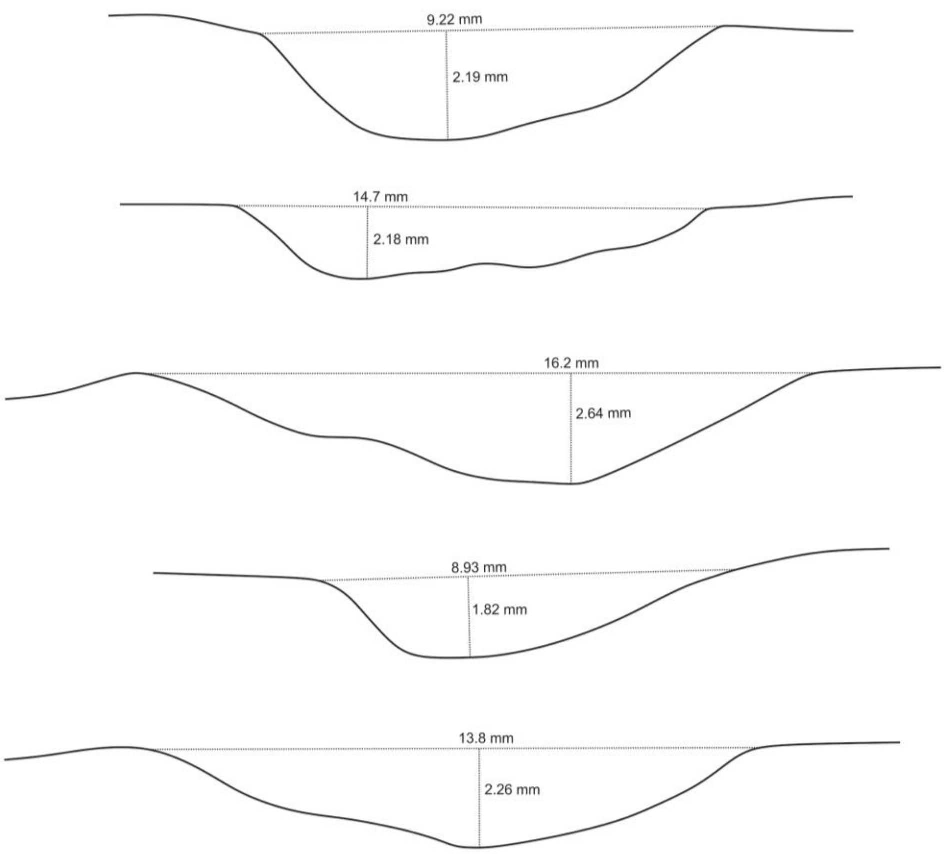


Fig. 3.36. The "cross-section list" with all types of profiles on the portable rock art specimen No. N12(A87)

Table 3.16. The information card for the portable rock art specimen N12(A87)

Specimen's ID	N12(A87)
Image front	
Length, cm	19.7
Width, cm	17.6
Thickness, cm	3.42
Date of discovery	1987
Finder	I. Aliev, G. Aslanov
Location	Bendysty site, Apsheron penninsula
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	The human figure is depicted in full growth. Near the assumed "shoulder" the stone block is broken (possibly intentionally). The image is schematic; the stomach is crossed with the belt line. Lines are shallow, scratched.
Description source	Report of Apsheron squad of Baku-Apsheron archaeological expedition in 1987 (June, 10 — July, 10): 13
Note	The block has been described only in the field report from 1987 field season. The measurements, provided in the field report, are not correct. The front side of a stone has been polished to create a flat shape before engraving. The assumption of Aslanov and Aliev that the belt line has been added after a vertical one proved to be correct. The sequence is well-defined due to the softness of limestone. The main engraving method is multiple scratches that cause the appearance of curvilinear and irregular profile. Left vertical line is featured with two short scratched or pecked lines.

3.2.8. Data interpretation as considered by the workflow

S4. Data interpretation (IDEF0 Diagram “S4”, Annex B).

The data interpretation stage is the final stage of photogrammetric research that goes through the shaping and systematizing of the acquired data and their comprehensive analysis as a holistic system in a frame of the portable rock art entity to the technological and technical conclusions and answering the stated research questions. The procedure of data interpretation consists of five stages.

1.1. Typology of engravings profiles is required to systematize the data on the portable rock art incisions and group the collection specimens into several entities following these technological criteria.

1.2. Analysis of specimens Harris matrixes help to find common motifs on the portable objects, to analyze the specimens in terms of their life cycle and the processes of their engraving further to reconsider their context and the role in the pre-Historic landscape.

1.3. All acquired data are then *assigned to* their *spatial context*, the current archaeological interpretation, and the existent hypothesis regarding the collection and the particular instances interpretation. This is required to provide a complex look at the collection in its pre-Historic context.

1.4. Determining the specific archaeological context according to the existing data and interpretation is needed to actualize the specific research question that each parcel of data can theoretically contribute. This last stage of data systematization brings us to the final part of the interpretation procedure.

1.5. *Testing of previous hypotheses on the portable rock art collection* taking into account the new data, allows contributing to the main research questions that have been stated so far. This is required to apply the newly obtained data and their interpretations to the specific archaeological interpretations and confront the former with the latter. The technological advances of digital photogrammetry bring an essential innovation into understanding the portable art specimen’s surfaces and the incised images. Thus, they can tremendously contribute to adequately reshaping our understanding of the rock art collection. Besides, the photogrammetric study, with the old hypotheses and the general context of the instances, can produce new and crucial data on the rock art of any site wherever applied.

However, this is just the final point of a technological study aimed at answering the research questions from the photogrammetric point of view and providing the impact point for the archaeologists and rock art experts to reconsider and improve our knowledge of a particular amount of heritage instances.

All these processes are the final and the most fruitful point of the fundamental research that brings us to new horizons of our knowledge on portable rock art instances. Therefore, they deserve to be considered in detail with all the accuracy. This is to be done in the following chapters, which focus on data interpretation procedures and what’s beyond them.

3.3. The applicability of image-based 3D modeling for the portable rock art study. First results

The procedures described in this Chapter are crucial to answering the core research questions of the current research. The math calculations persuade that there is a clear accuracy assessment strategy for the image-based 3D modeling of the portable rock art specimens. Starting from the desired accuracy and resolution of the 3D model, this leads to the specific parameters of the camera, equipment details, and specificities of the data acquisition protocol, i.e., aperture value, camera distance, etc. Altogether, these parameters can define how to receive the required models' accuracy. In the case of Kamyana Mohyla, it is defined as 'below 1 mm' since V. Danilenko determined the size of engravings' characteristic features on the engraved stones as close to 1 mm. The rough calculation of the developed data acquisition strategy proved the overall accuracy to be less than 0.5 mm which is enough to perform the photogrammetric study of study objects. IDEF0 diagrams and charts in Annex B describe the strategy in detail. The ways to calculate and achieve the desired accuracy are also presented there.

In practice, the accuracy assessment during the data acquisition procedure must be controlled by applying specific technological solutions. In this project, a clear technical solution is embodied in the metallic reference plate with the coordinate grid, calibrated with the laser interferometer. This device is produced specifically for the image-based 3D modeling of portable rock art specimens from Kamyana Mohyla. It provides an accurate assessment that allows the detailed analysis of these objects' surfaces. This technological solution is needed to perform a comprehensive and controllable image-based 3D modeling of portable rock art objects. By developing and applying it, I answer one of the postulated research questions of the current project. The details of these procedures are enlisted in Annex C.

It is clear that the engraved stones' surface, obtained with an accuracy below 0.5 mm, is an excellent source of information regarding the shape and parameters of engravings. It allows the detection of minor irregularities of the objects' surface, including differences in the engravings' cross-sections, depth, width, slope direction, etc. The procedure of artificial light simulation and 3D models post-processing will contribute to the determination of relative chronology and nuancing of the portable objects' life cycle. Moreover, this accuracy of 3D models will ensure the relevant accuracy of the volume and density calculations. It thus will be the basement for the analysis of engravings' relations with the engravings' support. Most important, accurate 3D models are essential to the accurate drawings and visual representations of rock art specimens.

Applied to the stones from Kamyana Mohyla, these tools and data acquisition strategies will form the fundament for creating the relevant engravings tracings and checking V. Danilenko's and B. Mykhailov's datasets. Moreover, they will ensure the reliability of calculations, cross-sections, relative chronology interpretations, and other data obtained from 3D models. Therefore, developed technological solutions are vital to make the photogrammetric study of portable rock art objects reliable, accurate, and informative. They are essential to answer other formulated research questions.

Only by being featured with the relevant accuracy assessment and data acquisition strategies and supported with clearly defined equipment can photogrammetry form a reliable basis to provide sensible conclusions for studying portable rock art specimens. A specific protocol that fits the study of Kamyana Mohyla rock art is developed and presented in this Chapter. At the same time, the general workflow schemes and relevant calculations are available in Annex B.

The data acquisition procedures showed great potential for analyzing the portable rock art specimens from Kamyana Mohyla. The concepts and results of these analyses are presented in the following Chapter. These procedures fit the goal of producing accurate and relevant image-based 3D models that form a great basement for further research.

Moreover, the data acquisition at the Gobustan National Historic and Artistic Preserve proved that the established workflows and technological solutions are applicable beyond the Kamyana Mohyla portable rock art collection. They fit well with the modeling of other mobiliary rock art assets worldwide. It is reasonable to assume that they can reveal additional information on the chronology, technology, and composition of the engravings, both for the stones from Ukraine and Azerbaijan. Therefore, the presented photogrammetric solutions are considered relevant to perform comprehensive image-based 3D modeling and the following study of portable rock art, as established by the initial hypotheses.

4. PORTABLE ART OF KAMYANA MOHYLA — TECHNOLOGICAL INTERPRETATION

4.1. The churingas from Kamyana Mohyla

The first ever found is a fish-shaped pebble found by M. Rudinskiy in 1952 (Danilenko 1986: 65). This was "similar to a catfish. It is covered with engravings and rhombic figures that depict the body of a fish. The comparatively big mouth and an eye are also depicted…" (Danilenko 1986: 67). However, according to V. Danilenko, "the concretion of similar shape containing pictures has also been found in 1938 ... Unfortunately, all these specimens were lost during World War II, and we are deprived of the possibility to consider the character of the engravings there" (Danilenko 1986: 65).

During the fieldwork season in 1973, V. Danilenko and his team discovered two caves with engraved pebbles — the "cave of Churingas" and the "Wizard's cave." The former has been named because of a high concentration of portable rock art specimens, the latter — following the first and most iconic motif that has been found in the cave — a therianthropic figure that has been interpreted as a man turning to a bison (Danilenko 1986: 75—76). One hundred nineteen stones were found during the season and later transferred to the Institute of Archaeology of the National Academy of Sciences of Ukraine in Kyiv. This fact has been reported by V. Danilenko and provided to the Institute. However, the location of the stones in caves was not specified, so contextualization is possible up to the level of a particular cave.

In 1974 V. Danilenko excavated the Wizard's cave once again. During this season, 28 stones were found. Unfortunately, the report of these excavations was never finished, so we know little about their context. V. Danilenko has provided an attempt to interpret these stones in his book "Kamyana Mohyla," published after his death (Danilenko, 1986). This is a complete source of information concerning his interpretation of the portable rock art from Kamyana Mohyla. During the preparation of photos and drawings for this book, V. Danilenko performed the coloring of the engravings with graphite or coil. Though this increased the visibility of what he considered engravings, the level of objectivity of the engravings recognition is shallow. To avoid the misinterpretations caused by the destructive impact of previous researchers, I intend to follow only the shape of the 3D surface during the technical analysis of the instances, avoiding the actual drawings and interpretations. The results of this analysis will be used to confront the photogrammetric data with the hypotheses and the interpretations provided by V. Danilenko and B. Mykhailov.

B. Mykhailov continued research on Kamyana Mohyla. During 1985—2005 he excavated Kamyana Mohyla every year, searching for new cave art and portable rock art specimens. His efforts (together with the Kamyana Mohyla Reserve staff) led to the discovery of a new assemblage of 233 stones. Most of them are now located in the stores of the National Historical and Archaeological Reserve "Kamyana Mohyla." Almost half of the stones were published by B. Mykhailov in his book "Petroglyphs of Kamyana Mohyla" (Mykhailov 2005). Unfortunately, this publication does not present any systematic study or methodology for researching these objects. Many of the interpretations by B. Mykhailov should be reshaped according to the contemporary development of rock art science (Radchenko & Nykonenko 2019; Radchenko et al. 2020).

Two more churingas were found during the fieldwork of N. Kotova (Kotova et al. 2018). They were discovered in the Mesolithic layer of the settlement Kamyana Mohyla — 1 (180 meters South-West of the Kamyana Mohyla Hill) and were attributed to the Late Mesolithic Kukrek culture based on radiocarbon dating of the fireplaces and bones found near the stone artifacts and the cultural attribution of the related cultural layers — 8416—8282 calBC (BE-6733, 2σ) and 7504—7334 cal BC (BE-6731, 2σ), both dates are modeled with Bayesian modeling, the results were calibrated with OxCal 4.4.2 (Ramsey 2009) using atmospheric data from Reimer et al. (2020) (Kotova et al. 2018; Kiosak et al. 2022).

To sum up, the total number of churingas from Kamyana Mohyla is currently 380 specimens. One hundred forty-six of them are stored in the deposits of in the Institute of Archaeology of National Academy of Sciences of Ukraine, Kyiv; 1 — in the Archaeological Museum of the Institute of Archaeology of National Academy of Sciences of Ukraine, Kyiv; 230 — in the storage of National Historical and Archaeological Reserve "Kamyana Mohyla," Myrne, Melitopol district, Zaporizhzhya region; 1 — in the Melitopol Regional Museum of Local History; 2 — in the Zaporizhzhya Regional Museum of local history.

I analyze the collection of the churingas collected by M. Rudinskiy and V. Danilenko to distinguish the natural portable rock art specimens. The collection consists of 148 specimens of different weights and sizes. Some are engraved, and some are not. Therefore, I will apply the abovementioned criteria to define the portable rock art specimens and look closer at their shape, engravings, and the context of their discovery (their original, etc.).

4.2. The advantages of photogrammetry as a way of the objective recording of rock art traces

One of the main goals of the photogrammetric recording of the portable rock art specimens from Kamyana Mohyla was to create an accurate and objective representation to receive a reliable dataset for future study, interpretation, and attribution. Previous research has shown the churingas of Kamyana Mohyla to be rich in various engravings and peculiar iconographic motifs, presented by V. Danilenko on the stone's surface and in the special drawing. As outlined in section 3.1., the current research methodology allows the creation of the relevant dataset to provide reliable digital traces of Kamyana Mohyla portable rock art traces and check the reliability of previously generated data. Consequently, it allows re-evaluating once constructed hypotheses on the chronological attribution and interpretation of the Kamyana Mohyla rock art.

To produce accurate digital traces of the portable objects, I used image-based 3D models, post-processed by the series of rendering tools (see sections 3.7—3.8) and observed through the artificial light simulation environment (the digital 3D-analog of RTI instrument, see Porter et al. 2016) (fig. 4.1).

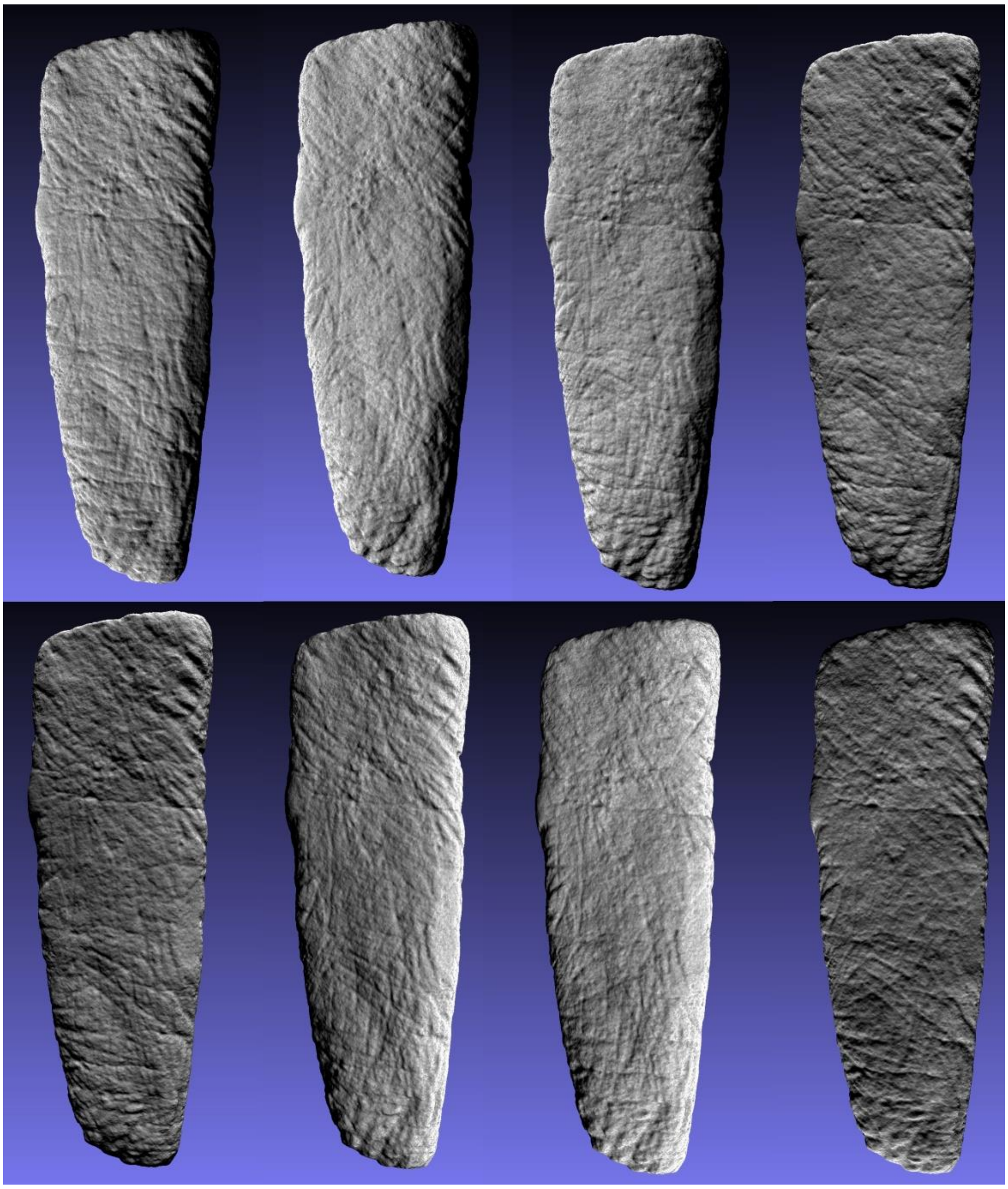


Fig. 4.1. The image-based 3D model of the portable stone No. 245, observed in the artificial light simulation environment

The series of images, generated from the artificial light simulation procedures, provides several data for the accurate digital tracing of the portable rock art specimen based on the accurate submillimeter 3D modeling of the artifact (fig. 4.2). Here, in section 4.2. these results are introduced on the example of iconic stone No. 245. The whole list of drawings is presented in Annex D.

Fig. 4.2. Digital tracing of the stone No. 245 made after image-based 3D modeling

The peculiar and valuable outcome of these traces is revealed in comparison with the drawings of V. Danilenko (fig. 4.3.) During his lab examination researcher considered this stone as features with the engravings of three women:

“The figure of an adult woman occupies more than the upper third part of the churinga; her face turned left. He is sitting; his legs are bent at the hips and knees.

The object her sitting at is not depicted. It is intended to be imagined. The middle part of the churinga is occupied with the image of another thicker woman. She is also sitting. Her breaths and legs are hypertrophied. He bears signs of pregnancy. Hands are under the stomach. The lower part contains the third woman figure. She is staying on her knees; her face is turned right. Their hands are close to her hips. Hair is loose and falls on the back in waves. Other space is occupied with deep horizontal and diagonal engravings."

Fig. 4.3. The comparison of different drawings of the stone No. 245. 1 — the image of the portable stone. Black pigment is added by V. Danilenko; 2 — interpretative drawing by V. Danilenko (1986: 127—128); 3,4 — traces, made from image-based 3D models. In 4 red notches mark those that were partially interpreted by V. Danilenko as components of iconographic image

However, the digital study shows that iconographic representations of women, considered by V. Danilenko as traces of Paleolithic imaginary, are not actually present on the stone. The drawings, as thus, the hypotheses of V. Danilenko considering these portable rock art stones, need to be reevaluated. However, the clues of such a state-of-the-art had been presented before (see

Radchenko & Nykonenko 2019), and the asset of portable stones is now used to reevaluate the old data.

The models created and processed following the workflow described in Chapter 3 were used to create a drawing of what is truly engraved on the stone's surfaces. The texture images were not considered to avoid Danilenko's misleading cues and provide a relevant abstraction and objectivity level (Rondini 2018). Following this, the results of the drawing procedures (see annex D) were compared to the drawings created by V. Danilenko on the churinga's surfaces (fig. 4.4).

18 out of 71 3D-modeled churingas were considered by V. Danilenko as featuring figurative engravings. The meaning of these engravings was supposedly deciphered and published in his book in 1986. However, all 18 appear to have been misinterpreted and mistakenly considered as bearing figurative images. All of them are adorned with abstract and reticulated ornamentation. Though the anthropogenic nature of the engravings is clear, the appearance of images that suggest any particular motif (not even necessarily indicating an Upper Paleolithic date) is proven to be false.

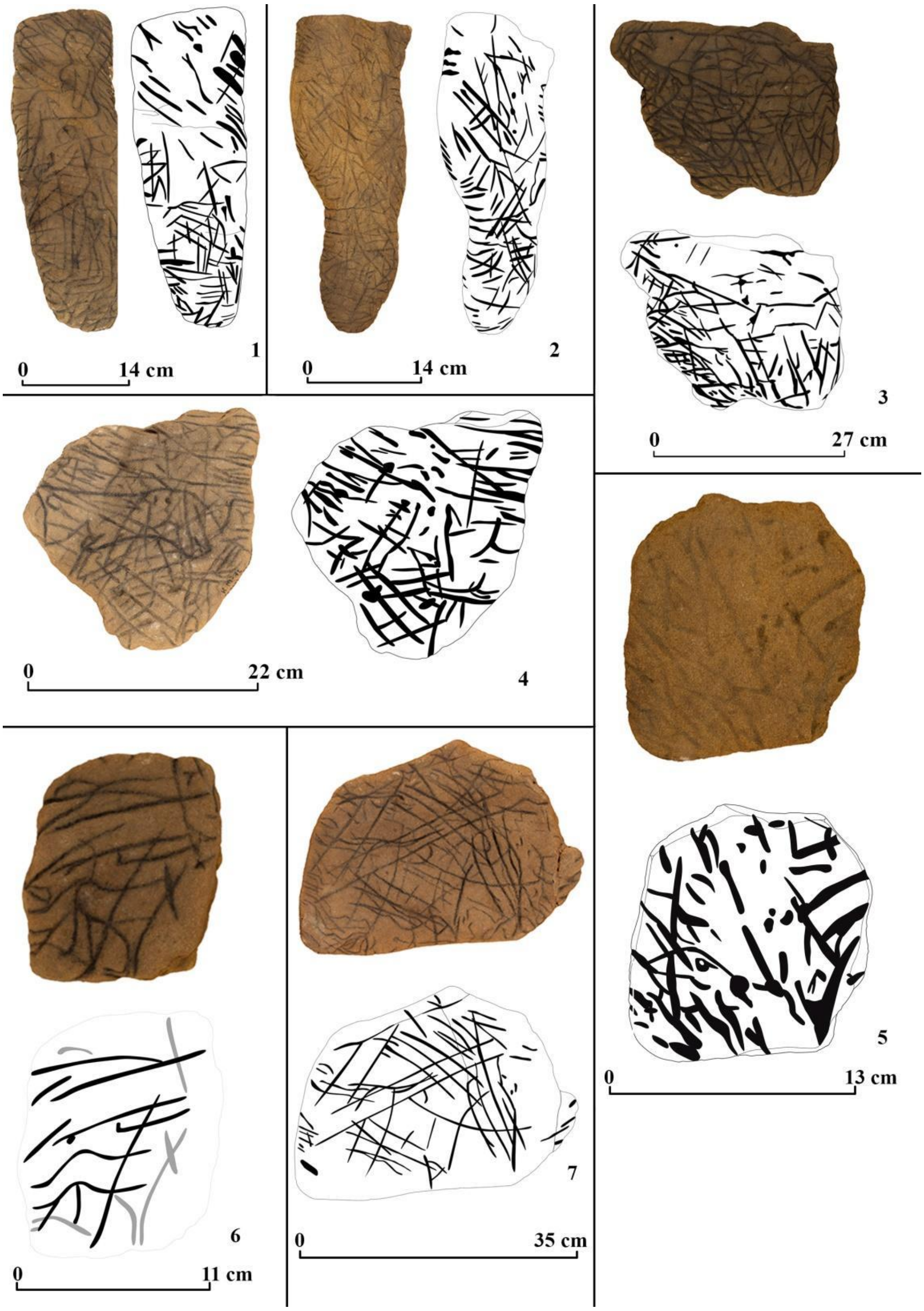


Fig. 4.4. Churingas from Kamyana Mohyla — image and drawings made after the surface examination. 1 — No. 245; 2 — No. 247; 3 — No. 283; 4 — No. 302; 5 — No. 338; 6 — No. KM74—1; 7 — No. KM74—2

Most sandstone blocks from Wizard's Cave share the same history — intensive reticulated and non-figurative ornamentation has been misleadingly traced. The analysis of 71 image-based 3D models from Churingas' and Wizard's caves shows that there is *not a single* iconographic image on the portable rock art objects published by V. Danilenko. These incorrect tracings represented what Danilenko considered a potentially Upper Paleolithic worldview and supported his attributing the specimens to the Pleistocene.

Most of the stones from the collection represent a clear non-figurative engraving pattern. None of the figurative engravings deciphered and considered by V. Danilenko as examples of the Upper Paleolithic worldview exist. Though the stones are engraved, and some are covered by very dense reticulated ornamentation, most of the lines appear chaotic and randomly placed. Therefore, a general conclusion on the collection would be that it remains challenging to interpret. The previous interpretations, considered valid for more than 50 years, turned out to be incorrect. Therefore, the wider collection must be reconsidered.

These stones can no longer be taken to represent evidence of Upper Paleolithic rock art at Kamyana Mohyla and Wizards Cave. Though churingas might belong to a tradition of Upper Paleolithic art, this attribution is as unwarranted as any other. It appears that the evidence needed to establish any kind of attribution is impossible to find in churingas themselves or through observation of the engravings on the stone's surface. Searching for evidence of the Upper Paleolithic (as well as any other origin) in Wizards Cave and portable art specimens within the cave will require further excavation of the site to search for new rock art objects and reexamine previously recorded examples. This should be carried out with a significant survey to probe the Upper Paleolithic of the region and implement novel dating methods, including thermoluminescence dating, if possible.

4.3. Microscopic examination of the portable objects

In order to confirm that the drawings by pastel coal do not necessarily correspond to the engraved parts of the stones surface, additional microscopic analysis has been performed by E. Palkina, PhD, expert in geology and mineralogy. This work also introduces additional evidence which is relevant for understanding the data obtained from image-based 3D-modeling of portable rock art specimens. The results of this examination are presented in table 4.1.

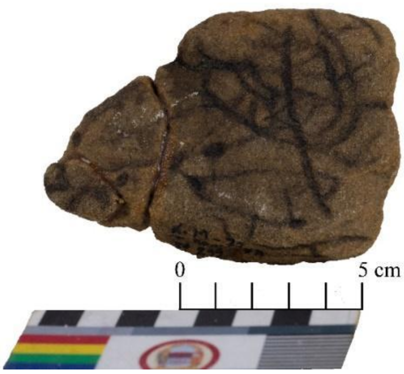
Table 4.1. The results of the microscopic examination of the churingas from the collection of V. Danilenko

<table>
<tr><td colspan="4">Microscopic investigation of the sandstone pieces under 3 to 6 times magnification was performed with a binocular microscope. The stones from the Kamyana Mohyla National Reserve are generally referred to as "churingas".

The aim of the study is to investigate the origin of the engravings and cupmarks on the sandstone surface and to check the correspondence of the lines, drawn with pastel pencil between 1975—1978 by V. Danilenko with the engravings on the stones.

The specimen represents medium- and small-grained quartz sandstone. The size of the grain is mostly 0.2—0.3 mm, 0.1 and smaller grains are rare. They are cemented with a clayish substance. The sandstone contains a lot of iron. The surface of the grains is opaque, sometimes polished to glance. Singular grains have chipped surfaces. Specimens are differentiated by the grain sizes and the nature of their ferruginization.</td></tr>
<tr><td>No.</td><td>Location</td><td>Image</td><td>Description made by E. Palkina</td></tr>
<tr><td>300</td><td>Wizard's cave</td><td></td><td>The stone contains 5 parallel engravings from 1 to 3 mm deep. Their depth is irregular both inside the notch and between the different notches. The walls of the notches contain three stairs. The investigation of the engravings' walls showed that the grains were artificially crumbled away; only a small part of them was chipped.

The surface of the engravings showed that the latter were created by scratching at least in</td></tr>
</table>

			three steps. According to the shape of the notches, the engraving tool had the shape of a little chisel with a rounded edge. Their cross-section is mostly U-shaped, rarely — V-shaped. Later the surface of the engravings was polished by a softer material, probably the small-grained sandstone.
302	Wizard’s cave, Scynia		The engravings on the stone’s surface are having a depth of 1—2 mm and create a complex composition. They are engraved similarly to those on the specimen No. 300. Some of them are colored with pastel coal. Some of the black lines, made with coal drawn not in the engravings (on the regular stone’s surface). For instance, the buttock’s and back of what is considered to be a wolf are painted with coal and don’t have the engraved basis.
299	Wizard’s cave		The stone is partially covered with glue. It contains cupmarks that were probably engraved by the rotation of a small chisel. The angle of a ‘chisel’ varied during the engraving process, so the cupmarks’ walls are featured with ‘steps’. Some of the black

			lines are made with coal drawn not in the engravings (on the regular stone's surface)
No. 1	Near Churinga's cave		A small- and middle-grained sandstone block. The shape is artificial, produced by the manufacturing of the surface. The surface features engravings. Some of them are painted by coal. Some coal lines are drawn on the engravings; some are randomly placed on the rock surface. Some engravings are not painted with the coal.
324	Wizard's cave		A small- and middle-grained sandstone block. It contains cupmarks that were probably engraved by the rotation of a small chisel. The cupmarks are usually doubled and have ellipsoidal shape. Their depth is irregular. Some of the black lines, made with coal drawn not in the engravings (on the regular stone's surface)
277	Wizard's cave, Eastern Entrance		A small- and middle-grained sandstone block. It contains cupmarks that were probably engraved by the rotation of a small chisel. Sometimes the engraving was performed with the tool under an angle to the surface rather than with

			vertically placed one. Some of the black lines, made with coal drawn not in the engravings (on the regular stone's surface)
284	Wizard's cave		A small- and middle-grained sandstone block. It contains cupmarks that were probably engraved by the rotation of a small chisel. Sometimes the engraving was performed with the tool under an angle to the surface rather than with vertically placed one. Some of the black lines, made with coal drawn not in the engravings (on the regular stone's surface)
KM74—9	Wizard's cave		A small- and middle-grained sandstone block. It contains cupmarks that were probably engraved by the rotation of a small chisel. Sometimes the engraving was performed with the tool under an angle to the surface rather than with vertically placed one. Some of the black lines, made with coal drawn not in the engravings (on the regular stone's surface)

<table>
<tr><td>332</td><td>Wizard’s cave</td><td></td><td>A small- and middle-grained sandstone block. The surface is manufactured. Traces of polishing are clearly visible.</td></tr>
<tr><td colspan="4">Conclusions. All investigated specimens contain traces of manufacturing — engravings, cupmarks, and polished surfaces. These features occur with different depths and lengths. The tools were probably oriented under different angles to the stones’ surfaces during the engraving process. The cupmarks have different shape and depth. The surface of the engravings and cupmarks are slightly polished. The black lines drawn by archaeologists do not usually correspond to the artificial engravings, notches, and cupmarks.

Increasing the accuracy of future investigations is potentially complicated by the coal lines and the surfaces covered with silicate glue.

E. Palkina, PhD</td></tr>
</table>

Among the engraved stones that were analyzed during the microscopic examination, only one (No. 300) featured coal lines that correspond to the engravings on the stone surface (there are no iconographic images on that stone). However, the majority of the stones contain drawings made with black pastel coal and produced by V. Danilenko that do not fit the prehistoric engravings on churingas. This statement is relevant both to the stones from Wizard’s cave and Churinga’s cave and is true for every engraved stone, especially to those that were considered as having been covered with figurative petroglyphs.

4.4. Towards the portability of churingas

While the iconographic and compositional reexamination of the Kamyana Mohyla portable rock art specimens showed the absence of any valuable and interpretable iconographic information, the technological outcomes of the photogrammetric study are still capable of revealing additional data that foster our understanding of the churingas of Kamyana Mohyla.

The first important issue regards the portability of the art specimens from Kamyana Mohyla. According to the official glossary of the International Federation of Rock Art Organizations (IFRAO), mobility (or portable) art is "*a form of palaeoart consisting of or made on objects small enough to be easily carried by humans*" (IFRAO Glossary 2020). However, portable art is generally considered the second and the last category of rock art after "parietal art" in its most general classification. This classification is still in use (Leroi-Gourhan 1988: 7; Whitehouse 1983: 331—332; for a detailed review, see Abadia, O.M & Morales, M.R.G. 2004, 321—322), though it was criticized as it faces numerous limitations (Sieveking 1979: 7—8; Abadia, O.M & Morales, M.R.G. 2004). For instance, according to this consideration, the Scythian Stellas and the sculptures from Lepenski Vir should be considered portable ones despite there was no intention to carry them somewhere after they were located (Plonka 2003: 10). Therefore, the fundamental feature of portable art is the intention of its maker to use the artifact as the portable one (Abadia, O.M & Morales, M.R.G. 2004, 321—322; Plonka 2003: 10). Such an understanding appears to be extremely important for the correct interpretation of any rock art instances due to its direct connection with the function of the rock art specimens and their life cycle (e.g., their *Chaîne opératoire* (see Tosello & Villaverde 2014: 6031)).

Unfortunately, we do not have enough data to apply this criterion directly to the portable rock art of Kamyana Mohyla. However, it is possible to analyze the churingas' weight to distinguish those we cannot consider as "mobiliary" (fig. 4.5).

It is clear that the three heaviest churingas (36 kg, 48 kg, and 99 kg) are a part of the main weights cluster and form the particular group of art pieces that are too heavy to be "*easily carried*."

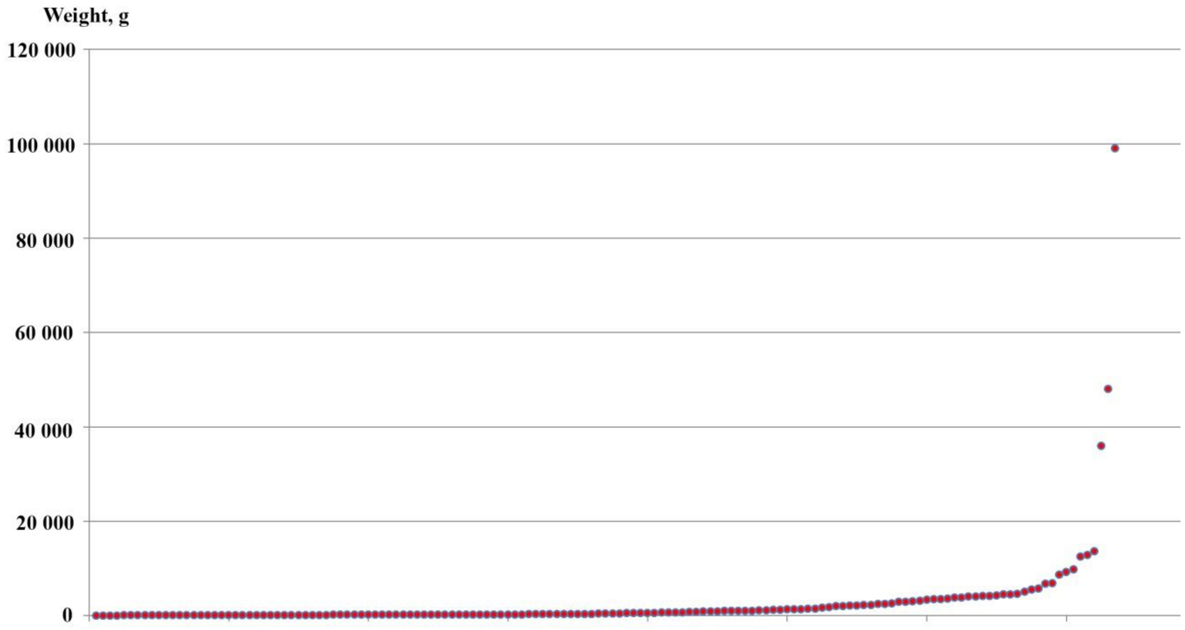


Fig. 4.5. Weight of the churingas stored in the Institute of Archaeology, Kyiv

Excluding those that are definitely not “mobiliary” specimens, I can also distinguish “the average group” — a cluster of those that are heavier than the usual churingas but theoretically can be transferred by one person. This group is evident due to the gap in the weights increase after the value of 6.9 kg (fig. 4.6).

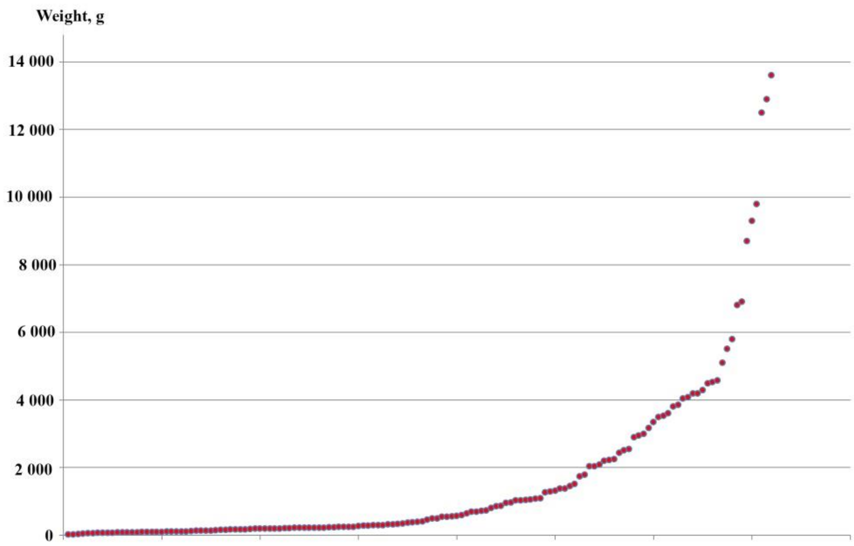


Fig. 4.6. Weights of the churingas excluding the heavies group

Thus, six churingas heavier than 6.9 kg (8.7 kg, 9.3 kg, 9.8 kg, 12.5 kg, 12.9 kg, 13.6 kg) fall into the average group of those that must be analyzed according to another parameter — the features of the shape, nature of engravings, etc.

Following the portability criteria, we can exclude the three heaviest stones from the collection as “non-portable” ones and shorten the list to 145. The next step is sorting according to the surface condition and the appearance of processing of the stone’s surface.

4.5. Technical and technological parameters of churingas at first glance

A significant issue for interpreting a particular Churingas lifecycle and the specific history of a specimen is its surface condition. This is also useful to approach the portability of the rock art specimens from the average weight group. As the site is a sandstone monadnock (Radchenko & Nykonenko 2019), stones and huge blocks can easily crush and crumble, breaking away from the bigger part of the rock or the cave wall. In this case, the stone can be misinterpreted as a churinga, or a part of the sculpture is just a part of the wider cave art scene. Some of these instances can be recognized as they are covered with "desert varnish" (and engravings) just from one side. The observation of the collection to exclude this kind of misinterpreted churingas allows narrowing their list ones more.

23 out of 145 remaining churingas from the stores of the Institute of Archaeology in Kyiv do not show any sign of engravings or notches. This is why they have been analyzed separately. Most of them are from the cave of Churingas (No. 54) — churingas No. 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 226, 227, 228, 266, 355, 356, 359, 360, 367; the rest two were found in the Wizard's cave (No. 52) — No. 327, 74—20. Though they cannot be considered portable art specimens or even engraved stones, these portable objects can provide additional data on the collection.

Most pieces listed from the Goat's cave are made of different rocks. The sandstone that forms the Kamyana Mohyla Hill consists of many seams, layers of different colors, and chemical compounds. However, most of the churingas from the collection are similar in color and structure (fig. 4.7: 1—3). In contrast, the stones without traces of engravings are primarily red, intense yellow, or multicolored (fig. 4.7: 4—9). This distinguishes them very clearly from the specimens analyzed and interpreted by V. Danilenko, which are dark brown or yellow due to the desert varnish on their surface.

This different geological structure causes several other parameters that distinguish the abovementioned stones from the engraved ones. More precisely, most red and robust yellow sandstone blocks (i.e., fig. 4.7: 6—8) are intensively crumbling and losing their shape, while the regular engraved stones are more compact. The red specimens' most intensive crumbling is typical as they are rich in iron, concentrated as *Fe2O3* (rust). Vice versa, the layered instances (fig. 4.7: 4—5) are much tighter and well-cemented than the others.

These dark, solid, and multicolored samples are also drawing attention because of their unusual structure (fig. 4.7: 4). Such a mixed sandstone structure is not typical for portable art specimens from any other Kamyana Mohyla cave except for the cave of Churingas. It is noticeable that the stone found in the Mesolithic layers of the settlement Kamyana Mohyla 1 (the site located close to the rock art complex) shares the same geological structure (fig. 4.7: 10). These are the only two places in the whole complex where the stones of that structure were found by now; one should assume this to be circumstantial evidence of the V. Danilenko hypothesis on the Late Mesolithic origin of the portable art specimens from the cave of Churingas.

Fig. 4.7. Churingas from the stores of the Institute of Archaeology in Kyiv. 1—3 — engraved stones; 4—5, 9 — stones without traces of artificial shaping; 6—8 — artificially polished stones; 10 — portable art specimen from the Mesolithic layer of the multilayered settlement of Kamyana Mohyla 1 (after Kotova et al. 2018, fig. 3). 1 — No. 247; 2 — No. 306; 3 — No. 328; 4 — No. 213; 5 — No. 214; 6 — No. 218; 7 — No. 220; 8 — No. 228; 9 — No. 356.

The stone's density also reflects the different geological structures of these stones, both crumbling and solid. As the sandstone might differ much in its compound, cementation level, the concentration of iron and limestone components, different churingas might have different density according to these parameters, which depends on the weight and the volume of the stone and can be calculated according to the formulae

$$\rho = \frac{m}{V},$$

Where ρ is density, measured as kg / m^3;

m — Churingas weight, measured directly, kg;

V — Churingas volume, measured by the automatic calculation performed by Agisoft Metashape software, m^3. The software contains a tool for the calculation of the “closed” 3D models without topological irregularities and holes in them. The accuracy of this calculation depends from the accuracy of the 3D model and the referencing quality.

The density was calculated for the 71 specimens that were 3D modeled in the research (fig. 4.8). It is clear that rock art specimens from the Wizard’s cave are less dense than those from the Churingas cave (except for one case). Their density varies from 1543 kg / m^3 to 2075 kg / m^3 (the average is 1933 kg / m^3). The geological structure of these pieces is similar — they are dark brown, covered with desert varnish, and well-cemented. The layer below the desert varnish is brighter, primarily yellow or dark brown.

The pieces from the cave of Churingas share a higher density than the latter (except for two pieces). Their density varies from 1937 kg / m^3 to 2742 kg / m^3. The average value is 2291 kg / m^3. They are mostly yellow, sometimes whitish. Their cementation level, however, is lower than observed in the Wizard’s cave stones. Among them, there is a unique group of very dense, which are the densest ones. These are the red or multicolored specimens without engraved surfaces described above (fig. 4.7: 4—9). Their density varies from 2366 kg / m^3 to 2742 kg / m^3. The average value is 2501 kg / m^3. This group is mostly non-engraved; the densest of these stones (fig. 4.7: 4, 5) are not even shaped or manufactured in any way.

These differences in their geological structure, cementation level, density, and intensity of desert varnish show different stories of the churingas from different caves' lifecycle, deposition, and post-deposition processes. This may also indicate the different cultural and chronological contexts of the portable instances' creation and use. However, such an assumption requires additional archaeological and rock art research.

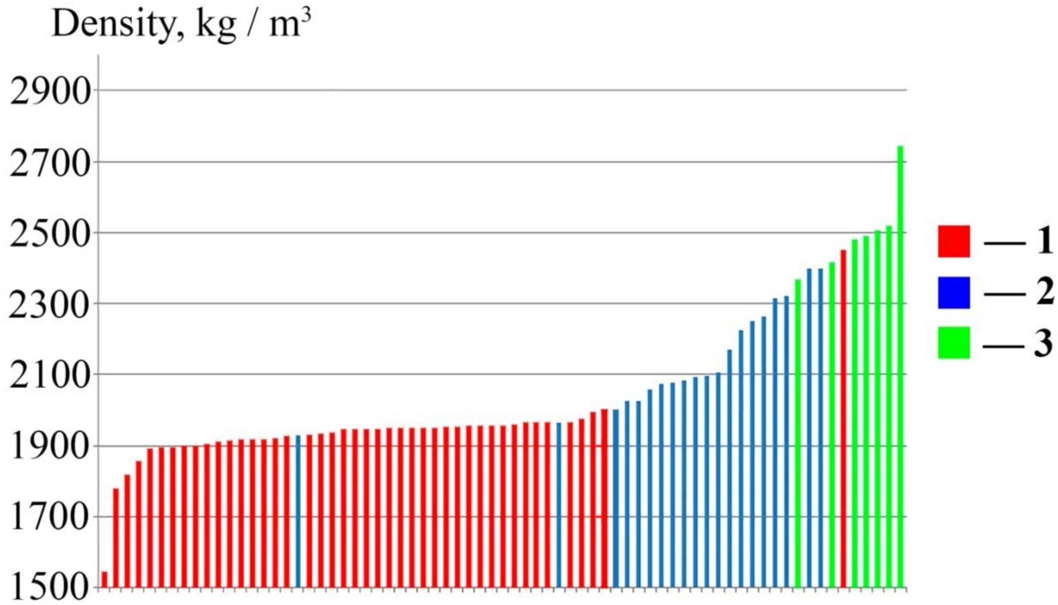


Fig. 4.8. Density of the churingas from the stores of Institute of Archaeology, Kyiv. 1 — engraved stones from Wizard's cave; 2 — engraved stones from Churingas cave; 3 — stones from Churingas cave without notches or engravings

Apart from those stones that have not been transformed by any means, some of the listed specimens show traces of intensive processing — they are heavily polished, and their surfaces are more or less flat. Such polished instances were found both in the Wizard's cave (No. 327 and No. KM74—20) and Churingas cave (No. 217, 218, 219, 220, 221, 222, 224, 226, 227, 228, 266, 355, 359, 360, 367). They are numerous in the latter, where most geologically exceptional specimens are located.

These stones are not engraved and not notched (fig. 4.9). Most of them have higher density, and their geological structure also differs (their color is bright yellow or red). These specimens can be considered as follows: either they were polished for some yet unknown reason or used to polish some other rock art objects.

Assuming that they were polished for some reason, we also have to remark that they do not have any other traces of usage. Moreover, the instances from this group are quite different in their morphology, solidness, and compound: some are crumbling, and others are not.

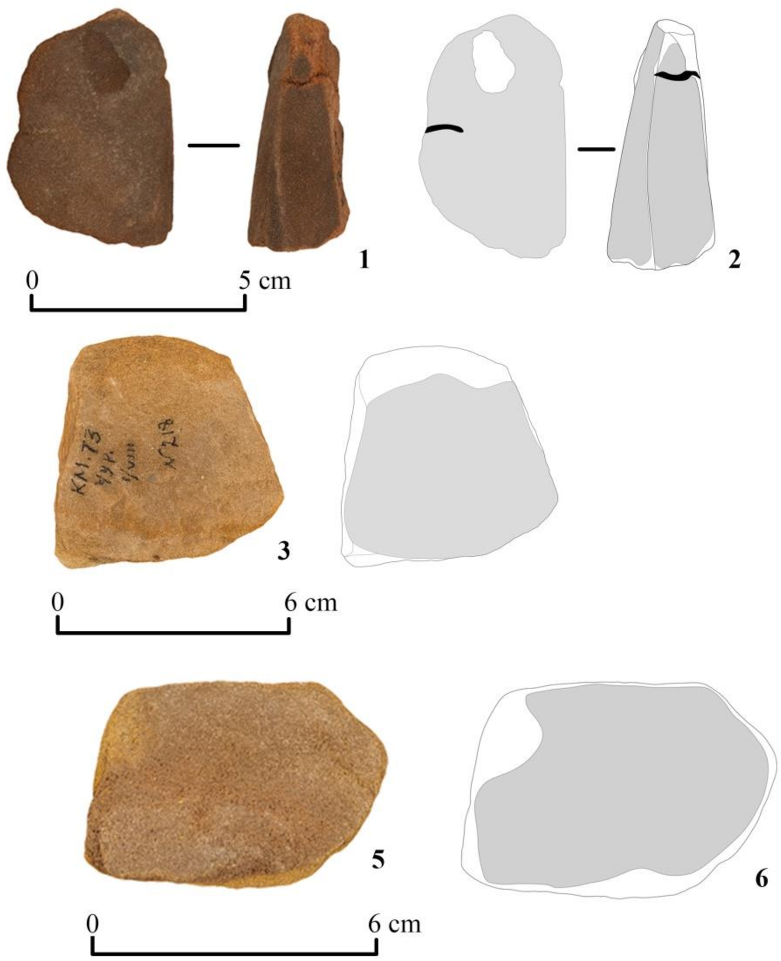


Fig. 4.9. Stones from the cave of Churingas with a polished surface. 1, 3, 5 — image; 2, 4, 6, — drawing. 1, 2 — No. 228 (front and right view); 3, 4 — No. 218; 5, 6 — No. 220. Polished surfaces marked with grey

The second hypothesis concerning their function is that they were used to polish other sandstone blocks. This idea can be considered for the following reasons: the density of most of these stones is higher than the average one of the portable stones in the collection. Therefore, the density and solidity of these sandstone pieces are enough to use them to polish another piece of sandstone. Moreover, most churingas are heavily polished: the shape of the portable art instances from the cave of the Churingas was modified to the shape of an ellipsoid, cigar, or fish (Danilenko 1986: 118). Also, most engraved stones from the Wizard's cave have been modified. Furthermore, some parietal art specimens in the caves of Kamyana Mohyla were made by polishing (Radchenko & Nykonenko 2019: fig. 7, 8, 10) or by shaping a natural protrusion (Radchenko et al. 2020) to a particular shape.

However, the question of the technology employed to engrave the stones from Kamyana Mohyla requires an additional traceological study and several experiments before any conclusion might be drawn. Though V. Danilenko and B. Mykhailov proposed several hypotheses on that score, they were never checked by any recorded experiment.

In this regard, churinga No. 356 (fig. 4.10) draws special attention as V. Danilenko publishes it as the "stone tool for the engraving of the images" (Danilenko 1986: 74, fig. 25). The specimen is made of a red sandstone rich in iron. According to B. Mykhailov (unpublished interview, 2005), the specimen was more solid due to its iron content and may have been used to engrave the softer sandstone. This consideration, however, appears to be wrong. The red sandstone breaks more than yellow or dark brown ones because an iron (*Fe*) is contained in the iron oxide (Fe_2O_3), e.g. rust. Engraving the sandstone pieces with this stone would cause immediate damage to the sharp edge. The traces of this process would be visible on the stone surface even after a few movements.

Moreover, as stone No. 356 is not well-cemented and its solidity is almost the same as the solidity of the engraved surfaces, an endeavor to create any notch using this stone would barely be productive. Even if this specimen was designed for engraving rock art objects, it was never used for that purpose. The hypothesis that the engravings on the portable rock art pieces were made by flint tools (Danilenko 1986: 70—72) seems to be reliable due to the high solidity of flint, the shape of the notches on the portable rock art instances, and the assemblage found in the Bull's cave (No. 9) (Danilenko 1986: 71—72, fig. 22, 23). However, any assumption on the specific type of tools used to create Kamyana Mohyla portable rock art specimens must be demonstrated by experimental means.

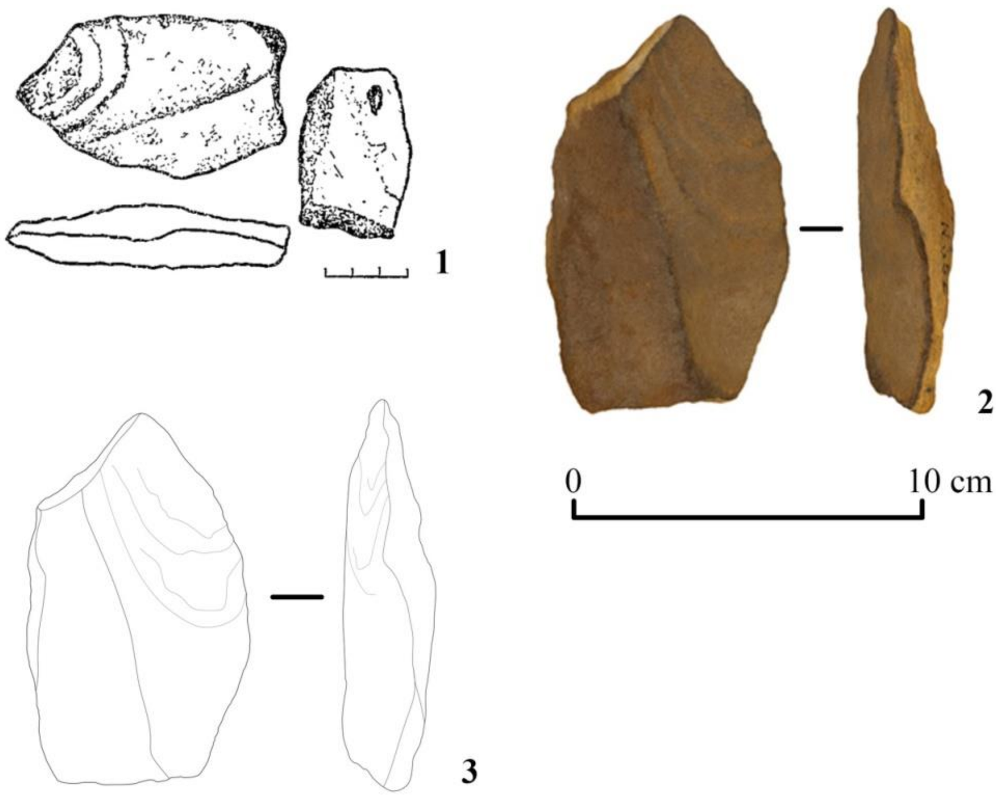


Fig. 4.10. The stone No. 356, wrongly considered as an engraving tool. 1 — drawing by V. Danilenko (1986, fig. 25); 2 — image, front and right view; 3 — drawing, front and right view

All these specimens differ by their physical parameters, features on the surface (intensity of desert varnish, shape, represented engravings, etc.), and their life cycle. Though they are not portable rock art objects, their analysis led to the conclusions that enriched our understanding of the Kamyana Mohyla rock art complex and provided additional technological and contextual details to the collection. Excluding specimens not engraved from the list, it shortens to 123 objects. These stones show notches on their surface that might be considered anthropogenic; thus, they are considered portable rock art pieces.

However, this leads to the additional issue of distinguishing natural traces from artificial ones. Typically a series of two, three, or more equidistant parallel lines on the cave ceilings or walls are considered to be the scratches left by the animals, which are most frequently observed in limestone caves (Bednarik 2016c: 174). According to this criterion, the rock art instances from Kamyana Mohyla, especially the portable rock art ones, contain many engravings that might be considered animal scratches. Such an assumption, however, would also be a misleading simplification. To begin with, animal scratches differ from the engravings that are typical for the portable art specimens from Kamyana Mohyla: "animals have produced rock markings with various parts of their bodies, such as antlers, tusks, mandibles (birds), though the most numerous are those made with claws.

In contrast to scratches with stone tools, claw marks usually bear no striations, are rounded and comparatively symmetrical, and tend to be U-shaped in cross-section" (Bednarik 1998). The engravings on the surfaces of sandstone blocks recovered from the caves of the Ukrainian complex are far from symmetrical and U-shaped in their cross-section. Some of them are striated; others have a complex or cross-section.

Moreover, the Mohs hardness of sandstone varies between 6 and 7. Though the surface of such hardness can be theoretically damaged by animal claws (considered softer and not exceeding 2.5—3 (Ivanov 1990)), these engravings would be even shallower than the ones from Kamyana Mohyla churingas. Onward, leaving the traces 0.5 mm deep on this sandstone required an animal to scratch the same place a hundred times, hitting the same line repeatedly. Even if we assume that the animals could scratch out the sandstone grains from the slabs (that would be uncomfortable to perform with the small blocks of irregular shape), this will create the irregular and curved edge of the engraving, which is not the case for the engravings on Kamyana Mohyla stones. Such scratching would not damage particular sand grains, while many contain chipped surfaces.

Last but not least, the engravings on the stone are too wide and deep to consider them zoogenic or accidentally produced — their creation required numerous repetitions over and over. This is barely possible on the portable stone objects in the sand or the other sandstone block. The mobility of these instances simply would not allow applying enough force to their surface. Once more, the traces of animal habituation are most frequent on the walls of soft limestone caves and can barely be left on the hard stone of the Kamyana Mohyla complex.

This can be extrapolated on the traces of fossil activity — the outlets of channels made by the infauna in the original sediment before its solidification. While this hypothesis on the origination of some linear engravings might be correct and is known in the rock art practice, it is reasonable to assume that such traces would look differently in the sandstones of Kamyana Mohyla. First, such traces would not damage the sandstone grains, leaving scratches on the individual pieces of quartz. In contrast, such traces (parallel to the assumed engraving direction) are presented on portable rock art specimens of Kamyana Mohyla. The edges of engravings on the stones from Kamyana Mohyla are smooth, without traces of crumbling that would probably emerge during the stone solidification. The fossil traces are generally rare on the sandstone blocks due to the comparatively large size and the smoothness of quartz grains. Finally, the experimental engraving of the Kamyana Mohyla sandstone resulted in traces similar to the glyphs on the ancient stones (see Kotova et al. 2018). Though fossils or animals might produce some engraved lines, 100 % of those examined so far are anthropogenic.

Considering all of these points, one shall notice that considerations on the zoogenic origin of the scratches on the Kamyana Mohyla portable rock art instances appear to be generally misleading. Despite their chaotic composition and shallowness, these engravings should be considered anthropogenic and counted as the components of pre-Historic art of the complex.

4.6. The engravings on the portable objects and the analysis of their shape

S4.1. Typology of the engravings cross-sections. Apart from the spatial and archaeological context of portable rock art specimens that is barely available for the Kamyana Mohyla collection, the surface of the objects and engravings are the most informative data source in terms of technological study. The detailed surface examination and 3D image-based reconstruction of the churingas surface revealed the lack of composition that was considered by V. Danilenko meaningful. This means that his assumptions regarding the portable art assemblage must be reconsidered and tested, considering the new data that derives mainly from the surface analysis of the specimens. Different shapes and metric parameters of the engravings on them reflect different approaches to engraving the sandstone and thus provide additional information on particular objects and a collection as a whole.

The spatial location of different engravings on the surface of rock art pieces introduces their general composition on the particular object and is primarily informative in terms of their semantic and relative chronology (superimpositions of numerous lines; see Radchenko et al. 2020; Rondini et al. 2018). However, the portable stones of Kamyana Mohyla appeared not to contain any informative or iconographical dataset able to introduce additional information on the interpretation or attribution of the artifacts. The form is generally simple — linear engravings are straight or (rarely) curved, do not form any iconographic expressions, or regularly form any geometric pattern. There are no similarities in shape, length, or other parameters of the different series of engravings, nor do they constitute any reasonable expressions to be studied. The complete absence of iconographical images on the stones forces us to focus further analysis on the universal and technologically informative dataset. The one is presented by the engraving's cross-sections that mainly provide information on the technology of their manufacture (see Melard 2010; Melard et al. 2016). V. Danilenko noticed that profiles (cross-sections) introduce a limited group of shapes that do not correlate to the parameter of length or shape of engraved lines. Indeed, their lengths' vary visibly from several millimeters to dozen centimeters remaining similar by depth and width. Therefore, the analysis of cross-sections extracted while examining the 3D model's surfaces is considered a necessary part of the technological study of the portable rock art collection.

The churingas from Kamyana Mohyla show a variety of cross-sections that falls into particular types by their shape and metric parameters. The most prominent type also falls into several sub-types depending on the metric parameters of the engravings. The distribution of the different engravings on the portable specimens from the Wizard's cave and Churinga's cave shows several patterns applicable to the future testing of the existent hypotheses concerning the portable rock art from Kamyana Mohyla's interpretation.

The cross-sections of **type A** are the largest group presented on every analyzed engraved specimen. The bottom is rounded; the profile of the notches is U-shaped, which is the main criterion that describes the type. The cross-section is mainly non-symmetric; however, symmetric profiles appear sporadically. Their depth differs, and thus the cross-sections of that type are divided into three subgroups. The division is based on the depth-to-length relation, where the length of the cross-section means the width of the engraved line.

Sub-type A1 is the minor type of engraving. This is also the most numerous one. The width of engravings usually varies between 1 mm and 7 mm. Its depth does not usually exceed 0.5 millimeters, and the depth-to-length relation is below 0.1 ($d < 10\ \%\ l$). The cross-section is symmetric, U-shaped, with a rounded bottom. The slope value (determined by the tangents of the angle between the notch cross-section and the horizontal line) is almost equal. The typological description of the type is given in table 4.2.

Table 4.2. The criteria list of the cross-sections of sub-type A1

Type Name	A1
Image	
Shape of the bottom	U-shaped
Length-to-depth ratio	$d < 10\ \%\ l$
Slopes ratio	$\tan\alpha \approx \tan\beta$
Flat bottom (subrectangular shape)	–

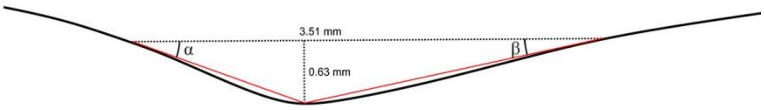
Group A1.1 is a non-symmetric modification of type A1. It is outnumbered and presented on the five specimens (No. KM74—19; 249; 259; 284; 306). The slope value from one side of the cross-section exceeds the second one by more than 10 %. The profile is U-shaped; the notches bottom is rounded (table 4.3).

Table 4.3. The criteria list of the cross-sections of group A1.1

Type Name	A1.1
Image	
Shape of the bottom	U-shaped
Length-to-depth ratio	$d < 10\ \%\ l$
Slopes ratio	$\tan\alpha > \tan\beta$ $(\tan\alpha \geq 1.1\tan\beta)$
Flat bottom (subrectangular shape)	–

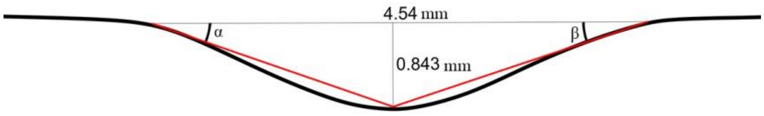
Sub-type A2 is a deeper version of type A1.1. It is asymmetric (though the symmetric instances appear sporadically and form group A2.1). Its depth-to-length ratio varies from 0.1 to 0.2. This type is presented almost on every specimen (except for five), introduced mainly by 40—60 % of the total quantity of notches on the object. The profile is U-shaped, and its bottom is rounded. The width of the engravings usually varies from 2 mm to 7 mm (table 4.4).

Table 4.4. The criteria list of the cross-sections of sub-type A2

Type Name	A2
Image	
Shape of the bottom	U-shaped
Length-to-depth ratio	$10\,\%\, l < d \ < 20\,\%\, l$
Slopes ratio	$\tan\alpha \geq 1.1 * \tan\beta$
Flat bottom (subrectangular shape)	–

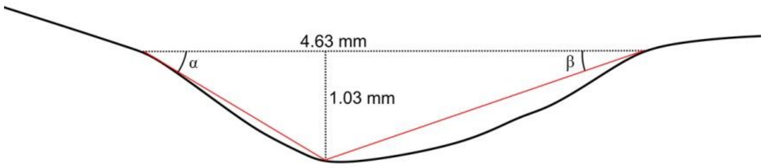
Group A2.1 is a symmetric modification of type A2. The slope value is comparatively equal. Although this group appears to be presented almost on all the engraved specimens, it is outnumbered compared to the sub-type A2. The existent engravings of this group spread sporadically across the instances of different types. There are no specimens of engraved stones where the symmetric notches of the sub-type A2 were more numerous than non-symmetric ones. The profile is U-shaped; the notches bottom is rounded (table 4.5).

Table 4.5. The criteria list of the cross-sections of group A2.1

Type Name	A2.1
Image	
Shape of the bottom	U-shaped
Length-to-depth ratio	$10\,\%\, l < d \ < 20\,\%\, l$
Slopes ratio	$\tan\alpha \approx \tan\beta$
Flat bottom (subrectangular shape)	–

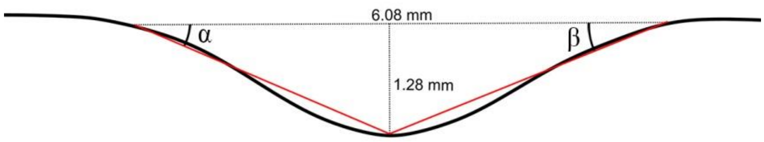
Sub-type A3 is the deepest one in type A. The profile is U-shaped, and the bottom is rounded. The depth-to-length ratio is maximal (more than 0.2). The main asset from this sub-type is non-symmetric (with different values of the slopes) (table 4.6). The sub-type is outnumbered compared to previous ones and spread chaotically across the collection (except for specimens No. 338 and KM74—21, where it is presented with more than 50 % of notches). The width of engravings usually varies from 4 mm to 10 mm.

Table 4.6. The criteria list of the cross-sections of sub-type A3

Type Name	A3
Image	
Shape of the bottom	U-shaped
Length-to-depth ratio	$d > 20\ \%\ l$
Slopes ratio	$\tan\alpha \geq 1.1 * \tan\beta$
Flat bottom (subrectangular shape)	–

Group A3.1 is a symmetric modification of type A3. The profile is U-shaped, and the bottom is rounded. The depth-to-length ratio is maximal (more than 0.2). The values of the slopes are comparatively equal (table 4.7). The group is presented on many engraved specimens (19 objects, which is more than for sub-type A3) but is outnumbered. The width of engravings usually varies from 4 mm to 10 mm.

Table 4.7. The criteria list of the cross-sections of group A3.1

Type Name	A3.1
Image	
Shape of the bottom	U-shaped
Length-to-depth ratio	$d > 20\ \%\ l$
Slopes ratio	$\tan\alpha \approx \tan\beta$
Flat bottom (subrectangular shape)	–

To sum up, **type A** is the primary technological type of engravings made on the portable rock art of Kamyana Mohyla. It is noticed on the surface of all the portable rock art specimens from the collection. Most of the engravings on the examined objects (96.7 %) belong to that type. This leads to the conclusion on the similarity in the technological process of the engraved stones from different caves production. However, the dispersion of different sub-types on the portable art of Kamyana Mohyla still tends to be informative.

The typological description of type A and its subtypes is also relevant for the parietal art of the complex, at least because its part has been reconstructed and studied through 3D-image-based modeling. For instance, engravings on the Vishap figure from cave No. 55 belong to the sub-types A2.1 and A3.1. It is noticeable that these are primarily symmetric, unlike notches of the same type on the portable rock art specimens. The cross-section's symmetry depends on the tool's direction during the engraving process (Bednarik 2016b). Therefore, it is an exciting notification regarding the technological and traceological study of Kamyana Mohyla rock art. Most of the engravings on that figure are resounding, e.g., they do not belong to the sub-type A1. The figure is attributed to be multilayered and belongs to the Mesolithic and Early Bronze Age (Radchenko et al. 2020).

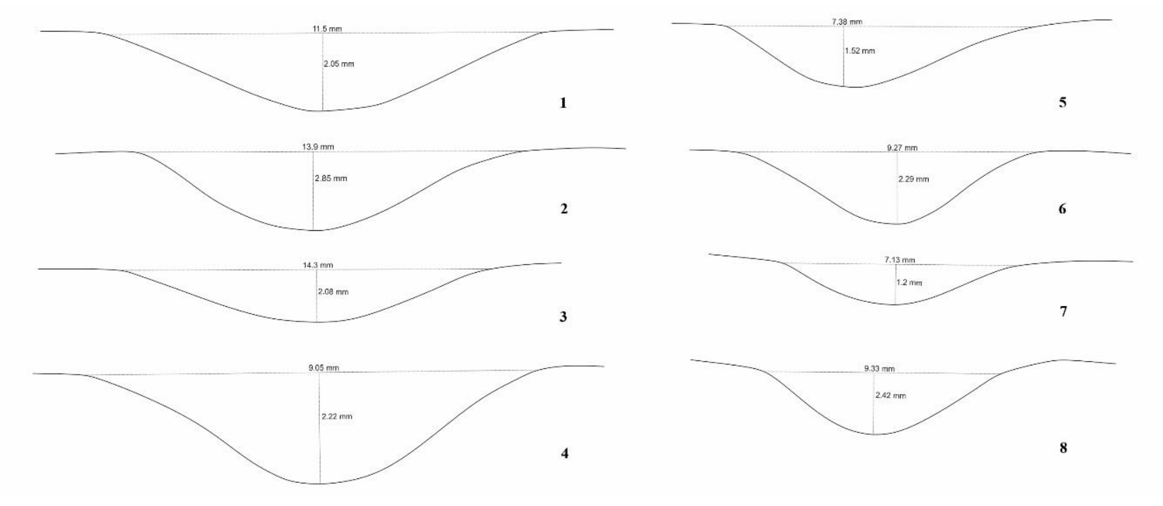


Fig 4.11. The cross-sections of engravings from the Vishap figure (cave No. 55, Kamyana Mohyla). 1. — engraving attributed to Early Bronze Age; 2—8 — engravings attributed to Late Mesolithic. 1, 3, 5, 7, 8 — Sub-type A2.1; 2, 4, 6 — Sub-type A3.1.

The cross-sections also are of the same shapes on the engraving of the Wizard, the eponymous one for the Wizard's cave. However, they are more diverse and include types A (A1 and A2), C, and D. In general, notches are much smaller than those on the Vishap figure, although they are of the same shape and configuration. This makes them closer in their metric parameters to those on the portable rock art specimens than those on the Mesolithic parietal art object. V. Danilenko has attributed the engraving to the Upper Paleolithic, and other parietal art objects from the same cave (Danilenko 1986: 74—94) and churingas found there.

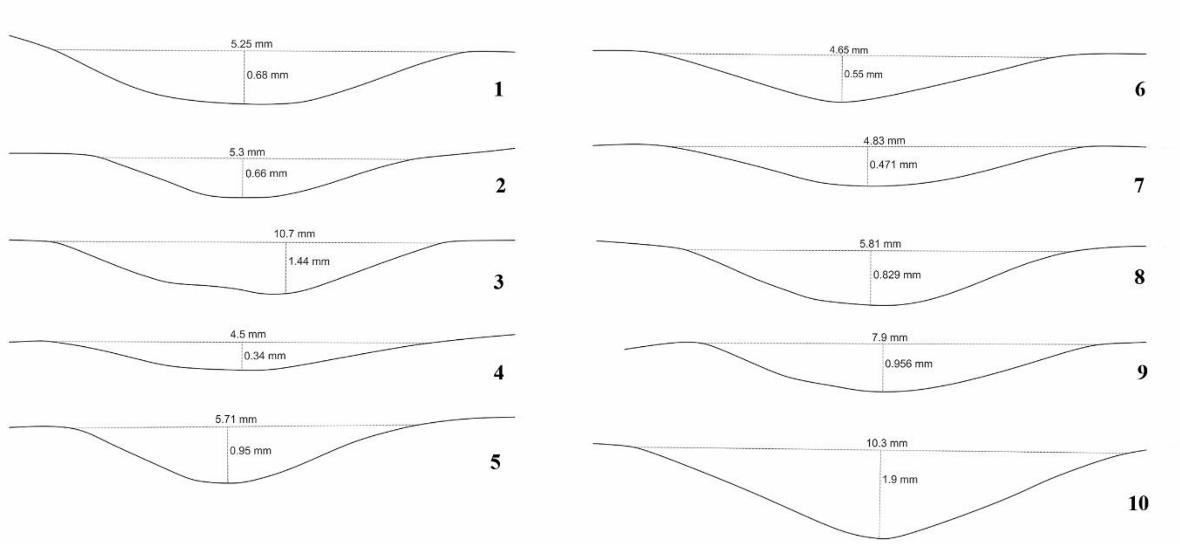
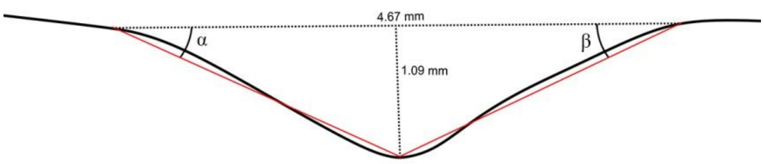


Fig 4.12. The cross-sections of engravings from the Wizard's engraving (cave No. 52, Kamyana Mohyla). 1, 2 — type C; 3 — type D; 4, 7 — sub-type A1; 5, 6, 8, 9, 10 — sub-type A2

Other types of engravings differ by the shape of their bottom. Other criteria are descriptive as all of these outnumbered types do not form any kind of sub-types or groups. Their total amount on engraved stones from the complex does not exceed 3.3 %. These notches are spread sporadically and outnumbered in all instances (except for churingas No. 225 and 277, which are described separately as the exceptions).

The V-shaped cross-section presents **type B**. The sides are convex, though the bottom might be rounded. The depth-to-length ratio is more than 0.1 (table 4.8). Both symmetric and non-symmetric instances are presented. The type is revealed on the engraved stones No. KM 74—4, KM74—6; KM74—8; KM74—15; KM74—17; KM74—24; 245; 278; 306; 310 (they are all located in the Wizard's cave except for the specimen No. 245).

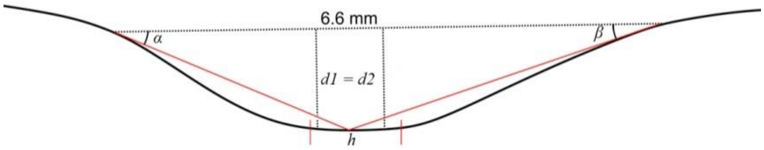
Table 4.8. The criteria list of the cross-sections of type B

Type Name	B
Image	
Shape of the bottom	V-shaped
Length-to-depth ratio	$d > 10\,\%\, l$
Slopes ratio	—
Flat bottom (subrectangular shape)	–

Cross-sections with the subrectangular bottom represent **Type C**. The depth of the cross-section is equal to the segment of its bottom, which length is at least 5 % of the total engraving's width (table 4.9). The engravings of this type can have different metric parameters. Their le

ngth varies from 2 mm to 10 mm, and the depth is between 0.2 mm and 2.5 mm. The engravings of these types are rare and appear not systematically on different specimens from the Wizard's and Churinga's caves.

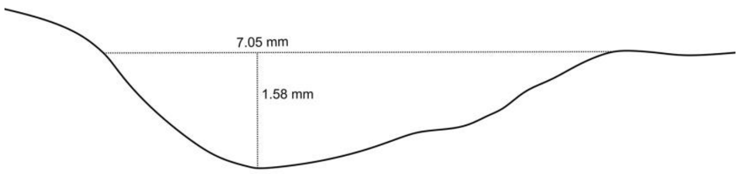
Table 4.9. The criteria list of the cross-sections of type C

Type Name	C
Image	

Shape of the bottom	U-shaped (subrectangular)
Length-to-depth ratio	$d > 10\ \%\ l$
Slopes ratio	—
Flat bottom (subrectangular shape)	$h > 5\ \%\ l$

Type D contains several cross-sections with an irregular profile that cannot be described as U-shaped or V-shaped. The bottom is also neither rounded nor subrectangular (table 4.10). The length varies from 3 mm to 17 mm, while the depth is between 0.4 mm and 2.5 mm. The shape of the cross-section is caused either by the destruction of the engraving profile or by the intensive engraving process with the tool hitting different lines in the same area destructing the usual profile of the initially planned notch.

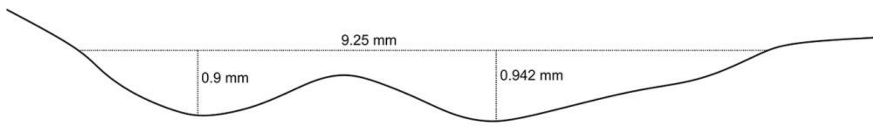
Table 4.10. The criteria list of the cross-sections of type D

Type Name	D
Image	
Shape of the bottom	Irregular shape with numerous extremums
Length-to-depth ratio	—
Slopes ratio	—
Flat bottom (subrectangular shape)	–

Group D1 consists of outnumbered cross-sections of complex shapes containing two or more types of profiles (table 4.11). Among the studied specimens, these profiles were revealed only for stone No. 277, which contains a composition of two close parallel notches of type A.

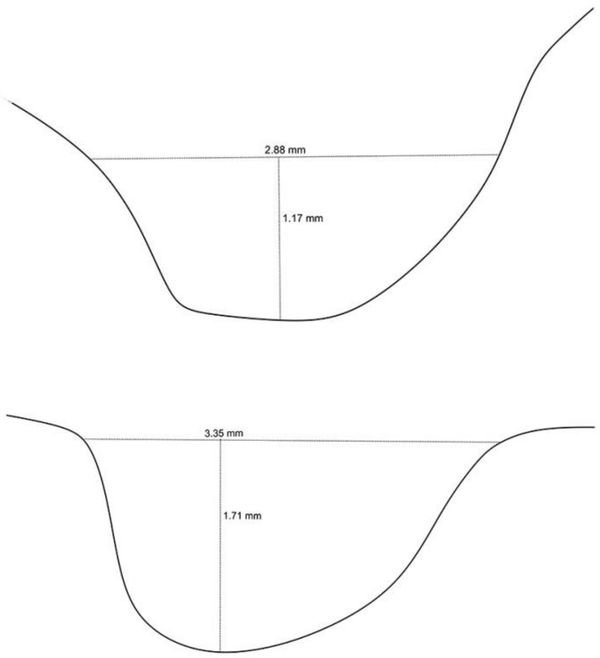
Table 4.11. The criteria list of the cross-sections of group D1

Type Name	D1

Image	
Shape of the bottom	Doubled shape, consists of two engravings of type A
Length-to-depth ratio	—
Slopes ratio	—
Flat bottom (subrectangular shape)	–

Deep engravings with a rounded or subrectangular bottom represent **type E**. Their depth-to-length ratio is the highest among all the engravings from the collection and exceeds 0.4 (table 4.12). The notches of this type are rare and were found only on two churingas (No. 225 and 343). These engravings appear technologically different from others due to their unusual shape and depth, which would require different technological solutions to produce.

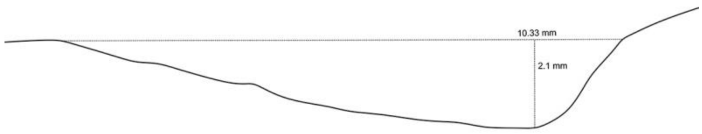
Table 4.12. The criteria list of the cross-sections of type E

Type Name	E
Image	
Shape of the bottom	U-shaped or rectangular
Length-to-depth ratio	$d > 40\ \%\ l$
Slopes ratio	—

Flat bottom (subrectangular shape)	–

Type F is the only type of engraving where the measures of cross-section vary mu depending on the part of the engravings from where the profile is extracted. It is presented by wide engraving, irregular non-symmetric profile, and rounded bottom (table 4.13). The walls are convex; the length metric varies from 1 mm on one side of the notch to 30 mm on the other. The depth is proportional and is more than 20 % of the cross-section's length (the depth-to-length ratio is more than 0.2). The examined collection contains only two engravings of this type — No. 260 and 309. V. Danilenko did not recognize these notches as artificial one.

Table 4.13. The criteria list of the cross-sections of type F

Type Name	F
Image	
Shape of the bottom	Doubled shape, consists of two engravings of type A
Length-to-depth ratio	$d > 20\,\%\, l;\ l \neq const$
Slopes ratio	—
Flat bottom (subrectangular shape)	–
Note	The engraving is wide and deep line that extends in one direction proportionally both to the width and depth; the cross-section is irregular

The portable art specimens of Kamyana Mohyla also consist of cupmarks that are divided into two types according to the shape of their bottom. Those with rounded bottoms are considered cupmarks of type A (table 4.14). Those subrectangular ones are gathered into type B (table 4.15). Both of them were produced by a small and sharp tool's round movements (that might be considered as "perforation," although this requires additional traceological study). Some cupmarks are more significant than others — their diameter mainly varies from 5 mm to 10 mm. However, all of them are smaller than those created on the cave's ceiling and walls of Kamyana Mohyla (see Radchenko & Nykonenko 2019). Some cupmarks were superimposed by engraved lines which affected the shape of the bottom, causing its irregularity.

Table 4.14. The example of a type A cupmark

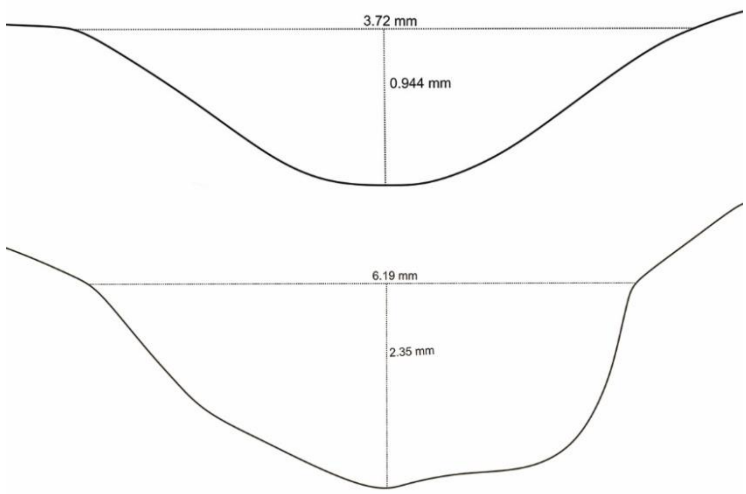
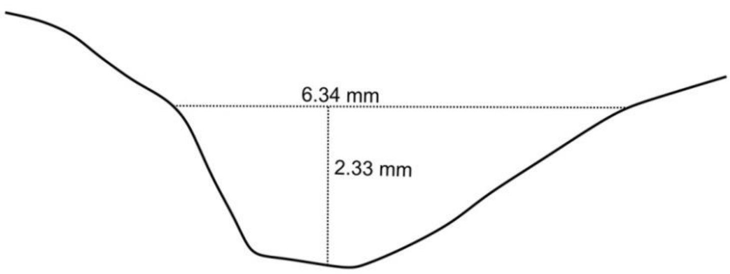
Type Name	Cupmark A
Image	
Shape of the bottom	Rounded, U-shaped

Table 4.15. The example of a type B cupmark

Type Name	Cupmark B
Image	
Shape of the bottom	subrectangular

All these types are sufficient to describe the engravings on the portable rock art specimens from Kamyana Mohyla and to show the technological similarity of most notches on churingas. Type A is dominant in the portable instances, and the semantic interpretation of the Kamyana Mohyla churingas, found by V. Danilenko, is mainly based on the engravings of that type. The type and all its sub-types are presented in table 4.16a.

Other types and cupmarks are outnumbered and positioned sporadically among the engraved stones. These types present the technological differences in the production of the engravings (that is yet to be defined experimentally) and features of their life cycle. These types are presented in table 4.16b.

Table 4.16a. Typology of engravings on the portable engraved stones from Kamyana Mohyla. Type A and its sub-types

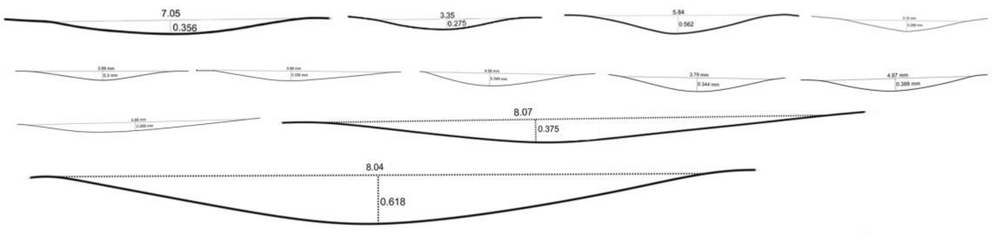
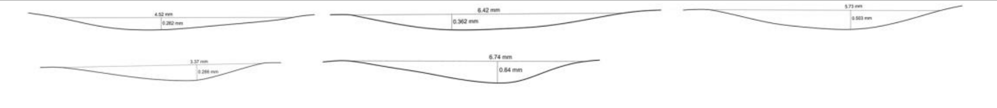
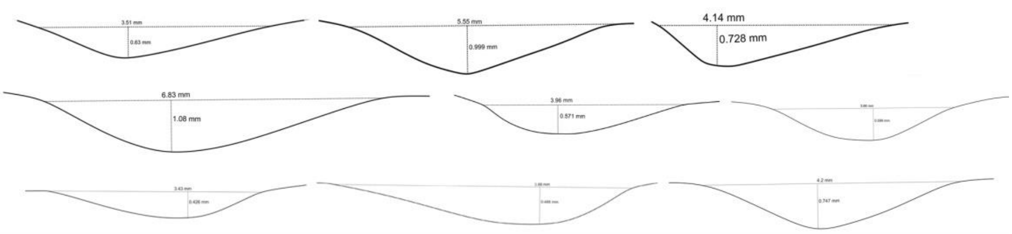
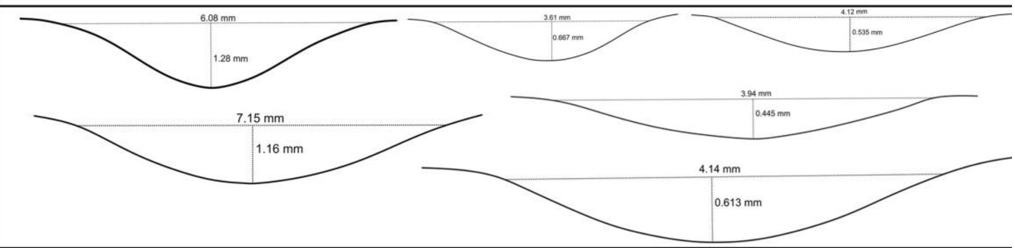
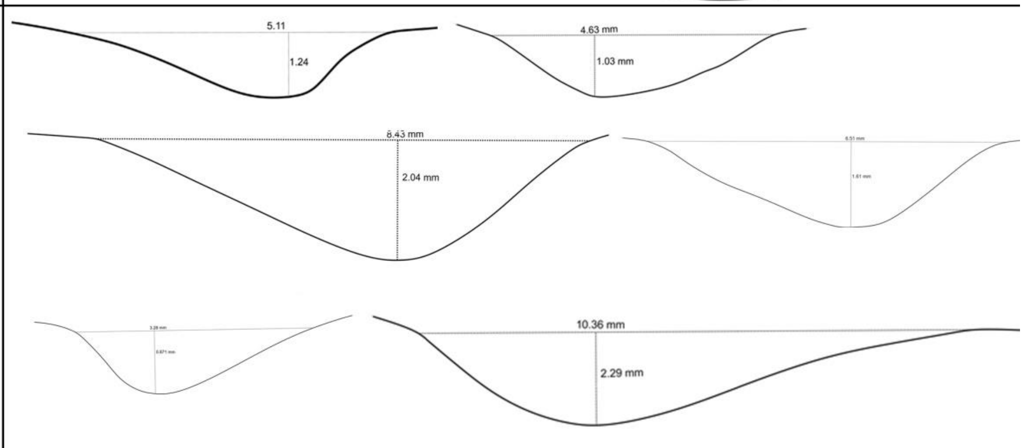
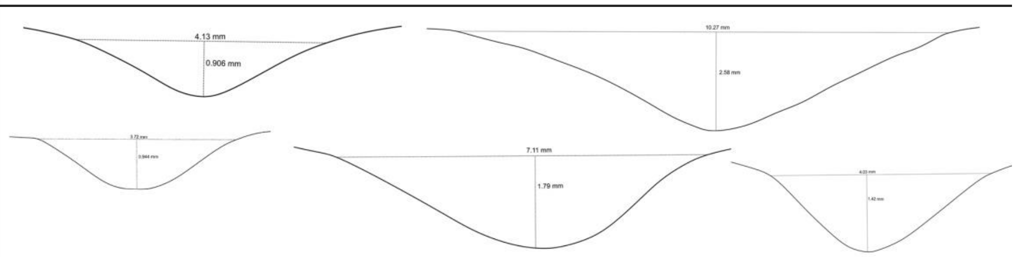
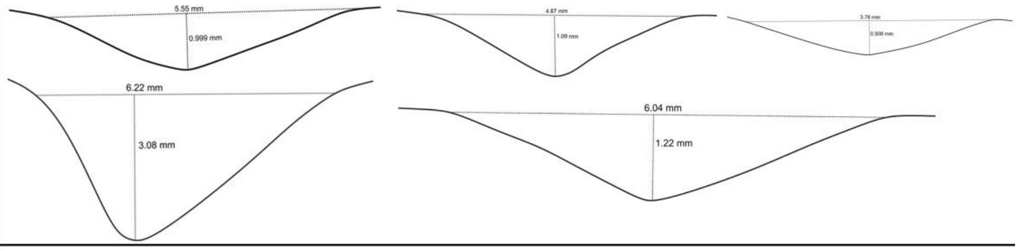
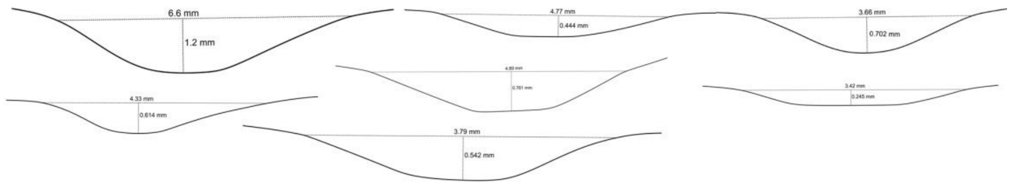
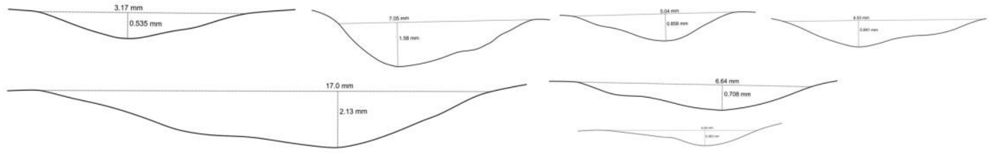
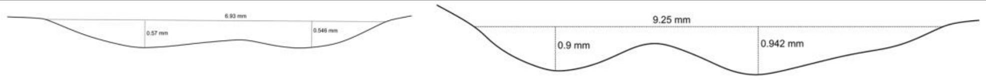
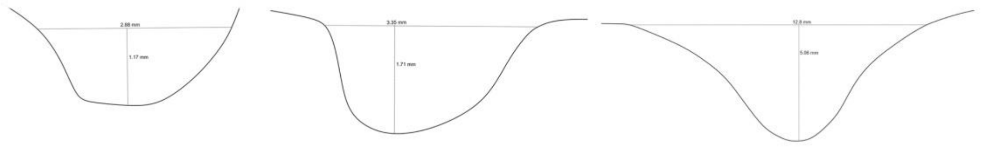
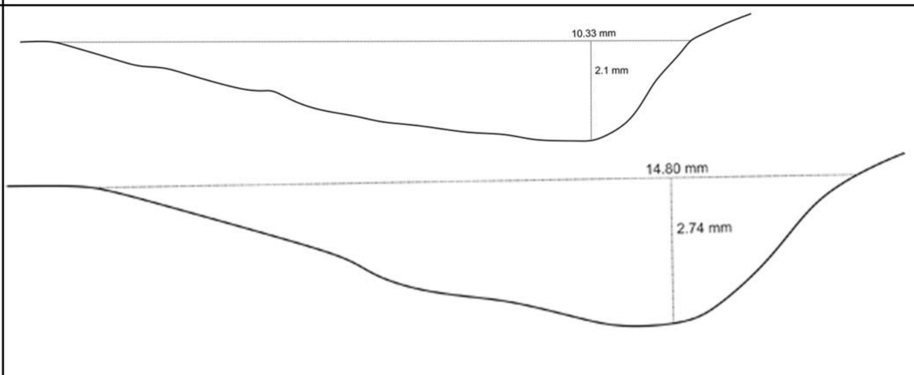
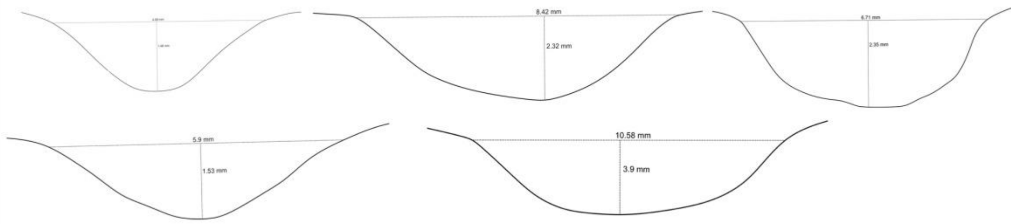
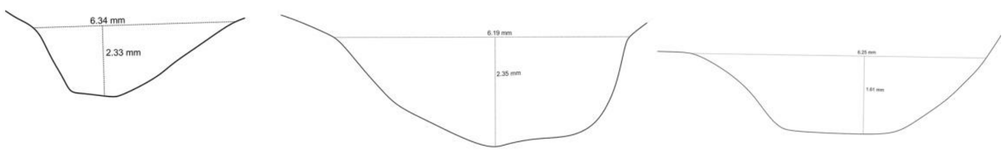
Type A1	
Type A1.1	
Type A2	
Type A2.1	
Type A3	
Type A3.1	

Table 4.16b. Typology of engravings on the portable engraved stones from Kamyana Mohyla. Types B—F and cupmarks types A and B

Type B	
Type C	
Type D	
Type D1	
Type E	
Type F	
Cupmark A	
Cupmark B	

The position of the different types of engravings on the portable stones from Wizard's cave and Churinga's cave is presented in table 4.17. This excludes churingas that do not contain any notches (No. KM74—20; 213; 214; 218; 220; 228; 261; 332; 356; 360).

Table 4.17. The spread of the notches of different types on the engraved stones of Kamyana Mohyla

No	Total notches	Type A1, %	Type A2, %	Type A3, %	Type B, %	Type C, %	Type D, %	Type E, %
225	6	0	50	0	0	0	0	50
245	103	44	48	8	5	0	0	0
247	112	49	51	0	0	0	0	0
248	96	58	42	0	0	0	0	0
249	59	75	75	0	0	0	0	0
252	77	42	50	0	0	8	0	0
254	39	73	27	0	0	0	0	0
257	9	100	0	0	0	0	0	0
258	16	100	0	0	0	0	0	0
259	29	62	38	0	0	0	0	0
260	11	91	0	0	0	0	9	0
265	68	74	26	0	0	0	0	0
268	58	57	38	5	0	0	0	0
273	16	94	6	0	0	0	0	0
276	34	55	45	0	0	0	0	0
277	50	66	28	2	0	0	4	0
278	101	50	48	0	0	0	0	0
283	123	54	43	0	0	3	0	0
284	97	65	31	4	0	0	0	0
287	36	35	62	0	0	3	0	0
298	85	30	67	0	0	3	0	0
300	28	0	69	18	0	3	10	0
302	174	31	67	2	0	0	0	0
306	27	32	44	16	4	0	4	0
307	14	57	43	0	0	0	0	0
308	88	0	93	7	0	0	0	0
309	31	31	54	12	0	0	3	0
310	99	33	63	0	2	2	0	0
317	97	53	43	1	0	3	0	0
321	21	35	65	0	0	0	0	0
324	24	76	24	0	0	0	4	0
328	57	51	49	0	0	0	0	0
329	97	45	52	0	0	1	2	0
331	23	50	40	0	0	0	10	0
335	25	28	52	12	0	0	8	0
336	94	0	89	9	0	1	1	0
338	67	46	0	51	0	3	0	0

Table 4.17 (cont.). The spread of the notches of different types on the engraved stones of Kamyana Mohyla

No	Total notches	Type A1, %	Type A2, %	Type A3, %	Type B, %	Type C, %	Type D, %	Type E, %
341	52	0	92	0	0	4	4	0
342	60	0	98	0	0	2	0	0
343	96	36	49	14	0	0	0	1
344	73	0	98	0	0	0	2	0
341a	31	45	43	0	0	9	3	0
KM74-1	18	40	55	5	0	0	0	0
KM74-11	34	46	45	6	0	3	0	0
KM74-13	39	13	74	0	0	8	5	0
KM74-15	30	0	97	0	3	0	0	0
KM74-16	20	35	40	15	5	0	10	0
KM74-17	24	42	58	0	0	0	0	0
KM74-18	20	0	95	5	0	0	0	0
KM74-19	50	50	46	4	0	0	6	0
KM74-2	50	28	68	4	0	0	0	0
KM74-21	4	0	25	50	0	25	0	0
KM74-23	10	10	80	0	0	0	10	0
KM74-24	29	20	72	0	4	0	4	0
KM74-27	97	44	56	0	0	0	0	0
KM74-4	44	30	68	0	2	0	0	0
KM74-6	29	38	58	0	4	0	0	0
KM74-7	10	40	60	0	0	0	0	0
KM74-8	15	93	0	0	7	0	0	0
KM74-9	14	0	100	0	0	0	0	0
Rudinskiy	48	98	2	0	0	0	0	0

Such a dispersion introduces the technological similarity of most rock art specimens' production. It also shows the differences in engraving some particular stones or stone assets. When assigned to the stones' archaeological and spatial contexts, these data are informative in testing the old hypotheses or formulating new ones that correspond to the received information. Though a dataset of portable engraved rocks contains specimens that differ by their size, shape, and number of engravings (that varies from 4 to 174), the general concept of their engraving stays the same and corresponds to the prevailing of the notches of type A that is also typical to the parietal art of Kamyana Mohyla. This reminds us once again that any kind of portable rock art specimens interpretation should be provided, taking into account the parietal art specimens from the relevant cave.

Moreover, this is a fundamental dataset and one of the most informative ones in the Kamyana Mohyla complex. In order to understand this collection and consider it in terms of any pre-Historic processes, one should notice that neither archaeological nor precise spatial or semantic information is available for the portable stones from the site. The interpretations provided by V. Danilenko that attributed churingas to the particular chronologic context were based on the motifs and semantics of the engravings. However, none of these motifs were found on the portable instances surface during the research. Some engravings appeared to be a chaotic set of linear notches; others did not exist. Therefore, the technological study and the data received from the models' surface and cross-sections, together with their spatial distribution, is the most informative data package.

The comparatively coherent collection found by V. Danilenko during his 1973—1974 research seasons contains two exceptional specimens that should be presented exclusively. The first one is the engraved stone No. 225 (fig. 4.13). It draws particular attention due to the deep and narrow engravings of type E that are noticed exclusively on this stone. Five deep parallel notches and one perpendicular to them create a clear lattice that is not covered or superimposed with any other notches. The stone was broken into two parts and then glued by V. Danilenko between 1973 and 1980.

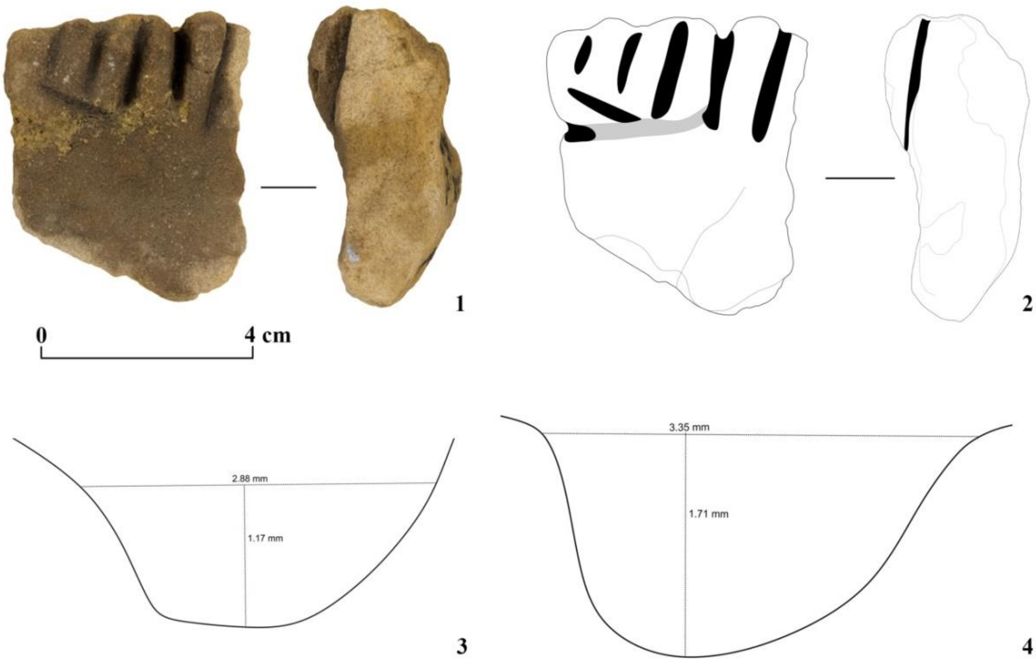


Fig. 4.13. Engraved stone No. 225, cave of Churingas. 1. — image (front and right view); 2 — Drawing (front and right view); 3 and 4 — engravings of type E (fourth and third respectively)

Another stone worth mentioning is churinga No. 277, found in Wizard's cave. Together with several other specimens, it was located near the Eastern Entrance, among the stones that covered the entrance to the location of vessels that accompanied Iron Age burial attributed as a Hunnic one. According to the interpretation of V. Danilenko, these churingas were moved during the construction of the burial. Initially, they belonged to the Upper Paleolithic times and other Wizard's cave instances. This stone is the only one that contains an engraving of D1 type (fig. 4.14). Notches introduce a semi-circle of two parallel lines of type A and thus present a unique geometric composition among the portable art specimens of Kamyana Mohyla. The semi-circle consists of short linear engraved segments of two parallel lines. Several shallow lines accompany it.

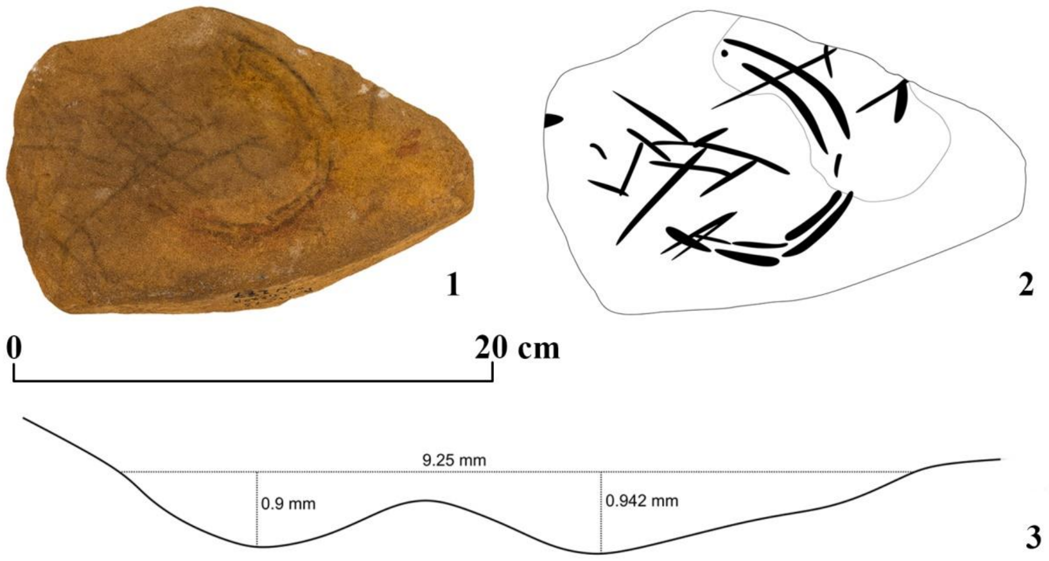


Fig. 4.14. Engraved stone No. 277, Wizard's cave. 1. — image (front view); 2 — Drawing (front view); 3 — engraving of type D1

These two specimens present two most notable examples of an engravings composition on the portable rock art specimens. Instead, others introduce a set of chaotic notches that do not make up any clear picture that contradicts most interpretations of V. Danilenko. Therefore, proposed hypotheses on the meaning of the engravings on the churingas of Kamyana Mohyla must be reconsidered in a frame of these new data.

4.7. Defining the superimpositions on the engraved stones from image-based 3D models

S4.2. Analysis of the specimens following the Harris matrixes. Another asset of data available during the analysis of 3D image-based models is the information on the sequence of engravings creation. This clarifies the life cycle of portable rock art specimens, the history of their active use, contextualization, and decontextualization, and sometimes contributes to the interpretation or chronological attribution of the instances. Considering that the portable art in general and the collection from Kamyana Mohyla usually lacks contextual data, it is essential to receive the maximum available information to provide relevant conclusions regarding these specimens' better understanding.

These data derive from surface analysis and the careful observation of the models after either magnification, or the light simulation procedures (or both) described above (see chapter 3).

Most specimens from Kamyana Mohyla are covered with superimposed notches and thus might be framed into a single relative chronology scheme. This scheme also includes natural accidents, the fall of the blocks into several parts and their re-use, or the instances brake during the engraving procedure (fig. 4.15).

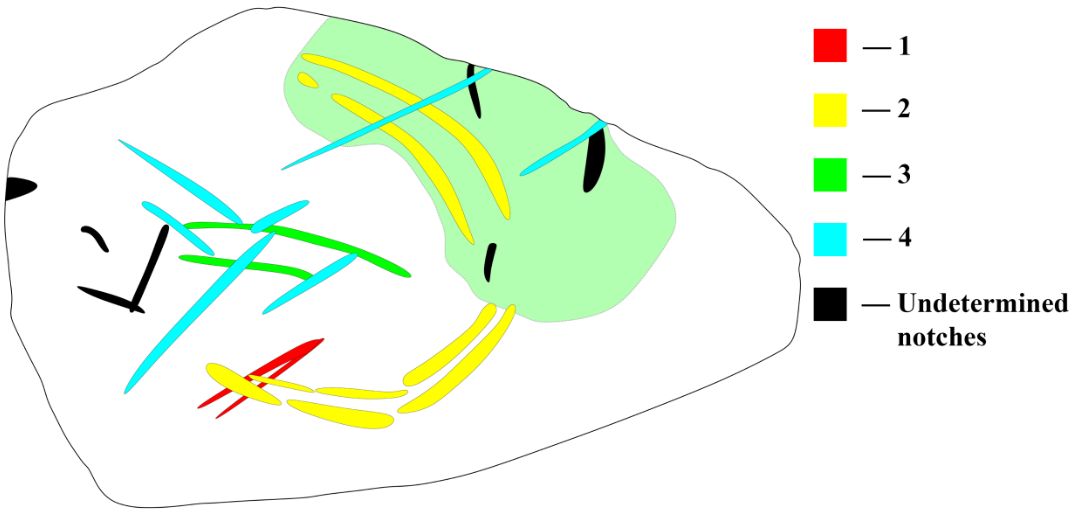


Fig. 4.15. The drawing of the specimen No. 277 with the engravings compound into a colored scheme

For instance, the surface analysis of the engraved stone No. 277 shows the following sequence of its modifications during active use:

- engraving of two shallow notches, creating the semi-circle of two parallel lines in the churinga's center
- an accident that caused the partial destruction of the specimen
- creating a few pairs of parallel notches above the destructed part of the stone or on the surface

This sequence is worth attention to as it shows that the specimen was used both before and after the partial surface destruction. It is also noticeable that the specimen has been engraved both from the front and back sides (the same as many stones from the collection). For such cases, it is usually impossible to determine which side was engraved first.

It seems reasonable and informative to organize this kind of sequence into Harris matrixes that simplify the visualization and interpretation of relative chronology schemes for both archaeological sites during excavation and rock art panels (fig. 4.16).

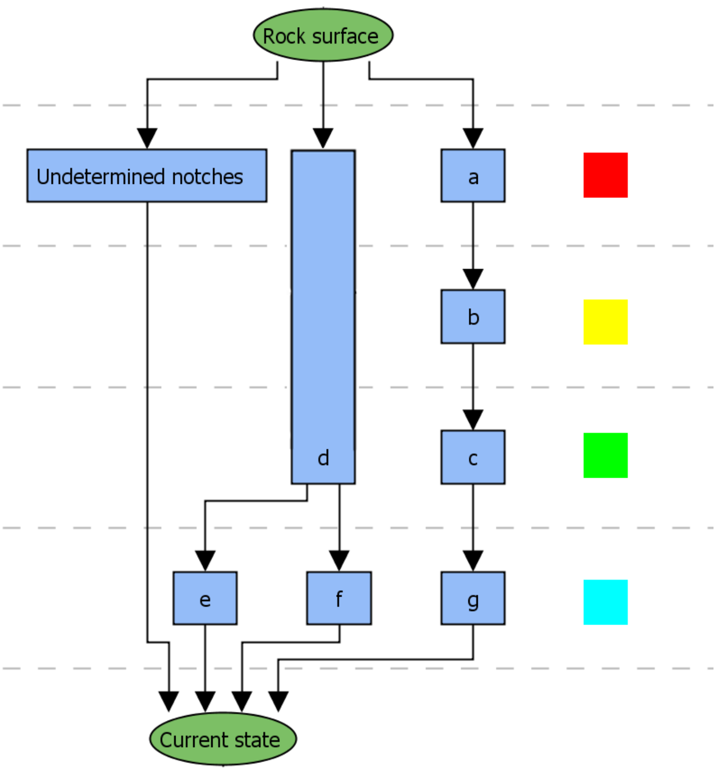


Fig. 4.16. The Harris matrixes that introduces the relative chronology of churinga No. 277 engraving. a — Two shallow lines that create a sharp angle in the block's central part; b — two parallel incisions that create a semi-circle; c — the destruction of the right part of the block; d — two parallel horizontal lines in the block's center; e — two pairs of diagonal lines in the center of the block; f — diagonal notch in the central part of the block; g — two narrow cracks of natural origin

Such visualization allows presenting the whole massive of engravings on the portable art specimen into a simple and informative scheme that reveals non-clear patterns and features in an evident and understandable way (Chippindale & Taçon 1993; Harris & Gunn 2017).

Therefore, the pipeline of defining the engravings' relative chronology consists of enhancing the model by surface scaling and observing it under the artificial light simulation tools, defining the relative chronology of the rock art specimen, and introducing it as a drawing and a Harris matrix (if relevant). It is already proven relevant for the parietal art objects of the Kamyana Mohyla complex. It provides researchers with additional data and presents and organizes them clearly and brightly. The workflow has been tested on two technologically different compositions that also differ by chronological attribution.

An analysis of the image of "Bulls in the defensive position" (fig. 4.17) and the "Rain Bull's" image from the Bull grotto (see Radchenko & Nykonenko 2019) gave additional data on the engraving technology. Also, they provided details that contribute to the interpretation and chronological attribution of the scenes.

For instance, fig. 4.17 introduces both the history of the specific panes and the technology of the images from Bull's grotto creation: A — A set of shallow notches covered with red ocher on the cave ceiling; B — polishing the approximate bulls' silhouettes on the surface; C — contouring the silhouettes and engraving the details — horns, tails, and legs of the creatures; D — Perforating the cupmarks covered with red ocher both inside and outside the bulls' images; E —partial destruction of the grotto ceiling (Radchenko & Nykonenko 2019: 52).

The surface analysis of this composition proved the hypothesis on the technology of these specimens' creation — preliminary contouring of the future silhouette — polishing the image to the required depth (that may be done by the intensively polished pieces of sandstone) — engraving the contour and details with the notches that fall into the type A of the typology, presented in S4.1.

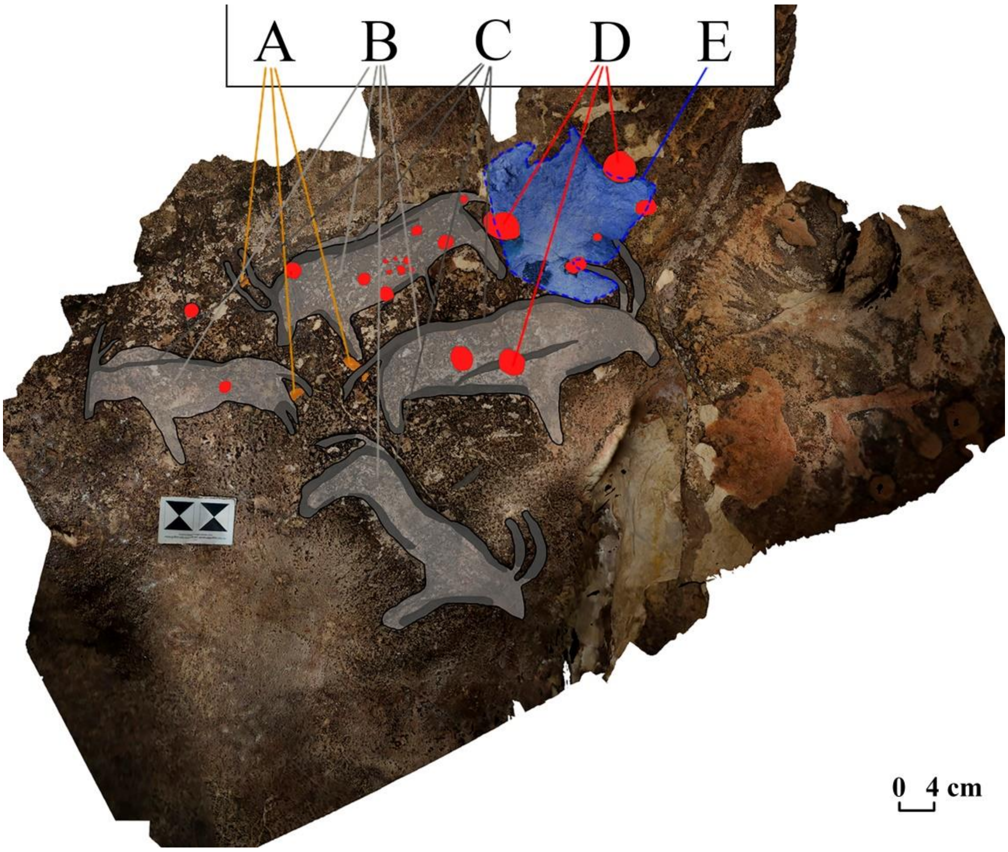


Fig. 4.17. An orthoscopic image of the "Bulls is defensive position with the relative chronology sequence shown (after Radchenko & Nykonenko 2019: fig. 7.3)

This analytical pipeline appeared to be quite relevant in the interpretation and chronological attribution of the Vishap from cave No. 55 (also known as the "cave of the Dragon"). The detailed study of the enhanced model introduced several clear superimpositions, providing an extensive relative chronology of the figure (fig. 4.18.).

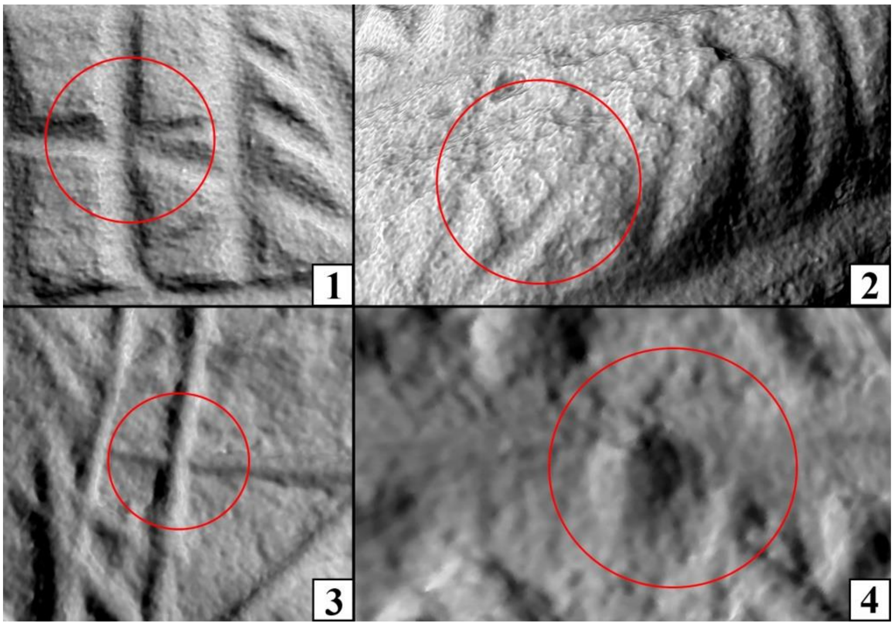


Fig. 4.18. The examples of superimpositions that provided data on the petroglyphs' relative chronology. 1 — Horizontal lines superimposed by vertical ones; 2 — Vertical lines inclination after the partial destruction; 3 — Horizontal line superimposed by vertical one; 4 — Cupmark engraved on the border of the horizontal line (after Radchenko et al. 2020: fig. 9)

Furthermore, the study of the specimen's relative chronology revealed the figure in the cave to be multilayered and engraved during two distant periods. It is connected to the region's Late Mesolithic and Early Bronze Age. The analysis of the object's relative chronology shows that all the engravings in the shape of zigzags were made before the footstep image (fig. 4.19: 1). They have many analogies with Late Mesolithic art of the region and are usually considered to be connected with fishing communities and the catfish adoration in the Molochnaya river basin (where the Kamyana Mohyla complex is located) and their neighborhood (Radchenko et al. 2020: 176—177). Later that composition was complemented by an image of a sandal typical for the Early Bronze Age of the region. Structuring the many data regarding the engravings' superimpositions into a simple Harris matrix (fig. 4.20) has produced a comprehensive interpretative scheme (fig. 4.19a) that explained the complete history of the multilayered figure and corrected the current hypothesis regarding the interpretation and chronological attribution of the figure and contribute to our understanding of both the Mesolithic and Early Bronze Age of the region.

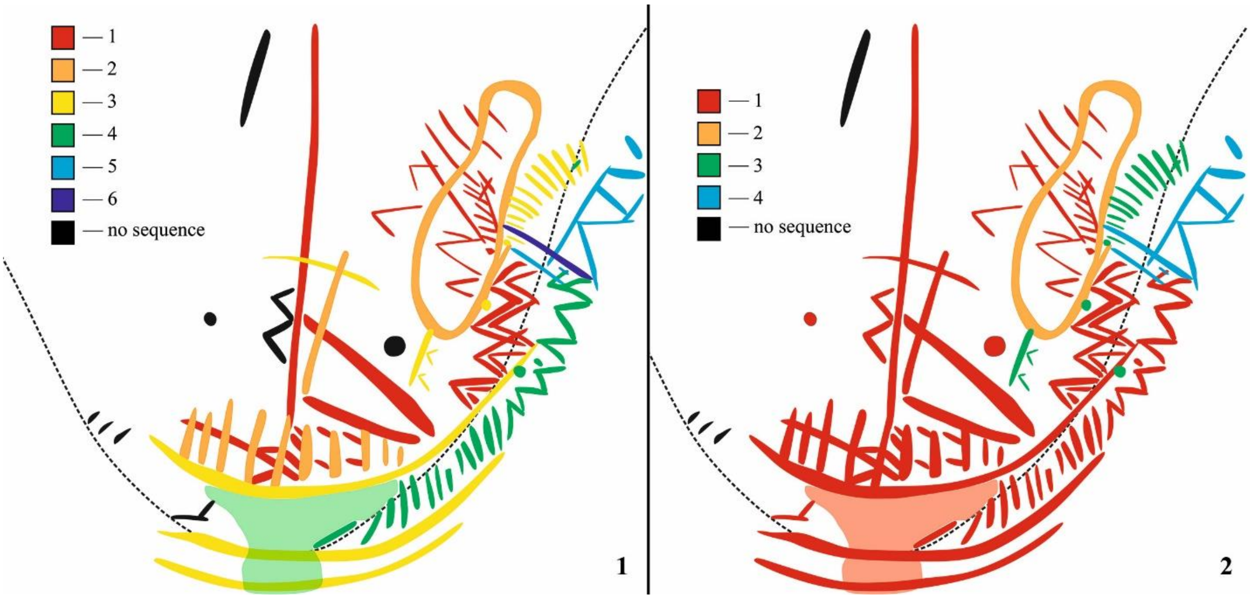


Fig. 4.19. Drawing and relative chronology of the Vishap's figure. 1 — the sequence of engravings creation; 2 — the interpretative sequence created considering the archaeological context of the site (after Radchenko et al. 2020: fig. 11, fig. 14)

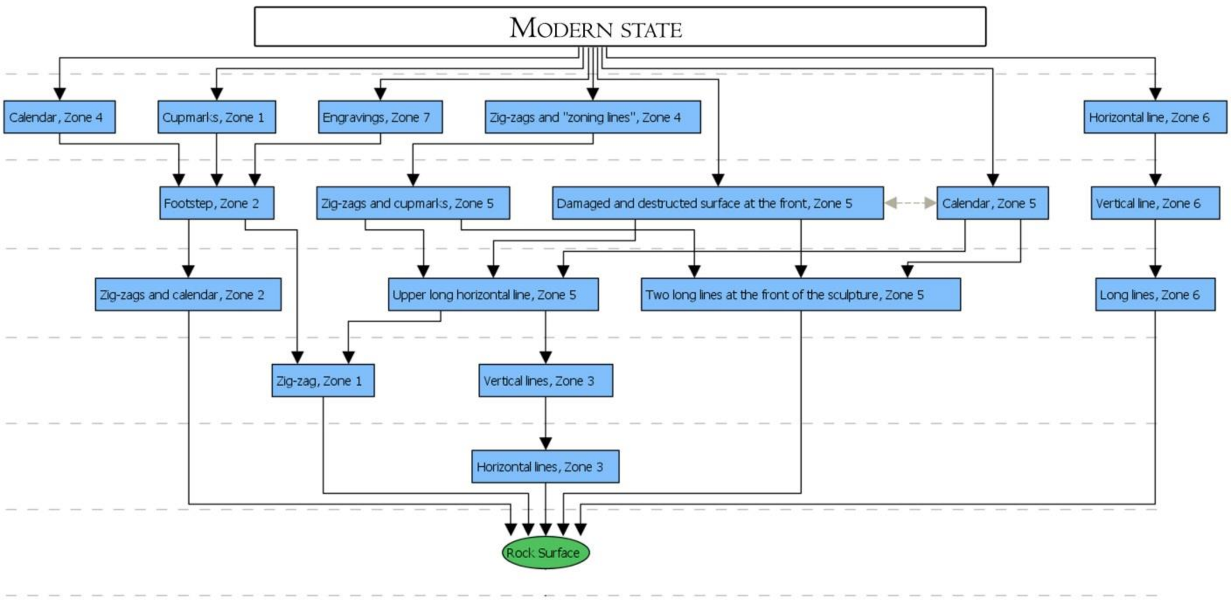


Fig. 4.20. Harris matrix of the petroglyph creation sequence (after Radchenko et al. 2020: fig. 12)

Although this pipeline proved efficient for analyzing the parietal art from Kamyana Mohyla, it appeared to be much less informative when applied to portable art specimens. This is caused by the features of the engravings composition on churingas from Kamyana Mohyla. Though a set of chaotic lines provide several superimpositions, it is not informative as it is not bound with any cultural, interpretative, or at least semantic context (fig. 4.21). The interpretation of the analyzed parietal art specimens won a lot from the relative chronology sequence and its interpretation as it bound images with the specific moment in the composition's history and, sometimes, with cultural and archaeological context. On the contrary, the superimpositions on the portable rock art specimens cannot provide additional data on that score as they are not bounded with any meaningful image.

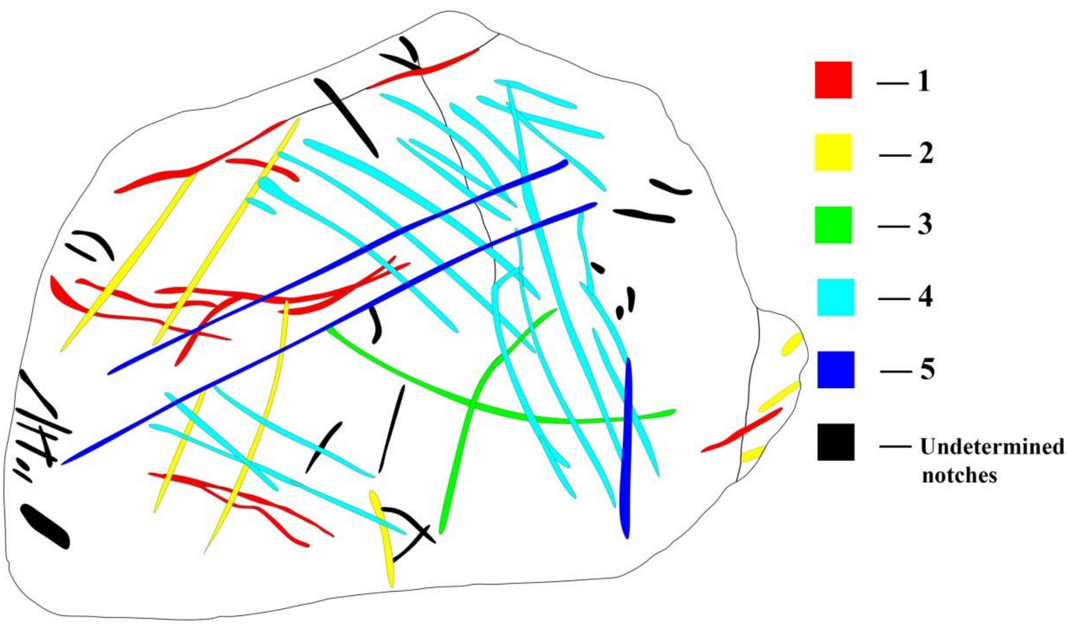


Fig. 4.21. The relative chronology of the stone No. KM74—2 engraving. The right part of the stone felt apart and was engraved separately. Churinga was glued by V. Danilenko after 1974

Moreover, such a sequence cannot provide comprehensive knowledge regarding the technological differences in the stone engraving because all the characteristic notches belong to the same type (type A) and its subtypes. These notches present the overwhelming majority of all engravings on the churingas;

their numerous superimpositions do not create any specific informative scheme that would contribute to our understanding of the technological differences in the creation of different specimens. However, a few details can be stated:

1. There is no relative chronological sequence for the subtypes of type A cross-sections that can contribute to the whole dataset;

2. Equidistant parallel lines usually belong to the same chronological phase;

3. The portable art specimens were used and engraved both before and after the accidental destruction or falling of the block into parts;

4. The examples of a specimen falling into parts and later being used as two separate specimens are presented (i.e., stone No. KM74—2);

5. Cupmarks on the specimens were manufactured relatively later than linear engraving (except for a stone No. 306);

6. The shape of the engraved stones was usually modified before the engraving process started (sometimes more than one face). This is exceptionally relevant for those churingas that used to be considered stones with "meaningful shape" (i.e., figures in a shape of a fish from the Churingas cave).

The pipeline, in general, and the relative chronology determination, seem to be essential data sources during rock art research. Moreover, 3D image-based modeling and surface examination through the relevant software provide an additional opportunity for such analysis if the relevant accuracy is provided. It is more informative and efficient than direct observation, faster and more straightforward than the microscopic examination, and also solves an issue of portable art (and, especially, parietal art) specimens portability. However, the information received from the relative chronology definition depends on the particular study case — the specific motif, its composition, semantics, technology, etc. Without these data or the transparent figurative art specimen available, the tool, although it provides additional technological information, remains much less efficient than it could be in favorable circumstances. Additional data concerning the collection might be achieved through the results of the technological study of the 3D models' surface to the particular spatial or archaeological contexts, which are always crucial data sources during the rock art research workflow.

4.8. Technological study of the portable stones from Gobustan

While the portable objects from Kamyana Mohyla introduce the absence of iconographic expressions and thus do not present a bright case for the technological study of the engravings, the iconographic interpretation or attribution, etc., the portable stones from Gobustan are yet another case. Since they contain several clear iconographic images, the accurate investigation of the image-based 3D model might provide additional data on the engraving procedures or at least evaluate the existing hypotheses. This dataset is used here to reveal the potential of photogrammetry to provide the data for sensible conclusions regarding portable rock art objects beyond the specific case of Kamyana Mohyla. An example of such analysis is presented here for the stone number N11(A87), while others are introduced in Annex E.

The stone was found in the Baku-Absheron archaeological expedition at the Bendyustyu site in 1987 and is reported only in the field report of this expedition. The front surface of the limestone block is flat and contains a positive relief image of a human figure. Its height is 14—15 cm, and its width — 4—5 cm. The shape of the thighs indicates the image represents a female figure (fig. 4.22).

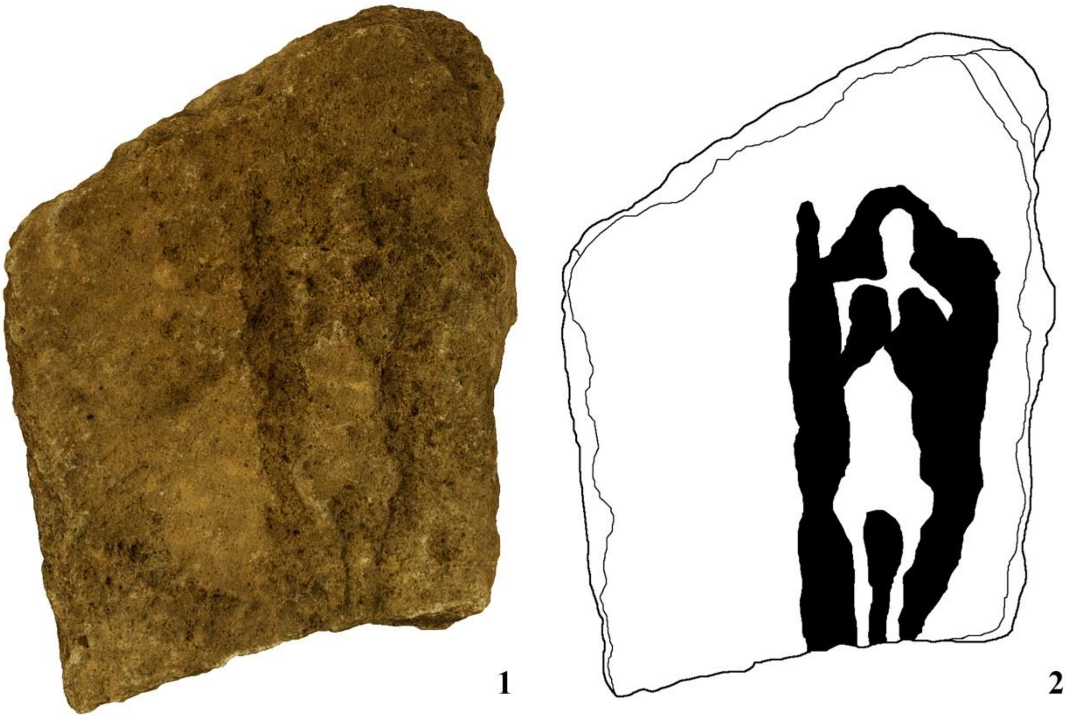


Fig. 4.22. Portable stone No. N11(A87) from Gobustan National Historical and Artistic Preserve. 1. — 3D model; 2 — digital tracing

Detailed analysis of the surface of the stone and the engravings on its surface revealed the traces of three different engraving techniques. First, the front side of the stone was polished to create a flat surface that will form the fundament for the future engraving of the figure contours (fig. 4.23). Traces of these surface preparation actions are visible to the naked eye. Onward, the engraving is done in a mixed technique of scratching (fig. 4.24) and pecking (fig. 4.25), with further smoothing of the engravings' edges that partially cover the linear traces of scratching.

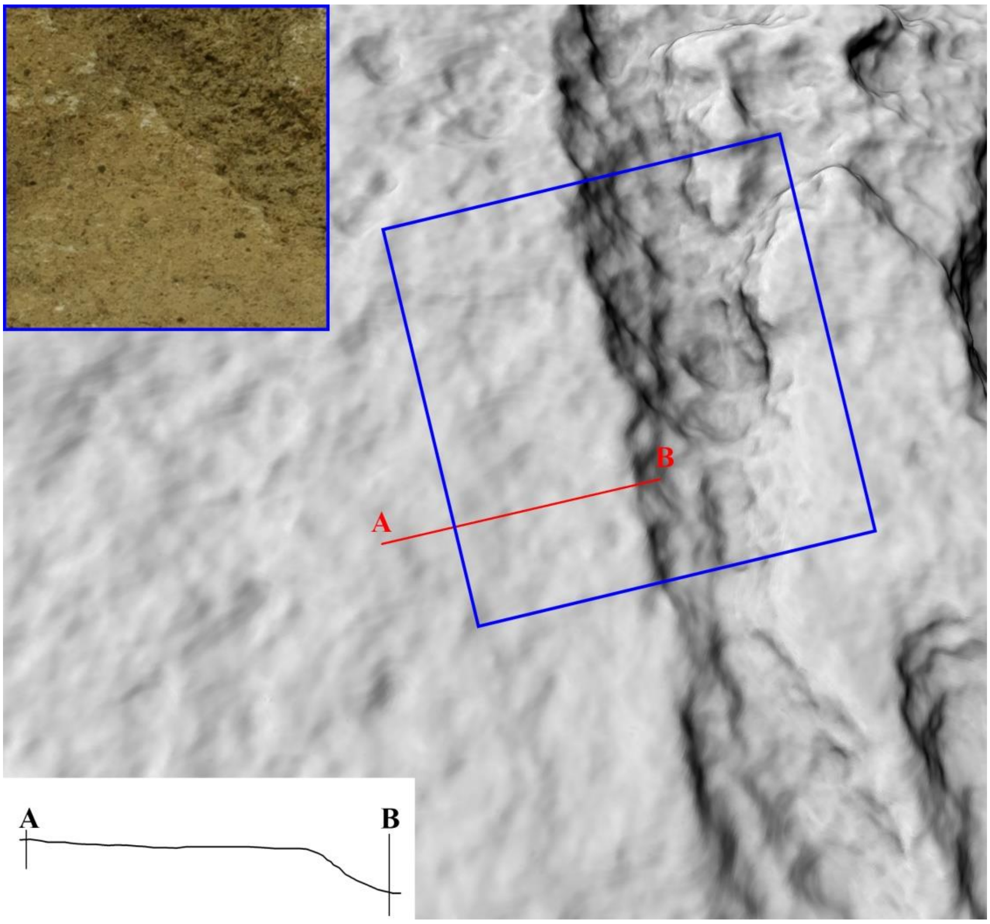


Fig. 4.23. 3D model of the stone N11(A87). Blue square indicates the area, reproduced on the image in the left upper part. Red line marks the location of the cross-section, depicted in the lower left part of the figure

The traces of scratching are multiple, irregular, and well-visible on the surface of the image-based 3D model. They form an asset of narrow curved lines joined in the vast and long contour of the figure. This technique was used only to create the longest left and right contours of the figure, while shoulders, head, and hands were done in other techniques. It is noticeable that the irregular profile of the cross-section of the scratched engraving is similar to those found on Kamyana Mohyla — the irregular shape with an asymmetric profile. The outer edge of the line contains clear traces of smoothening — it is straight and clear compared to other edges and does not contain traces of separate scratches (unlike the inner contour of the engraving).

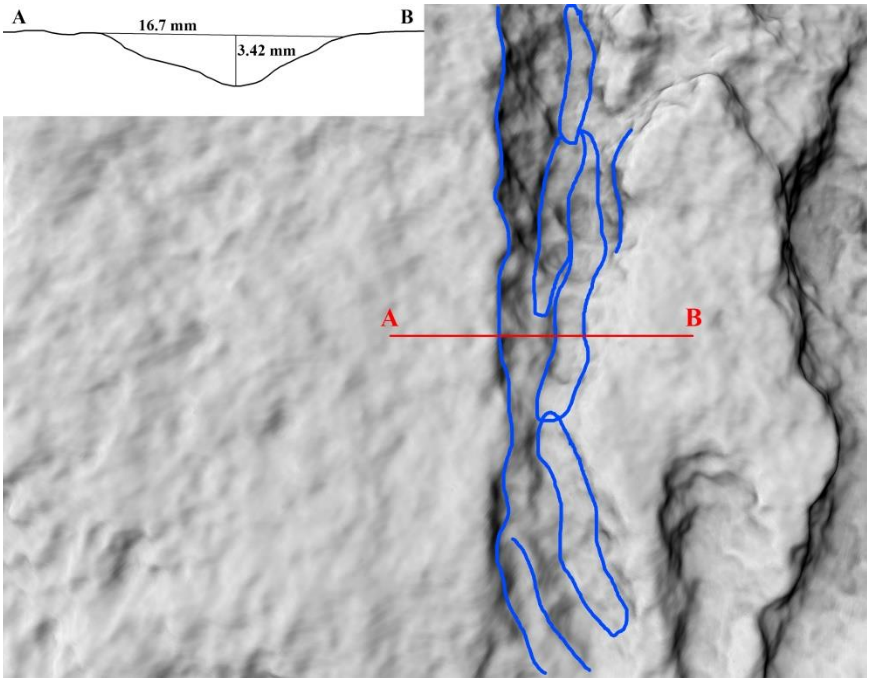


Fig. 4.24.Fragment of the 3D-model of the stone N11(A87). Blue contours indicate the traces of scratching

In contrast to the longer lines, the shoulders and hands of the figure are done by pecking. The cross-section of these traces is generally wider and shallower, with an irregular bottom and complex geometry. They do not contain an apparent asymmetry and are irregular with any explainable pattern — i.e., done by multiple separate strikes. The figure's head is most probably done in a mixed technique: the contours of the figure are shaped and contain traces of scratching, while the overall relief bears signs of intense pecking. The hypothesis of composite technology of engravings production was formulated by Aliev and Aslanov in 1987 in the corresponding field report. Now, it seems to be supported by the results of the photogrammetric study.

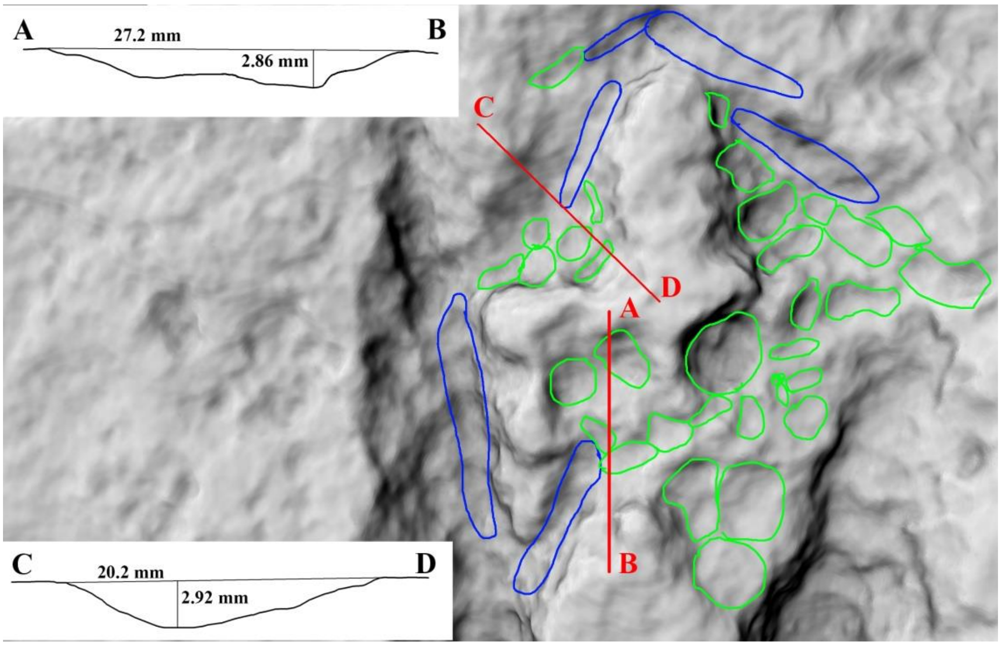


Fig. 4.25. The upper part of the figure's body. Blue lines indicate traces of scratching, green lines — traces of pecking.

The surface's state and the engravings' technological diversity allow the reconstruction of the engravings' relative chronology and the overall strategy of the object creator (fig. 4.26). Polishing and smoothening of the block's front side mark the beginning of the engraving production. The long vertical lines that contour the body were engraved first. They contain traces of multiple scratching. The contours of these long lines were smoothened after the engraving was over. Further, the shoulders and hands of the figure were shaped with pecking, and the head was shaped in mixed technique — contours were emphasized with scratched lines, while overall engraving is mainly featured with pecking traces. The long line between the figure's legs was probably created by pecking.

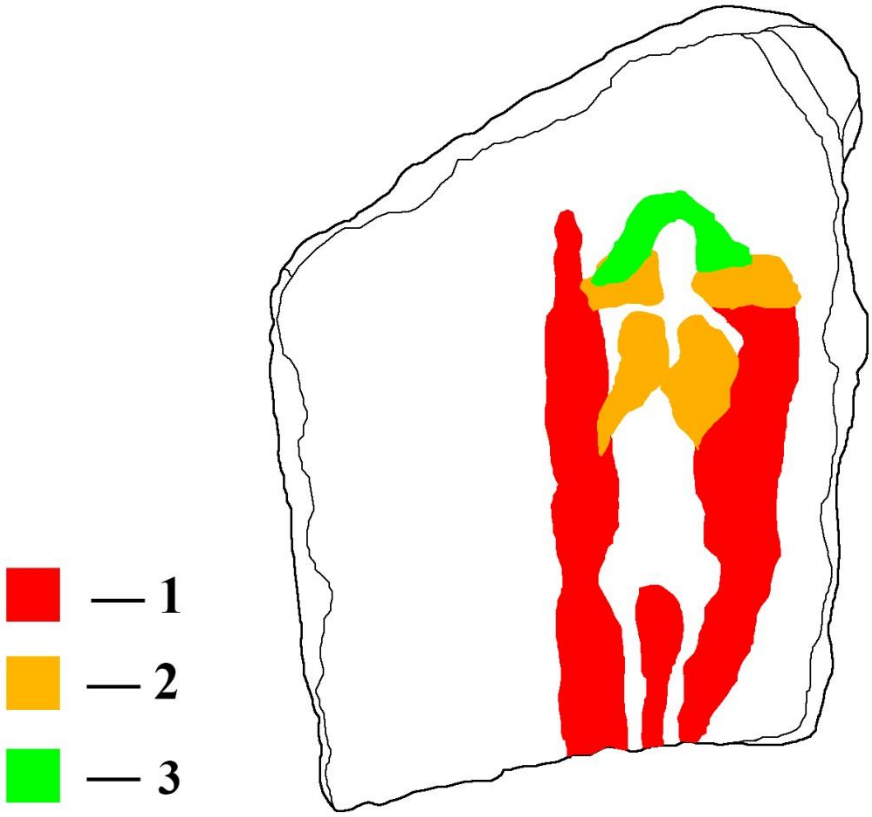


Fig. 4.26. Relative chronology of the engraving of the N11(A87) portable stone from Bendyusyu site, Azerbaijan

Though each of the six portable stones from Bendyusyu is featured with unique nuances and details in the engraving production (outlined and represented in Annex E), they share a common engraving strategy. The technological features are sometimes evident during the plane observation of the stones but are much better emphasized with the photogrammetric study. The latter not just gives the data to produce accurate digital drawings of the stone but enables submillimeter examination of the stone surface for the traces of the engraving procedures and allows linking these traces to the specific cross-sections. While scratches leave smooth asymmetric and comparatively regular traces, pecking is responsible for the shallow and wide irregular cross-section without any recognizable pattern (as the strikes are generally chaotic).

The overall study of the iconographic rock art representations from Gobustan National Historical and Artistic Preserve reveals the full potential of photogrammetry as a tool to define technological and technical nuances of portable rock art production on a sufficient level. While the complete absence of any iconography makes the case of Kamyana Mohyla much less clear and informative, additional data might still be received from examining churingas — especially in connection with their spacial and archaeological context.

4.9. Technological features of analyzed churingas in their spatial context

S4.3. Assigning the achieved data to the spatial context of specimens. The knowledge concerning the spatial context of the portable rock art specimens is approximate. It was introduced only by the name of the cave where the specimen was found and (rarely) by the specific part of the Wizard's cave. For instance, the place called "Scynia" was described by V. Danilenko as the distant part of the cave where he founds several churingas lying on the bigger stone as on the kind of rack. "Eastern Entrance" is the part of the Wizard's cave where the Hunnic burial was discovered and excavated (Danilenko 1986: 78—79). Besides these descriptions, any other spatial context for the collection specimens is unavailable.

The absence of precise compositions or clear iconography on the portable art specimens from Kamyana Mohyla deprives the determination of the relative chronology of any analytical or interpretative meaning. Though the proposed pipeline appears to be generally efficient for analyzing engravings superimpositions, the specific dataset of Kamyana Mohyla portable art wins almost nothing from it. Therefore, considering these superimpositions regarding the spatial context of specimens is also meaningless.

The cross-section interpretation, however, appears to be more informative in terms of our knowledge of the stones' spatial context. The typology of the engravings shows an interesting pattern in the distribution of churingas between different caves (fig. 4. 27). Besides the outnumbered engravings of types B—F, the portable art specimens covered with the notches of different sub-types of type A. They differ by the depth-to-length ratio of their cross-sections. Producing deeper notch requires more effort and is more time-consuming than the shallower ones

(Bednarik 1998). Therefore, the typology of the cross-sections appears to be informative after quantifying the engravings according to their type.

It is noticeable from the counting (see table 4.17) that the percentage of sub-type A1 among the notches of other types varies from 0 % to 100 %. However, the distribution becomes much more ordered if considered together with the spatial context of churingas. The percentage of A1 engravings on the specimens from Wizard's cave varies from 0 % to 56 % (excluding three specimens of 93 %, 76 %, and 65 %) with an average value of 32 %. Vice versa, the percentage of the same type on the engraved stones from the Churingas cave varies from 42 % to 100 %, averaging 71 %.

This percentage correlates with different parameters of the examined stones. The specimens from the cave of churingas have higher value of hardness / density. Therefore, engraving them is more challenging, and this process is even more exhaustive, resource- and time-consuming than usual. In this regard, it is noticeable that three stones from the cave of Churingas with a minimal percentage of A1 notches have a minimal density and are closer to the specimens from Wizard's cave to the ones from Churingas cave by that parameter.

The deeper engravings of A2 and A3 cross-section types are primarily found in the Wizard's cave, while the shallower A1 engravings concentrate in the Churingas' cave. This, according to V. Danilenko, indicates the differences in stone engraving and production technology. Based on these observations, V. Danilenko determines different chronological attribution for the portable stones from different caves. It is noticeable, however, that the growing percentage of the shallower traces (A1 ones) correlate with the density of the stones. Indeed, the rocks from Churingas' cave mostly share a higher density than those from the Wizard's cave. The exception of three objects from Churingas' cave is very iconic — the less dense stones (that are, consequently, most accessible to engrave) share a higher percentage of deeper notches (A2 and A3) and are somewhat similar to those from Wizard's cave by that parameter.

At the same time, the stones from Churingas' cave are the densest (a small group of 7 objects with an average density of 2501 *kg / m3*) and do not feature any kind of engraving. They are either smoothened right to the state of the flat surface or do not introduce any kind of manufacturing at all. The stones from that group are also featured by the specific coloring that has been noticed only in two particular locations — Churingas' cave and the Late Mesolithic layers of the Kamyana Mohyla 1 settlement. While these densest stones are diverse in their coloring, varying from black through red to bright yellow, the other group from Churingas' cave shares bright yellow, which used to be interpreted as a collection of fish figurines. In contrast, the less dense one from Wizard's cave is brownish and covered with desert varnish.

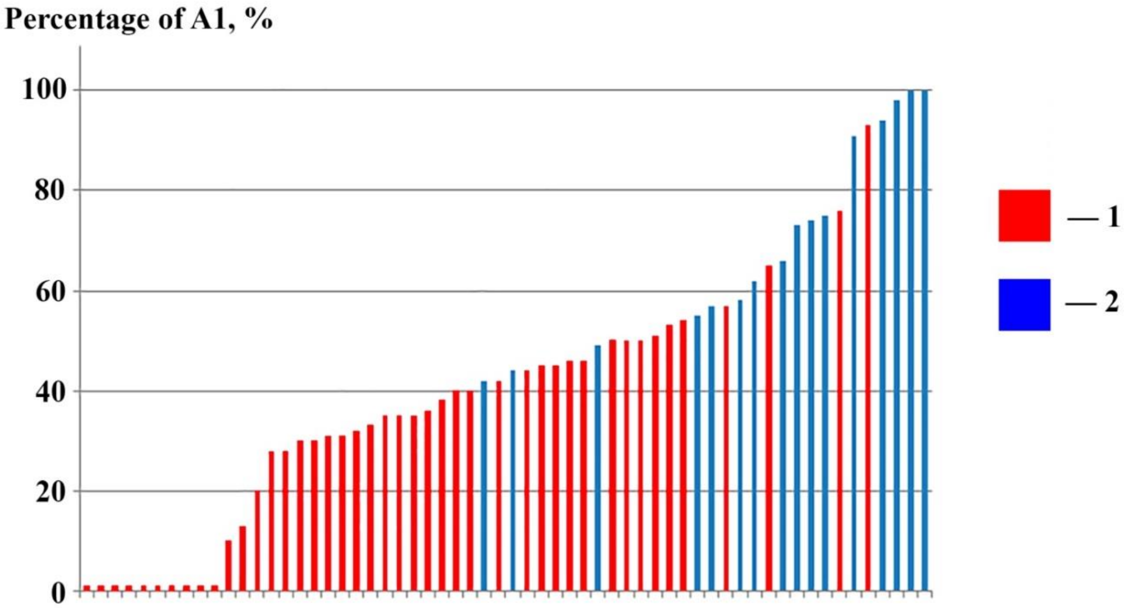


Fig. 4.27. Percentage of the sub-type A1 notches on the engraved stones from Kamyana Mohyla. 1 — specimens from Wizard's cave; 2 — specimens from Churinga's cave

This means that the difference that V. Danilenko considered as technological is instead caused by the physical parameters of the stones — those harder share shallower engravings. In contrast, softer ones are engraved deeper and contain various engraved lines. Most probably, the engraving procedure depended not on the specific visual parameter of the result but rather on the parameter of time to be spent to engrave a single line or a series of those. One more thing to be noticed is that except for the several pieces, the collection of 148 objects found in the Wizard's and Churingas' caves might be divided into two groups by their physical features and the specificity of their compound. Moreover, these groups correspond with the stones' spatial context and the sandstone engravings' technological features.

The hypothesis on the engraving time being a more valuable parameter than the outcome of this process corresponds with the complete absence of iconographic depictions on the portable stones of Kamyana Mohyla. These features support the hypothesis on the importance of the engraving process rather than the semantic 'meaning' of engraved stones. Moreover, this forces us to draw attention away from the direct interpretation of the rock art objects and concentrate on the other features of the stones — the processes behind their engraving, contextualization, and deposition — i.e., the life cycle of the portable stones. Luckily, the photogrammetric study of these artifacts gives clues on the physical and technological features that were hidden before.

4.10. Summary on the technological results of the photogrammetric study of portable rock art specimens

Tested workflow on the image-based 3D modeling of the portable rock art specimens from Kamyana Mohyla and Gobustan brought new data that contributed to these artifacts' technological and technical interpretation. These models are a valuable source of information regarding the portable stones, engravings, the features of their production, composition, relative chronology, and stone support, just as the research hypotheses formulated it. Specifically, the study of image-based 3D models can contribute to the following issues:

1. Accurate and objective digital tracing of the portable rock art specimen is possible due to the highest level of abstraction from the additions to

the stone support. In the case of Kamyana Mohyla, the examination of 3D models allowed observing and reproducing of the engravings ignoring the black pigment additions by V. Danilenko. This finally leads to accurately representing these objects with the nuances of engravings' shape and parameters. The immediate result revealed the misleading nature of V. Danilenko's rock art research results and the complete absence of figurative and iconographic images on the stones. On the contrary, churingas from Kamyana Mohyla are covered with chaotic and irregular linear ornamentation.

2. The photogrammetric study appeared to be an efficient way to extract the visibly unreachable information from the stone surface, such as reproducing engravings cross-sections with submillimeter accuracy for further typological and technological analysis. As engravings cross-sections are the source of valuable information regarding the features of engravings' production, they form a great asset for the photogrammetric study. In the case of Kamyana Mohyla, the typology of engravings profiles revealed that they share relatively similar shapes and are likely to be produced with the exact technological solutions. However, the spotted difference in the depth and parameters of particular engravings corresponded with the spatial distribution of the finds and is likely affected by other features of the portable stones.

3. The mathematical calculations of the 3D models parameters introduced a new characteristic to describe the features of the portable stones sandstone support — their hardness, calculated from the measured objects' weight and volume (received from 3D models' processing). This parameter gives additional knowledge on the material that engravers interact with and thus might reveal new information concerning engraving technology and the specific priorities of the objects' creators. In the case of Kamayan Mohyla, these calculations showed the principal impact of sandstone hardness on the depth (and typology) of engravings. Moreover, as the depth of the carving is connected to the hardness of the stone support, it is reasonable to assume that the processing time and efforts were more valuable for those engraving the stone than the iconography of the

engraving result. This indicates the parameters of stone support as the source of the features on the engraving's sub-types' spacial distribution rather than technological, chronological, or contextual factors.

These results might also contribute to understanding churingas' life cycle as they determine the priorities of ancient 'artists' and the features of specific technological solutions. Even more valuable is the correlation of the obtained result with the spatial distribution of the portable stones with the prevalence of particular engravings types between different caves of Kamyana Mohyla. All these nuances are obtained from the results of the photogrammetric study and contribute to the contextualization of Ukrainian portable rock art objects.

4. The detailed study on the superimposition of the numerous engraving on the portable stones of Kamyana Mohyla shed light on the relative chronology of these engravings. Though this is a theoretically valuable source of information, it is barely helpful in the case of chaotic and non-iconographic images of Kamyana Mohyla. The complete absence of any archaeological or semantic context makes this knowledge scarcely applicable. However, future excavation and research might use the photogrammetric study for relative chronology identification, as in the case of Kamyana Mohyla parietal art images.

To sum up, the photogrammetrical study is an excellent data source for portable rock art research. It gives a uniquely precise and efficient way of producing accurate rock art objects' tracings. It provides data on the superimposition of the images, i.e., the relative chronology of different artistic expressions. Moreover, the additional spatial instruments might reveal technological features of engravings production, while the increased knowledge of the differences in stone support reveals the preferences and priorities of ancient artists. Finally, the high accuracy and abundance of visual data perfectly collide with technological ones to improve understanding of the rock art specimens' life cycle. Both visual details, e.g., the intensity of desert varnish and traces of past accidents and break-offs, and the technological data, e.g., the distribution of the engravings' cross-sections, contribute to our knowledge of what exactly happened with these objects.

Using all these instruments and datasets together makes photogrammetry able to provide sensible conclusions for studying Kamyana Mohyla rock art. Starting from the dismantling of churingas semantic context and the reevaluation of the existing hypotheses on their archaeological and chronological attribution up to the more profound understanding of these stone's role in the cultural landscape of Kamyana Mohyla, photogrammetry gives a bunch of different datasets that are expected to collide into a coherent knowledge on the portable rock art of Kamyana Mohyla.

It shines bright on how photogrammetry might contribute to the knowledge of portable rock art specimens in the case of portable stones from the Bendyusyu site in Azerbaijan. Image-based 3D modeling allowed the creation of submillimeter digital tracings. The detailed analysis of the engraving's interaction and superimposition revealed the relative chronology of different lines and structures on the stone. Finally, examining the surface and the cross-sections of other engraved fragments shed light on the technological aspect of the portable rock art specimens' production, revealing three different techniques used during the petroglyph creation. Altogether, these data fostered the engraving strategy's reconstruction and the image creation sequence. Similar iconography and the figurativeness of the engravings allow limited comparisons between different stones of the asset. Altogether this brings much data on portable rock art specimens from Azerbaijan, even beyond their archaeological context.

The situation is slightly different for the decontextualized and non-figurative engraved stones from Kamyana Mohyla. The information acquired from the photogrammetric study is valuable to our knowledge of the churingas from Wizard's Cane and Churingas' cave. However, its application requires a high level of coherence with the existing data on these artifacts — formulation of the new hypotheses and evaluation of existing ones, even down to the nuances of specific arguments. This will be the actual contribution to the understanding of Kamyana

Mohyla's portable art through a photogrammetric study. An attempt at such a procedure is described in the following Chapter.

5. PORTABLE ROCK ART INTERPRETATION — CONFRONTING NEW DATA AND THE OLD THEORIES

Photogrammetric study of the portable art from Kamyana Mohyla that has been performed in the course of this research project brought to light many additional data on the churingas creation and life cycle, specific features of their support, engraving technology, and the engravings composition. These days form the basis for the step forward in the understanding of the portable art of Kamyana Mohyla, bringing several concepts to be taken into account:

1. The portable stones from Kamyana Mohyla do not contain iconographic inscriptions. It is evident after the digital tracing performed after the image-based 3D modeling that there are no figurative motifs on the portable stones. While the figurines from Churingas cave might resemble fish by their shape (as V. Danilenko suggested and is to be considered in the following chapter), those from Wizard's cave appear to be the plaquettes with the chaotically engraved surface. The results of the photogrammetric study affect the attribution and interpretation of the stones and foster the re-evaluation of V. Danilenko's hypotheses.

2. The collection from caves No. 52 and 54 generally consist of two separate assets of portable stones, divided by the parameters of support — the sandstone hardness (density). The exact calculations of the density of the stone are possible only as a consequence of performed photogrammetric modeling. This parameter affects the measured parameters of engravings and is the new explanation of what V. Danilenko considered as the technological difference of engravings.

3. The analysis and typology of the engravings cross-sections indicate scratching as the main engraving procedure. The latter appears to be an exhausting and time-consuming action. Both churingas from Wizard's and Churingas's caves were engraved similarly. However, the difference in the support hardness caused the difference in the depth of the engraving.

4. The detailed photogrammetric study of each object in the collection contributes to revealing the general pattern of their lifestyle, creation, existence, and deposition in the caves of Kamayna Mohyla. These data are of additional value since any direct interpretation of portable stones that do not contain iconographic expressions is impossible, and the critical question, postulated by V. Danilenko (what is the semantic meaning of churingas), is no longer applicable to these artifacts.

In this chapter, I apply the results of the photogrammetric study (especially the new knowledge on the engravings composition and non-figurativity of the engravings on the stones) to reconsider and re-evaluate the old hypotheses regarding the rocks from the collection. This will be preceded by the considerations of the churingas' possible lifestyle according to the clues revealed by the photogrammetric study.

5.1. The life of portable rock art objects from Kamyana Mohyla

5.1.1. Towards speculative realism in rock art research

The process of rock art interpretation, especially those from Kamyana Mohyla, inevitably assumes the assigning of specific meaning to the objects. This meaning might be discussible or even introduced by two hypotheses simultaneously. Even the consideration of non-figurative specimens, such as cupules, is usually considered through the conceptual framework of 'meaning' (see Arca 2018; Bednarik 2010a, 2019). Well, most non-figurative engravings will remain 'uninterpreted' for now (if not forever) as their 'deciphering' does not lead to any particular result. When we cannot see any particular image or symbol behind a given rock art specimen, it is condemned to remain uninterpreted. And even if we manage to see 'something,' any assumption will inevitably be spoiled by the contemporary researcher's mindset, which affects the interpretation and distorts the conclusions (Bednarik 2017b; Conkey 2018).

To some extent, the idea of rock art interpretation is produced by a humanistic view of archaeological assemblages in general. The same might be stated about the rock art specimens. There is nothing more human-ish than to dwell on the interpretation of things, attempting to explain them and search for their meaning. The situation becomes critical when related to objects previously manufactured by past humans. Those who come later (and most of them are archaeologists) apply their worldview and imagination to explain the archaeological collections, which doubles the distance to the material itself. Not only are we incapable of defining and revitalizing the intention of the ancient creator and the purpose that curated their actions, but we are also moving away from considering the object as they are, the objects beyond humans. In this regard, interpretation is an aggressive act of assigning something alien to archaeological assemblages.

The process is even more daring when discussing rock art research and interpretation. This is probably due to a visual component that teases modern human beings who are used to considering visual stimuli through the prism of explanation. Moreover, when assigned to prehistoric art, an inaccurate concept of art also pushes the interpreter in the wrong direction (Conkey 1983; 1987).

The idea of interpretation has recently been criticized for neglecting the objects themselves. Indeed, the process of assigning 'meaning,' 'purpose,' or 'interpretation' to components of archaeological assemblages remains rooted not in the objects themselves but rather in our view of the objects, ignoring the fact that the objects are 'non-humans' and they are pretty different from what we can imagine them to be. "If objects are not 'surrogate humans' but operate in their ways, should we not show greater respect for their independent role in our shared world" (Olsen et al. 2012: 202)?

The idea that objects should be considered appropriately assumes that they are independent actors in a complex world that might generally exist without any interpretational impact provided by human beings. This idea is based on Quentin's Meillassoux concept that "there can be no X without a givenness of X, and no theory about X without a positing of X. If you speak about something, the correlations will say, you talk about something that is given to you and posited by you" (Meillassoux 2008). Meillassoux offers a different way of thinking that allows us to avoid correlations. We must admit that physical laws of reality are no necessity but just a result of our observations and explanations. We cannot state that our representation of the Universe is accurate, nor can we deny the idea that everything can work differently. Our concept of causal relationships is solely ours; expectations and confirming results are not guaranteed but just facticity (Nezabytovskyi & Radchenko 2022: 43).

Melliassoux's concept formed a solid basis for the appearance of a vast philosophical shift, provided by Graham Harman in his "Speculative Realism" (2011). Previously, humans imagined themselves as the epistemological summit (they were the cognizing subject, they notice all the connections of this world), and now a viewpoint has emerged in which everything, including the human, is only a set of objects, and this set is uncountable. The human as a substantial mediator is no longer necessary (Nezabytovskyi & Radchenko 2022: 44).

Such an approach to the ontology of things as separate from human beings removed the wrapping from numerous concepts that reintroduced the world of things differently, considering the demise of human's role in the world. This includes multiple ontologies (Alberti 2013: 45), the agent network theories of Bruno Latour that consider society as "something that people and things conspire to bring into being" (2005: 4), posthumanism (Harris & Crellin 2018; Cipolla, Crellin & Harris 2021), etc.

Most of these ideas appear quite well-rooted in archaeological theory and archeological practice. The main reason for that is that archaeology is a discipline focused on things (Olsen 2003; Olsen et al. 2012), having the exploration of "the other ways of being and doing" (Cipolla, Crellin & Harris 2021: 8) as one of its main objectives. Therefore, objects and things start to be considered distinct from human beings, assuming that their independent existence is also an essential part of studying material culture (Petursdottir 2012; Petursdottir and Olsen 2017). Generally, "more recent approaches within archaeology have begun to identify objects as independent actors" (Thomas 2015a: 1289).

Such shifts in understanding non-human parts of archaeological assemblages have formed a solid basis for rejecting anthropocentric interpretations of objects. It is much more reasonable to consider materials as subjects of interactions and agents that can independently shape and transfer memory (Cipolla 2008).

5.1.2. The interpretation of portable rock art objects' life as a result of their image-based 3D modeling

During his study of Kamyana Mohyla portable rock art specimens (especially those from the Wizard's cave), V. Danilenko focused on the issue of deciphering churingas' semantic meaning, i.e., interpreting them and the engravings on their surface. However, the photogrammetric study of these specimens proved his input data to be misleading — there are no iconographic compositions on the stone's surfaces. This makes the complicated question of these objects' interpretation even more complex. The question of "what interpretation is possible for these specimens" is melting as irrelevant for the moment. The focus, thus, shifts to the other things that can be stated on these stones. It may be fruitful to pay proper attention to their life cycle alongside human beings rather than to human needs and thoughts, which will most probably remain unknown forever. In addition, the capacity of photogrammetric study to reveal the tiny nuances of the rock art stone surface modification (emphasized in annex D) over time gives an additional clue to the general pattern of the whole collection life cycle.

The life of the portable rock art specimens, as well as other sandstone from Kamyana Mohyla, is tightly connected to the hill of Kamyana Mohyla itself and the special landscape formed in the hill's surroundings. The land near the mountain is within reach of different archaeological assemblages and numerous objects related to the hill itself — a so-called cultural landscape (see Makhortykh et al. 2020). The notion of the cultural landscape is born from the strong connection between human and non-human beings that inhabited the area surrounding the Kamyana Mohyla hill to the landscape itself. The appearance and the function of specific objects in historic and prehistoric periods are caused and impacted by landscape features. Among them, Kamyana Mohyla is the most important and unusual. The rocks that were taken from the hill for ritual purposes were found both on the nearby settlement (Kotova et al. 2018), in the burial complex near the hill (Makhortykh et al. 2020; Kotova et al. 2020) (fig. 5.23), and in the surrounding complexes. This includes tumuli located in the nearest surroundings of Kamyana Mohyla (less than 1 km from the hill) (Vyazmitina et al. 1960) and the graves, which feature sandstone boxes up to 20 km from the site (Mykhailov 1990; 2006). These sites, either burials or settlements, utilize sandstone from Kamyana Mohyla to frame the landscape according to their relevant traditions, beliefs, and worldview.

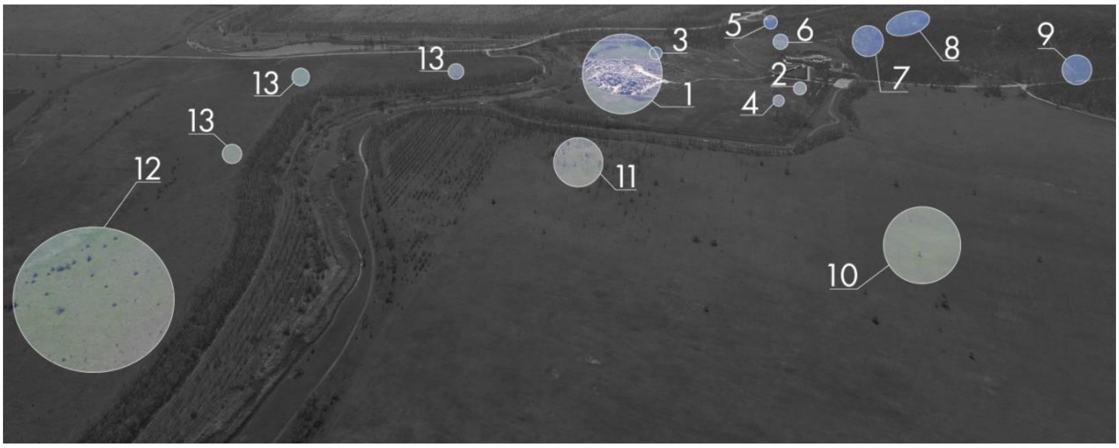


Fig. 7.1. The cultural landscape of Kamyana Mohyla immediate vicinity. 1 — Kamyana Mohyla Hill; 2 — the settlement of Kamyana Mohyla 1; 3 — the Kamyana Mohyla 2; 4 — Kamyana Mohyla 6; 5 — Kamyana Mohyla 4; 6 — tumuli near Chervona Hora; 7, 9 — stone constructions on top of Chervona Hora; 8 — tumuli in the northwestern part of Chervona Hora; 10 — Kamyana Mohyla 5; 11 — burial site to the north from Kamyana Mohyla (after Makhortykh et al. 2020); 12 — tumuli to the west from Novopylypivka; 13 — lone tumuli on the left bank of Molochna River

Although it is clear from all of these sites, the ethnographic sources (Tarasenko 2017; 2019), and the appearance of rock art in the caves on the hill that Kamyana Mohyla affected the life of these cultural landscape inhabitants, the hill itself was not inhabited. People never lived there and only came to interact with the stones or take them away to use for their purpose. This is evident not only from the huge (sometimes artificially processed) blocks used for burial practices near the hill but also from churingas found in the cultural layers of the Kamyana Mohyla 1 settlement. It is possible that the rock art specimens were removed from the hill to other locations, processed, and then brought back into the caves. Such a pathway is also suggested by the desert varnish on the portable rock art specimens — most of which were exposed to the sun and the wind for a period. Notably, the exposure time probably varied from stone to stone as the varnish intensity appeared to vary.

Such specific relationships between objects and space inevitably affect their life cycle, slightly modifying them conceptually, as described by Tosello & Villaverde (2014). The story of churingas from Kamyana Mohyla cannot be understood without considering their transfer from one place to another before finally being deposited in one of the hill's caves.

It is clear that the story of every single churinga starts on the Kamyana Mohyla Hill or even inside the hill. Specimens were taken from there and engraved somewhere out of the cave. The lack of engravers or their pieces in the Kamyana Mohyla caves proves that the engraving practices have happened outside the cave. This is confirmed by the portable rock art objects found on the settlement or in its vicinity and by the desert varnish on the sandstone pieces' surfaces. The latter clearly indicates that specimens were exposed to the sun; sometimes, this took a while. In short, the lifecycle of Kamyana Mohyla churingas consists of several specific events that fit the general scheme. Each stage of the cycle can be followed by the abandonment of the churingas or their initial transfer into the cave (fig. 5.1):

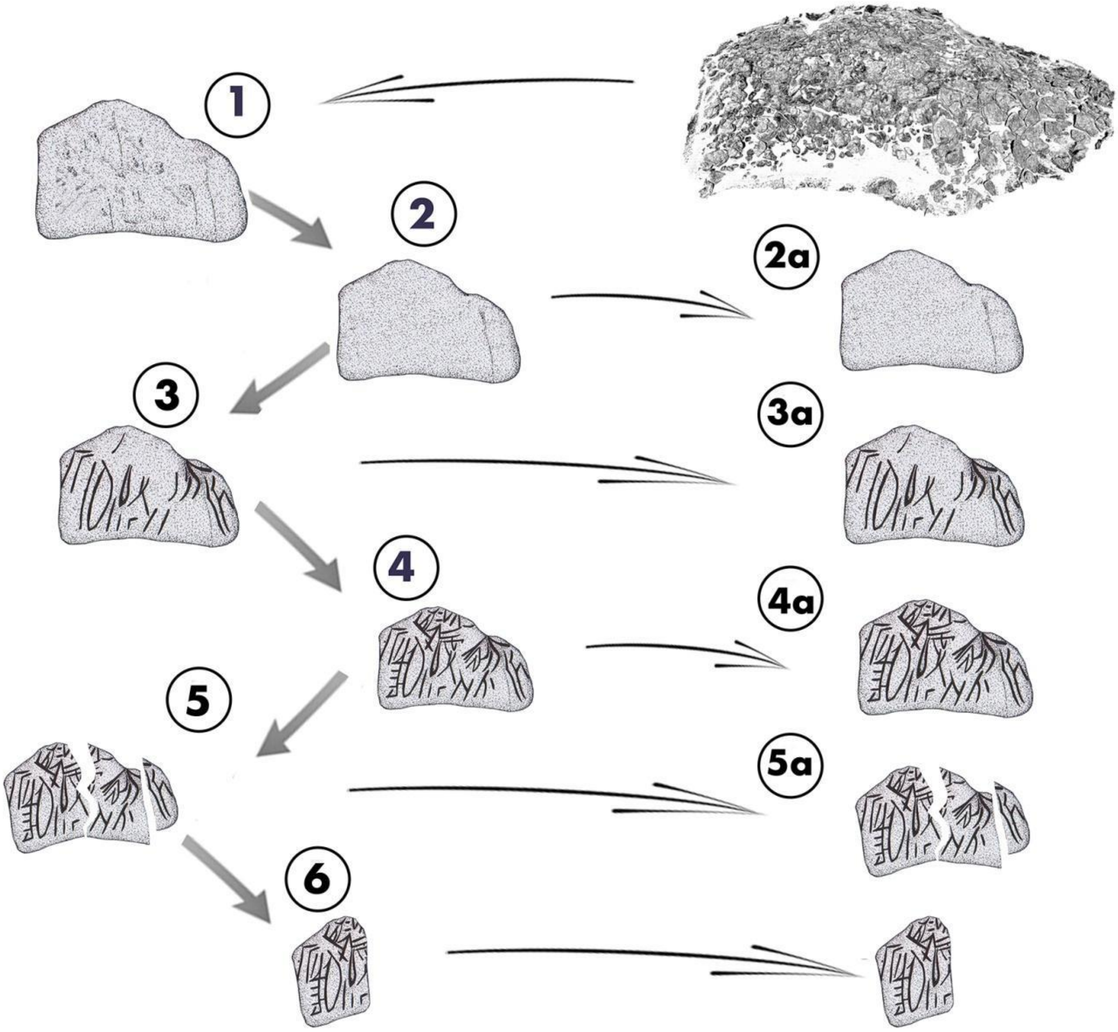


Fig. 5.1. A theoretical graphical scheme of a churingas lifecycle (S. Radchenko scheme based on Tosello & Villaverde 2014: 6031 and archaeological data from Kamyana Mohyla)

a piece of sandstone is gathered from the slopes of Kamyana Mohyla hill or one the caves;

1) the stone is polished or modified to a particular shape;

2a) abandonment or placement in the cave;

2) the manufactured stone is engraved with non-figurative reticulated ornamentation. These kinds of stones are considered portable rock art specimens called churingas;

3a) abandonment or placement in the cave;

3) second (third, fourth etc.) phase of engraving;

4a) abandonment or placement in the cave;

4) churinga is broken into several parts

5a) abandonment or placement in the cave;

5) A piece of churinga is manufactured by polishing and the engravings become a churinga itself;

6a) abandonment or placement in the cave.

The time lapse between different stages is not defined and may be unpredictably long. Moreover, as the scheme is theoretical, some components might be missing, and other specific features might appear only in particular cases.

The most iconic representation of this scheme is provided by the story of Churinga No. KM 74—2 (fig. 5.2). The photogrammetric study of the stone revealed the relative chronology of the events that happened with this stone, reconstructing its individual 'biography,' which is representative of the general life cycle of the Kamyana Mohyla portable rock art objects. In the first stage, churinga was removed from the hill and artificially shaped (it seems from the image-based 3D model surface analysis that it was prepared by smoothening). Then it was engraved with irregular reticulated ornamentation. Most engravings on that stage belong to the sub-type A1, though other sub-types are represented. Later it was broken into two pieces. The smaller part was then taken away and engraved once more. The photogrammetric study indicated the engravings at this stage to belong exclusively to the sub-type A2. This small part has been long exposed to the sun and wind: the desert varnish on its surface is darker and more intense than on the larger piece. However, both pieces were later returned to the hill. Both fragments were found by V. Danilenko in Wizard's cave during his fieldwork in 1974 and glued together for reconstruction.

This life cycle which combines the engraving procedure with the afterward deposition in the cave in a new way connects the portable stones from Kamyana Mohyla with the general term "churingas" and its direct meaning — "something hidden, but which is personal to me." If considered in terms of human—things relations, portable rock art objects from Kamyana Mohyla might be regarded as churingas on a certain level of generalization.

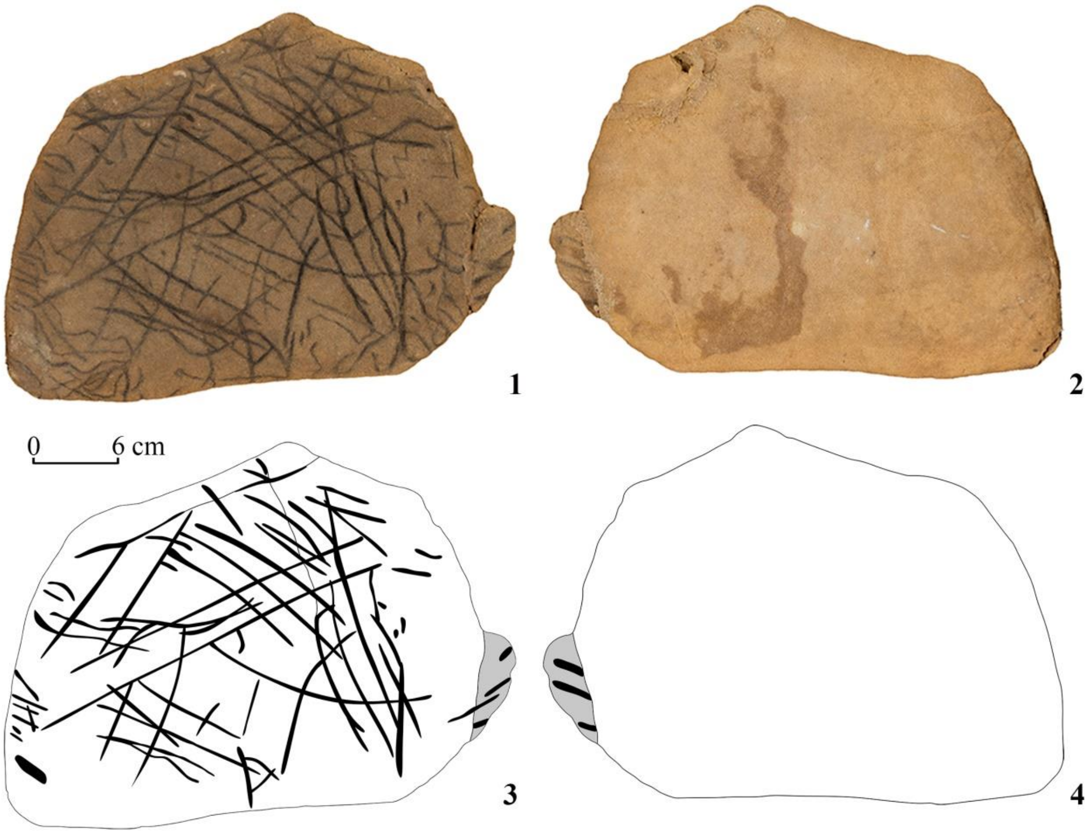


Fig. 8.2. Churinga No. KM74—2. 1 — image front; 2 — image back; 3 — trading front; 4 — tracing back. Grey tone on 3,4 marks the broke off part that was reshaped, engraved and used separately.

Clearly and transparently, this story demonstrates that churingas share a complex life cycle well beyond the basic concepts described by V. Danilenko. They were around human beings for a long time and were considered in a complex and complicated way. Moreover, the time-consuming process of engraving might have taken dozens of hours, even for one portable stone (like it is for KM74—2), which makes it reasonable to assume the long period of being involved in the human beings' route o Kamyana Mohyla. Probably, these stones might be considered as the active participants in a complex relationship between three independent actors that formed and shaped the cultural landscape: the Kamyana

Mohyla and the landscape itself, the human being that inhabited the latter, and the portable rock art specimens from Kamyana Mohyla. Each of these participants interacted with others in their own special yet bilateral way, both affecting others and being affected by them. The worldview of the inhabitants of this landscape was impacted by the Kamyana Mohyla itself, which led to the formation of unique archaeological and rock art sites. The landscape both caused the emergence of churingas and was influenced by their existence. Finally, portable rock art pieces were indeed produced and transferred by human beings, though they affected their habituation and shaped their life and routine (fig. 5.3).

5.1.3. The human — churingas — landscape entanglement on Kamyana Mohyla

The manner in which portable rock art specimens interact with human beings and landscapes is of particular interest here as these interactions are complex, non-linear, and ambivalent. Moreover, the specimen—human interaction is particularly different from the specimen—landscape one, not only by its nature but also by the role churingas take.

The basis for this difference lies in the different characteristic nature of the objects and is derived from the conceptual premise of object-oriented ontologies. According to Graham Harman, the object’s interaction should be considered not through the objects qualities or the objects themselves, but rather through different facets of their nature that introduce and reveal the nature of the interaction itself: “It cannot be said that stone and fire simply collide with the qualities of other objects: fire does not burn away the “whiteness”, “combustibility”, or “cottoniness” of cotton, just as stone does not destroy the “brittleness” or “glassiness”. On the contrary, fire burns cotton, and a stone breaks a window. Yet these objects do not completely touch each other, as each of them hides additional secrets that the other cannot, such as when the light scent of cotton and the ominous glare of fire remain deaf to each other’s songs. In short, inanimate causality is driven into the same mysterious middle ground as the no-man’s-land of human perception, belonging neither to qualities nor objects, but only object-oriented, even at the mysterious level of tangible elements" (2005: 170). Prehistoric relations between humans, landscapes, and art specimens appear to follow these rules: their different components are occurring together with different 'facets' of the objects. While the interaction between human and thing might be considered from anthropogenic perspective (although it does not reveal the churingas nature in their entirety), the interaction between specimens and landscape is different, conducted by other means, and belongs to a no-man's-land that can't be explained by human perception. Considering churingas only as engraved stones here would mean ignoring them being a presentation of Kamyana Mohyla (in contrast to the distanting concept of representation — see Fahlander 2019: 115) beyond the borders of Kamyana Mohyla Hill, the relational object between inhabitants of the Kamyana Mohyla landscape and the rock art complex itself and the messages that are to be delivered between agents of cultural landcape. In the most direct way these stones are the pieces of Kamyana Mohyla: they do not represent the Hill but they are its pieces themselves.

However, we can consider all of that through the role the objects take in their relation to the human and landscape. The complexity and multiplicity of these roles once more provides evidence that the churingas of Kamyana Mohyla should not be considered straightforward and we should not focus solely on the anthropocentric concept of 'meaning'. The consideration of the role taken by portable rock art specimens during the interaction with the landscape has shown that this role is a comparatively simple one. It is evident that the sandstone pieces take part as objects of interaction, i.e. they are active participants of the interaction procedure. The nature of this process is far from clear to human beings as it belongs to the world of materials and represents a bright case of post-human relations. This relation lies, as mentioned above, in no-man's-land.

The interaction between human beings and stone pieces is different and should be considered as a complex one. While it is clear that the art specimens are objects and fully-privileged participants in the interaction, they are also subjects of this process. Indeed, the manufacturing of the surface of the stones is an act of both communication *with* churingas and modification *of* churingas. On the one hand, the selection of the particular stone, its transfer from the hill, and other features of its life cycle indicate two-sided relations between equal objects — human beings and sandstone beings. On the other hand, the stone beings are also bear traces of the interaction and it is their surface that was modified and changed during the interaction.

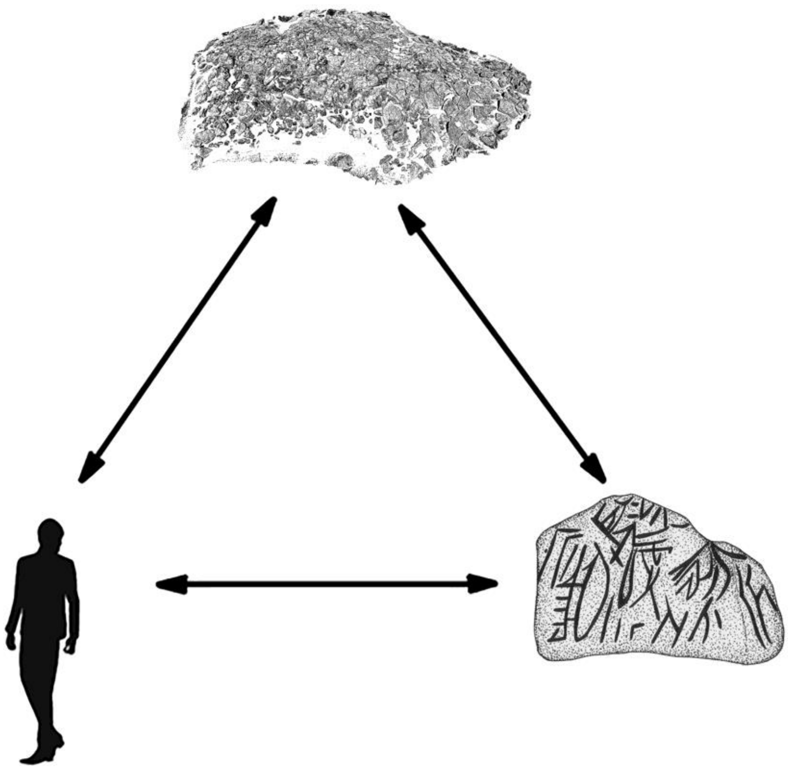


Fig. 5.3. Three components of cultural landscape are in complex bilateral interaction

Therefore, the processes of churingas life cycle that involve humans are inevitably ambivalent: we can’t ignore the stone’s active part in these processes, but we also need to simultaneously consider them as a subject of an act that results in the engraving of the churingas surface.

The stones itself are both the recipients of a message (i.e. ‘interaction impact’) and the bearers of this message itself. It appears both in static and dynamic relation to the world and, what is more important, to the human being. The idea of an archaeological object's ambivalent nature has already been considered by Fowler and Harris through the metaphor of particle-wave duality which lead to the material instance perception as the object and the relation in the same time (2015; also see Barad 2007: 123). Being general and poetic, this approach, however, avoids a one-sided view of things and prevents an overly anthropocentric perception of the archaeological data which contemporary archaeological theory tends to overcome. Moreover, it represents processes of human interaction with the world in a more holistic, dynamic, and complex manner.

Furthermore, portable art specimen as a message bearer appears to be a subject of interaction between human beings and cultural landscape. Though people are involved in direct relation with the landscape (both in general and at the Kamyana Mohyla hill in particular), they also use portable stones as a mediator of their interaction. These mediators provide the possibility for *transitive* indirect relations between human and landscape, providing their interaction with different levels and contexts. It is peculiar that the term 'churinga' as it interpreted by Strehlow (1947: 85—86) considers all sides of this relation, presenting both the specimen—landscape interaction ('tju' — 'hidden') and specimen—human one ('ringa' — 'which is personal to me').

Fortunately for us, the most complex and yet the most interesting part of the portable rock art specimen's life cycle — their interaction with human beings — is reflected in the changes of the objects matter. Indeed, the engravings on the sandstone surface are clear traces of prehistoric human—thing relations in the Kamyana Mohyla landscape. Our current analysis is focused on the results (or rather leftovers) of this interaction and gives a new perspective to the engraving process itself.

Therefore, the latter is both the purpose and meaning of the human—specimen interaction. Indeed, the particular incision, a piece of lattice or reticulated ornamentation appears to be irrelevant compared to the process behind its creation

— the long and exhaustive engraving procedure. Focusing on the materiality of things, we are not only giving the relevant respect to the things themselves that should be the focus of the research, but we also have a more sober look at the human—things relationship in general. Moreover, ethnographic sources testify that the process of the interaction with materials is a crucial concept of prehistoric being by its very nature (Durkheim [1912]2018; Lévy-Bruhl [1923]2010; Bromlei 1986). As the *law of contagion* of sympathetic magic states that "things that contacted [interacted — SR] in the past remains bound afterwards" (Fraser 1890; Tokarev 1964), it is the contact between the things that matters in the first place, rather than the interpretation of specific symbols. After all, the long sought 'meaning' behind the engravings on the churingas from Kamyana Mohyla was to create them on these sandstone pieces.

Such an approach to understanding these portable rock art specimens is beneficial for several reasons. To begin with, the change of focus to the interaction between the different components of an archaeological assemblage reveals a new notion about the complex relations not only between humans and things but also to the Kamyana Mohyla landscape which is an important influence on prehistoric processes in the region. The opportunity to consider all three actors of these two-sided relations broadens our view and offers a new perspective for understanding the prehistoric world. Moreover, we have a chance to see the role those different actors played during the interaction, concentrating on the differences between the different parts of the assemblage. The complexity of the processes is also embodied in the newly encountered transitive interactions between humans and landscape that should not be ignored when discussing the churingas of Kamyana Mohyla.

Furthermore, such an approach shows a correspondence with the material-oriented shift in contemporary archaeological theory grounded in what's called the 'return of empiricism' (Flannery 2006), as it is based on technological data and the examination of the stone's surface and derives from accurate image-based 3D modeling. Indeed, a novel view of the portable rock art object is fostered with the data obtained from the technological study of the churingas and the examination of the material itself instead of attempts to interpret them using our modern-minded conscience.

Last but not least, the correlation between the hardness of sandstone and the depth of the engravings' cross-sections, revealed in the course of the photogrammetric study of the rock art specimens, indicates the time and effort to be the crucial parameters that affect the shape of engravings on the stones' surface. This discovery is additional support to the hypothesis on the relevance of the engraving process rather than the iconographic result of this process.

And this is, perhaps, the most important thing about the concept. Assuming that the process of engraving (i.e. of interacting with the stones) is core deprives us of the need to chase shadows in search of the specimens' meaning. Attempts to interpret and understand meaning lead to constant discussions even during the analysis of the figurative art specimens (that is evident for the Rain Bull figure and many other cases all around the world). The interpretation of non-figurative examples is even more fruitless and dubious by its nature. The study of these specimens' interaction with the assemblage around them seems to be a feasible solution for improving our knowledge of them. For the churingas of Kamyana Mohyla, this process began with the material itself — its shape, features and life cycle. Paying close attention to these components and to the non-figurative rock art objects' interaction with human beings, landscape, and other things is hypothetically a more informative and fruitful way to think about them than the established interpretation-based approach. On the other hand, it leads us beyond simply recording — to an understanding of what these objects really are. Treating materials in this way appears to be a solid basis for further research, especially when there is virtually nothing we can state about them with absolute certainty.

5.2. Re-evaluation of the old hypotheses on the chronological and cultural attribution of Kamyana Mohyla portable rock art

The latest and only attempt to interpret the portable stones from caves No. 52 and No. 54 was carried out by V. Danilenko and published in his book called “Kamyana Mohyla” (Danilenko 1986). Though the author considers the complex in its entirety and ties it to the archaeological data in the complex surroundings, he also provides each cave with its own interpretation pattern. Moreover, he describes in detail the specific stones and compositions revealing his interpretation of their meaning and mythological nature. Danilenko states that he prefers “to pay a crucial attention to the interpretation of compositional entities and not like the popular practice to consider the data not in complex, distinguishing separate images” (Danilenko 1986: 137). Moreover, he attempts to find the real meaning behind every single image. This work has been conducted “in the lab, during 1975—1978; after a detailed analysis the meaning of some images on the blocks became clearer and we hope that it will become even clearer in the future. … This difficult work is not finished yet…” (Danilenko 1986: 94). However, coming toward the conclusion of his book and his works in the Kamyana Mohyla in general (this was published after his death in 1982) he states that “during the 1973—1974 field works the cave of Churingas and Wizards cave were discovered. The sites are found *in situ* and dated back [assigned] to the Upper Paleolithic (the Wizard's cave) and the Mesolithic — Neolithic periods (Churinga’s cave). Therefore, the history of Kamyana Mohyla is prolonged by a few thousand years” (Danilenko 1986: 135).

A general interpretation of Kamyana Mohyla portable rock art specimens (churingas), out of their complex, was presented by Danilenko very briefly. Besides the meaning and the interpretation contained in the name given to these stones (see Chapter 4), he mentions his own notion of a few technological and functional details: “…usually contain reticulated ornamentation from one, or, sometimes, from both sides. In a few cases, engravings were slightly painted with red or black pigment. Technically, all images on churingas are made in the same way — by engraving narrow and shallow lines, probably with flint blades. This is additional proof of the Stone Age origin of these definitively ritual objects" (Danilenko 1986: 74).

Unfortunately, the pigments Danilenko describes here, have not survived because of the rock art recording strategy that was chosen during the fieldwork: "a) the discovery of the images: b) their observation; c) drawing the engravings with a pastel charcoal [made literally on the stones themselves]; d) tracing of drawings by pencil on the polyethylene etched with acetic acid; e) transferring the drawings from polyethylene to the paper through the light table; covering the engravings on a sandstone by the glue BF—2 and nitrodope [for the conservation purposes]" (Danilenko 1986: 77). Photo fixation was impossible, according to Danilenko, due to the lack of proper electric light systems. Therefore the interpretation of parietal art specimens were provided by V. Danilenko after his own drawings while the portable ones were analyzed later in the lab.

Therefore, Danilenko's interpretations consist of two complex hypotheses and should be considered separately for each group of portable rock art specimens, i.e. for each cave. As both caves had been considered by their discoverer as found and studied *in situ*, he applied one interpretation per cave. Both hypotheses must be considered separately, according to their own rock art, archaeological and determined cultural and chronological contexts. Fortunately, much new data appeared during the research process and the analysis of the 3D models. These new data are capable of contributing to our current knowledge of the Kamyana Mohyla rock art specimens, to test current hypotheses and consider new ones if needed. Moreover, new information regarding the archaeological context appeared since 1986 both for the specific region and for Eastern European prehistory in general. This must be taken into account when creating a coherent image of the processes on the Kamyana Mohyla rock art complex.

5.2.1. The Late Mesolithic case

5.2.1.1. The collection from the Churinga's cave

The stated hypotheses regarding the churingas cultural and chronological attribution remain unproven and represent Danilenko’s opinion as the caves discoverer. It is clear, however, that they derive from the interpretation of particular rock art objects meanings presented in the course of his book. For instance, as Danilenko publishes many portable and parietal art specimens from Wizard's cave interpreting them as a mythological images or hunt scenes containing the Paleolithic fauna of the region — mammoths, rhinoceros, cave lions etc. — it seems reasonable for him to consider the related stones and the cave in general as Upper Paleolithic.

In the same way, the fish-like stones from the cave of Churingas were assigned to the Late Mesolithic and Early Neolithic of the region in in accordance with Danilenko's understanding of the prehistoric processes on Kamyana Mohyla during that time. It is also worth mentioning that considering the archaeological context of these terms, V. Danilenko uses the term “archaic Neolithic” to describe the local inhabitants connected to the Kukrek culture and bearers of the Kukrek cultural tradition (see Kotova et al. 2017; Kiosak et al. 2022). They, however, appear to be the locally represent Mesolithic societies of the Kukrek culture and do not bear any of the markers of Neolithization that V. Danilenko assigned them to, such as pottery production and animal domestication (see Danilenko 1986: 12, 17; see Kiosak et al. 2022 for the brief description of the state of the art). To reveal the actual processes regarding the Late Mesolithic of Kamyana Mohyla and to examine Danilenko’s hypotheses regarding the portable rock art specimens from the Churinga’s cave, one should follow his approach and take into account both the archaeological data from the settlement of Kamyana Mohyla 1 and the technological interpretation of the portable rock art specimens that were found in the cave.

The technological interpretation and the photogrammetric study of the image-based 3D-models had shown that the specimens from Churinga’s cave fall into two large groups. One of them is related to non-engraved specimens of unusual chemical compounds that also includes polished stones with flat surfaces.

This might be considered as tools or non-engraved stones. The second one is represented by 13 specimens (among those 71 that were modeled) and might be described as a group of objects characterized by their specific rounded or ellipsoid shape; the high percentage of engravings with the A1 cross-section type; light color of the sandstone; and low quantity of engraved lines.

Danilenko considers the shape of these specimens as resembling the shape of a fish: "… suboval shape. The similarity of these stones to the river fish is beyond any doubt" (1986: 118). He distinguishes catfish, dolphin, flounder, chebak, and spindle-like specimens considering them as chronologically distant though related to the same cultural context.

Although these specimens bear some natural shapes and protrusions, most of their surfaces were created artificially. Most probably, the ancient inhabitants of the region searched for stones of suitable shape (close to suboval or ellipsoid) and then processed these by polishing what they initially wanted to make of it. Some of these specimens are similar to the fish sculptures; others just share the same suboval or spindle-like shape (fig. 5.4—5.8). However, these shapes are produced artificially, and represent the common model located in the mutual context of the same cave. Therefore, the whole group indeed might be considered as an entity of the fish-like figurines sharing the same context.

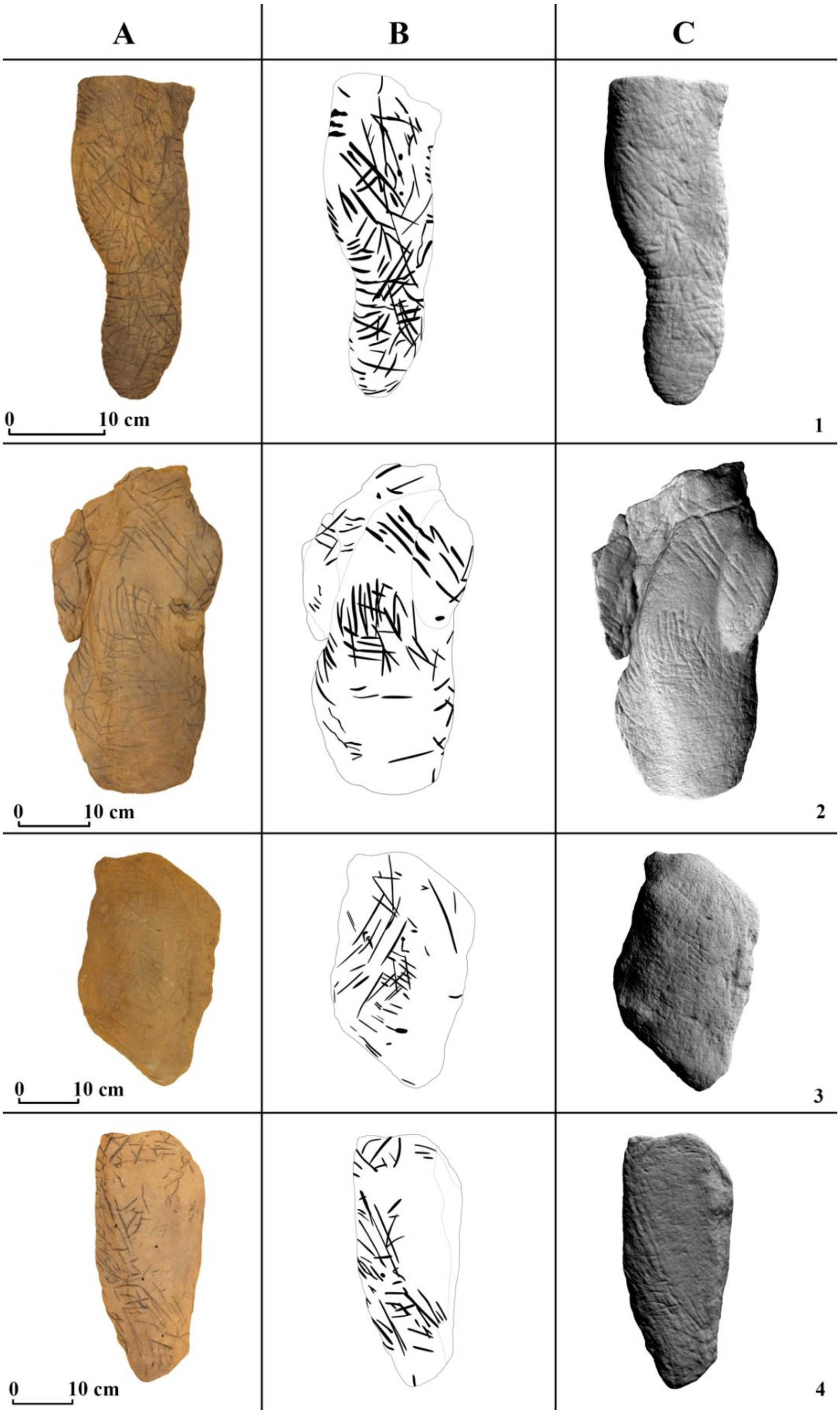


Fig. 5.4. Fish figurines from Kamyana Mohyla, Churinga's cave. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 245; 2 — No. 247; 3 — No. 283; 4 — No. 302.

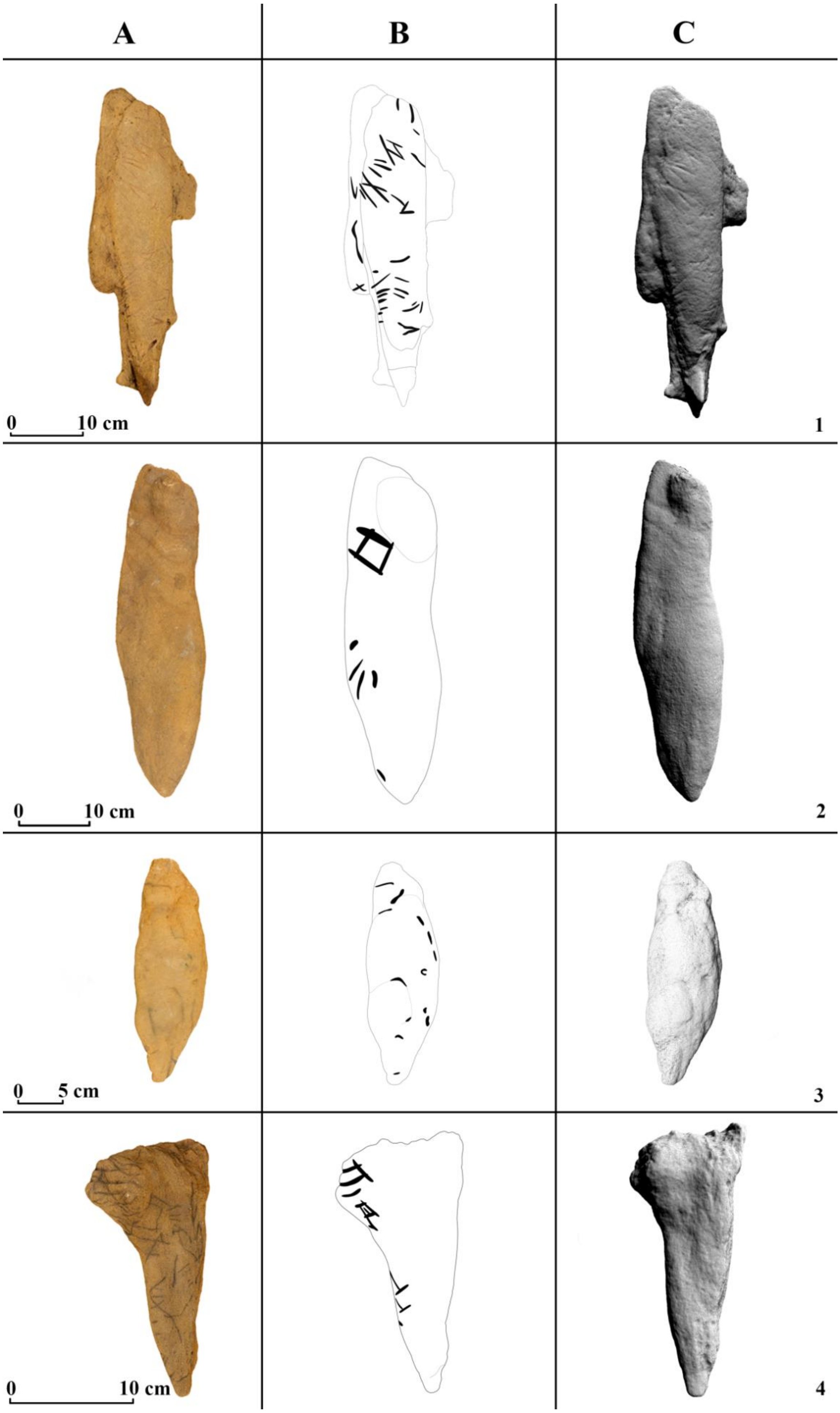


Fig. 5.5. Fish figurines from Kamyana Mohyla, Churinga's cave. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 254; 2 — No. 257; 3 — No. 258; 4 — No. 259.

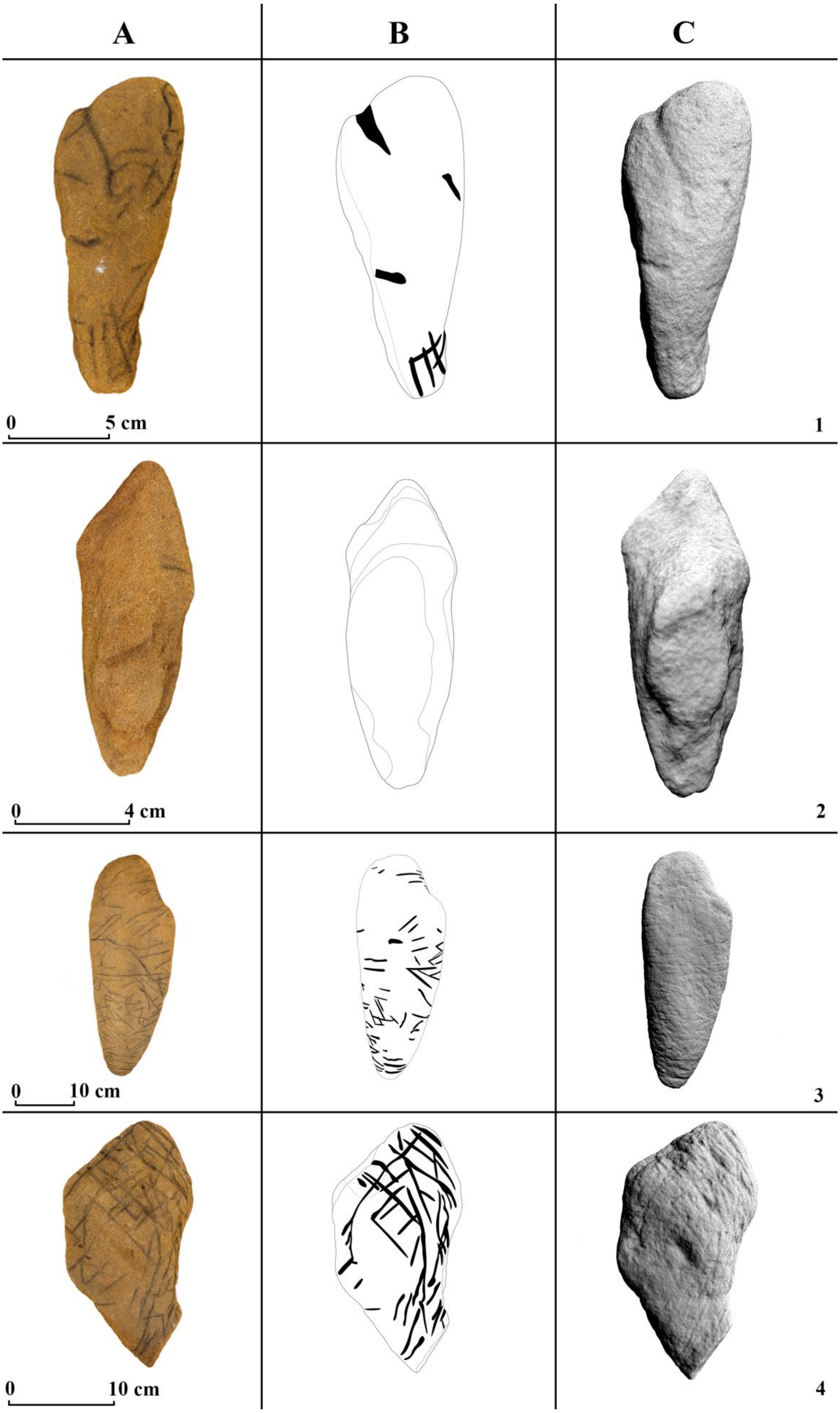


Fig. 5.6. Fish figurines from Kamyana Mohyla, Churinga's cave. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 260; 2 — No. 261; 3 — No. 265; 4 — No. 268.

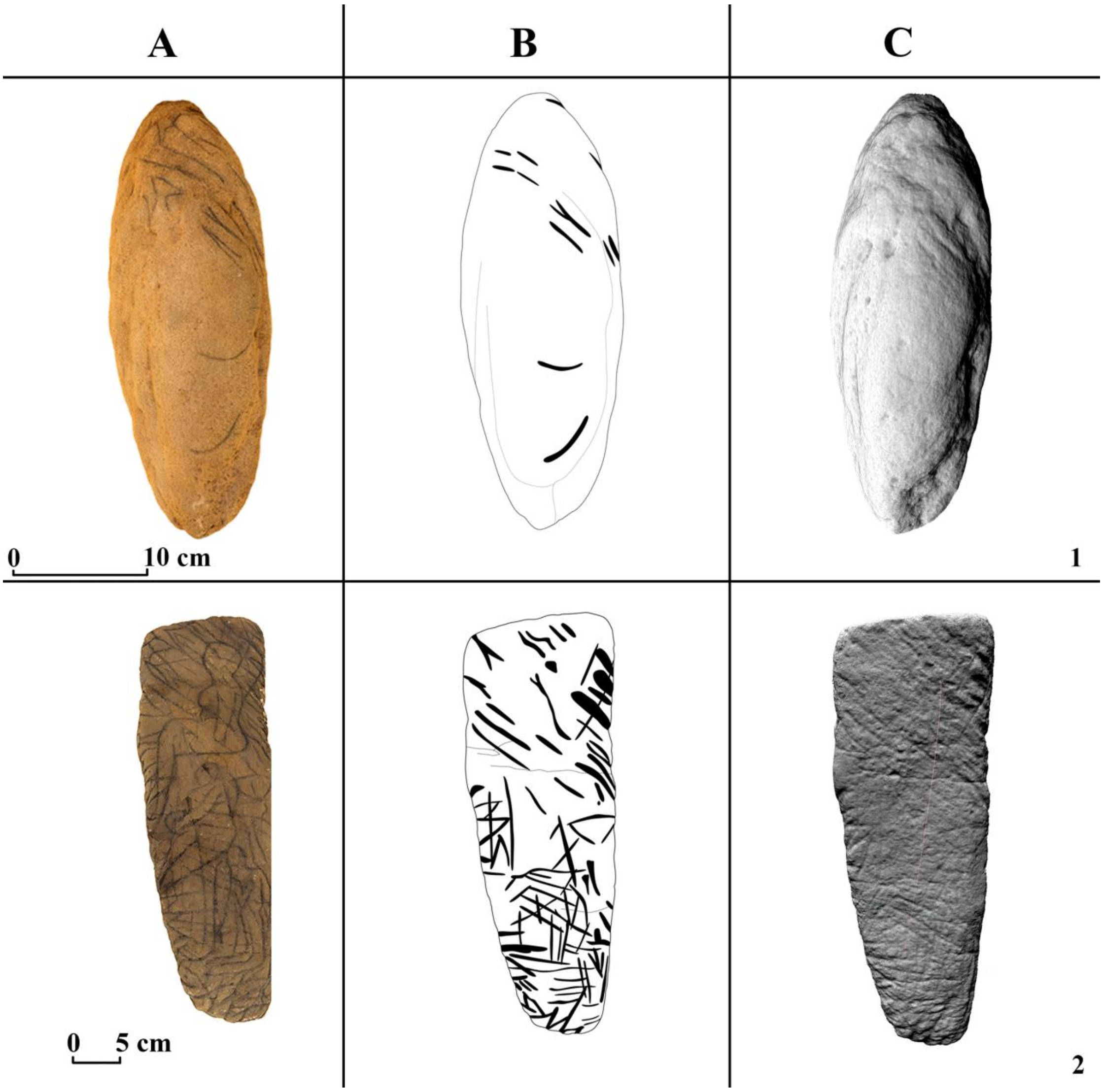


Fig. 5.7. Fish figurines from Kamyana Mohyla, Churinga's cave. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 273; 2 — No. 245.

Fig. 5.8. Fish figurines from Churinga's cave. 1 — No. 246; 2 — No. 246a; 3 — No. 250; 4 — No. 251; 5 — No. 253; 6 — No. 255; 7 — No. 256; 8 — No. 262; 9 — No. 264; 10 — No. 266; 11 — 272.

It is extremely important to notice that the elongated shape of these stones is most definitely artificial, even though fins are sometimes almost not shaped. This artificial shape is very important as it is the only clearly meaningful element that adorns these portable stones. Producing a similar rounded shape for all these stones and processing them from all sides gives a solid ground to search for the comprehensive interpretation of these materials. The suggestion of V. Danilenko regarding the meaning of the artifacts as representations of fish, therefore, appears to be relevant and solid, though requires additional data to be considered in the relevant cultural and chronological contexts. Do not forget that these hand-made shapes also feature shallow engravings, typical of the rock art of Kamyana Mohyla in general. The latter are incredibly shallow and small, sometimes almost invisible. However, their geometry is the same as for the larger ones (see Chapter 4). It is also worth mentioning that sometimes the engravings on the portable specimens create a sort of zigzag that might also be found on the parietal art specimens of Kamyana Mohyla, especially those considered to be Late Mesolithic in date (Radchenko et al. 2020).

The assumption that the depth of the engravings is in correspondence with the density of the stones (the stones with high density are feature shallow engravings), that has been made after the comparison of the results of photogrammetric study, leads to yet another curious suggestion: the time, that is needed to produce the engraving of the sub-type A2 on the less dense stones is approximately equal to the time that is needed to produce the A1 engraving on the more dense ones. If this suggestion is correct, this means that the time (and the energy, spent on the engraving) is the crucial variable that defines the shape of the notch. This idea is in good coherence with the interpretation of the portable stones life cycle described above. Moreover, considering this, the V. Danilenko hypothesis on the specific difference in the engraving styles of the assemblages from Churingas' cave and Wizard's cave is proven wrong. It is clear, however, from the hardness calculations themselves that these two assemblages are different by their nature. Even though engraving technology is barely different, the difference in the support parameters impacts the final exterior of the artifacts.

Unfortunately, the sandstone that fills Churinga's cave does not yield any stratigraphic context. Moreover, most of the caves (including Churinga's cave) do not include any archaeological assemblage that would contribute to the interpretation of the rock art objects. With the exception of the Bull's cave and Wizard's cave, all archaeological signs of the processes which occurred inside the caves are absent.

Some links, however, might be found between the Mesolithic layers of the settlement of Kamyana Mohyla 1 and the portable art stones from Churinga's cave. The stones that have been found in the lower layers of this settlement (so-called layer B and layer C) (Kiosak et al. 2022) exhibit chemical and geological structure which appears to be rare for the sandstone of Kamyana Mohyla. It consists of multicolored strings of different sandstone, a slightly lighter yellow sandstone structure and density that is higher than average for the churingas of Kamyana Mohyla (as calculated from the results of image-based 3D modeling). Such features characterize only the stones that have been found near the fireplaces of the settlement and those from Churinga's cave (fig. 5.9, 5.10). The latter are mostly represented by a small subgroup of specimens (7 specimens out of 71 that were 3D-modeled) that lack any engravings though sometimes exhibit polishing. It is notable that similar stones or big blocks were not found in any cave or location around Kamyana Mohyla except for these two. Therefore, it seems reasonable to suggest that the connection between these two groups of stones clearly distinguishes them from other churingas. Moreover, this gives an additional clue for those searching for the links between the archaeological processes nearby the hill and the portable art of Kamyana Mohyla.

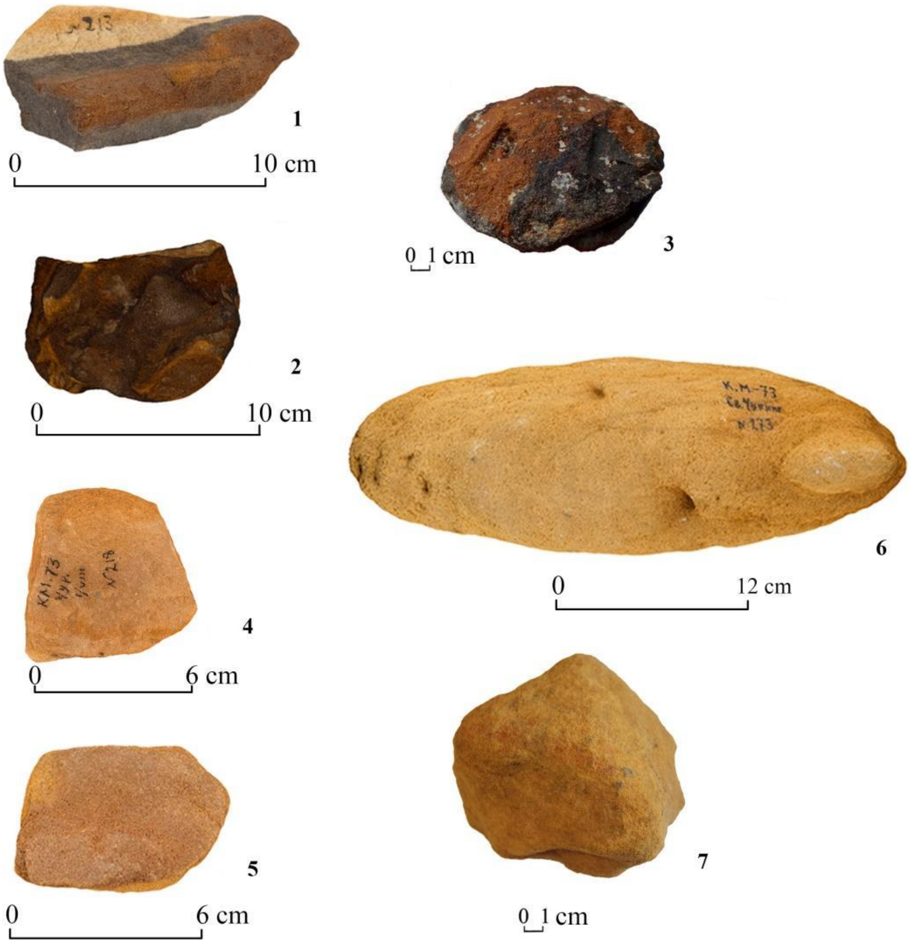


Fig. 5.9. The stones feature unusual geological structure from Churinga's cave (1, 2, 4, 5, 6) and the settlement of Kamyana Mohyla 1 (3, 7). 1 — No. 213; 2 — No. 214; 3 — portable art specimen from the Mesolithic layer of a multilayered settlement at Kamyana Mohyla 1 (after Kotova et al. 2018, fig. 3); 4 — No. 218; 5 — No. 220; 6 — No. 273; 7 — No. portable art specimen from the Mesolithic layer of a multilayered settlement at Kamyana Mohyla 1

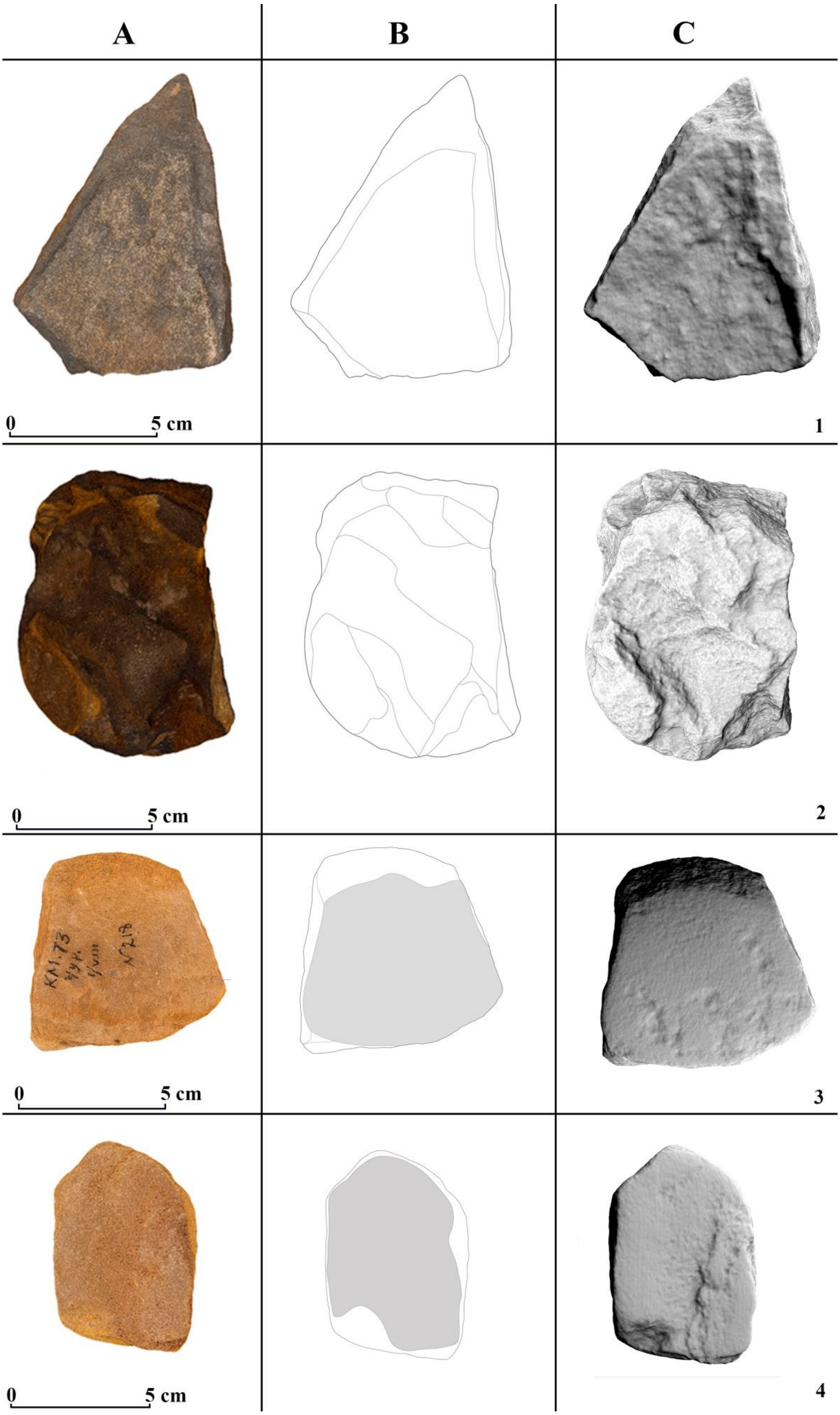

A
B
C
0
5 cm
1
0
5 cm
2
0
5 cm
3
0
5 cm
4

Fig. 5.10. Churingas from Churinga's cave. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 213; 2 — No. 214; 3 — No. 218; 4 — No. 220.

The stones from the settlement of Kamyana Mohyla 1 were discovered during fieldwork carried out in 2016, by a team led by Nadiia Kotova (Kotova et al. 2018). Therefore, Danilenko could not use them for a comparison of the stones geological structure. However, he probably considered some connection between the stones and the settlement when assigning the stones to the Mesolithic. I assume that his attribution of fish figurines to the Mesolithic derives from his understanding of the relevant processes on the settlement he excavated back in 1947 and 1973 and in the region in general.

Considering the river-oriented and fish-oriented economy as dominant to the Late Mesolithic inhabitants of the region (as described in Chapter 2), it is reasonable to assume the ritualization of the fish images during that time in the vicinity of Kamyana Mohyla. The abundance of river-related finds on Kamyana Mohyla 1, including Unio shell middens and a flint figurine of a fish, serve as additional proof of that hypothesis. Last but not least, the peculiar chemical compound of the portable stones extracted from the Late Mesolithic layers of the settlement is similar to the one that exclusively features the rocks discovered in Churinga's cave. The decisive argument here would be the fish-like shape of the stones (roundish, oblong, and smooth-contoured), fins (made of natural protrusions), and rare zigzag ornamentation. Altogether, these pieces of evidence indicate the connection between the fish figurines from the cave No. 54 and the Late Mesolithic inhabitants of the settlement nearby, and thus, construct the theory of their chronological attribution to VI—VII millennia BCE and cultural attribution to the different aspects of the local Kukrek culture. Most probably, these stones belong to the archaeological assemblages dated to the Mesolithic and Late Mesolithic and to the "classic" Kukrek and "Kukrek cultural traditions," respectively (Kotova et al. 2018; Kiosak et al. 2022).

Indeed, since the ritualization and depicting of fish is typical for the same contexts in Eastern Europe and Siberia and the relevant context is proven to be discovered on large rivers shores in Ukraine, it is reasonable to assume that the same processes took place at Kamyana Mohyla 1, inhabited by representatives of the Mesolithic Kukrek culture. It is also worth considering that the geological anomaly nearby served as a source of material for the creation of the figures and figurines that would embody these beliefs through the efforts of human beings, shaping and engraving the sandstone blocks from the hill.

Since the tracings and the input data that V. Danilenko used while constructing his hypotheses on the cultural and chronological attribution of the Kamyana Mohyla rock art is proven to be mistaken, it is precious that the photogrammetric study, digital drawings, and hardness calculations supported his old hypothesis on the Late Mesolithic origin of the fish figurines. Though his tracings and the pigmentation of the stone support are still proven to be inaccurate, and his detailed classification of the fish figurines by their similarity to particular fish species seems to be abundant and misleading, the general idea seems correct. However, its test and proof would be impossible without accurate and abstract recording and the evaluation of the technological and stylistic concepts that have been done in the course of photogrammetric study and would be impossible without it.

5.2.1.2. Parietal art objects on Kamyana Mohyla assigned to the Mesolithic river-oriented societies

Additional proof of the Late Mesolithic attribution and 'fish' interpretation of this dataset might have come from the parietal art objects of Kamyana Mohyla. Some caves yield engravings that might be assigned to the Mesolithic due to the precise depiction of fish and the related ornamentation on the walls and ceilings. Together with the portable art specimens, they contribute to the concept of fishing-oriented Mesolithic societies that inhabited the surroundings of the hill and ritualized fish, leading to the creation of relevant images both on the small portable stones and in the caves.

The most notable image of a fish is on a sandstone protrusion inside cave No. 55 (Dragon's Cave) (fig. 5.11). This one was slightly shaped to the ellipsoid shape and then engraved with long and wide horizontal and numerous short engraved lines and zigzags. Its unusual look and location are considered to represent a chthonic creature — catfish that lives near the entrance to the Underworld (Studzinskaya 2011: 47).

Figure 5.11. Images of the sculpture: front (1), left side (2)

This association of the figure with Mesolithic beliefs and material culture is enhanced by a specific double zigzag ornamentation on the sculpture. Indeed, among the many different types of zigzags on the catfish 'body' (fig. 5.12), the double one is of particular interest.

The wide possible chronological attribution of this ornament might be narrowed by the capacities of photogrammetric study to reveal the details of engravings' superimpositions and their relative chronology. As shown in section 4.6, the double zigzag ornament on the sculpture from cave No. 55 is superimposed by the engraving of a sandal. Such sandals are well-attributed to the region's Late Eneolithic or Early Bronze Age. They are numerous on the surface of anthropomorphic stelae related to Yamna culture (see Fig. 2.37 and 2.38). Similar sandals are noticed among the petroglyphs near the Skelnovskiy village (fig. 2.36). They might all be dated to the beginning of the third millennia BC, while the double zigzag ornamentation is expected to be older.

While singular and multilinear zigzags have broad expansion and dating ranges, zigzags of two lines are rarer. The double zigzag is known on European Mesolithic bone tools, stone and bone pendants, and a unique wooden idol from Shigir peat bog (Ural, Russia). This large sculpture is dated to 9600–9000 calBC (Zhilin et al. 2018: Fig. 1). The double zigzag is known in the Mesolithic forest zone of Russia, namely in the Veretye culture, which is rich in ornamented bone products (Oshibkina et al. 1992: Fig. 16.10). It is also found on small, decorated stones (churingas) from the Zamostye 2 camp near Zablolotskoye Lake in Sergievo-Posadskiy district of Moscow oblast (Sidorov and Engovatova 1998: Fig. 1.26, 32). Double zigzags are among the ornaments represented on Mesolithic and Early Neolithic bone figures from this camp as well (Sidorov and Engovatova 1998, Fig. 3.2; 4.1). These zigzags were used to decorate stone pendants and bone figures dated to 7000 cal BCE, found on Late Mesolithic sites of the lower Don River (Gorelik et al. 2016). This element is also found on a bone tool from a Mesolithic level at the Icoana settlement in Iron Gates on the river Danube (Fig. 21.8) (Plonka 2003: Fig. 28.2, after Boroneant 1973).

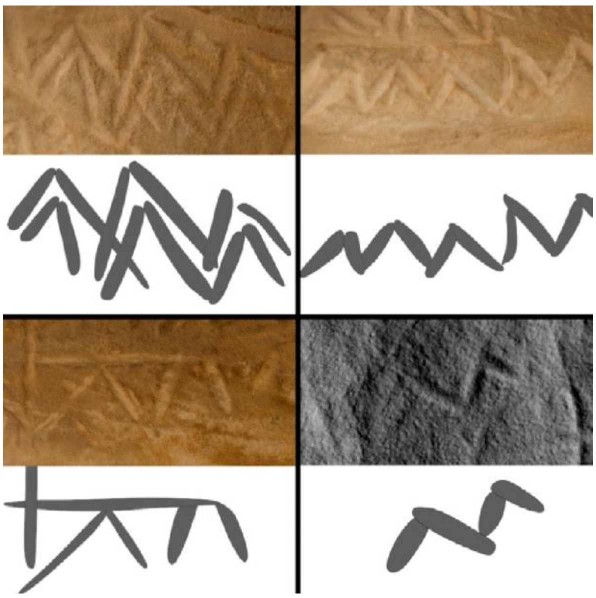


Fig. 5.12. Different types of zigzag ornament on the different zones of the figure from the cave No. 55 and their drawings: (a) zone 1; (b) zone 4; (c) zone 5; (d) zone 6 (after Radchenko et al. 2020: fig. 13)

Double-zigzagged bone and stone finds are known from Late Mesolithic and Neolithic sites of the Dnieper region. Fragments of spear/dagger bone tips from Surskoy Island 1 and the Igren' 8 settlements have engraved double parallel and crossed zigzag ornament compositions on them. Double zigzag compositions are known on talc tools from Poltavka and Kizleviy 5 and a bone bracelet fragment from the Vasilyievskiy II burial site (fig. 5.13).

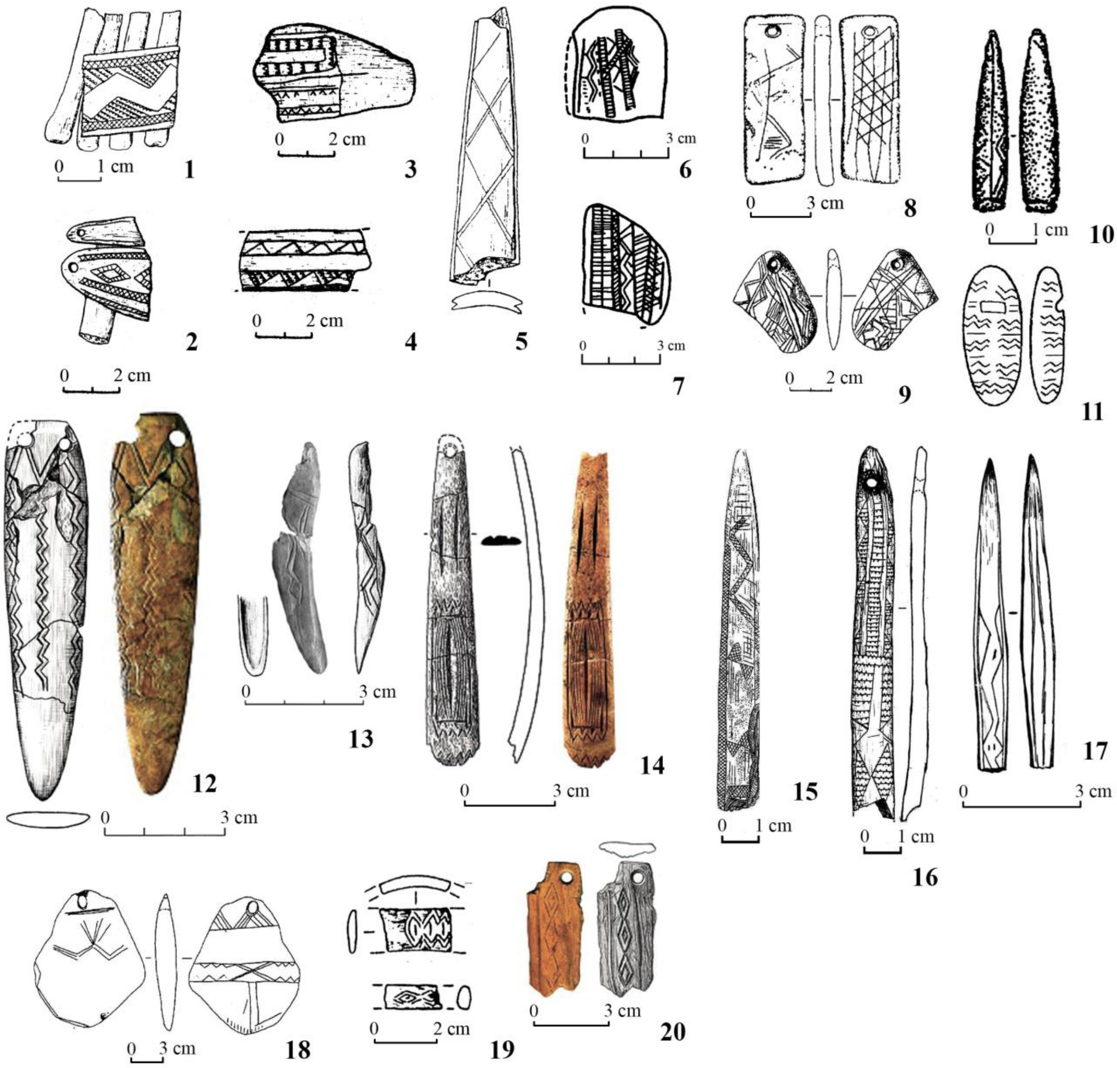


Fig. 5.13. Artifacts with double zigzag ornamentation from the Eastern Europan sites (VII—VI millennia BC). 1—4 — Vasylivka 2 (after Telegin 1991); 5

— Igren' 8 (after Telegin 2000); 6—7 — Zamostye 2 camp (after Sidorov & Engovatova 1998); 8, 9, 12—14, 19—20 — Razdorskaya 2 (after Gorelik et al. 2014); 10, 17 — Kyzlevyi 5 (after Kotova, Tuboltsev 2013); 11 — Poltavka (Telegin 1968); 15 — Varfolomeevka layer 3 (after Yudin 2004); 16 — Sursky 1 (after Danilenko 1950b); 18 — Rakushechniy Yar (after Kijashko & Tsibriy 2004). Nos 1—5, 12—17, 19—20 — bone; 6—11, 18 — stone. Nos 5 and 11 are not scaled.

All in all, this combination of digital relative chronology interpretation and iconographic contextualization supports the interpretation of the sculpture in the cave No. 55 as an image of a fish (catfish?) attributed to the Late Mesolithic of the region (see Radchenko et al. 2020) and thus sharing the archaeological context with the artifacts from Kamyana Mohyla 1 and churingas found in Churinga's cave.

Other relief images on the Kamyana Mohyla slabs representing fish do not contain double zigzags or any other ornamentation connection with this particular cultural phenomenon. However, they feature some non-figurative elements also represented in the Vishap sculpture from cave No. 55. The image of the so-called 'dolphin' is located inside a big cave that lacks any other clear engravings. The back of a relief image features a zigzag ornamentation, while the body and tail are contoured with linear engravings. Similarly, the shape of the body is emphasized by the engravings of a 'fish' on the block nearby that presumably was part of the same cave. The 'fish' lacks a head and is surrounded by linear engravings (fig. 5.14). It is noticeable that the conceptual scheme of engraving these images is similar: manufacturing the contours of the stone surface to emphasize what is meant to be engraved. Such 'style' is spotted both on the parietal art objects from Kamyana Mohyla and the portable ones.

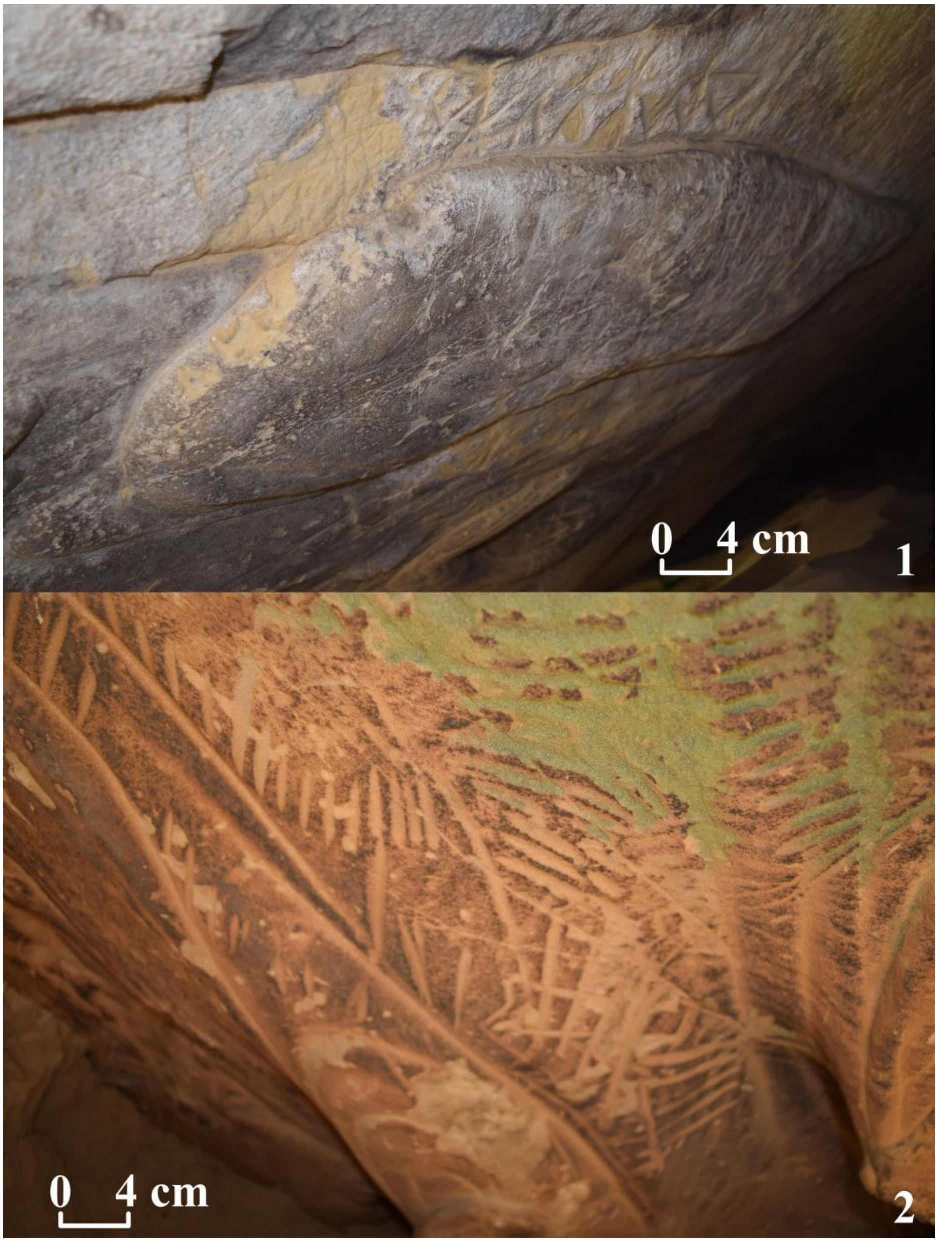


Fig. 5.14. The relief images of the fish from the caves of Kamyana Mohyla. 1 — an image from "Cave of a Dolphin"; 2 — an image from "Cave of a Fish" (after Radchenko 2022: fig. 3:4)

To sum up, the assemblage of rock art objects, which might be considered Mesolithic, is exhaustively represented in the Kamyana Mohyla complex. It includes both parietal art and portable art specimens. Some of them are probably connected to the nearby settlement due to their similar geological structure and, what is also clear by the general orientation toward the depictions of fish. Creating fish figures from flint and sandstone appears to be a notable feature of Eastern

European and some Asian Late Mesolithic societies resulting from a similar economic orientation to rivers and the resources that rivers provide. The same features characterize the Mesolithic assemblages near Kamyana Mohyla. This similarity probably pushed Danilenko to consider the images of fish as examples of Mesolithic rock art objects. For now, this interpretation appears to remain valid.

Moreover, it is enforced with several technological (the geological and technological homogeneity of the collection), archaeological (appearance of fish images in the cultural layers of Kamyana Mohyla 1), rock art (the figure of Vishap and the relief images in the Kamyana Mohyla caves), and cultural (ritualization of fish, detected and demonstrated for the Mesolithic societies of the region) data, revealed and developed since 1986. Therefore, this hypothesis, claimed by Valentin Danilenko, appears valid and corresponds to the current state of archaeological research and the current understanding of prehistory in the region. Worth noticing that the misleading arguments and tracings by V. Danilenko have been since then supported by the actual archaeological contexts and the photogrammetric study of both portable and parietal rock art objects that provided accurate digital data and enabled further analysis.

5.2.1.3. Portable objects formerly assigned to the Mesolithic

It is notable that the fish figurines were found not only in Churinga's cave, but also in other locations of Kamyana Mohyla. Though V. Danilenko excavated and published only the material from Churinga's cave and Wizards cave, later his research was continued by B. Mykhailov (2005). Mykhailov found a series of other portable rock art specimens, mostly in Goat cave (No. 60) and a cave of a Bison (No. 36). His collection consists of 231 items in total, recovered from 10 locations — inside the caves (e.g. Goat cave (No. 60), Artemis cave (No. 59), Horseshoe cave (No. 53), Churinga's cave (No. 52) Mysteries cave (No. 51b), Bison's cave (No. 36a and 36b), Bull's cave (No. 9)) and on the hill's slopes (Polissoir No. 8, Location No. 65 and location No. 59).

Some of these stones represent fish figurines or at least were interpreted by Mykhailov as doing so (see Radchenko 2022). However, researchers used different chronological attributions for the stones with similar technological parameters (see table 5.1) — shape, similar to that of a fish, shallow linear engravings on their surface and desert varnish.

Table 5.1. Fish figurines found by B. Mykhailov and their cultural and chronological attribution (according to the collection list of the National Historical and Archaeological Reserve "Kamyana Mohyla")

Number of specimens	**Attribution by B. Mykhailov**
34	Mesolithic, XII—VII millennia BC
7	Meso / Neolithic, VIII—VI millennia BC
33	Neolithic, VI—IV millennia BC

Moreover, these figurines were found in the same locations — Goat cave, cave of Churingas, and Bison's cave (fig. 5.15). Therefore, either the complexes with Mesolithic, Meso / Neolithic, and Neolithic specimens were somehow distinguished by Mykhailov according to an unknown principle or we shall consider them as homogeneous until further investigation and reconsideration.

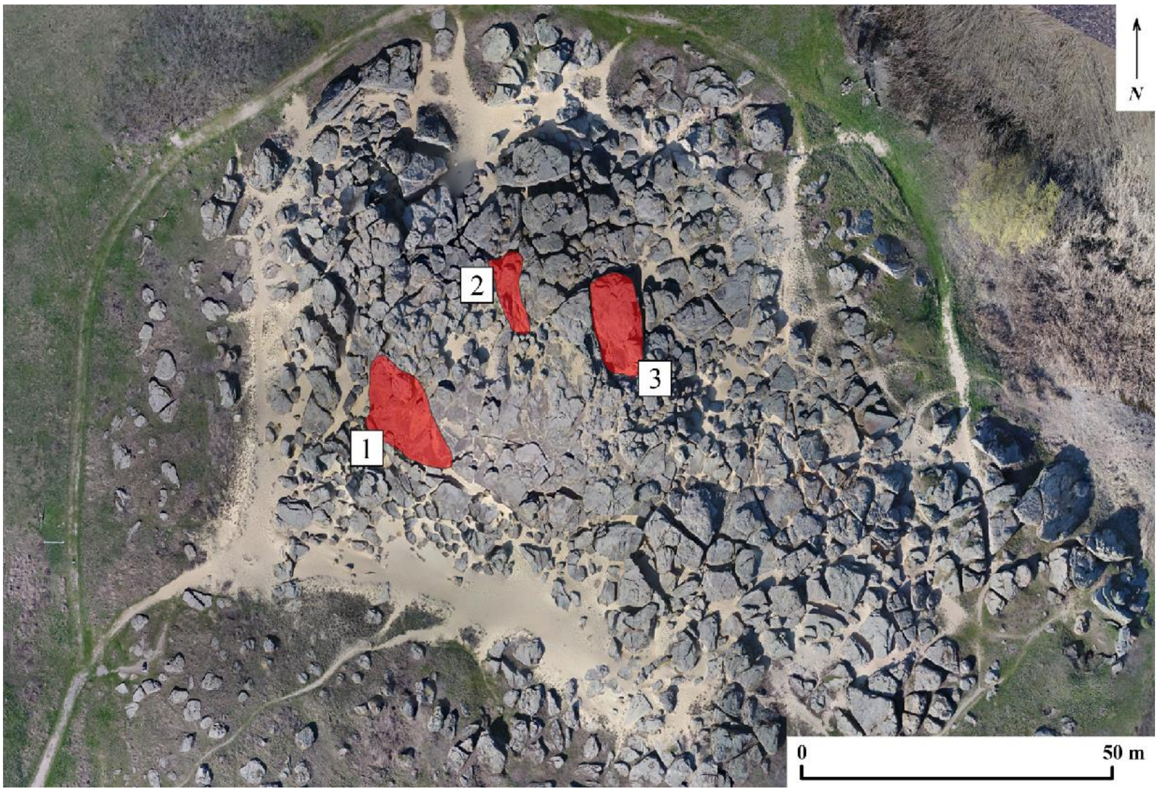


Figure 5.15. Location map of Mesolithic complexes on Kamyana Mohyla (except for Polissoir No. 8). (1) The Cave of Churingas (No. 54); (2) Goat Cave (No. 60); (3) the Cave of a Bison (No. 36) (after Radchenko 2022: fig. 14)

These three locations represent the complexes that might be considered Mesolithic according to the appearance of the fish figurines inside the caves. At least for one of them, the connection with the Mesolithic layers of the settlement nearby appears to be considerable. Others still require further detailed study, including contextual and technological analysis (fig. 5.16). Therefore, the portable rock art specimens of Kamyana Mohyla that might somehow be considered Mesolithic amount to approximately 100 objects and inhabit at least three large caves on the hill. Two of these caves also yielded parietal art objects that Mykhailov defines as Mesolithic. Their chronological attribution, however, requires re-examination for each case as errors and mistakes often confound the interpretative efforts of Kamyana Mohyla's rock art.

For instance, the Mesolithic attribution of the Goat's cave is bounded by the eponymous portable rock art specimen from that cave, featured with quite a remarkable asset of figurative images (fig. 5.17). A large block's surface was prepared for the engraving from the front side. It is almost perfectly flat and has some vertical sides of the block. The back side is rough and covered with a few non-figurative linear engravings.

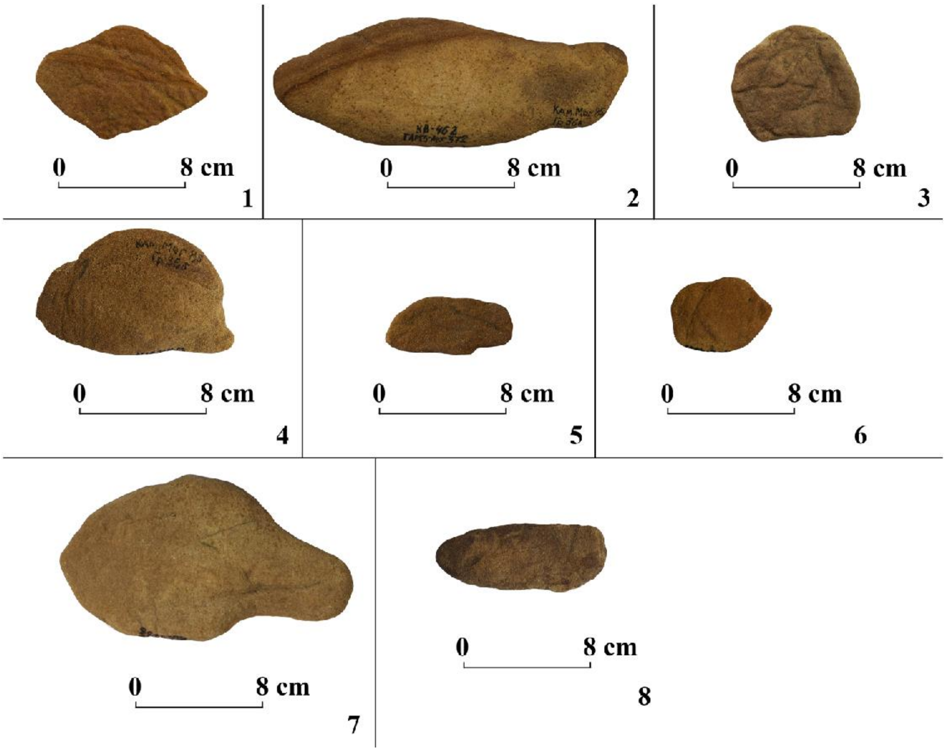


Figure 5.16: Fishing-related churingas of Kamyana Mohyla, described by Mykhailov (images taken by S. Radchenko). (1, 2, 4—8) Fish-like figurines; (3) block with the image of a fish on the front side. (1) No. 458; (2) No. 462; (3) No. 3840; (4) No. 4695; (5) No. 4703; (6) No. 4769; (7) No. 4779; (8) No. 4838 (after Radchenko 2022: fig. 13)

The front side contains a group of engravings that includes: two zoomorphic, most probably resembling goats; an anthropomorphic figure with a spear, bow, and horns; a complicated image of a rectangle and two circles near the anthropomorphic; lattice in the left part of the block that partially overlaps the goat's image.

According to the block's description from the archives of Kamyana Mohyla reserve, these engravings represent "a goat in a fence, a goat with the long horns and furs, a hunter in the deer mask with bow and spear, a hut-like image. The back side contains numerous linear engravings that form a zoomorphic image. The presence of the goat hunter might indicate a depiction of driven hunting and the process of goat domestication". Mykhailov states that "goat hunting scenes are the classic examples of prehistoric rock art, e.g., 1) Spain (Levante); India (Bhimbetka); 3) Azerbaijan; 4) South Turkey (Çatalhöyük); 5) South Africa" (Mykhailov 2005: 108). This idea of B. Mykhailov corresponds to V. Danilenko's hypothesis on the local domestication processes near Kamyana Mohyla.

Fig. 5.24. The block from the Goat's cave, front and back. 1 — 3D-model; 2 — tracing

However, all these concepts appear to be wrong or at least not proven. To begin with, the issues of domestication practices in the Ukrainian Steppe and the origin of the Ukrainian Steppe Neolithic are proven to be wrong or at least debatable, as described in Chapter 2. Besides, this assumption neither corresponds with the archaeological materials from the settlement nearby (Kotova et al., 2017) nor with the recent data on goat domestication in Eurasia (Zheng et al., 2020).

The overall interpretation of the hunting scene also requires additional remarks. First, Mykhailov's expectation of the "archer in the dynamic posture" was not fulfilled by the engravings from that block — the anthropomorphic figure does not indicate any motion. Moreover, the archer is not an indicative feature of Mesolithic rock art per se. Not only might it belong to any of the later periods, but recent advances in archaeological studies have also shown signs of active bow use during the Pleistocene in Ukraine (Demidenko 1987) and abroad (Brown et al. 2012).

Second, what Mykhailov considered a fence should be described as two separate lattices. The photogrammetric study indicated the superimposition of the right lattice over the left one. The former is featured with wide lines and regular geometry. Most importantly, unlike its left precursor, it is painted with red ocher. This indicates that ocher-painted images on Kamyana Mohyla are mainly known from the Bull's Cave and attributed to the Eneolithic Age. Onward, the presence of any pigment leaves some future possibility on the dating of the engravings, so one could hope that the issue will be eventually clarified.

The left goat image is neither covered nor surrounded by what B. Mykhailov considers it a fence. Therefore, there might be no direct semantic connection between the irregular image of a lattice and the goat. In fact, only one tiny contact zone allows cautiously assuming the superimposition of the zoomorphic image over the fence. This, however, remains uncertain before the microscopic study. The left zoomorphic image is worth noticing in one more context: this is the only engraving on the block made in the silhouette technique. While their contours introduce the second goat, anthropomorphic image, and other engravings on the block, the left image represents a relief with a polished silhouette.

Among others, the example of the block from the Goat's Cave shows that both hypotheses and datasets presented by B. Mykhailov should be re-examined in the same way as those offered by V. Danilenko. Though some concepts might be actual, neither data nor archaeological and chronological attributions are reliable. While there might be other Mesolithic portable and parietal rock art objects on Kamyana Mohyla, especially among those discovered in one of the three abovementioned caves, all of them require reexamination similar to the one performed for the portable art objects from Churinga's cave, the sculpture from the cave No. 55 (misinterpreted by B. Mykhailov as the image of Vritru) or the eponymous block from the Goat's cave.

5.2.2. The Upper Paleolithic case

While the stones from Churinga's cave were considered by Danilenko according to the general archaeological context of the settlement excavated nearby, the collection from Wizard's cave was treated differently. Though he considers both parietal and portable art specimens from this cave as Upper Paleolithic, he does not provide any evidential support for his interpretations. This is probably due to the lack of Upper Paleolithic sites that have been excavated, studied, and published in the surroundings of the hill. The other reason might be a common desire to find Paleolithic art object, which used to be considered of greater value than more recent examples (see Abadia & Moralez 2004). Finally, the interpretation of any art object as Upper Paleolithic often stops as soon as the examples of Pleistocene fauna or another clearly identifiable example of an Upper Paleolithic worldview is revealed. However, such of thinking about these objects is clearly misleading as it is grounded in two potentially incorrect assumptions:

1) The archaeologist is capable of detecting an example of Pleistocene fauna in the rock art image. Besides the general problems with the recognition of extinct fauna, described by R. Bednarik (2015; 2017b), the abstract and schematic art of Kamyana Mohyla causes an additional challenge to the researcher eager to provide a comprehensive interpretation.

2) Our contemporary notion of what the Upper Paleolithic worldview used to be is probably wrong or at least unproven and should not be a source of any interpretation if not supported by clear archaeological evidence. Even figurative

images are often a matter of controversy between what we think they are and what they really are (Bednarik 2015; 2017a, b). Non-figurative or even just schematic images might be unreachable far from any of our assumptions.

However, the state of rock art research in Ukraine back in 1970s allowed Danilenko to proceed with the 'Upper Paleolithic hypothesis' for the rock art complex at Wizards cave. His explanation for these phenomena consists of several theses that should be considered one by one before any reasonable conclusions can be drawn:

1) The existence of Upper Paleolithic sites in the region;
2) The existence of Upper Paleolithic rock art in the other caves of Kamyana Mohyla (Bull's cave, No. 9);
3) The existence of parietal art specimens that depict Pleistocene fauna or typical Upper Paleolithic myths in Wizards cave;
4) The existence of figurative images on portable art specimens from Wizards cave that represent examples of a Paleolithic worldview.

5.2.2.1. The Upper Paleolithic sites of the region

Danilenko states that local museum workers, including B. Mykhailov and O. Ogulchanskiy, reported a series of Upper Paleolithic findings in different locations of the Azov Sea region. The most important among them is the Kashtaeva balka near the Mykhailivka district center in Zaporizhzhya region. Here a homogeneous assemblage of different Upper Paleolithic objects was found. "Considering the appearance of Gravettian points and the core-like tools, one can assign these materials to the Amvrosiivska culture… Probably, the same cultural group also includes a destroyed camp near Novopavlivka that was discovered by B. Mykhailov a few kilometers down along the Molochna river from Kamyana Mohyla … One should recall the old discovery of the author [V. Danilenko] that contains a number of Late Paleolithic flints found on the boundary of Sekiz in the southern part of Terpinnya village (few kilometers to the North from Kamyana Mohyla). There were also two Upper Paleolithic flint tools found in the surroundings of the Kamyana Mohyla hill itself" (Danilenko 1986: 135—136). The researcher states that the discovery of Upper Paleolithic camps in the Kamyana Mohyla surroundings is only a matter of time and requires an accurate survey that should be provided as soon as possible. Though this assumption is reasonable, one should note that such surveys are yet to come. Some efforts by the staff of the Kamyana Mohyla reserve appear to be fruitless. Moreover, the materials that were reported by V. Danilenko in his book also still need to be processed, described, quantified, or published. Therefore, the idea of Upper Paleolithic locations in Kamyana Mohyla's closest surroundings, though hypothetically may be correct, is a matter for further investigation. Without careful and comprehensive analysis of the extant materials and the identification of new sites, it remains unproven. Once this investigation happens, the question of assigning the rock art that used to be considered Paleolithic to a specific archaeological context might be raised again, though additional data are needed.

Indeed, the broader archaeological context of the Kamyana Mohyla features a number of Upper Paleolithic locations (see Chapter 2 of this work), but the nearest surroundings of the hill contain only two poorly excavated camps, namely Sekiz 1 and Kamyana Mohyla 5. Without a proper understanding of their archaeological and chronological attribution, the question of an Upper Paleolithic imaginary on Kamyana Mohyla will remain difficult to solve.

5.2.2.2. The engravings inside Bull's cave and their chronological attribution

The importance of discovering Paleolithic sites for V. Danilenko was also motivated by his hypothesis regarding the engravings in Bull's cave. Indeed, these engravings were first considered by him as examples of typical Paleolithic rock art "not only due to the typical Paleolithic style of its depiction, but also because the image of mammoth and bulls belong to the same stylistic group" (Danilenko 1986: 53). The figurative and naturalistic engravings in Bull's cave, created by polishing of the creature's silhouettes, were considered by him as examples of Paleolithic rock art. This is due to his interpretation of the largest image of the group which he considered to represent a mammoth (Danilenko 1986: 53—54). This hypothesis immediately gave rise to a long discussion and led to the emergence of different interpretations. Since the first interpretative attempts up to his death in 1982, Danilenko argued that the images in Bull's cave (or Mammoth's cave as he called it) represent figurative images, similar to the Upper Paleolithic of the Franco-Cantabrian region. This would mean that the Paleolithic art of Kamyana Mohyla consists of two technically and stylistically different entities: one from Bull's cave and one from Wizards cave. However, the latest photogrammetric study demonstrates clearly that the image depicts a Bull pierced with a number of spears (fig. 5.25), rather than a mammoth (Radchenko & Nykonenko 2019). The 'trunk' itself is, according to the examination of the 3D model surface, the linear engraving of the spear with the traces of accidence happened during the engraving procedure (fig. 5.26). Together with other images from Bull's cave it is now considered to belong to the Eneolithic Age. This is confirmed not only by numerous analogies in the Eneolithic rock art of Central Asia (Tamgaly and Eshkiolmes mountains etc.), but also by bull depictions found during the excavation of an Eneolithic burial nearby (Daragan, Polin & Svoyski 2021).

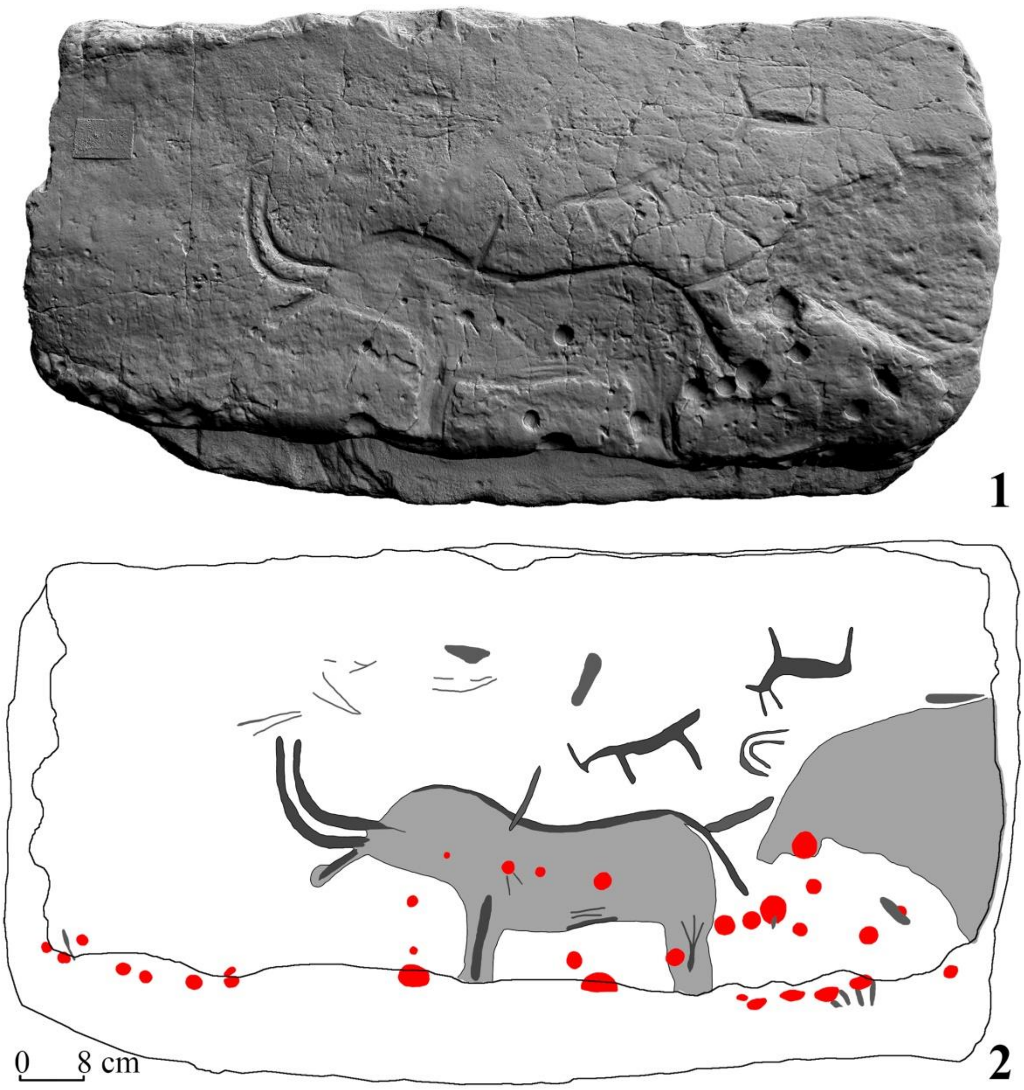


Fig. 5.25. The "Rain Bull" panel. 1 — 3D model of the panel's surface; 2 — digital tracing of a panel made from ortophotoimage (after Radchenko & Nykonenko 2019, fig. 11)

Therefore, Danilenko's hypothesis that the Upper Paleolithic art of Kamyana Mohyla is represented by two different styles of engraving — polishing the contoured silhouette and incising the schematic image (1986: 51—58) appears to be incorrect. While the figurative art from Bull's cave is already proven to belong to the Holocene, the schematic images from Wizard's cave remain under question. The existence of archaeological sites and objects that would be chronologically or culturally connected is still to be investigated. Moreover, the interpretation of rock art specimens from Wizards cave requires additional research and considerations.

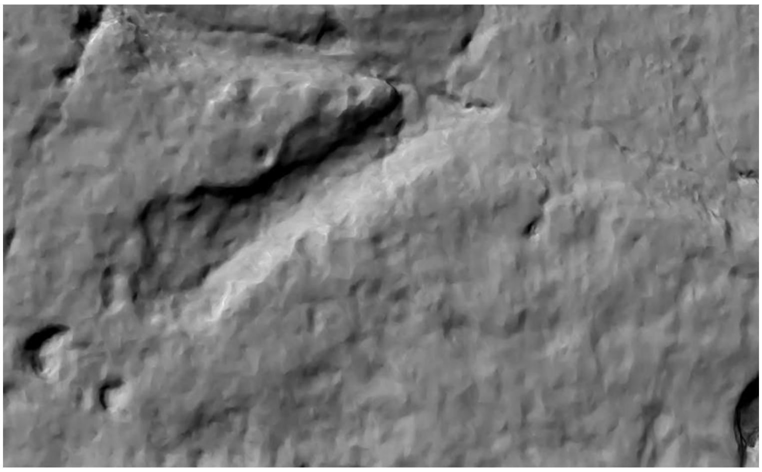


Fig. 5.26. A part of the panel’s 3D model representing bull’s “trunk”. The thickening is amorphous and superimposed by the scratched line

Unlike the images from Bull’s cave that were discussed by B. Zemlyakov (1939), O. Bader (1941), V. Gladilin (1969), M. Rudinskiy (1961), V. Danilenko (1986), B. Mykhailov (2005) and me (Radchenko & Nykonenko 2019), the compositions from Wizard’s cave were never a matter of discussion among Ukrainian scholars after their publication in 1986. In his book which summarizes rock art research at Kamyana Mohyla, B. Mykhailov states that the Upper Paleolithic nature of the specimens there is clear and considers it in a special chapter (2005: 99—106). However, neither V. Danilenko nor B. Mykhailov provide reasoned or persuasive evidence which proves the Pleistocene origin of the images in this cave. Therefore, the position of these petroglyphs and the cave in general in Ukrainian archaeology remains ambivalent — its chronological attribution is neither proven nor discussed. Such state of the art is explicable as both researchers who addressed this question are now deceased and the cave was not accessible for a long period of time. The accuracy and the relevance of the drawings made by V. Danilenko were not re-examined since their creation, as well as his interpretations and considerations. The latter, however, is challenging due to the lack of explanation and argumentation V. Danilenko provides for his understanding of rock art specimens in the cave.

5.2.2.3. Parietal art in Wizards cave and its chronological attribution

The images in Wizards cave are quite different technologically from those found in Bull's cave. Instead of the polished silhouette, engravings are introduced by "incised images that of consist 10-cm long and 1—2 mm wide lines." (Danilenko 1986: 79). All the images drawn and published by V. Danilenko introduce schematic and abstract contours, made of incised shallow linear engravings with a total width of 1—2 mm (fig. 4.12).

Unfortunately, the lack of electric light sources and the limited possibilities to provide the recording of the images forced researchers to paint them with coal. Moreover, for the same reason, photo fixation and accurate drawings of the rock art panels were impossible. The only drawings that remain available now are those, produced by Danilenko and published in 1986. Their level of visibility, abstraction, accuracy, and objectivity, however, remains unknown (fig. 5.27). All of these schematized drawings complicate any scientific debate on the rock art from Wizards cave. Although they are published long ago and represent a bright and considerable part of Kamyana Mohyla rock art complex, it is hardly possible to consider them as a material for further analysis as we simply don't know how realistic these drawings are.

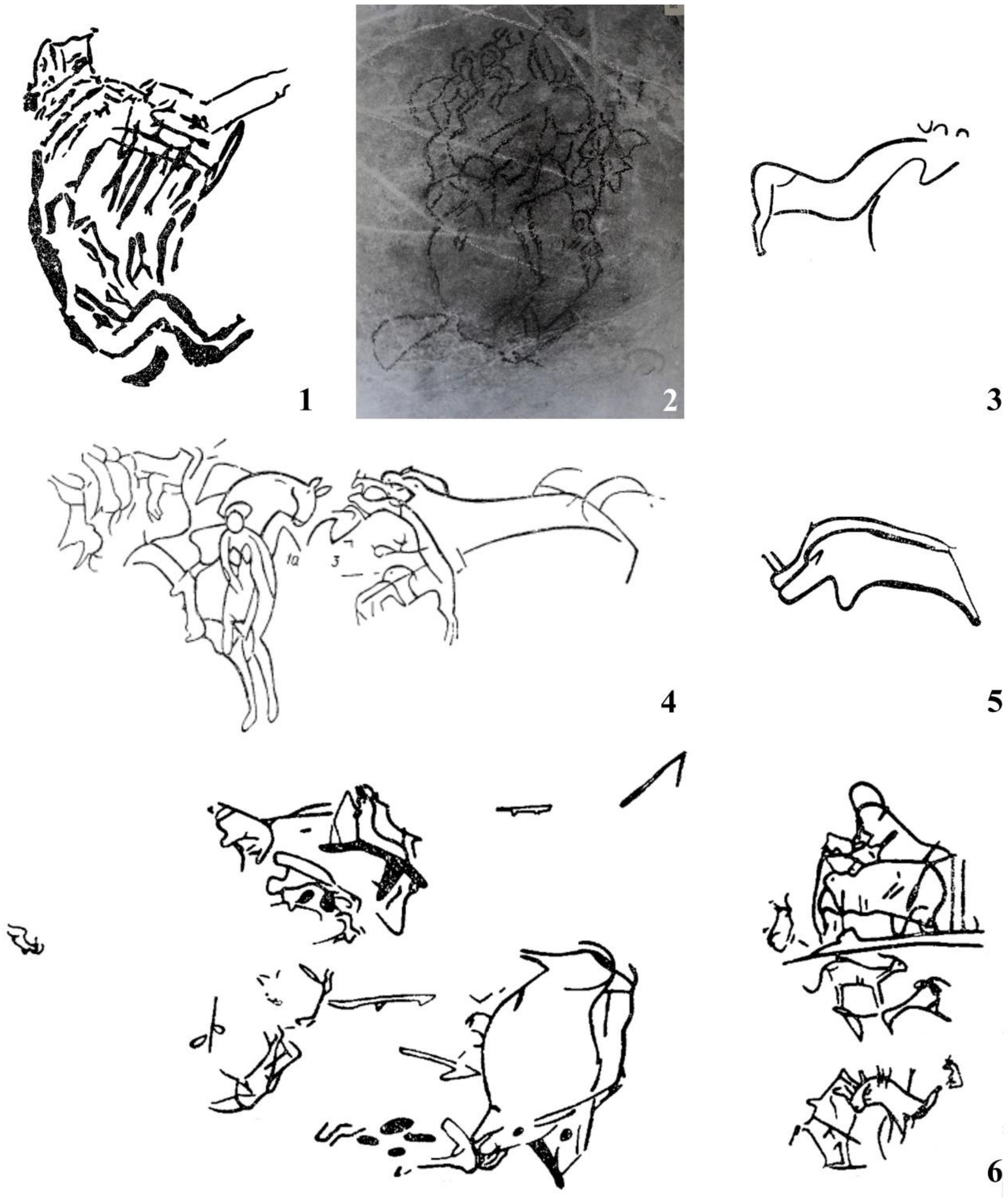


Fig. 5.27. Engravings from the Wizard's cave from Kamyana Mohyla. 1 — drawing of the 'Wizard' (after Danilenko, 1986: 137, Fig. 91); 2 — killed mammoth and the anthropomorphic figures surrounding him (after Danilenko, 1973, fig. 12); 3 — an image of a cervidae (after Danilenko, 1986: 77, Fig. 28:2); 4 — composition of a "Great goddess" and a cave lion, the first group from Scynia (Danilenko, 1986:90, Fig. 41); 5 — a pair of rhinoceros (after Danilenko 1986: 77, fig. 28: 2); 6 — second and third group of images from the Bison's rout (after Danilenko 1986: 85, fig. 36).

Therefore, the only appropriate way to include these images in the study of rock art and to consider their possible Upper Paleolithic origin would be to re-record and re-analyze them using the benefits of current digital and technological capacities. This means entering the cave and re-acquisition of the data from the cave ceilings, including drawings and digital images. This, however, appears to be a long and expensive process that would include the partial excavation of the cave, requiring strengthening constructions, cave investigation, data acquisition, and later data interpretation.

Only one part of the cave — the area that is closest to the entrance — can be safely accessed during the winter or spring seasons, when the amount of sand in the cave is less than during the summer. This implies crawling into the cave and observing its ceiling by lying on ones back. Despite the fact this would significantly complicate the data acquisition process, few engravings from Wizards cave are available for observation. The most figurative and notable of them is the figure of the so-called Wizard (fig. 5.27: 1). Danilenko describes it as "a zooanthropomorphic figure. Its length from the tail to the end of a snout is 22.5 cm. The length of a human being 'inserted' into the silhouette of the creature is 10 cm … the width is 13 cm. A body of an animal is schematized and reticulated; a snout contains ears but is also similar to a bird's one. It is impossible to recognize an animal that contains an inscribed image of a man. It is impressive that the image of a human is quite small compared to the image of an animal therefore the latter might be alternatively considered as a construction. … The sacral nature of the figure is beyond doubt. Obviously, the silhouette of the entailed man is inscribed into the animal figure. We called this image a Wizard and named the whole cave on the basis of this image [the first that was found in the cave]." (Danilenko 1986: 81).

"This complex embodies at least three components: the anthropomorphic symbol of a Wizard, a creature with a tail that might be also considered as the tail of the Wizard himself and the animal-like body of a creature around the figure of the Wizard (the most obscured phenomenon). Searching for possible analogies among known fauna proved fruitless. The snout does not belong to the hoofed animal, as it features a beak-like ending.

Therefore, it is possible that the zoomorphic basis of the creature represents a bird. It is possible to state the similarity of its head to the image of the sacral bird in Wizard's cave that is curved as a central image on one of the sandstone blocks. It is worth noting that the motif of a Wizard (or a shaman) is often pictured as a bird and is one of the most ancient motifs on the Neolithic stage, probably the most common one." (Danilenko 1986: 137—138).

The interpretation provided by V. Danilenko for the figure of the Wizard becomes clear from these statements as well as the inspirational sources for such an interpretation. Indeed, the therianthropic (zooanthropomorphic) images that were found in the caves of Central Europe shaped the understanding of the shaman and shamanism of this age (Lommes 1966; Lewis-Williams & Dowson 1988) (fig. 5.28). Therefore, it was possible for Valentin Danilenko to assume that the image he discovered in Wizards cave represented the same phenomenon, depicted in the sandstone of Kamyana Mohyla. This is also quite possible as the existence of Upper Paleolithic rock art was not a matter of discussion for V. Danilenko. As soon as other images were interpreted by him as Upper Paleolithic, depicting Pleistocene fauna and the 'typical Paleolithic motifs' (Danilenko 1986: 137), an image of a Wizard would logically contribute to the same collection of rock art specimens. However, Danilenko avoids applying specific references and analogies (apart from Marshak 1970). Moreover, the available analogies from European Paleolithic art are much more figurative and clearer than the Wizard image from Kamyana Mohyla. Besides, there was no clear and accurate drawing that would be based on the cave ceiling's engravings that could be interpreted or at least considered for further processing. This raises the question regarding the re-acquisition of rock art data from Wizard cave once again. If the engraving of the Wizard is real, it is possible to record it and contribute to our understanding of V. Danilenko's hypotheses regarding the site and, what is more important, to our understanding of the prehistoric art of Kamyana Mohyla in general.

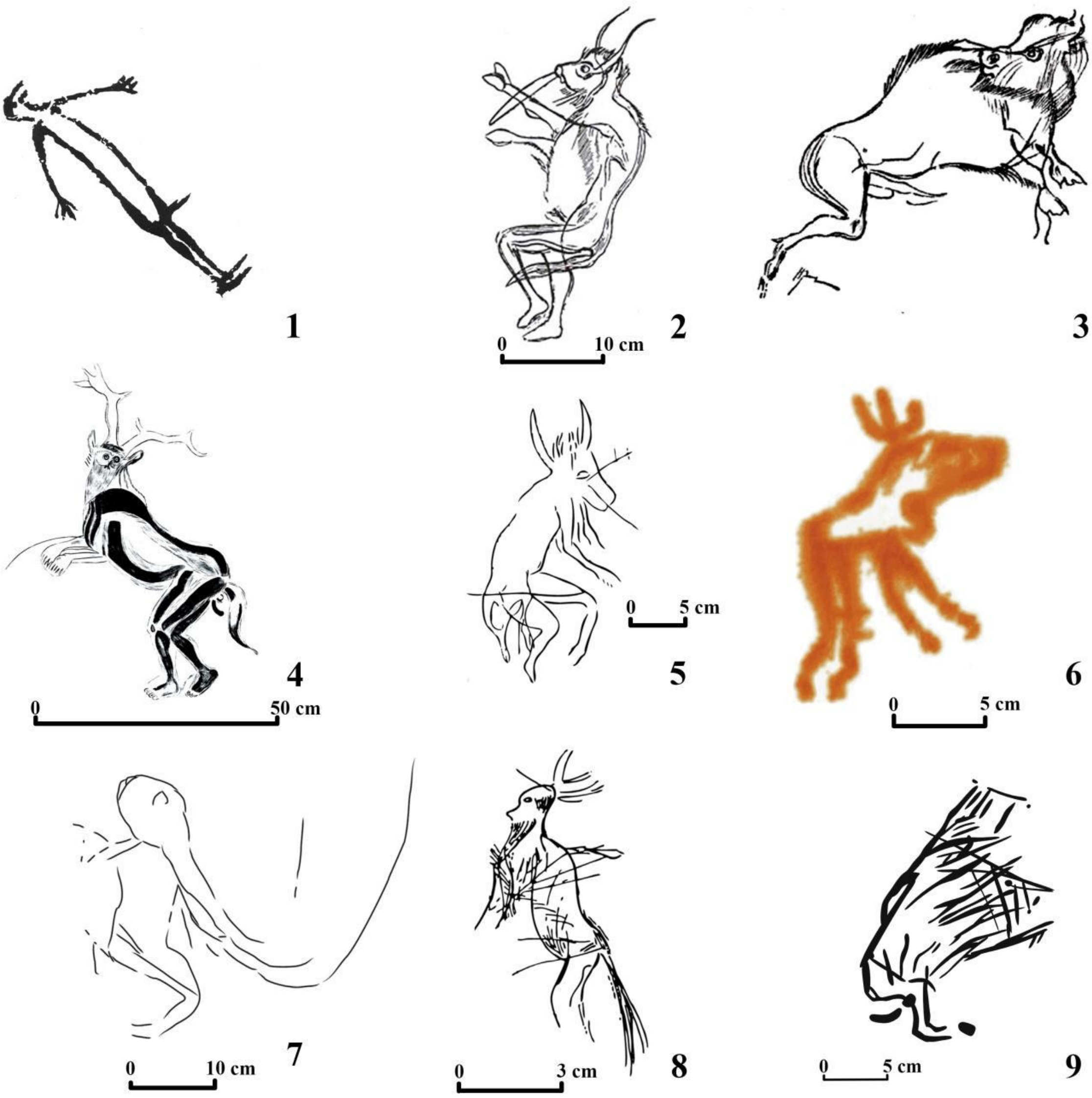


Fig. 5.28. Images of composed beings from the Central European Upper Paleolithic. 1 — an image of a man with birds head from Lascaux (after Lommel 1966); 2—4 therianthropic creatures from Les Trois-Freres (after Bégouën et al. 2014); 5 —parietal art of Gabillou cave (after Gaussens 1964, fig. 19); 6 — parietal art of Carriot cave (after Lorblanchet 2010); 7 — parietal art of Combarelles cave (after Archambeau and Archambeau 1991); 8 — portable art of Espelugues (after Capitan, Breuil & Peyrony 1924); 9 — wizard from Kamyana Mohyla (drawing by Simon Radchenko).

During fieldwork in the summer of 2020, I was fortunate to enter Wizards cave and provide image-based 3D modeling of a small part of the cave's ceiling that contains an engraving of the "Wizard" (fig. 5.29). The accuracy of the model, estimated by Agisoft Metashape software is below 1 cm and can be sufficiently improved with the relevant light and scaling equipment. However, the applied data are informative enough to analyze the surface of the ceiling and provide an accurate and comprehensive drawing based on the real engravings on the sandstone slab surface (fig. 5.30).

The photogrammetric study of the cross-sections of linear engravings that compound the 'Wizard's' figure shows their similarity to those on the surface of churingas from the same cave. Like the engravings on the portable rock art objects, these (fig. 4.12) mainly belong to sub-type A2, deeper than the A1 engravings from Churinga's cave. The asymmetric profile of these carvings indicates scratching as the primary engraving strategy. Though these lines are generally deeper than those on churingas, typologically, they remain similar. Considering the spacial proximity, irregularity of composition, and the cross-section typological similarity, it is reasonable to assume that parietal and portable rock art objects from Wizard's Cave share mutual archaeological and chronological contexts.

The importance of the discovery regarding the engraving of the so-called 'Wizard' is that the cave ceiling is really engraved and the image generally corresponds to what was depicted by V. Danilenko.

Fig. 5.29. The engraving of a Wizard. 1 — the surface of the stone ceiling (3D-mesh); 2 — textured 3D model of a figure (coal and glue were used by V. Danilenko for recording and conservation purposes)

On the one hand, the absence of a human figure appears to be obvious as the figure lacks a head and part of the stomach as compared to what was drawn previously. Indeed, the ‘Wizard’ can’t be considered as a zooanthropomorphic figure due to the absence of a clear anthropomorphic component. Therefore, the interpretation given by V. Danilenko is dubious.

On the other hand, the presence of an image in general and its clearly artificial nature is also beyond doubt. This might be considered either as a non-figurative image and reticulated ornamentation or as a part of a schematic and abstract yet figurative image. Considering this image to be just a reticulated ornament does not require any additional assumptions or interpretations.

It is notable, however, that the image of what used to be the buttocks and legs of an anthropomorphic figure has a rounded shape and is actually similar to part of a figurative image. Unlike other parts of the cave ceiling, it does not contain any other engravings and represents two continuous curved lines made of several linear segments. The “back” of a figure, therefore, remains comparatively figurative, while the “front” one is covered with intensive reticulated ornamentation. The shape of the latter allowed V. Danilenko to consider it as the fur of an unrecognizable animal.

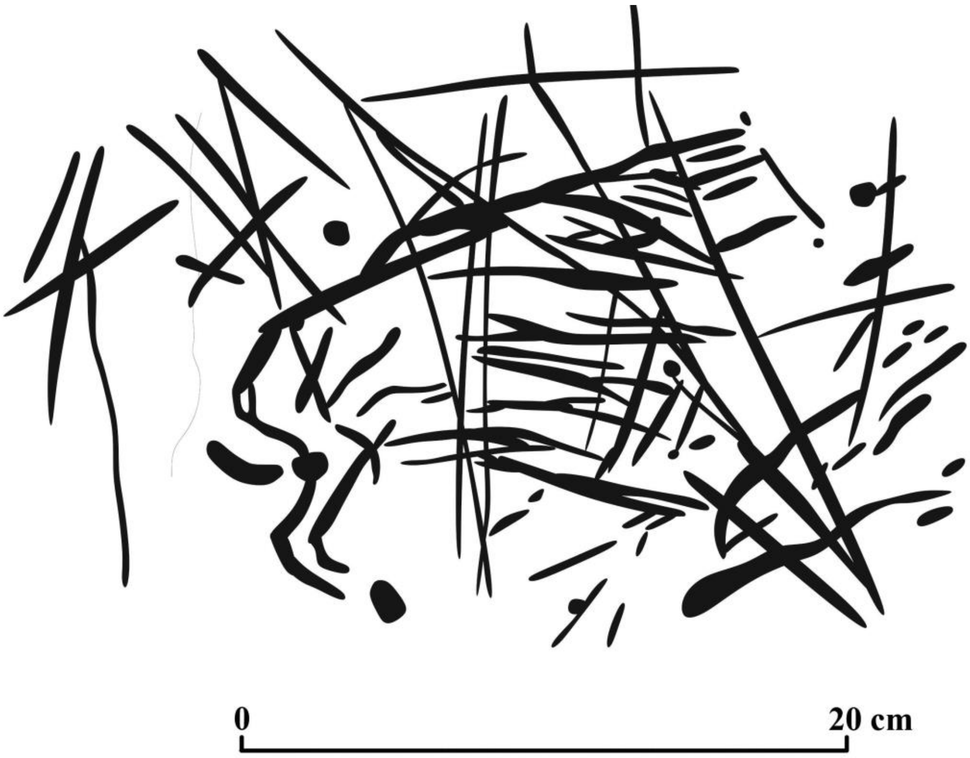


Fig. 5.30. A drawing of the "Wizards" figure made after the examination of an image-based 3D-model surface

Similar motifs with clearly depicted leg(s) and the schematic silhouette of a body are known in the Magdalenian cave art of Cantabria, Northern Spain (fig. 5.31). Though it is similar from a compositional point of view, the composition is very different due to the different geological parameters of the cave's surface. The sandstone is much more solid and dense than the surface of karst caves in the Franco-Cantabrian region, therefore the production of even a single short and shallow line on Kamyana Mohyla is much more time-consuming than the creation of a whole set of reticulated ornamentation in the Central European caves. This implies that searching for direct and clear analogies between the European and Ukrainian cave art is fruitless. Moreover, the technological processes that characterize the Upper Paleolithic of the Ukrainian Steppe are also different from the European ones (Zaliznyak 2010; 2014).

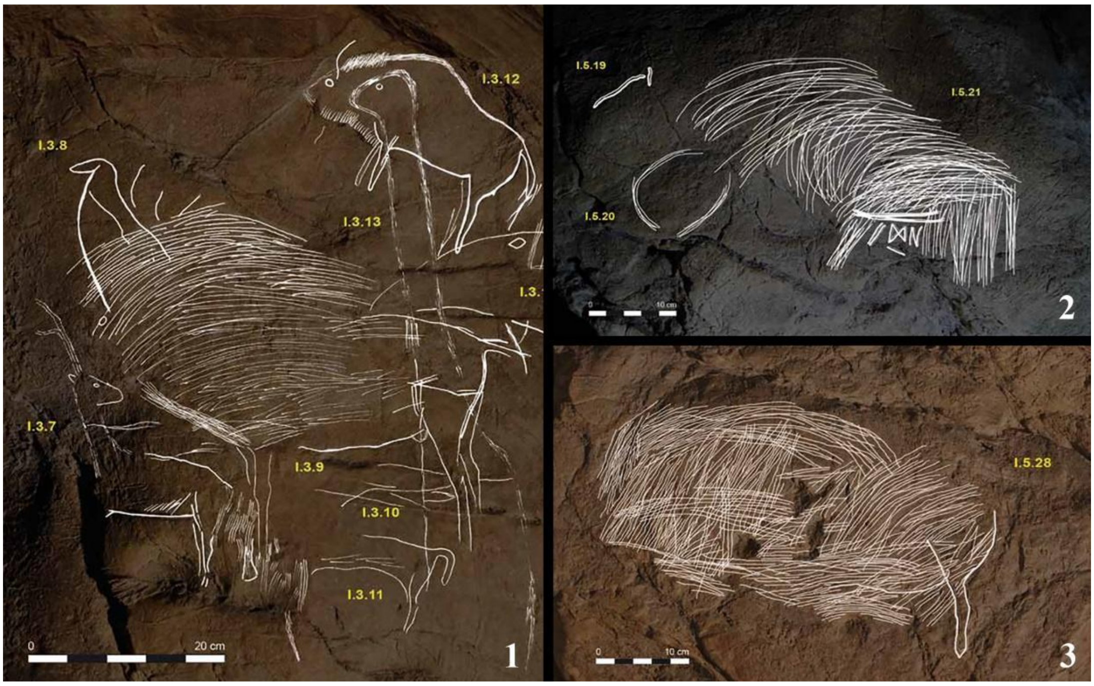


Fig. 5.31. Images of partially schematic Bison with figurative buttocks' and hind legs from the Altxerri complex, Cantabria, Spain (Magdalenian cave art). After Ruiz-Redondo 2014: 66—74. 1 — after fig. 6-4; 2 — fig. 6-7; 3 — after fig. 6-9.

Therefore, the question regarding the rock art of Wizard's cave at Kamyana Mohyla remains open. On the one hand, the ceiling of the cave is covered with numerous engravings and most of them are anthropogenic. On the other hand, the cave is considered to have been visited both during Pleistocene and Holocene (Danilenko 1986: 75, 89—90), and the precise dating of the engravings in the cave remains impossible.

Only one image among those published by V. Danilenko has been tested so far. Though his hypothesis regarding its meaning and possible interpretation appears to be wrong, the image is real and represents a set of engravings, which might be considered and studied further. The statement that the engraving is figurative, and it represents a motif, like the one assigned to Magdalenian rock art in Cantabria, requires additional research of the engraving itself, the cave in general, and the Upper Paleolithic of the region to improve the hypothesis with archaeological data. Assessment of this figure with the advances of digital technologies as well as modern data on Upper Paleolithic rock art has paved the way for proposing more reasoned hypotheses regarding the understanding of the Kamyana Mohyla Upper Paleolithic art. However, it still requires additional research. It is crucial to emphasize that either the direct application of approaches that work in Central Europe or searching for analogies with Central European rock art would be irrelevant due to yet another geological and archaeological reality.

5.2.2.4. Confronting the old hypothesis regarding the chronological attribution of portable objects

Therefore, the premise for confronting V. Danilenko's hypothesis regarding the Upper Paleolithic origin of the portable art specimens from Wizard's cave is as follows:

1) The archaeological context that could be considered as related to or at least relevant for the Upper Paleolithic cave art of Kamyana Mohyla remains unproven. Though the sites are considered to exist, none of them were found or proven to belong to any Upper Paleolithic industry, and there are no publications to this effect.

2) The rock art specimens from other caves of Kamyana Mohyla that were considered by V. Danilenko as Upper Paleolithic are proven to be produced much later, during the Holocene. He linked most of those highly figurative images with the figurative art of the European Upper Paleolithic. Those now appear to belong to the Eneolithic of the region.

3) The presence of Upper Paleolithic cave art in Wizard's cave at Kamyana Mohyla *remains possible but highly hypothetical*.

4) The only reasonable and valid argument that would support the provided Upper Paleolithic attribution of the artifacts from Wizard's cave would be the iconographic representations from the portable rock art objects discovered in that cave. However, the photogrammetric study of their specimens and the accurate digital tracing of their surface showed the misleading pattern developed by V. Danilenko. In contrast to his hypotheses and materials, the real incisions on the

churingas' surface do not show any iconographic representations that would support the Upper Paleolithic (or any other) attribution of these stones or the complex in general.

The Upper Paleolithic origin of portable rock art specimens from Wizard's cave, however, was beyond any doubt for V. Danilenko due to what he considered the presence of Pleistocene fauna and 'typical Upper Paleolithic motifs'. He states that "most of the engraved blocks were found in situ on the abovementioned shelves. Many were located on the surface of the whitish sand layer and probably fell from the shelves due to the partial destruction of the cave. More than 50 blocks were found. On the basis of the analysis of engraving techniques and the shape of the blocks we are eager to consider these blocks as archaic predecessors of churingas." (Danilenko 1986: 76—77). It is notable that part of the collection (marked as the "Eastern Entrance") was, probably, decontextualized in V century AD, during the construction of the Hunnic burial in the cave (Danilenko 1986: 75).

Danilenko provides a detailed explanation and interpretation for most of the engraved stones in the same book, considering them as a part of a homogenous collection. His work was probably carried out during 1975—1978 in the lab in Kyiv and included gluing and 'reconstruction' of the blocks, creation of the drawings, emphasizing the detected motifs with pastel coal, photo fixation, and textual interpretation. The third stage appears to be extremely important during both V. Danilenko's and my own analyses — it reveals the particular images that were behind his interpretations and allow for comparing them with the actual shape of the block's surface and engravings on the latter. The textual descriptions are quite exhaustive and represent his theory in a clear way (these are available in Annex B — the catalog of churingas from the collection of V. Danilenko). Danilenko mentions images of mammoths (1986: 97), rhinoceros (1986: 98—99), bison, wolves, and cave lions (1986: 100—102), as well as the numerous anthropomorphic figures (e.g. 1986: 110). On this basis he considers the whole collection of specimens to belong to the Upper Paleolithic period. Indeed, the stated location of the blocks (on the shelves in the cave) and their similar appearance (artificially processed shape and the similar intensity of desert varnish) indicate the homogeneity of the collection and might be an additional proof of the block's common chronological origin.

The engraved content, however, appears to be a completely different issue and must be considered separately (fig. 5.32—5.44). The image-based 3D-modeling of the portable rock art specimens after the workflow, described in a chapter 3 and the subsequent technological analysis described in chapter 4, revealed a source of new data regarding the stone's surface. The engravings and cross-sections are technologically similar to one another and represent one engraving technology. The latter is the same that was used during the engravings of the churingas from Churinga's cave, but the notches are deeper and mostly belong to the sub-types A2 and A3. Cupmarks of both type A and B appear to happen more frequently. They might have a different diameter and a different orientation angle (that is generally typical, i.e. see Bednarik 1998). However, the drawing, published by V. Danilenko appeared to not correspond to the actual engraved parts of churinga's surface (see Annex D). Even though the accuracy of the models was beyond 0.4 mm and the precision is a few times higher, some parts of what Danilenko considered to be engraved represented an unmodified part of a rock surface. This raises an important question about the relevance of the drawings and interpretations published by Danilenko, which is the crucial issue to be solved in order to confront the current theory on the interpretation of the portable specimens and thus, on their cultural and chronological context.

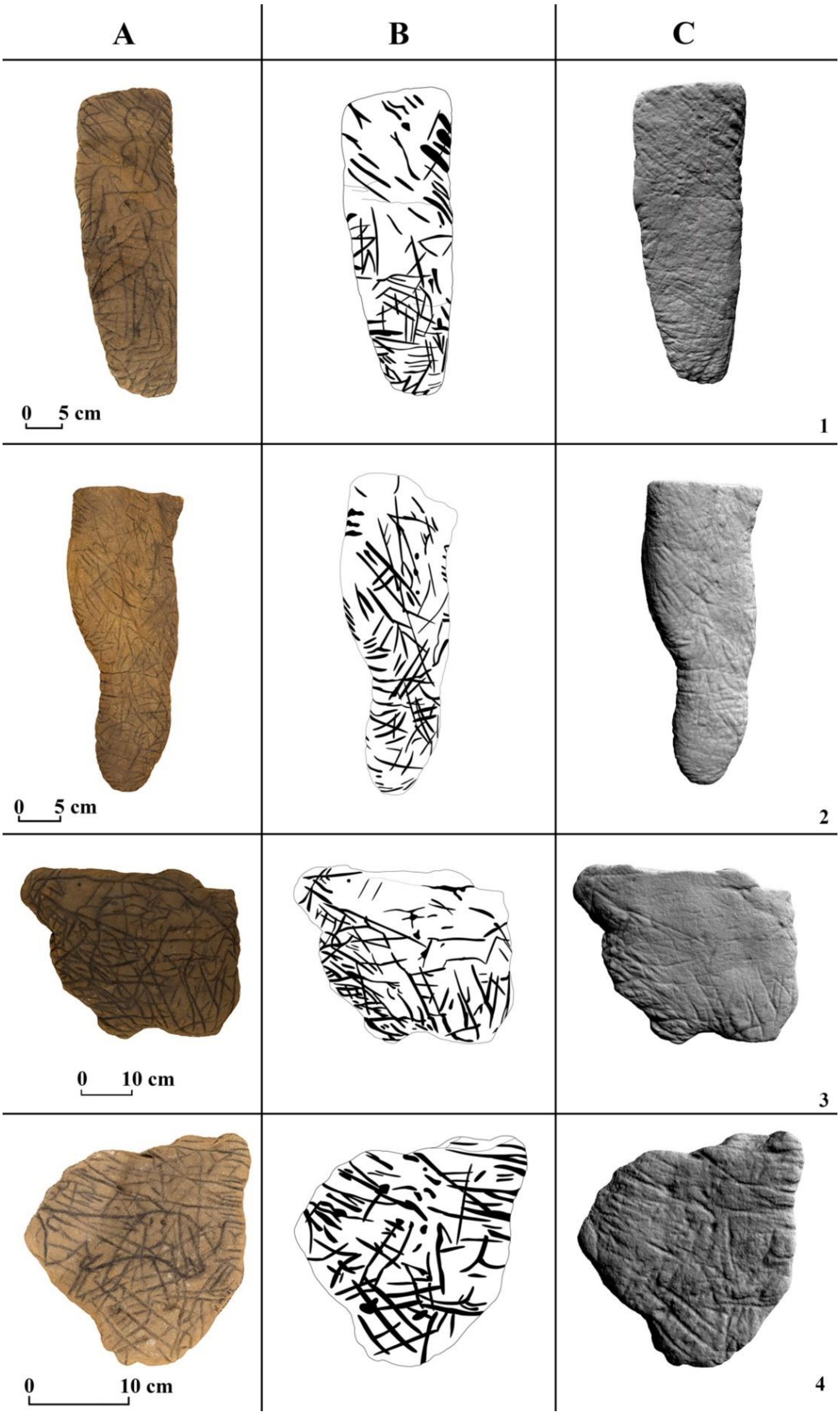


Fig. 5.32. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 245; 2 — No. 247; 3 — No. 283; 4 — No. 302.

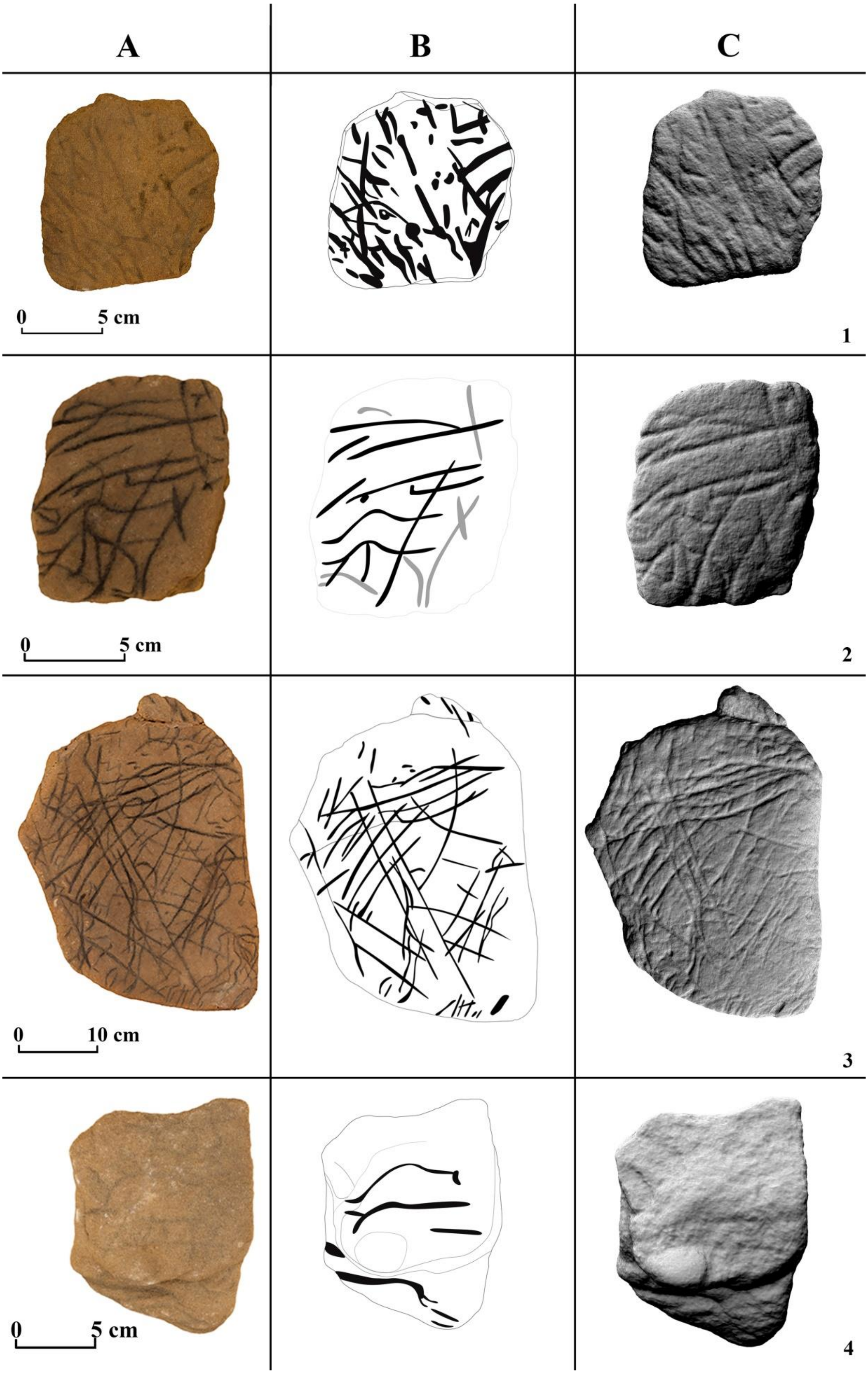


Fig. 5.33. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 338; 2 — No. KM74—1; 3 — No. KM74—2; 4 — No. 307.

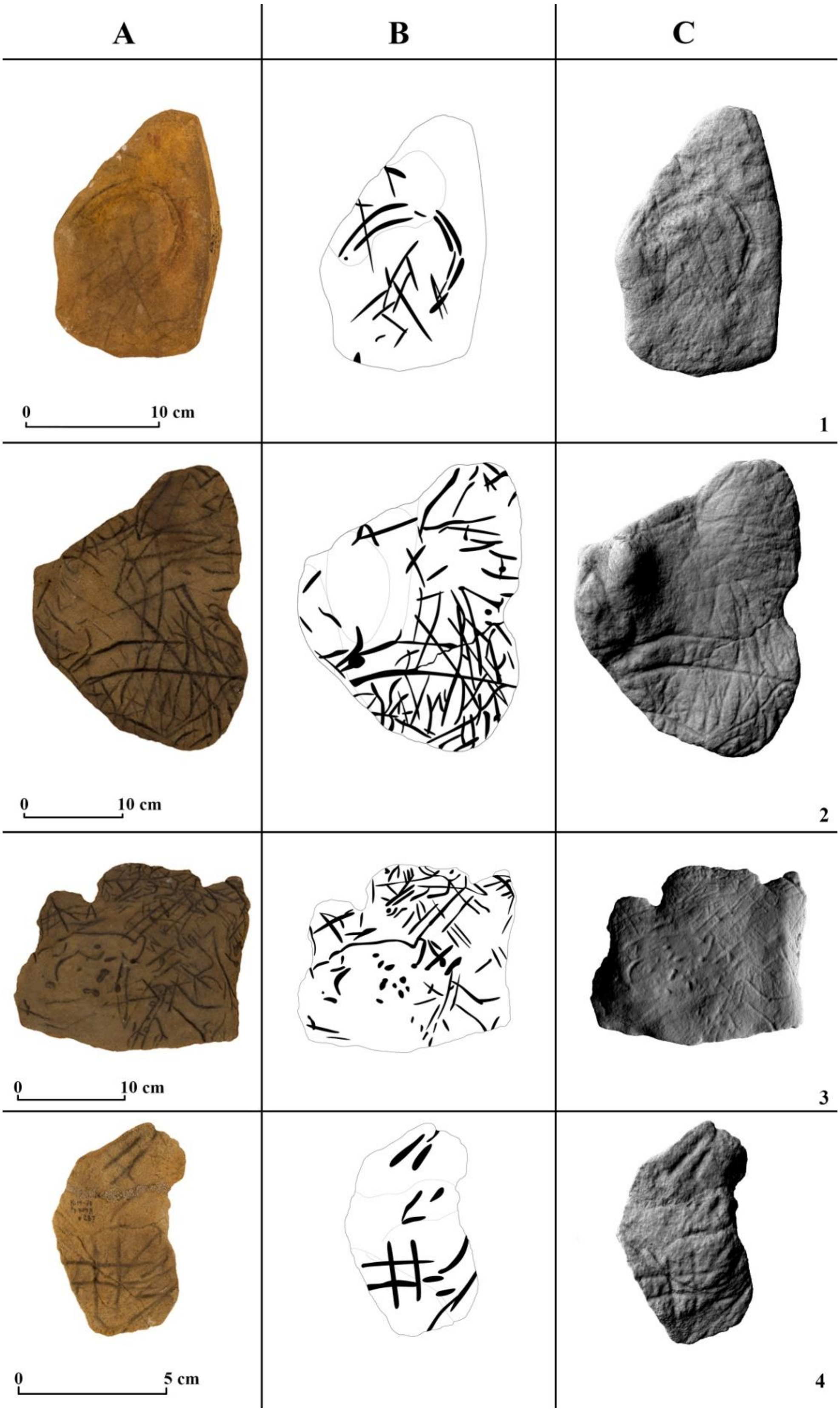


Fig. 5.34. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 277; 2 — No. 278; 3 — No. 284; 4 — No. 287.

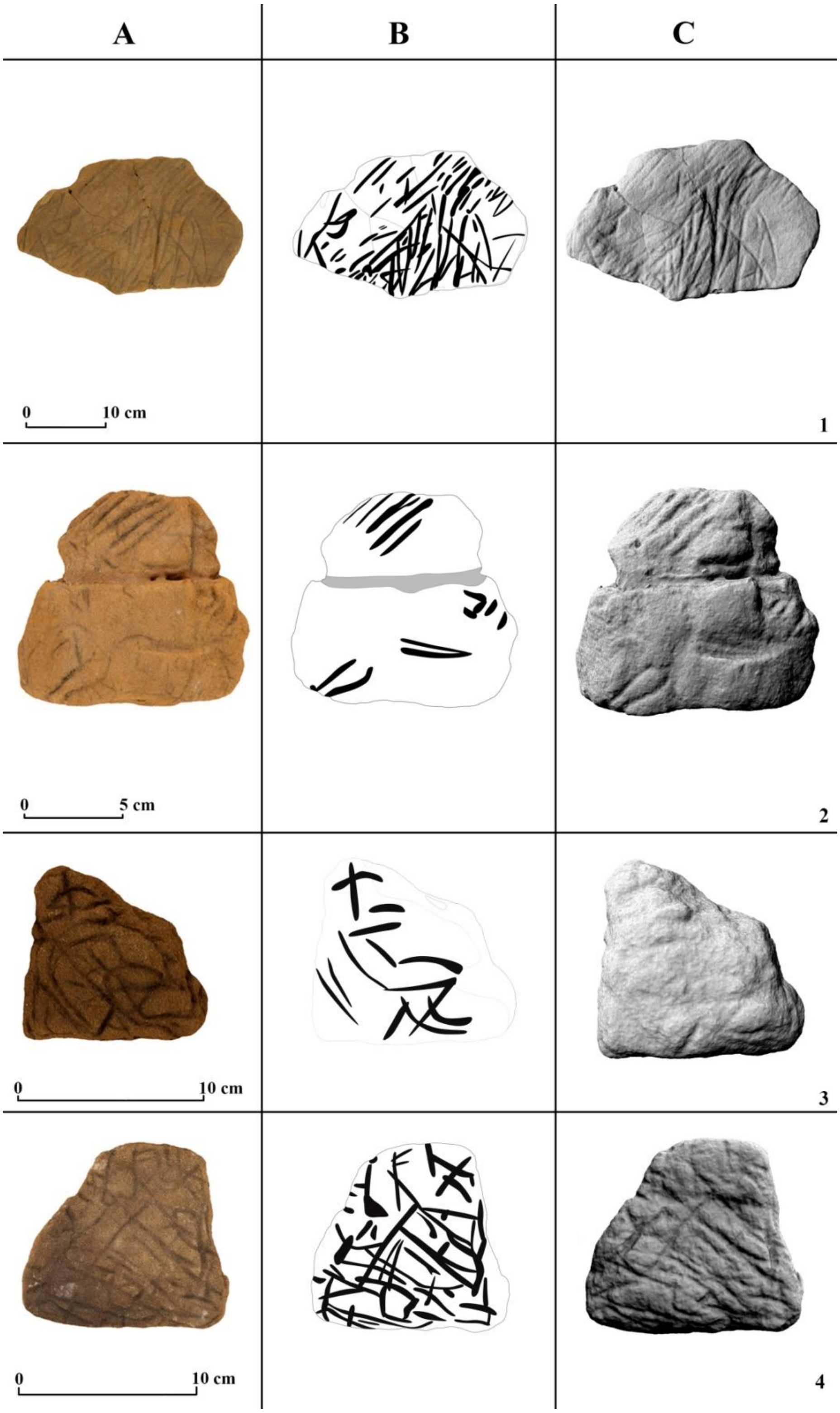


Fig. 5.35. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 298; 2 — No. 300; 3 — No. 306; 4 — No. 308.

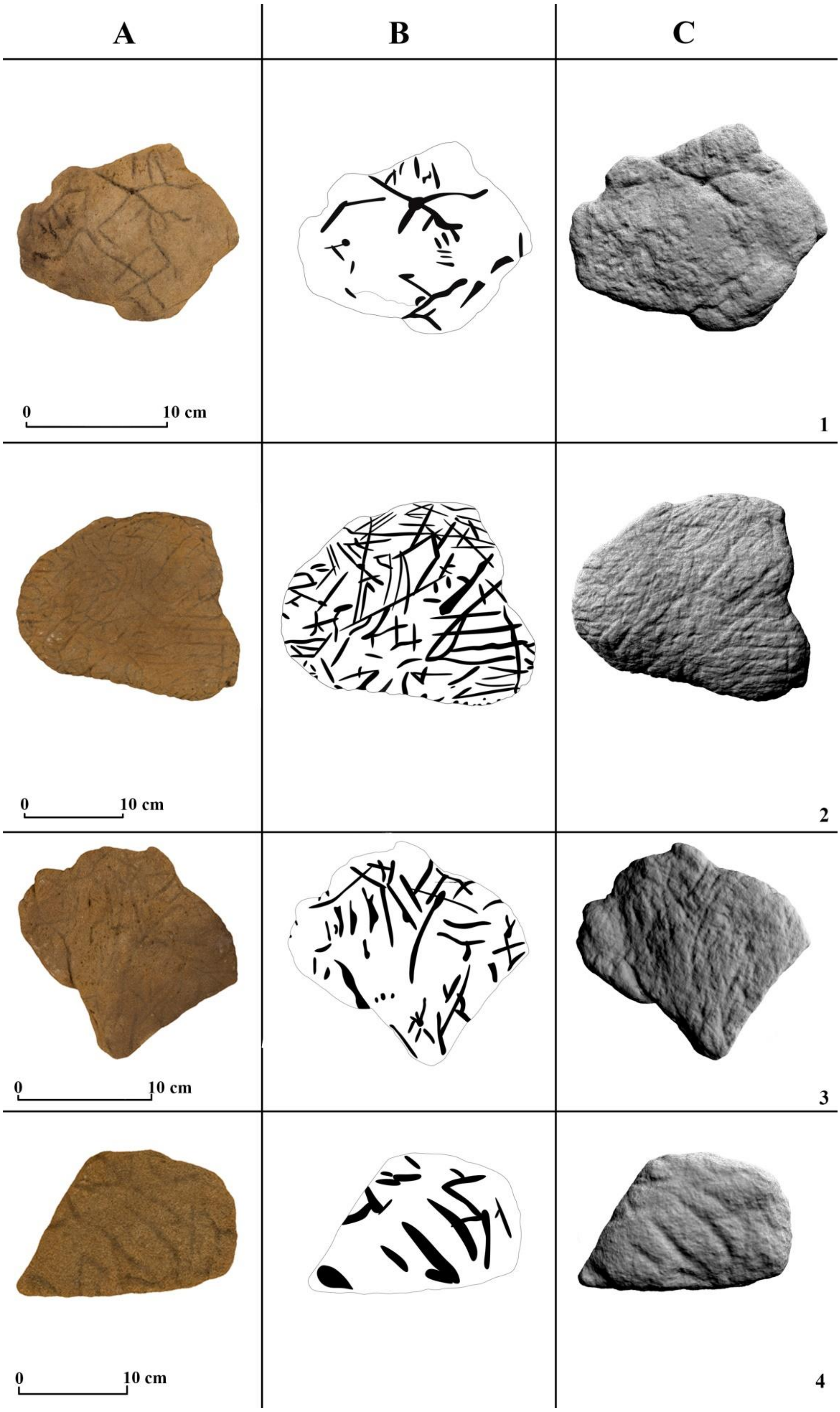


Fig. 5.36. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 309; 2 — No. 310; 3 — No. 317; 4 — No. 321.

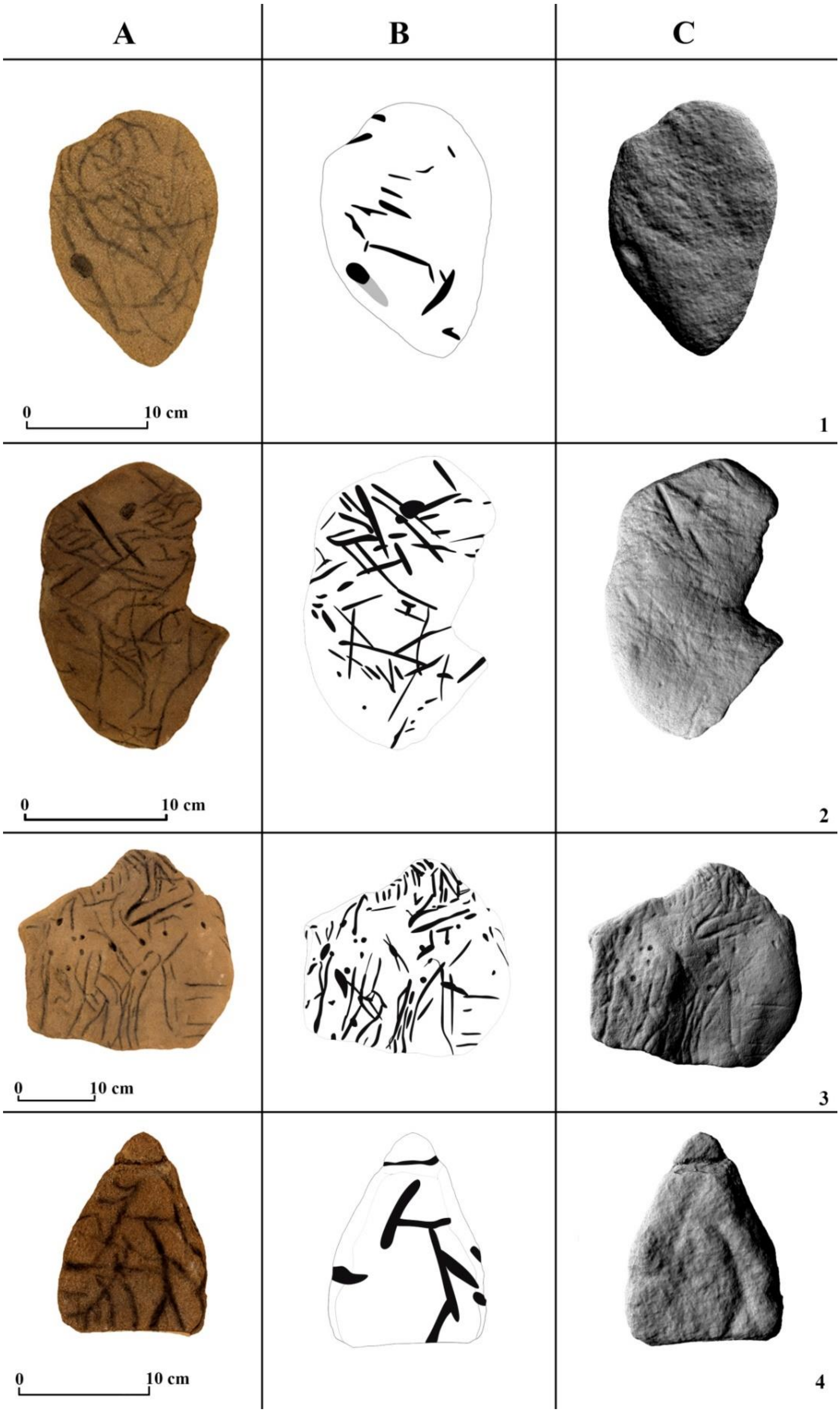


Fig. 5.37. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 324; 2 — No. 328; 3 — No. 329; 4 — No. 331.

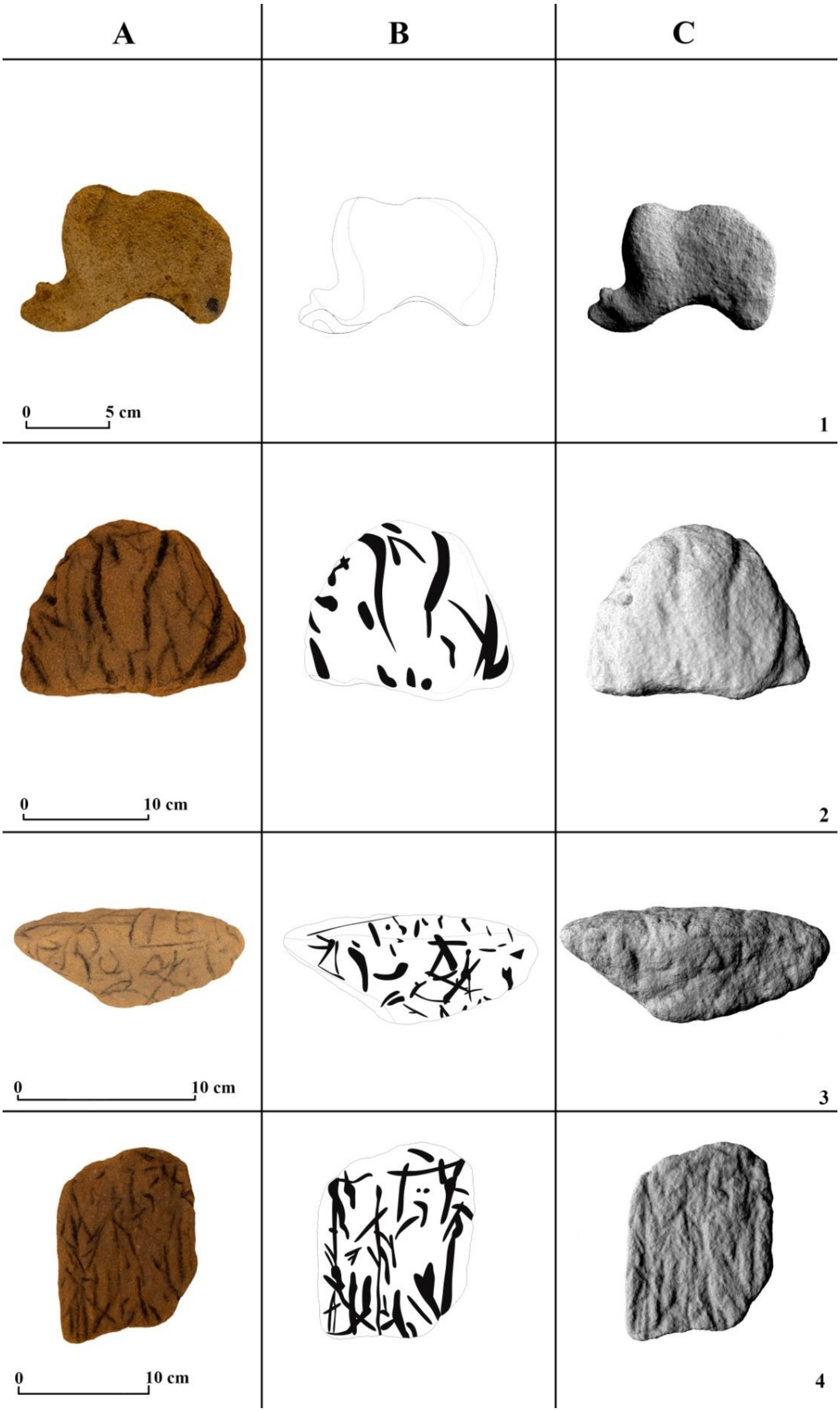


Fig. 5.38. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 332; 2 — No. 335; 3 — No. 336; 4 — No. 341.

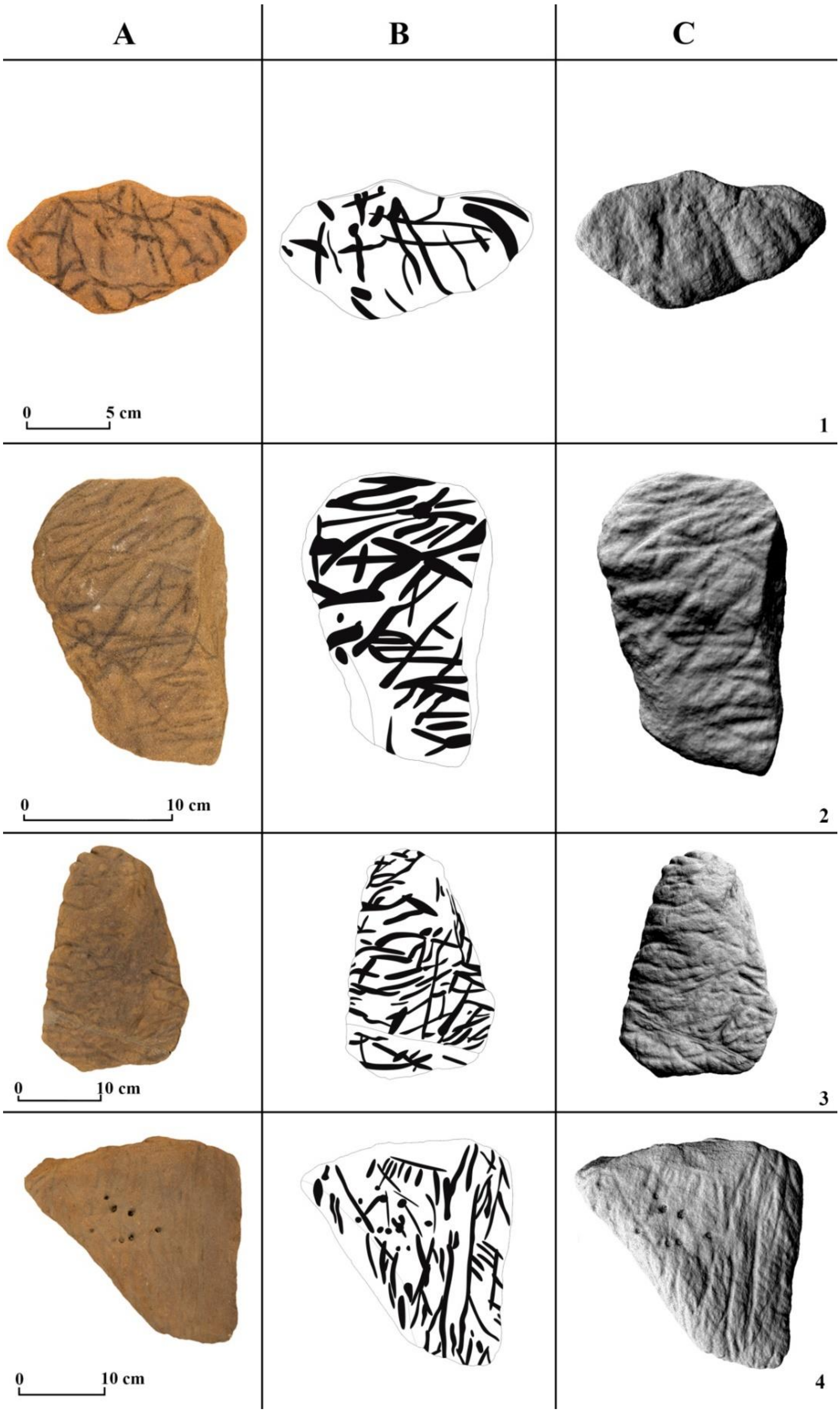


Fig. 5.39. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 341a; 2 — No. 342a; 3 — No. 343; 4 — No. 344.

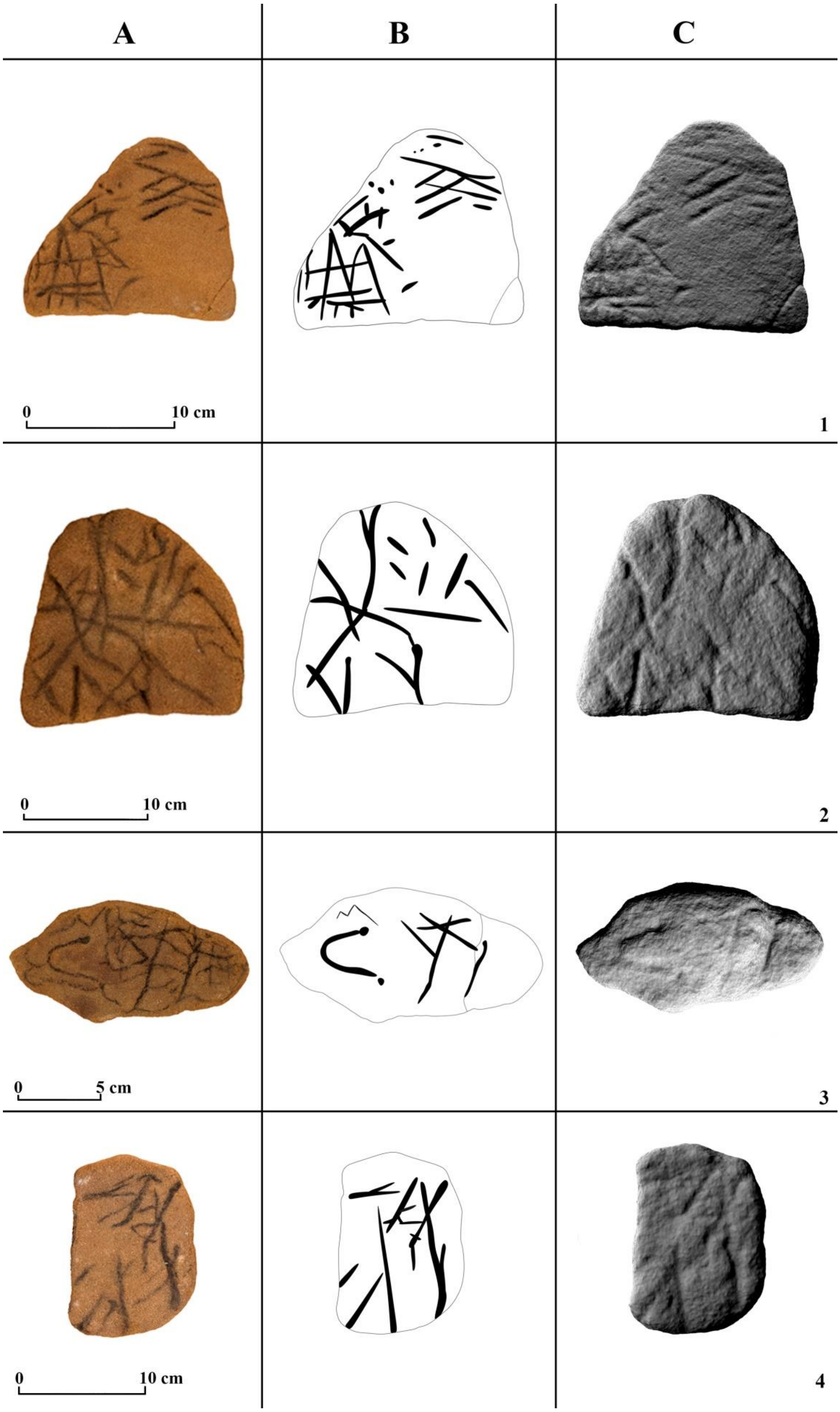


Fig. 5.40. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 74—4; 2 — No. 74—6; 3 — No. 74—7; 4 — No. 74—8.

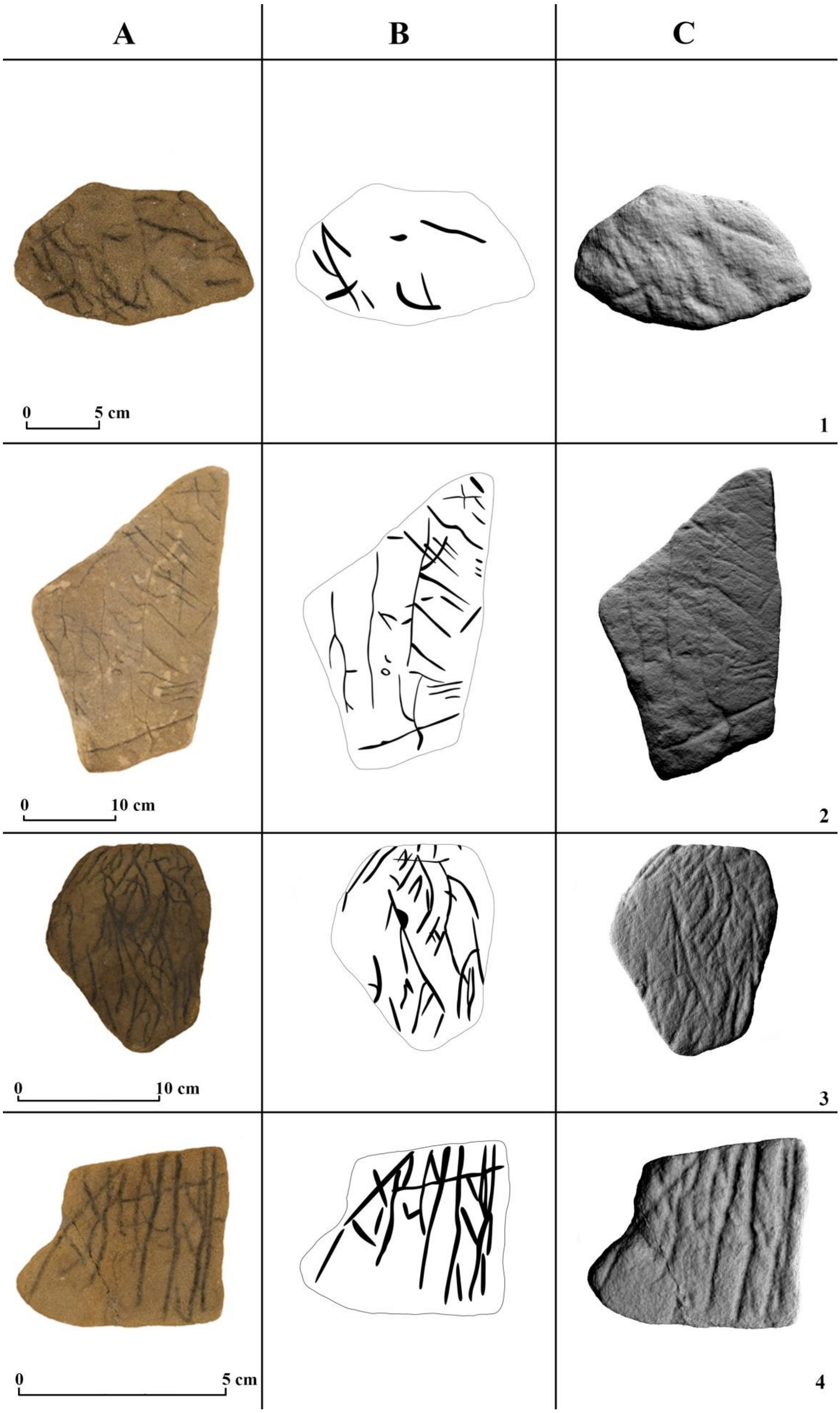


Fig. 5.41. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 74—9; 2 — No. 74—11; 3 — No. 74—13; 4 — No. 74—15.

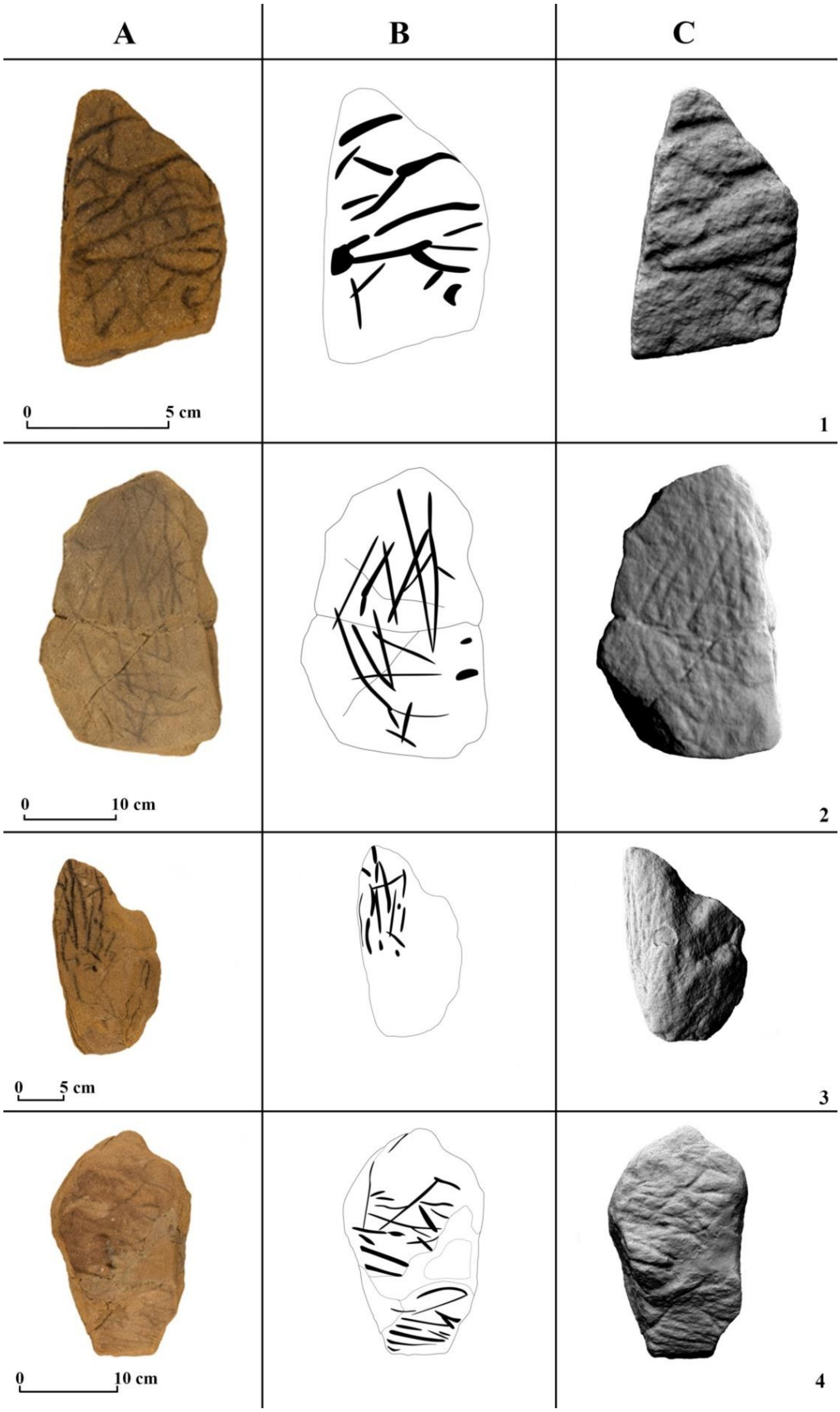


Fig. 5.42. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 74—16; 2 — No. 74—17; 3 — No. 74—18; 4 — No. 74—19.

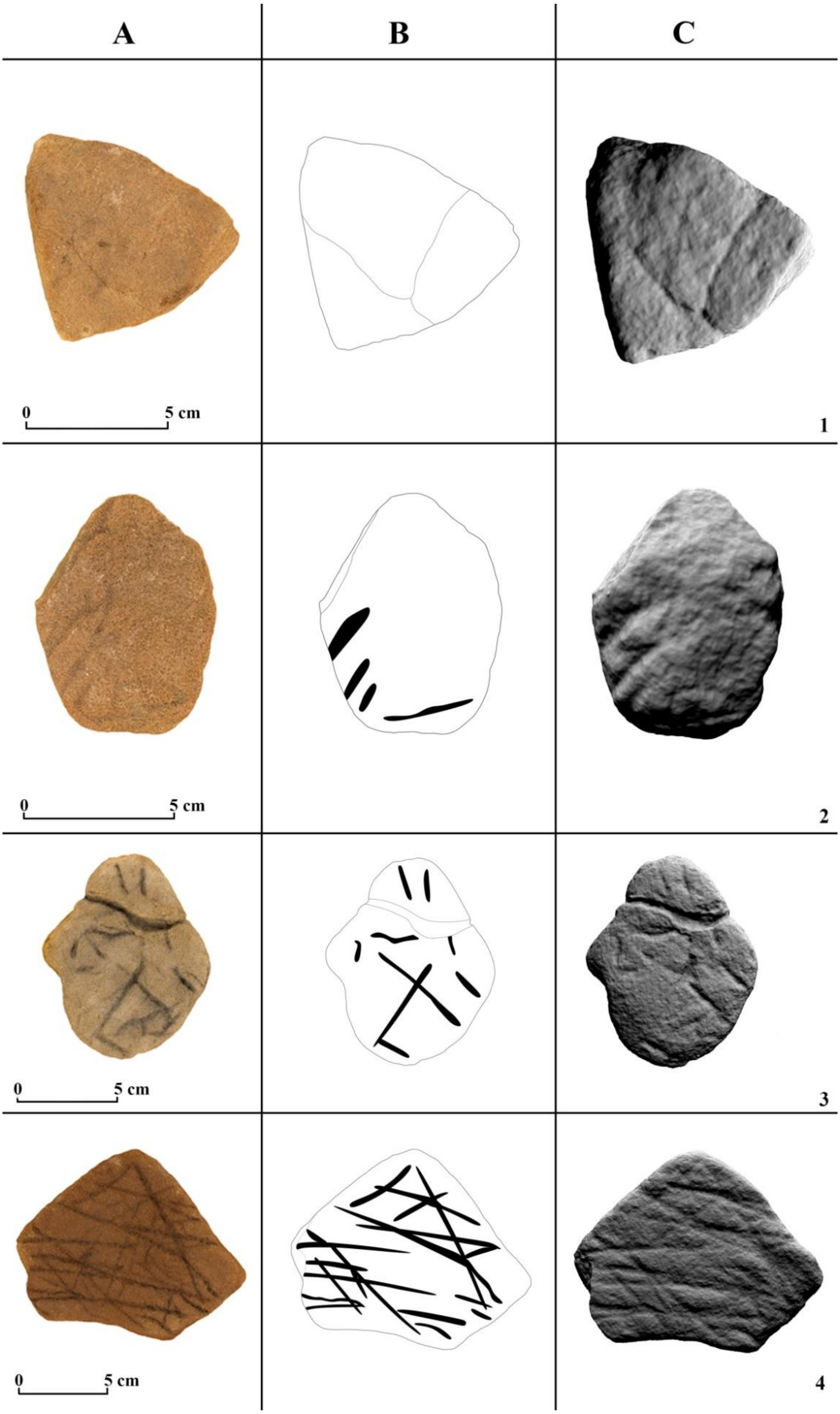


Fig. 5.43. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 74—20; 2 — No. 74—21; 3 — No. 74—23; 4 — No. 74—24.

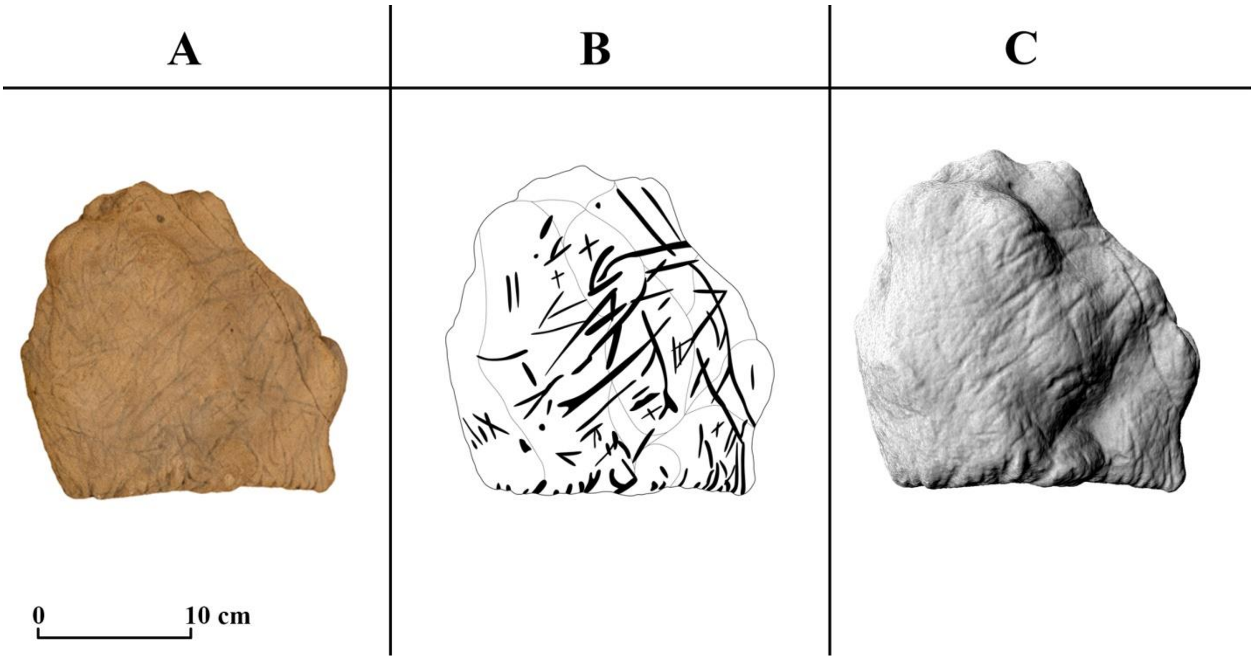


Fig. 5.44. Churinga No. KM 74—27 from Kamyana Mohyla. A — Photo; B — Drawing made by S. Radchenko after examining 3D-models; C — 3D-mesh.

The study of the portable stones from the Wizard's Cave of Kamyana Mohyla indicates several characteristic features to be mentioned for their technological description and contextualization. First, the shapes of the objects from the Wizard's cave were slightly manufactured before engraving. All stones from the collection are covered with desert varnish. Moreover, the portable stones from Kamyana Mohyla lack archaeological context; we are forced to consider them *per se*.

Second, the typological analysis of the engravings cross-sections showed the absence of technological differences between different portable rock art specimens assets. At the same time, these assets are different by the physical parameters of stone support and, thus, by the depth of engraved lines.

Third, there is an apparent technological similarity between parietal and portable rock art engravings in Wizard's Cave. Though measured parameters of engravings might slightly differ, their overall geometry remains the same, indicating scratching is the primary engraving strategy.

Lastly, portable rock art specimens from Wizard's Cave share irregular and non-iconographic engraving patterns without recognizable motifs. While this complicates their attribution and contextualization, some parallels might be hypothetically drawn under existing circumstances.

The structuring of discovered Western European stone plaquettes collections showed that "simplified representations are also found in the Upper-Final Magdalenian together with very naturalistic figures, some turning very schematic" (Naudinot et al. 2018; also see Ruiz et al. 2022). These recent finds (Roussot 1987; Paillet and Man-Estier 2014) introduce 1) the gradual shift from the classic Magdalenian figurative art towards the abstract expressions on the portable stones; 2) the presence of schematic representations in the Magdalenian art complexes — "the presence of geometric elements is another typical feature of Epimagdalenian rock art and of the mobiliary art included in this style" (Ruiz et al. 2022: 18). The chronological and technological attribution of Upper Paleolithic sites within the Kamyana Mohyla surroundings so far refers to the same chronological stage while the portable art specimens show the high level of non-figurativeness.

Moreover, non-figurative ornamentation of the portable stones is common in the Upper Paleolithic art of Northern Europe (Plonka and Kowalski 2017). Most of it is presented with engraved bones from Hamburgian or Azilian complexes (Plonka and Kowalski 2017: 174) but also includes Magdalenian ones (Sieveking 1987a). Such motifs are also known from Upper Paleolithic decorated bones, antlers, and tusks of Mezhyrich, Mizyn (Iakovleva 2009), and Rogalik (Gorelik 2001: 209). However, decorated bone objects from Ukraine mostly feature geometric ornamentation — lattices, so-called meanders, zigzags, etc. (Iakovleva 2010). If this is considered, the portable rock art from Kamyana Mohyla remains alone with other Ukrainian archaeological objects. However, it shares some standard features with the mobile art of Western Europe. Under no circumstances might they be persuasively attributed to Upper Paleolithic without direct archaeological or chronological proof. Such attribution, however, is possible due to the relevant features of Magdalenian objects and the known archaeological context of the region. This should be taken into account in future research.

For now, it is clear that the second hypothesis of V. Danilenko has been demonstrably proven to be false. Unlike the contextualization of fish figures from Churinga’s cave, the interpretation and contextualization of the specimens from Wizard’s cave have failed. The reasons for this were a failure in the comprehensive recording of the rock art, a lack of resources, methodological limitations, and tendentiousness in the interpretation process. This once again raises a poignant question about the existence of Upper Paleolithic art at Kamyana Mohyla, potentially rendering previous assumptions or interpretations as dubious, and highlighting a severe lack of comprehensive evidence to support those assertions. At this point, there is literally not a single rock art specimen that would persuasively support such an attribution.

5.3. Concluding remarks on the interpretation of the portable rock art objects

The results of the photogrammetric study of the portable and parietal art objects from Kamyana Mohyla allowed adding new data and concepts to the interpretation and attribution of these artifacts. The photogrammetric survey of the artifacts' surfaces brought a bunch of new data regarding the parameters of sandstone support, engraving technology, a relative chronology of the engraving, tiny nuances of the 'biography' of some particular stones, and the accurate representation of the compositions on the stones surfaces. The latter seems to be the most important in evaluating and reevaluating the existent hypotheses on the interpretation and attribution of Kamyana Mohyla rock art.

By being consciously applied and performed, photogrammetry can be used to provide a bunch of sensible conclusions regarding the rock art of Kamyana Mohyla. Though this requires a clear data acquisition protocol and a considerable amount of processing and post-processing effort, the resulting data significantly contribute to the knowledge of the Ukrainian rock art complex.

The objectivity, accuracy, and highest possible level of abstraction give photogrammetric study the power to provide the relevant digital tracings of the rock art objects, including the tiniest marks on the sandstone surface. Applied to the case of Kamyana Mohyla, these 3D modeling-based tracings show the misleading nature of the previous data generated on the rock art of Kamyana Mohyla. The re-evaluation of these data in light of new archaeological and rock art research fostered the upgrade of the old hypotheses regarding the rock art of Kamyana Mohyla.

The former hypotheses on the Upper Paleolithic attribution of the rock art specimens from Wizard's Cave have been formulated by V. Danilenko based on the portable rock art objects attribution and interpretation. However, the photogrammetric study of these objects allowed the recreation of their digital tracings and completely dismantled the hypothesis. Moreover, such a procedure has been replicated in the eponymous parietal art engraving from the cave. While parietal and portable rock art specimens show similarity in engraving technology and overall engraving pattern, as is evident from the 3D models surface analysis, no contextual or iconographic information might have supported the initial idea of V. Danilenko.

Furthermore, the photogrammetric study of the whole collection revealed the differences in the support parameters and, consequently, in the engravings parameters between the objects from Wizard's Cave and Churinga's Cave. These data added several aspects to distinguishing different assets of the portable rock art object from different caves based on their quantifiable parameters through photogrammetric study. At the same time, this overlook emphasized the connection between the Churinga's cave assemblage and the portable stones from Kamyana Mohyla 1.

Even though a photogrammetric study showed the insufficiency of V. Danilenko's data and arguments on the churingas from Churinga's cave attribution once again, the Late Mesolithic hypothesis on these stone's attribution remains valid. The archaeological contexts of the settlement and the region additionally support it. Moreover, the photogrammetric study of the parietal rock art object from the cave No. 55 and the following analysis of its relative chronology with the consequent cultural and chronological attribution of the particular motifs created additional support for that hypothesis, connecting the fish figurines, fish-like sculpture from that cave, other parietal art objects from Kamyana Mohyla, and the river oriented society of the Hill's nearest vicinity into one frame of the Late Mesolithic occupation and imagery in Azov Sea Region. Therefore, it is reasonable to sum up the relevance of the Late Mesolithic attribution of these objects, including those from Churinga's cave, as was suggested by V. Danilenko and proved in the series of recent research. Once again, this would be impossible without the photogrammetric recording of these objects with sufficient accuracy.

Lastly, B. Mykhailov's hypotheses on the interpretation and chronological attribution of the stones from Bull's Cave and Goat's Cave have been wrong due to insufficient recording and contradictions in the archaeological contexts. Their study through image-based 3D modeling modified this hypothesis and enabled reconsideration and recontextualization of these artifacts.

As a way of producing accurate and reliable data and providing a sufficient level of the rock art recording, photogrammetry can be used to support the formulation of sensible conclusions regarding Kamyana Mohyla's rock art. However, this requires following the data acquisition strategies outlined in Chapter 3.

Last but not least, the close look at the portable rock art objects from Kamyana Mohyla performed through the lens of digital photogrammetry enabled us to consider churingas in the context of their life cycle, the story of their engraving, transportation, and deposition. This way of thinking about portable rock art assemblages has not been previously applied to this material. However, as image-based 3D modeling of portable stones allowed the proper recording of the engravings' composition in combination with the detailed analysis of their shape, it revealed the stories of reuse and reengraving of churingas followed by their deposition in the same cave — distant in time for separate fragments of the same stone. This is enhanced by the typological difference of engravings on portable stones that can be defined through photogrammetric study.

To sum up, reevaluating and reconsidering the existent hypotheses on the attribution of portable rock art objects is possible due to the sufficient level of digital recording and digital study of these stones. Supported by archaeological context and the photogrammetric study of related parietal art specimens, it provides a solid evaluation of former hypotheses and (if possible) novel contextualization of the portable stones. Due to the performed research efforts, understanding these artifacts reached a new level, supported by the adequate record and relevant additional (technological, contextual, and compositional) data extracted from the photogrammetric study of these objects.

CONCLUSION

This is my research. Starting with the puzzling finds in the 2016 field season it developed into a study of the largest portable rock art collection in Ukraine. It was driven by the artifacts and methods and sometimes led me in an unpredictable direction. After all, that is what is expected from archaeological research. The known collection of portable specimens from Kamyana Mohyla grew from 170 objects to 370, developing in terms of find locations, forms, and technological characteristics. Research tools and the results of their application led to new concepts and new horizons, widening our view on the portable object assemblages and what can be known about them. Finally, research questions twist and collide with methods to introduce new knowledge and to reveal the future prospective. All of these brought me back to the archaeological and rock art context of these decontextualized objects and incorporated the whole site into the whirlpool of the research process — bringing answers and pointing to additional questions. This is the correct place to draw a line and make a conclusion on the research questions formulated in the first chapter of the text.

As the whole concept of the work is transdisciplinary and covers both photogrammetric and rock art research, the research questions broadly cover the vast spectrum of technical, technological, methodological, archaeological, and rock art issues. Starting from determining the technical basics of photogrammetrical study of the rock art research, they go down to the particular case studies on the archaeological and chronological attribution of the Kamyana Mohyla rock art with the small additional case study on the portable rock art objects from Gobustan National Historical and Artistic Preserve. Here are these research questions and the conclusions — answers to them, delivered in the course of this research:

1. What are the accuracy assessment strategies for the photogrammetric study of the portable rock art? How to calculate and achieve required accuracy throughout the data acquisition procedures?

The successful and informative photogrammetric study of the portable rock art specimens must rely on the clear and conscious accuracy assessment procedure that includes calculating data acquisition parameters based on the desired parameters of the model. In order to reconstruct a sufficient level of details with the quantifiable surface, the accuracy of the image-based 3D model should go well beyond the submillimeter level, with the calculated precision of the model at least three times higher than its accuracy. The determined accuracy calculation workflow has been structured to guide the research process from determining the desired accuracy to the specific camera resolution. This has been codified in the procedure IDEF0 diagrams and flowcharts defining workflow and accuracy assessment strategies.

Another issue during the process is the calculation of the resulting accuracy based on the reference instruments used during the data acquisition process. In order to support this level of accuracy, this solution must provide the submillimeter reference accuracy at the highest possible level of reliability. Moreover, such a solution must be complementary to the data acquisition features for the image-based 3D modeling of portable objects. The design and test of this solution is the answer to research question No. 2.

Therefore, as an answer to the first research question, the thesis proposes a series of diagrams and charts that explicitly describe the workflow and calculation procedures behind the accuracy assessment strategy for the photogrammetric study of portable rock art specimens.

2. What technological solutions are needed to perform a comprehensive image-based 3D modeling and the following study of the portable rock art?

The research procedures described and tested in Chapter 3 of this study present a series of products that aim to answer this research question. First, the developed metallic reference plate as a specific technological product shows the efficiency, sustainability, and reliability during the data acquisition for image-based 3D modeling. The technological design behind this plate is unique: it uses the advances of CNC technology and Postscript language to provide a portable and scalable material solution to the data acquisition process. Moreover, the product has been tested metrologically and photogrammetrically and proved suitable for the image-based 3D modeling of portable rock art objects. The research outlined that to achieve reliable 3D models for further analysis. The applied technological solutions must be sustainable, transparent, reproducible, and enable accuracy estimation and evaluation. The developed tool fits these criteria in the best possible way.

In order to ensure compatibility with the data acquisition for the image-based 3D modeling of the portable objects, this metallic reference plate has been tested in combination with different software solutions — those that followed the essential criteria of presenting the reliable and applicable workflow for the wholistic 3D modeling of portable objects (masking before alignment). This combination resulted in a specific workflow for the image-based 3D modeling of the mobile rock art specimens. The workflow has been structured and codified in the IDEF0-diagram as the reproducible and open solution for the photogrammetric study of similar materials. Last, but not least, it has been tested and evaluated on several different objects, including the portable specimens from Kamyana Mohyla and Gobustan Historical and Artistic Preserve. The resulting RMSE for these case studies does not exceed 0.5 mm, while the models' precision is close to 0.15 mm.

Last but not least, the results of image-based 3D modeling have been post-processed by specific program solutions to make analyzing the models' surface more efficient and straightforward. This is another addition to the proposed workflow.

Therefore, this research question is addressed by developing the specific piece of equipment that makes the photogrammetric study of portable rock art objects with submillimeter accuracy achievable, reproducible, and straightforward. Moreover, the workflow procedures that stay behind the use of this equipment have been described as the specific workflow that updates the methodological nuances of the photogrammetric research of portable rock art.

3. What information can be obtained from the study of image-based 3D-models of portable rock art objects regarding the engravings production, composition, relative chronology and relation to the specific stone support?

The application of the developed technological solution and workflow to the portable rock art specimens from Kamyana Mohyla and Gobustan highlighted the information that might be achieved through a photogrammetric study of the digital surfaces of engraved stones.

To begin with, this digital collection enables the reproduction of rock art specimens' digital traces with the highest achievable moment level of accuracy, objectivity, and abstraction. Though this result is not novel, it is the first time presented in combination with the detailed accuracy assessment strategy and accuracy evaluation procedure. It is extremely valuable, given the poor recording of the artifacts under study.

Second, the post-processing and analysis of the image-based 3D models revealed the capacity to define the superimpositions, e.g., the relative chronology of the engraved surfaces, and extract the contextual information regarding the sequence of the rock art surface's modification. As shown by the parietal art examples under study (e.g., the sculpture from cave No. 55), this is a valuable and informative tool for determining the features of the objects 'biography' and its chronological and possibly cultural attribution.

Third, photogrammetric modeling of the portable stones gave access to a new feature of the stone support — hardness/density. Although theoretically reachable by other methods, this parameter is first introduced in the context of studying the collection of portable rock art objects. Applied to the particular study case, it provided additional data on the engraved stones.

Fourth, photogrammetric modeling of the rock art specimens provides:

- Abundant information regarding the parameters of specific engravings.
- Giving insights into the engraving technology.
- The metric parameters.

- Tiny differences between engravings under study.

The proposed metric evaluation and typological classification of the engravings ‘ cross-sections for the portable stones of Kamyana Mohyla proposes technological and metric solutions for determining the specific differences between the particular carvings and stones. It provides sufficient data to describe the specific engravings outside their iconographic and figurative context. Applied to the particular case of Kamyana Mohyla, this feature becomes a great advantage of the method.

In short, the image-based 3D modeling of the portable rock art artifact can contribute to the study of mobile rock art specimens by providing information on the engraving composition (with a sufficient level of accuracy, objectivity, and abstraction), technology (from the difference on the engraving procedure (scratching, pecking or polishing) down to the nuances of the difference of time spent on the particular engraving procedure), parameters of the stone support (hardness of the rock), the relative chronology of engraving (through the analysis of the specific engravings on the stone surface superimposition) and the quantification-based typology of the engravings' through their cross-sections.

4. How can photogrammetry be used to provide sensible conclusions for the study of Kamyana Mohyla rock art?

In terms of using photogrammetry to provide sensible conclusions for the study of Kamyana Mohyla rock art, this research has shown an abundance of practices that were applied to these objects for the first time and are completely changing our former perception of this assemblage. Among these, accurate and reliable digital tracing was probably, the most important from the contextual and attributional point of view. Since the painting on the churingas surface that was done during the previous study prevented the adequate perception of the object, the abstraction level provided by photogrammetry was crucial to make the proper observation and provide reasonable conclusions. Indeed, this procedure revealed the complete absence of the iconographic image in the whole collection and the non-reliability of the tracings made during the previous study, which launched the new procedure of their interpretation and attribution.

Moreover, combining the metric-based typology of engravings' cross-sections and the portable stones' density separated them into three groups. It highlighted the technological similarity of these groups in contrast to the physical difference of the stone support. This emphasized the effect that this difference caused on the shape of engravings and revealed the probable parameters of principle importance for those who made the engravings during pre-History. Moreover, this procedure dismantled the hypothesis on the principal technological difference between the churingas from different caves.

In short, no sensible conclusions would be possible on the cultural and chronological attributions of the Kamyana Mohyla rock art without the support of a photogrammetric study. It revealed the previously misleading data acquisition and interpretation patterns and showed new ways to consider and contextualize these objects in light of further data.

5. What can image-based 3D modeling and an analysis of the Kamyana Mohyla portable rock art specimens’ collection add to our understanding of their life cycle?

The detailed analysis of the portable objects' surfaces resulted in a comprehensive understanding of their engraving, breakage, deposition, and decontextualization. Together with the archaeological knowledge of the procedures of these stones' transportation to and from the caves of Kamyana Mohyla, this gives a general understanding of the life cycle of these stones with a particular emphasis on the specific and the most indicative cases. The analysis shows that these portable rock art specimens follow the generalized scheme described by Tosello & Villaverde, modified by the specific deposition in the particular cave and the complete absence of iconography on the objects' surface. As the data of the photogrammetric study revealed the impact of the support hardness (and, consequently, efforts spent on the engraving) of the portable stones, they emphasized the importance of the engraving as a process for those modifying the stone. This indicates that the way human beings interacted with the portable stones was connected to the previously non-discussed categories. Thus, the human-nonhuman relations between the Kamyana Mohyla cultural landscape agents are embodied in the non-iconographic expressions on churingas and are a component of their life cycle. Such a way of thinking was never applied to portable objects from Ukraine.

As an additional case, the photogrammetric study of the portable objects from Gobustan National Preserve showed the capacity of photogrammetry to contribute to the reconstruction of the engraving strategy for the specimen. The detailed analysis of the plaquettes from Bendyustyu surfaces revealed the clear relative technological sequence of engraving these stones on a detailed and technologically sufficient level. This is emphasized by differences in engravings' cross-sections and the surface traces on the block as studied through image-based 3D modeling.

In short, photogrammetric study as an observation and investigation practice enables a closer look at the artifact's features, revealing the generalized life cycle of portable objects and indicating the features of unique cases. Moreover, such a study can provide data for the detailed reconstruction of engraving technology, down to the nuances of specific processes. While the case study from Kamyana Mohyla shed light on the churingas' life cycle and the human-nonhuman relations of the engraving procedure, the study of the plaquettes from Bendyustyu was beneficial in defining the specific engraving strategy.

6. Is it possible to upgrade the old V. Danilenko and B. Mykhailov's hypotheses on the archaeological and chronological contexts of Kamyana Mohyla portable rock art or formulate new ones based on the information obtained from the results of the performed photogrammetric study? What are these updates and hypotheses?

The data extracted during the photogrammetric study of the portable rock art objects from Kamyana Mohyla contribute much to the issues of their archaeological and chronological attribution. The former hypotheses were formulated, modified, and updated by V. Danilenko and B. Mykhailov and relied on the data produced by these scholars according to the methodological trends of their time. However, a novel way of digital recording and the study of this assemblage affected these theories in a new way. The photogrammetric research became a crucial supportive statement to the argument regarding the Late Mesolithic attribution of the specimens from Churingas cave. Though V. Danilenko postulated his idea without reliable and considerable proof based on his (generally misleading) recording methods, his initial idea appeared correct. The photogrammetric study that has been done in the course of this research filled the hypotheses with a series of arguments: the relative chronology and cultural attribution of the sculpture from the cave No. 55; the accurate digital traces of the portable stones from the Churingas cave; the possible connection between the assemblage from this cave and the portable rocks from the Late Mesolithic layers of Kamyana Mohyla 1 settlement; the quantifiable difference with the portable stones from Wizard's cave in contrast to the similarity of the specimens from Churingas cave; the mutual context of all these pieces of evidence as indicating the general Late Mesolithic context of river-oriented societies as typical for the vast area from Danube to the West to Siberia to the East. Together, these arguments transform an initial hypothesis into a solid and sound statement on the Late Mesolithic attribution of this assemblage.

The other way around, the hypothesis on the Upper Paleolithic attribution of churingas from Wizard's cave has been completely dismantled during a photogrammetric study. The parietal art motifs considered Upper Paleolithic back in the 1970s have been studied photogrammetrically, reexamined, and reattributed. Moreover, as the portable stones from Wizard's cave revealed the complete absence of iconographic motifs, it is clear that V. Danilenko's statement does not rely on any reasonable arguments. Though there is a clear connection between the parietal and portable art of Wizard's Cave, there is not a single piece of evidence that these are connected to the Pleistocene imagination. In this case, the photogrammetric study indicated the impossibility of any cultural or chronological attribution before the new round of fieldwork came. Instead, it allowed shifting focus on the human-nonhuman interactions and the life cycle of the studied objects.

In short, the photogrammetric study of churingas from Kamyana Mohyla gave an essential update to the former hypotheses on attributing portable stones from Churingas and Wizard's caves. While several arguments have supported the Late Mesolithic attribution of the former, the context of the latter one becomes unclear. It requires additional study before any attribution can be provided.

To sum up, the conclusions of this complex transdisciplinary work consisted of developing accuracy assessment strategies, workflows, and technological solutions for the photogrammetric study of portable rock art specimens. These solutions were developed, tested, schematized, and applied to case studies. Furthermore, the research revealed the potential of photogrammetry to contribute to the specific aspects of the portable rock art study, including digital tracing, relative chronology, parameters of stone support, the life cycle of the portable stones, and specific technological details of the engraving procedure. Applied to the particular study case of the portable stones from the Kamyana Mohyla rock art complex in Ukraine, photogrammetry allowed for their careful and reliable recording. It fostered the careful contextualization of these specimens in light of previously formulated and new cultural and chronological attribution hypotheses. Last but not least, this data-driven research enables the latest look at the portable rock art of Kamyana Mohyla, apart from the fruitless (for the moment) attempts of its direct semantic and iconographic interpretation.

Therefore, the conclusion statement of this research would be that by relying on the properly determined, designed, and tested accuracy acquisition strategies that are supported by sufficient technological and methodological solutions, the photogrammetric study of portable rock art will be able to produce new knowledge on many different aspects of this assemblage, i.e., the engravings' technology and relative chronology, the physical parameters and the features of the complex life cycle of portable objects, their chronological attribution, contextualization, and cultural and chronological attribution. However, this amount of different data is a good payback for transdisciplinary and data-driven research as the photogrammetric study of portable rock art is. The current research is a valid example of such a workflow and the benefits it brings even for comparatively modest study cases, deprived of helpful iconographic expressions or informative archaeological context.

The last statement to be made is on the importance of digital studies and digital recording of Ukrainian cultural heritage today. While my country is at war, every single cultural heritage object threatened by destruction, damaged, or illicitly displaced. Therefore, 3D modeling of rock art specimens from Kamyana Mohyla has now become a vital task during this page of our history. Moreover, nobody knows if the site will survive the war — my study might be the last one ever performed there. And if not (and I really hope this is not the last one), it forms a solid basis for further digital preservation and recording of this incredible site and is a good starting point for a structured digital recording of prehistoric cultural heritage of Ukraine in general.

At long last, this research is an important cornerstone not only for my academic career, but also for the study of Kamyana Mohyla and the rock art of Ukraine. Together with my colleagues we have enhanced our shared knowledge of the site and the region during the past decade and taken an incredible step toward making the rock art of Ukraine visible and understandable, while our scientific methods were achievable, relevant, and presentable to the community worldwide.

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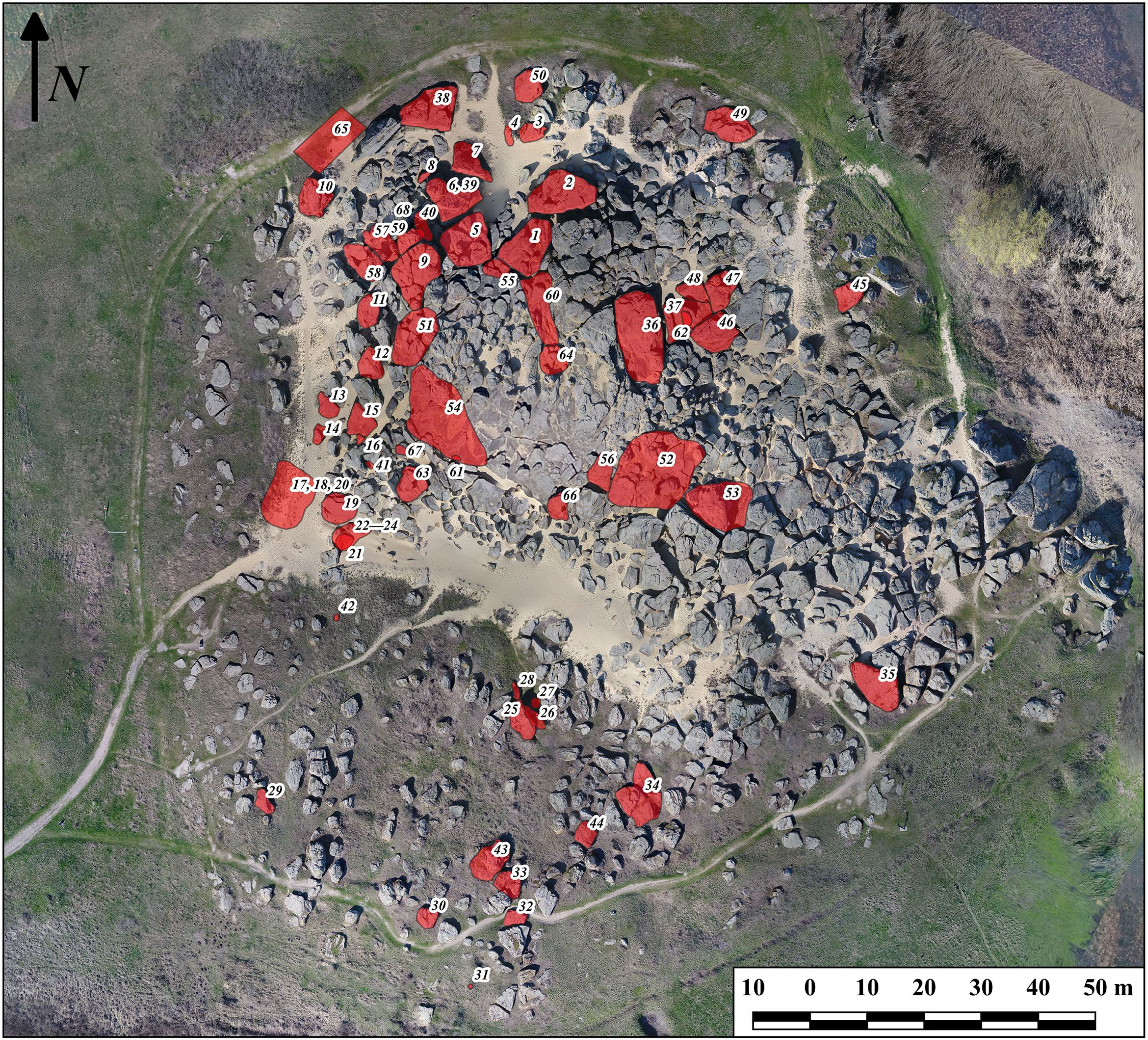
Annex A

The list of Kamyana Mohyla rock art locations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The map of Kamyana Mohyla locations.

1—5, 7, 8, 10—14, 17—24, 26—32, 38—45, 47, 49, 50, 57—59, 61—68 — unnamed locations;

6 — Cave of a Fish;

9 — Bull’s cave;

15, 16 —Dog’s cave;

25, 26, 27, 28 — Horses blocks;

33 —Bagaturs stone;

34 —Blocks of Footsteps;

35 — Cabinet of M. Rudinskiy;

36 — Bison’s cave;

37 — Harnessed Bulls cave;

46 — Harnessed Bulls cave;

48 — Harnessed Bulls cave;

51 — Cave of Mysteries;

52 — Wizard’s cave;

53 —Horseshoe cave;

54 — Cave of Churingas;

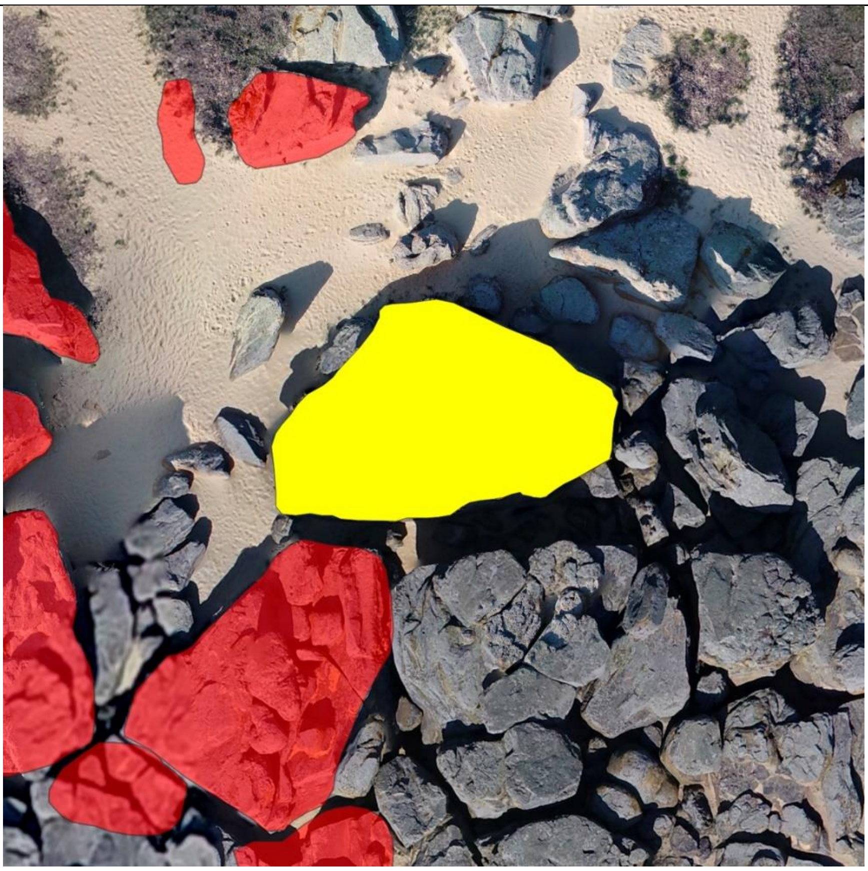
55 — Dragon’s cave;

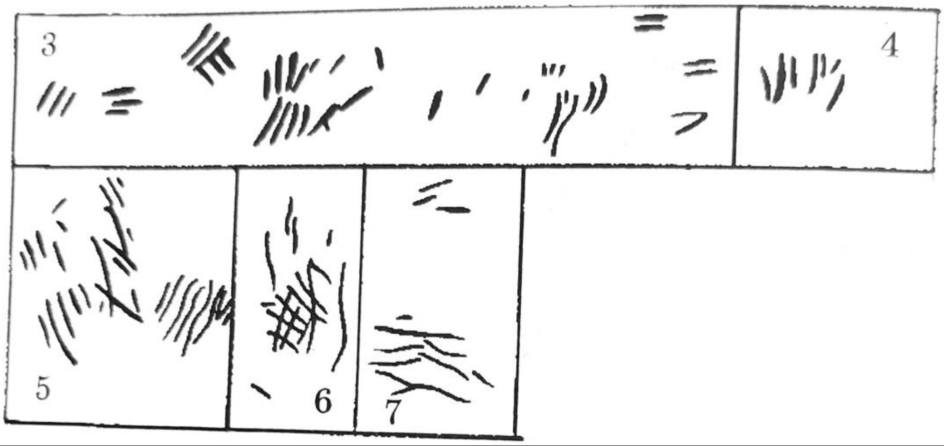
56 — Cave of a Fish;

60 — Cave of a Goat.

Location No.	**1**
Location Name	**Location No. 1**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description	The ceiling once belonged to the big cave in the deep part of the protrusion. The cave occurred due to the destruction of the hill monolith. Engravings are located on the façade and lower part of the ceiling.
Parietal art specimens description	Linear engravings; geometric engravings; fish-like image.
Description source	Mykhailov 2005: 44

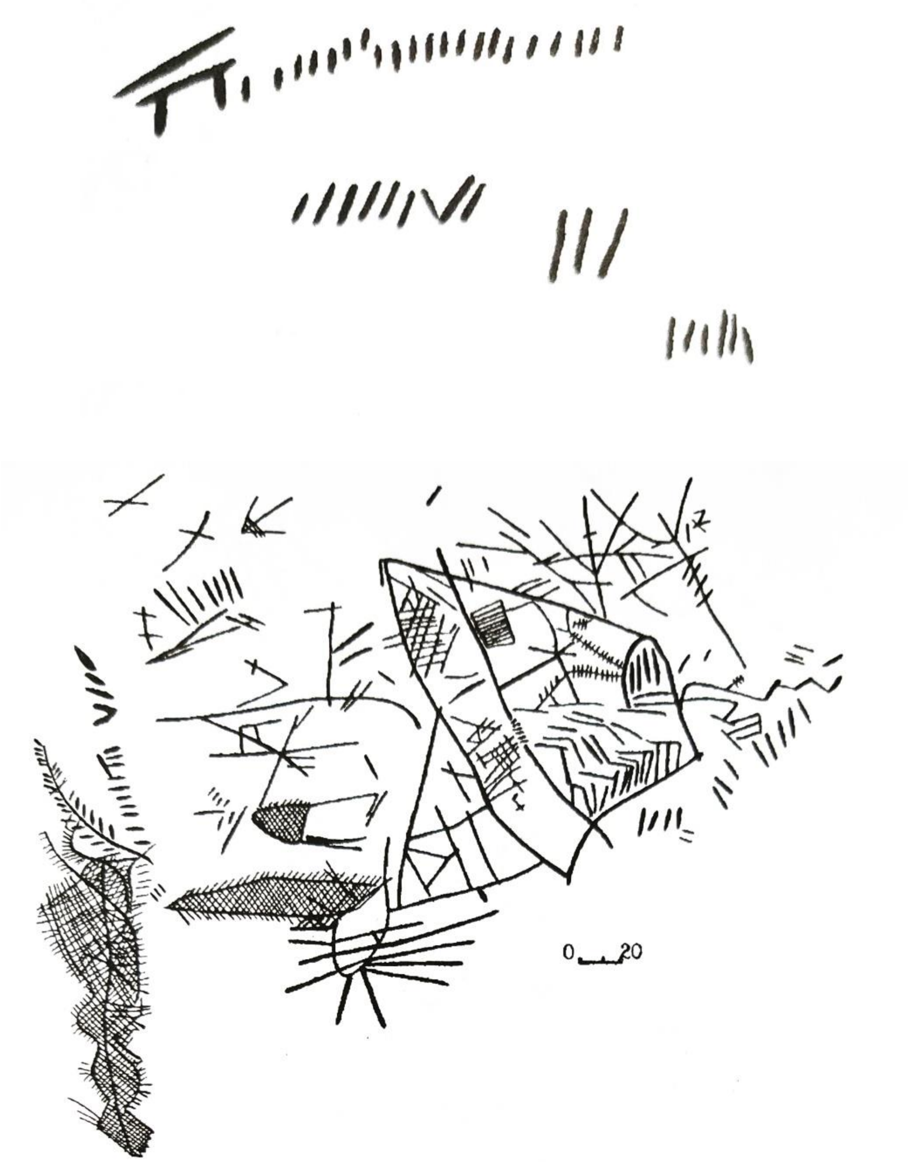
Parietal art drawings	
Drawing source	Mykhailov 2005: 198, fig. 3
Attribution	—
Attribution source	—
Portable art specimens	1 instance, amorphous, dated back to Neolithic Age
Portable art specimens No.	3788

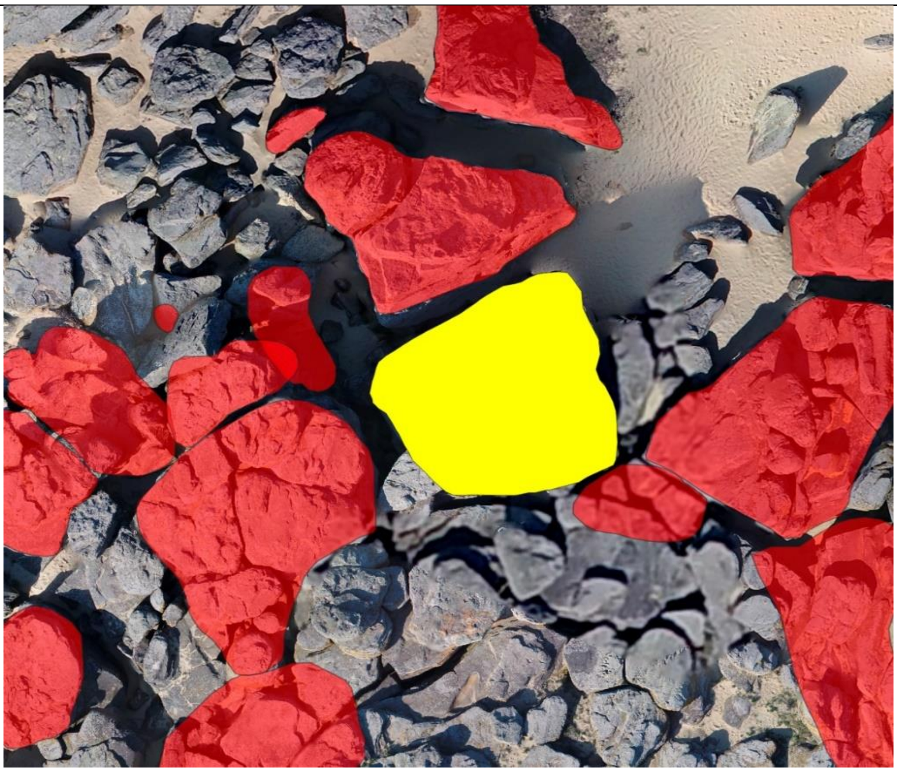
Location No.	**2**
Location Name	**Location No. 2**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description	Massive block with zoomorphic images
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic engravings.
Description source	Mykhailov 2005: 45

Parietal art drawings	
Drawing source	Mykhailov 2005: 198, fig. 3
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

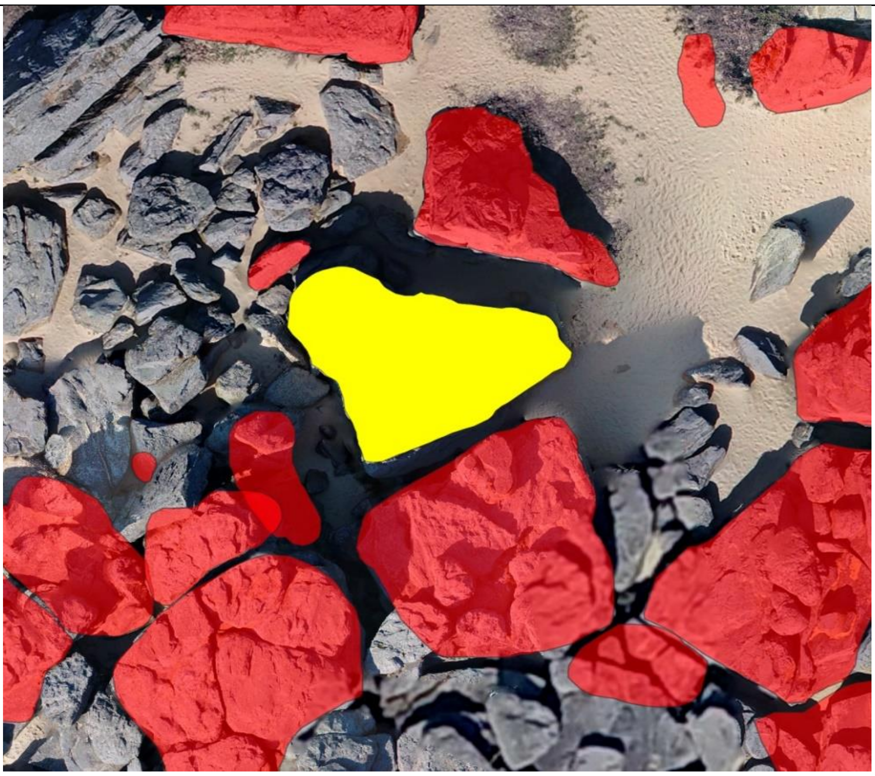
Location No.	**3**
Location Name	**Location No. 3**
Place on the map	
Placement description	Northern shelf of the Hill
Current state	Accessible, well preserved
Description	An oval-shape block lies near the Northern part of the Hill under an angle of 45 degrees. Linear engravings are located on the external scrapping of the block nearby the entrance of the small cave.
Parietal art specimens description	Linear engravings; geometric engravings
Description source	Mykhailov 2005: 45
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**4**
Location Name	**Location No. 4**
Place on the map	
Placement description	Northern shelf of the Hill
Current state	Lost or covered with sand
Description	Massive block with half-protrusions. It broke away from block (location) No. 3 and lies under the 80o on the Northern shelf, oriented North. Engravings are located on the lower part of the block, on the northern part.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic image; probably an image of the fishing tools.
Description source	Mykhailov 2005: 45—46

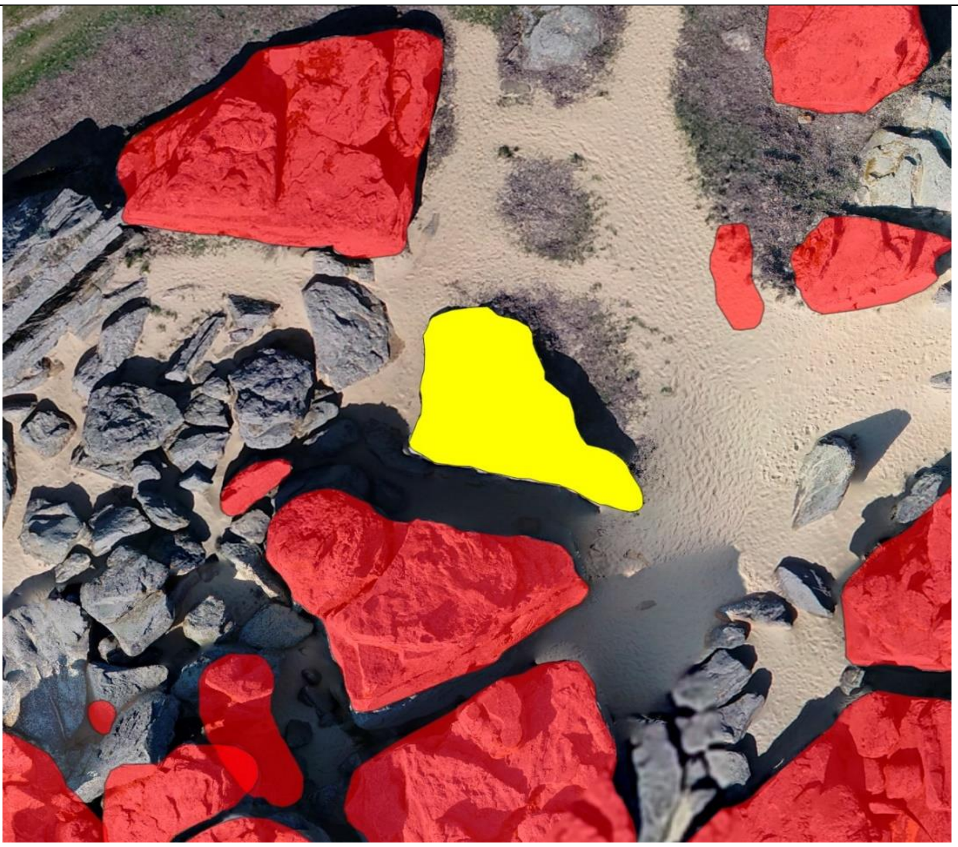
Description source	
Parietal art drawings	Mykhailov 2005: 198—199, fig. 3, 4
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

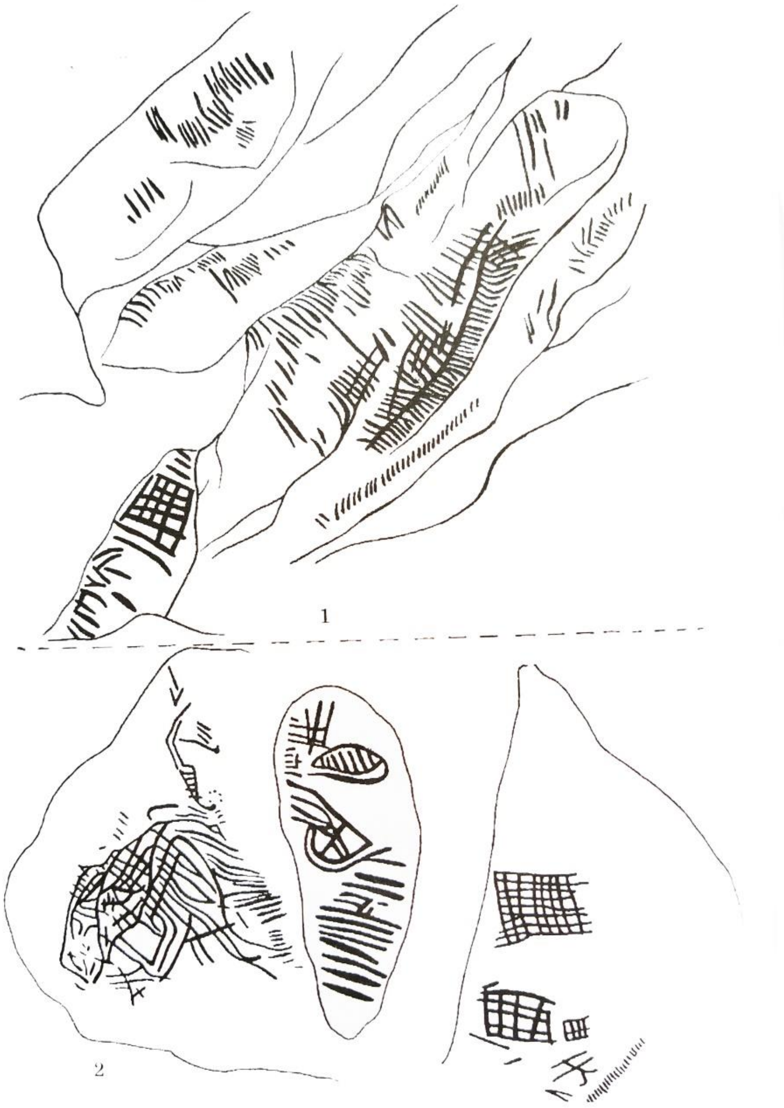
Location No.	**5**
Location Name	**Location No. 5**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description	A massive block is located on the Northern slope of the hill. The ceiling contains protrusions and engravings and is blackened with smoke. O. Bader, V. Danilenko and M. Rudinskiy have discovered numerous different engravings.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic image.
Description source	Mykhailov 2005: 46

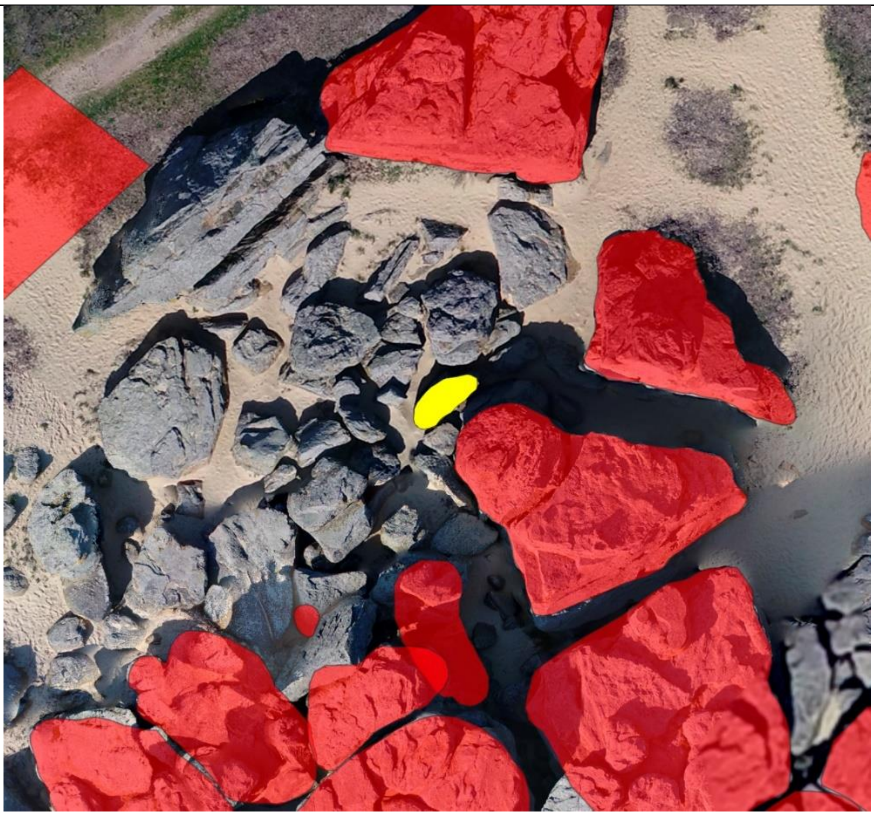
Parietal art drawings	
Drawings source	Mykhailov 2005: 198—199, fig. 3, 5
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**6**
Location Name	**Location No. 6; The cave of a Fish**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description (Mykhailov 2005, 46)	Block is a part of the block [location] No. 5 that crumbled during ancient times.
Parietal art specimens description	Linear engravings; geometric engravings; reshaped fish-like protrusion.
Description source	Mykhailov 2005: 46

Parietal art drawings	
Drawings source	Mykhailov 2005: 199, fig. 5
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

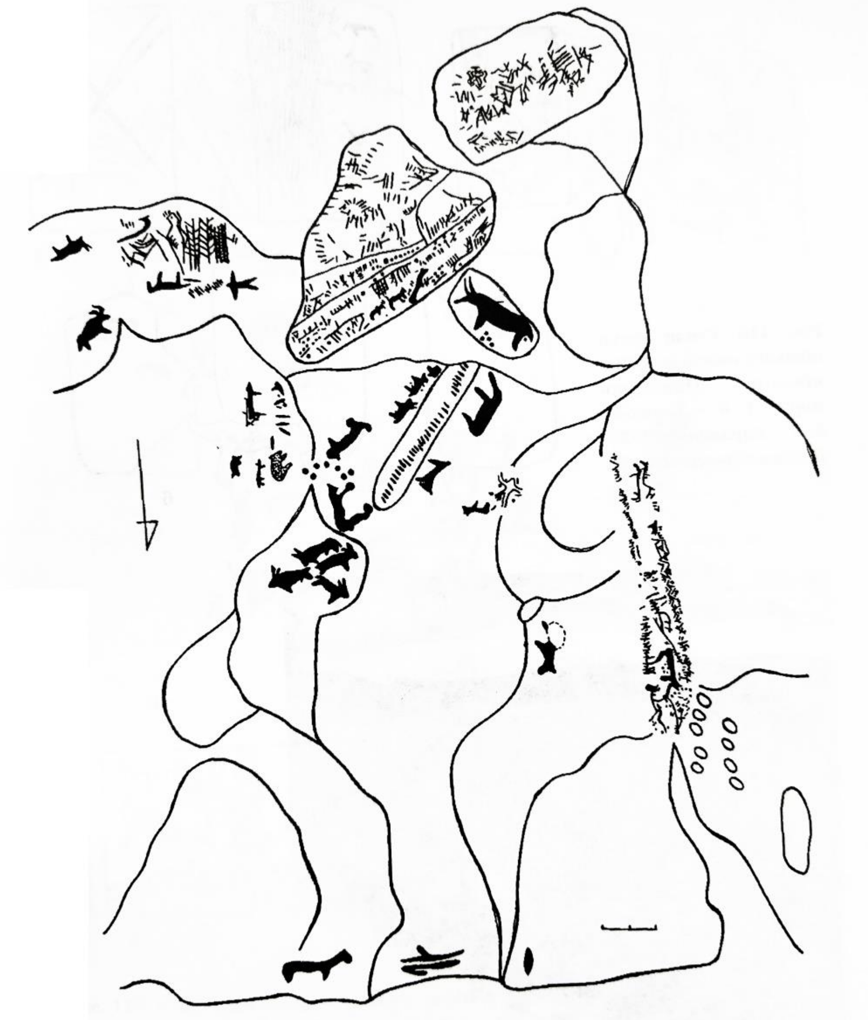
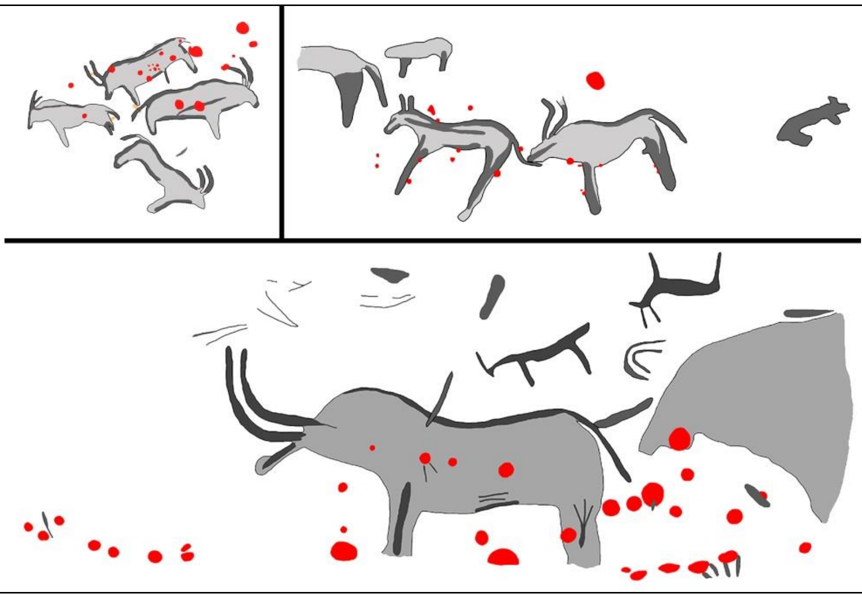
Location No.	7
Location Name	**Location No. 7**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description (Mykhailov 2005, 46—48)	A massive block that previously was one of three parts of a giant canopy. Probably, this block crashed long before the appearance of the engraving. The ceiling contains numerous canopies and protrusions.
Parietal art specimens description	Linear engravings; geometric engravings; anthropomorphic sculptures and engravings; probably an image of a boat.
Description source	Mykhailov 2005: 46—48

Parietal art drawings	
Drawings source	Mykhailov 2005: 200, fig. 6
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**8**
Location Name	**Location No. 8**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description (Mykhailov 2005, 48)	Block is located nearby the location No. 7. The small surface contains two rows of 6 engravings.
Parietal art specimens description	Linear engravings.
Description source	Mykhailov 2005: 48

Parietal art drawings	
Drawings source	Mykhailov 2005: 198, fig. 3
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

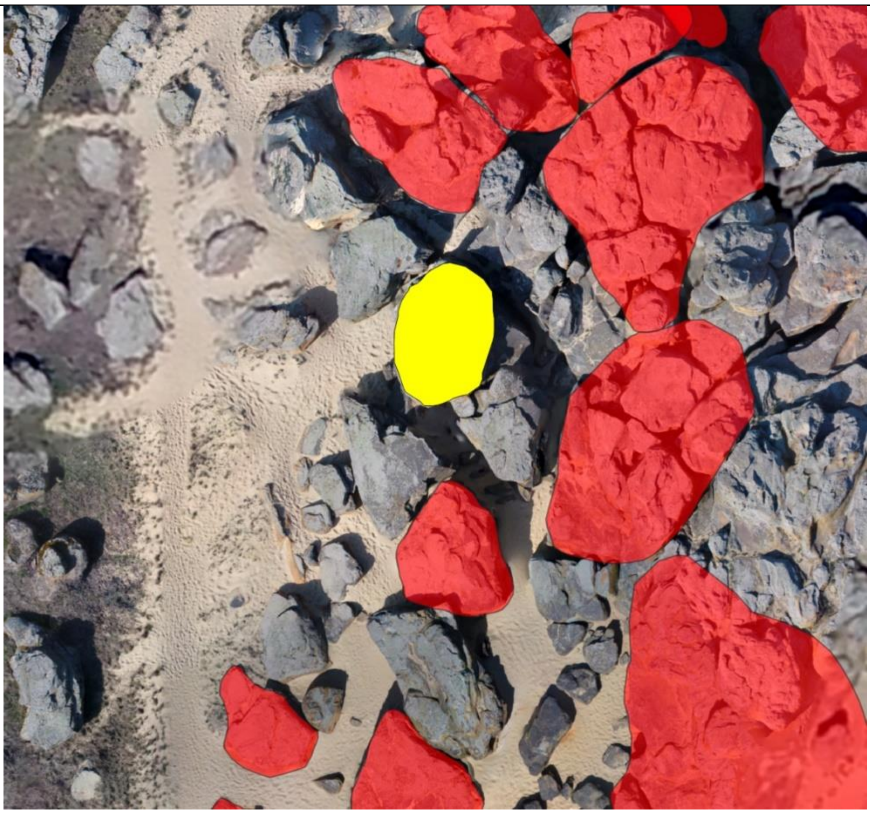
Location No.	**9**
Location Name	**Location No. 9; Bull’s cave; Mammoth’s cave**
Place on the map	
Placement description	North-Western slope of the Hill
Current state	Accessible, well preserved
Description	M. Veselovskiy discovered this first cave in 1890. The cave contains numerous engravings of animals, cupmarks, and linear and geometrics petroglyphs, some of them painted with red ocher. Engravings cover walls and ceilings. An assemblage of flint tools and pottery has been found inside the grotto.
Parietal art specimens description	Linear engravings; geometric engravings; animals; cupmarks.
Description source	Mykhailov 2005: 48—51

Plan of the cave	
Source	Mykhailov 2005: 277, fig. 115
Parietal art drawings	
Drawings source	Radchenko & Nykonenko 2019, fig. 7, 8, 11

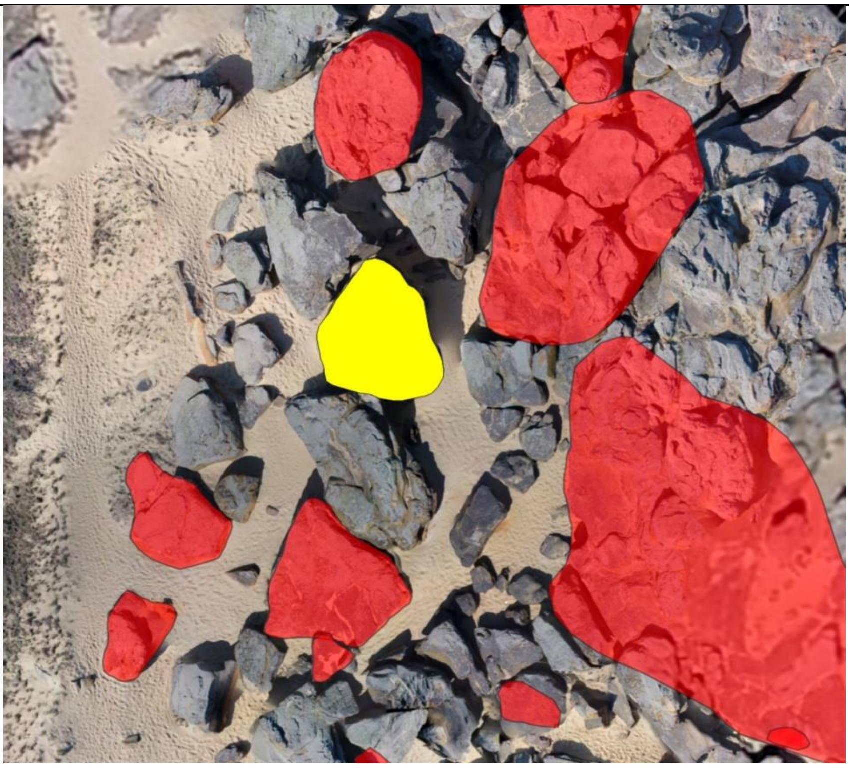
Parietal art drawings	
Drawings source	Mykhailov 2005: 201—204, fig. 8, 11, 12
Attribution	Eneolithic—Early Bronze Age
Attribution source	Radchenko & Nykonenko 2019
Portable art specimens	1 instance, subtriangular, dated back to Eneolithic Age.
Portable art specimens No.	No. 4199

Location No.	**10**
Location Name	**Location No. 10**
Place on the map	
Placement description	North-Western shelf of the Hill
Current state	Accessible, well preserved
Description	The big block on the Northern slope of the Hill. From the Eastern side of its lower part numerous notches have been engraved.
Parietal art specimens description	Linear engravings; geometric engravings
Description source	Mykhailov 2005: 51

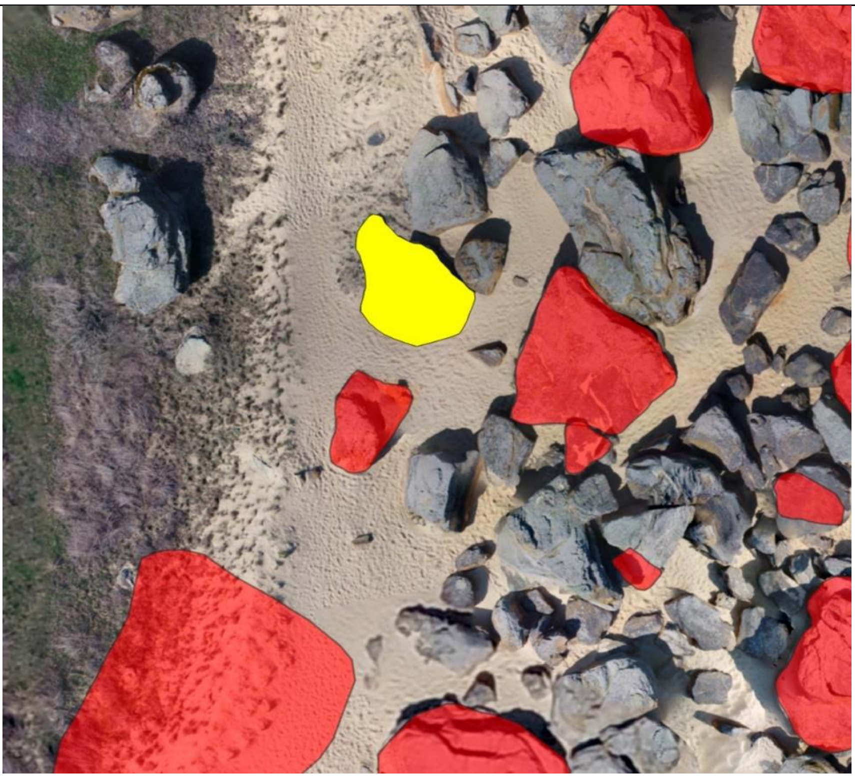
Parietal art drawings	
Drawings source	Mykhailov 2005: 199, fig. 5
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

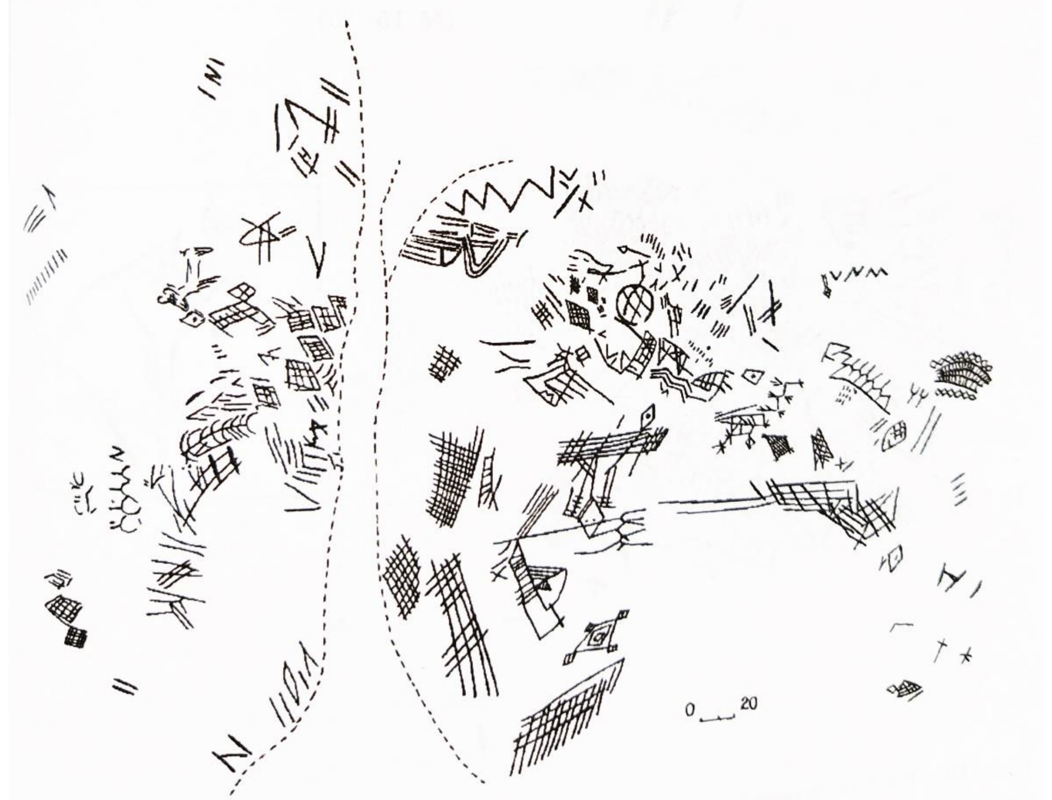
Location No.	**11**
Location Name	**Location No. 11**
Place on the map	
Placement description	Western slope of the Hill
Current state	Accessible, well preserved
Description	Block lies horizontally between location No. 9 and location No. 51. The surface of 0.5*0.5 m is covered with linear engravings and an image of an animal.
Parietal art specimens description	Linear engravings; geometric engravings; animal image
Description source	Mykhailov 2005: 51

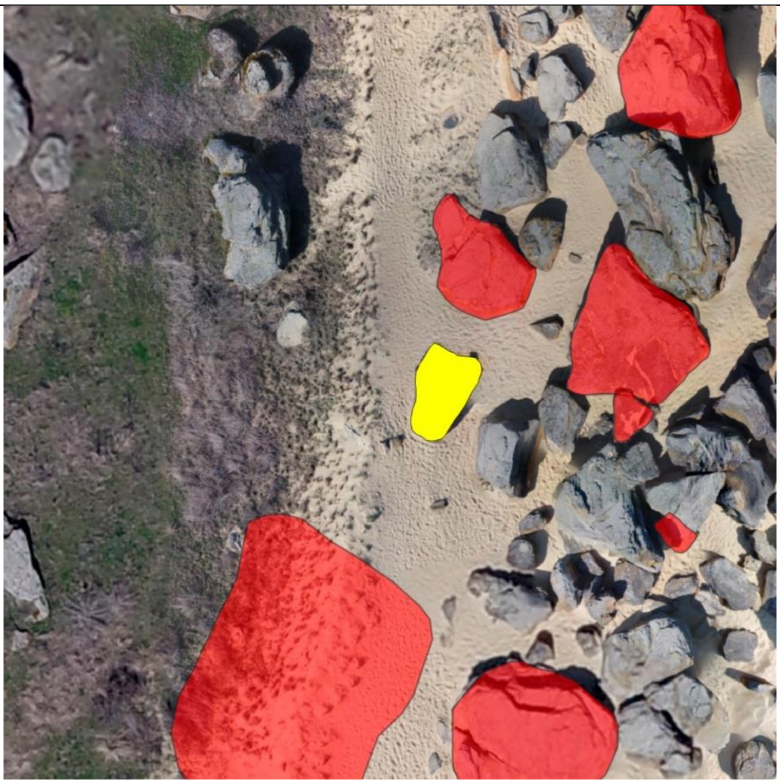
Parietal art drawings	
Drawings source	Mykhailov 2005: 199, fig. 5
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**12**
Location Name	**Location No. 12**
Place on the map	
Placement description	Western slope of the Hill
Current state	Accessible, well preserved
Description	The lower part of the block is highly destructed, though the northwest side contains shallow and narrow notches and zoomorphic figures.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic image
Description source	Mykhailov 2005: 51—52

Parietal art drawings	
Drawings source	Mykhailov 2005: 198—199, fig. 3, 5
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

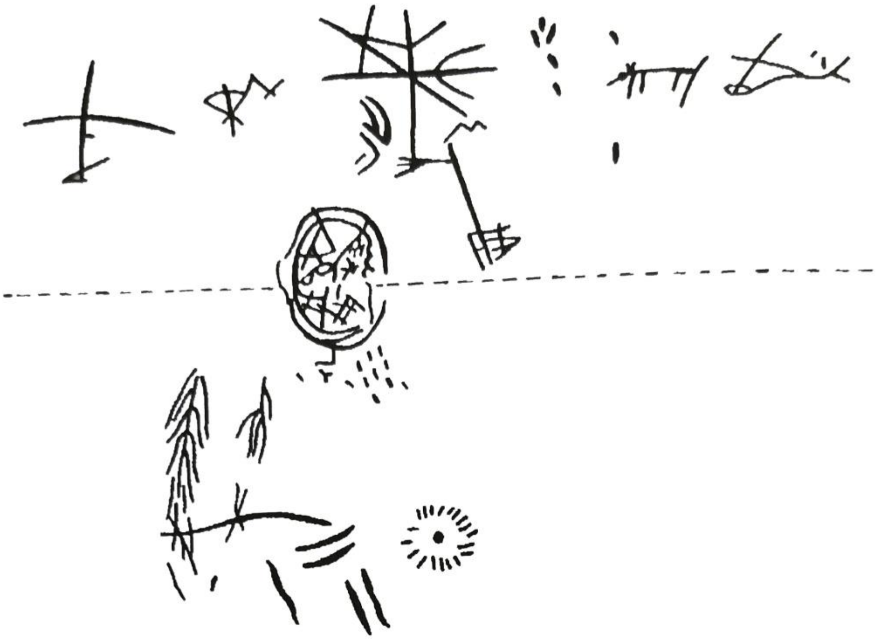
Location No.	**13**
Location Name	**Location No. 13**
Place on the map	
Placement description	Western slope of the Hill
Current state	Accessible, well preserved
Description	Engravings are located on the lower surface of the block.
Parietal art specimens description	Linear engravings; geometric engravings; an image of a boat.
Description source	Mykhailov 2005: 52

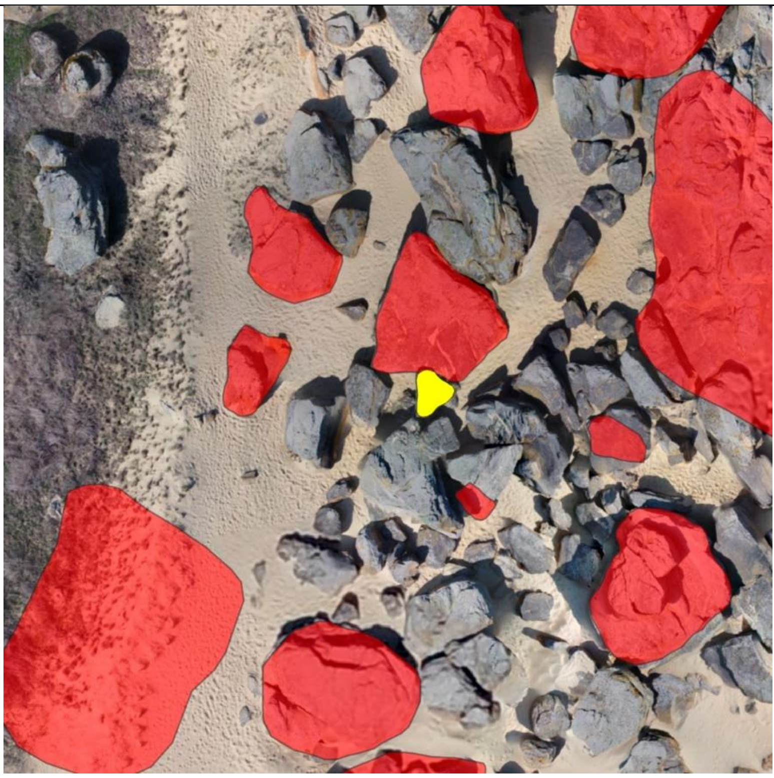
Parietal art drawings	
Drawings source	Mykhailov 2005: 205, fig. 14
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

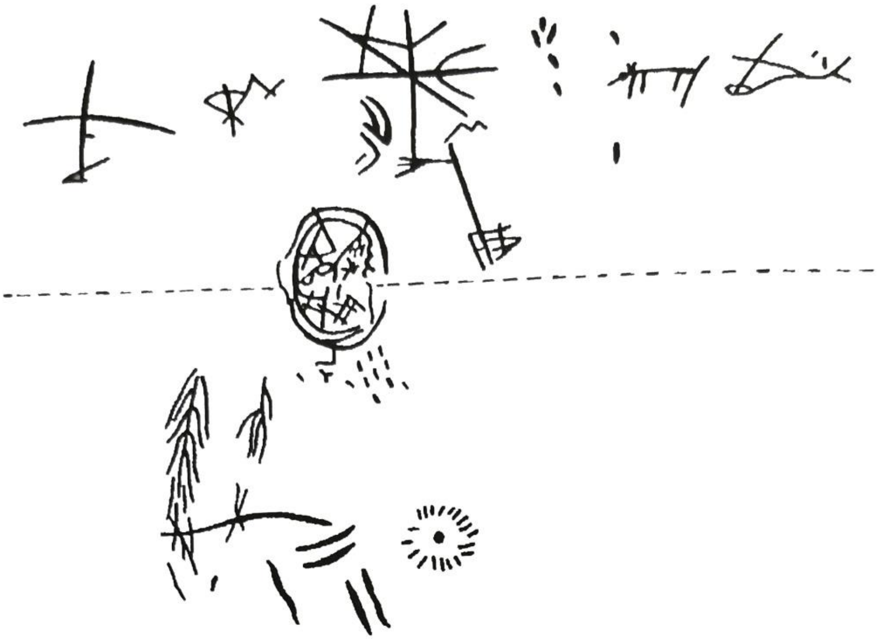
Location No.	**14**
Location Name	**Location No. 14**
Place on the map	
Placement description	Western shelf of the Hill
Current state	Accessible, well preserved
Description	Linear engravings are situated on the lower surface of a block. They grouped in groups of different quantities.
Parietal art specimens description	Linear engravings.
Description source	Mykhailov 2005: 52

Parietal art drawings	
Drawings source	Mykhailov 2005: 199, fig. 5
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

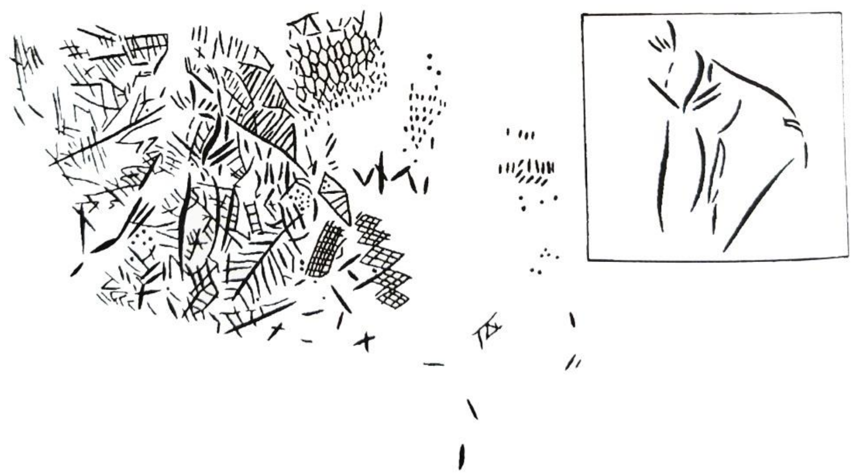
Location No.	**15**
Location Name	**Location No. 15; The Dog's cave**
Place on the map	
Placement description	Western slope of the Hill
Current state	Accessible
Description	Blocks revealed a monolith canopy connected to the central part of the Kamyana Mohyla Hill. The lower surface contains linear and realistic images. Some of them are zoomorphic. V. Danilenko considered them as a picture of a dog.
Parietal art specimens description	Linear engravings; an image of a dog; an image of a horse; a part of a circle from the location No. 16.
Description source	Mykhailov 2005: 52

Parietal art drawings	
Drawings source	Mykhailov 2005: 206, fig. 16
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**16**
Location Name	**Location No. 16; The Dog’s cave**
Place on the map	
Placement description	Western slope of the Hill
Current state	Accessible
Description	Blocks revealed a monolith canopy connected to the central part of the Kamyana Mohyla Hill. The lower surface contains linear and realistic images. Some of them are zoomorphic. V. Danilenko considered them as a picture of a dog.
Parietal art specimens description	Linear engravings; a part of a circle from location No. 15.
Description source	Mykhailov 2005: 52

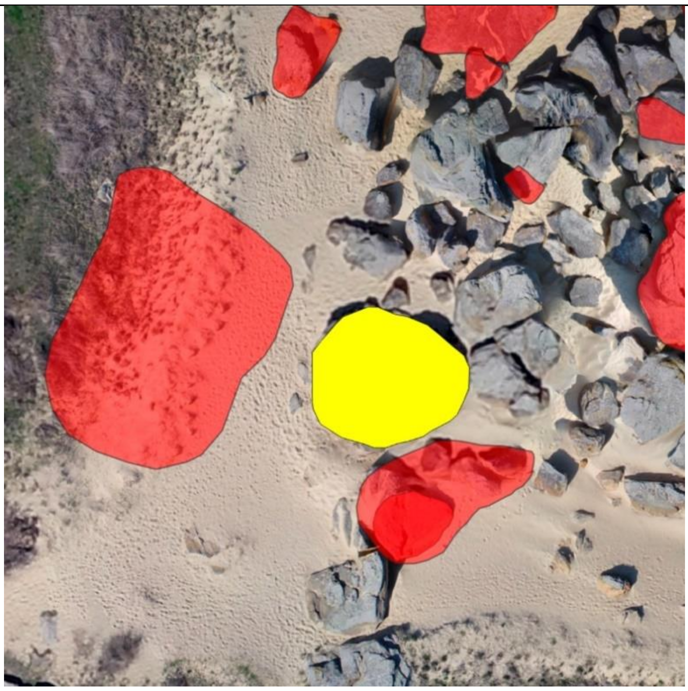
Parietal art drawings	
Drawings source	Mykhailov 2005: 206, fig. 16
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**17**
Location Name	**Location No. 17**
Place on the map	
Placement description	South-Western shelf of the Hill
Current state	Lost
Description	The ceiling once belonged to the big cave in the deep part of the protrusion. The cave occurred due to the destruction of the hill monolith. Engravings are located on the façade and lower part of the ceiling.
Parietal art specimens description	Linear engravings; geometric engravings; therianthropic image.
Description source	Mykhailov 2005: 52—53

Parietal art drawings	
Drawings source	Mykhailov 2005: 206, fig. 16
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**18**
Location Name	**Location No. 18**
Place on the map	
Placement description	South-Western shelf of the Hill
Current state	Lost
Description	The block belongs to the western group.
Parietal art specimens description	Linear engravings; geometric engravings.
Description source	Mykhailov 2005: 53

Parietal art drawings	
Drawings source	Mykhailov 2005: 199, fig. 5
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

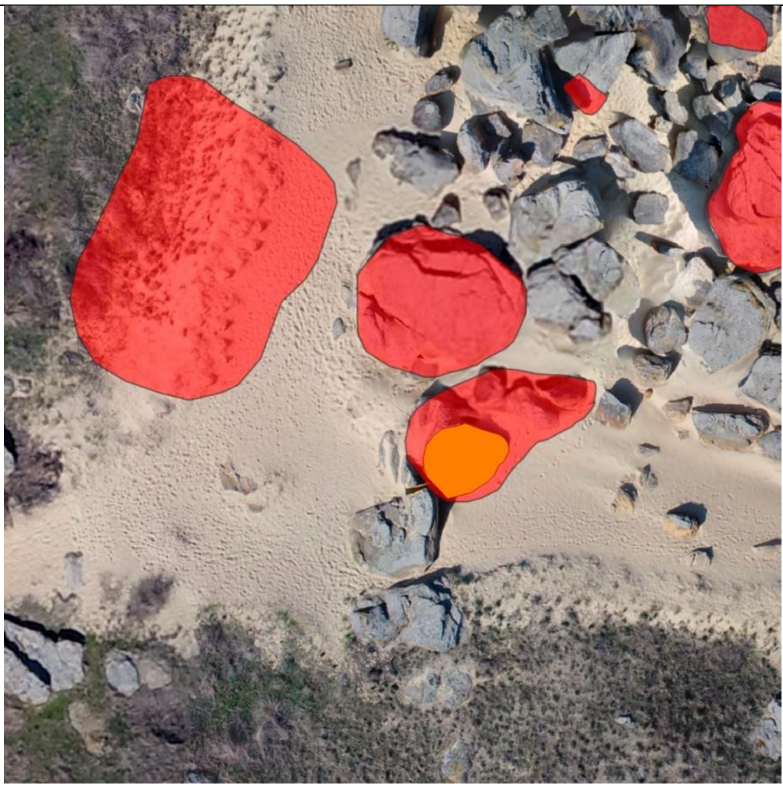
Location No.	**19**
Location Name	**Location No. 19**
Place on the map	
Placement description	South-Western slope of the Hill
Current state	Accessible
Description	According to M. Rudinskiy's ideas, the number of blocks formed a single monolith that broke before the first Kamyana Mohyla habitant's arrival. Engravings form 4 groups of linear, geometric, zoomorphic, and anthropomorphic engravings, cupmarks, etc. published by M. Rudinskiy. Most of them are covered with desert tan and located on the blocks' lower surface.
Parietal art specimens description	Linear engravings; geometric engravings; chthonic animals; zoomorphic and anthropomorphic images; an image of a turtle.
Description source	Mykhailov 2005: 53—55

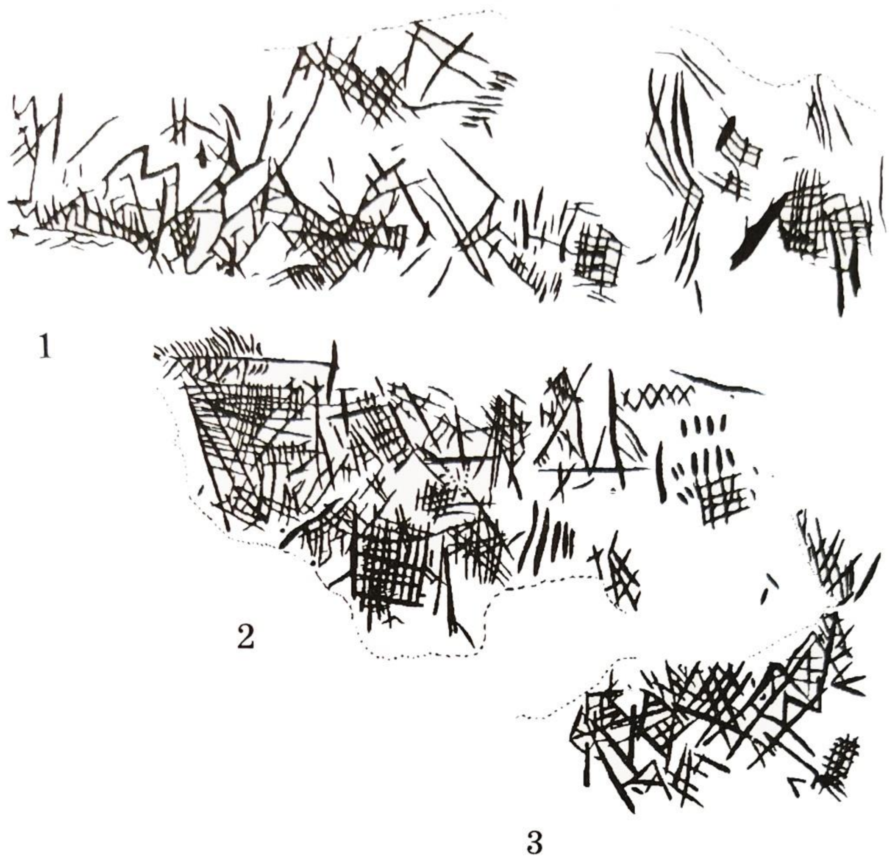
Parietal art drawings	

	
Drawings source	Mykhailov 2005: 209—210, fig. 19, 20
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**20**
Location Name	**Location No. 20**
Place on the map	
Placement description	South-Western slope of the Hill
Current state	Lost
Description	The numerous linear and geometric notches are situated on the lower surface of the block. The block itself is part of the South-Western group.
Parietal art specimens description	Linear engravings; geometric engravings.
Description source	Mykhailov 2005: 55

Parietal art drawings	
Drawings source	Mykhailov 2005: 210, fig. 21
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

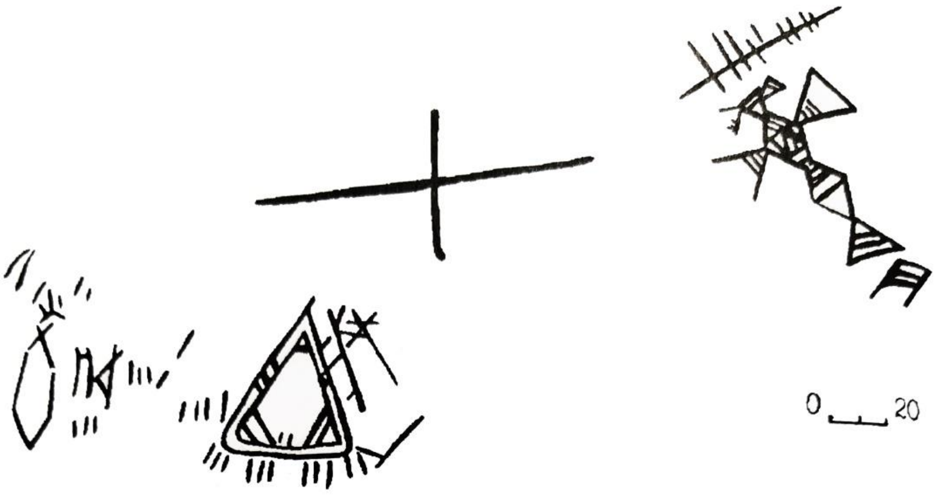
Location No.	**21**
Location Name	**Location No. 21**
Place on the map	
Placement description	South-Western shelf of the Hill
Current state	Accessible, well preserved
Description	Engravings are located on the third part of the stone and are highly eroded. They are created with two different techniques.
Parietal art specimens description	Linear engravings; geometric engravings; an image of a 'house' and a tree; an image of a deer (?).
Description source	Mykhailov 2005: 55

Parietal art drawings	
Drawings source	Mykhailov 2005: 211, fig. 22
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**22**
Location Name	**Location No. 22**
Place on the map	
Placement description	South-Western shelf of the Hill
Current state	Accessible, well preserved
Description	A massive vertical block of in a shape of a pyramid.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic images; anthropomorphic images; foot image.
Description source	Mykhailov 2005: 55

Parietal art drawings	
Drawings source	Mykhailov 2005: 211, fig. 23
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**23**
Location Name	**Location No. 23**
Place on the map	
Placement description	South-Western shelf of the Hill
Current state	Accessible, well preserved
Description	The lower part of the stone is covered with engravings
Parietal art specimens description	Linear engravings; geometric engravings; anthropomorphic images; fish-like images
Description source	Mykhailov 2005: 55—56

Parietal art drawings	
Drawings source	Mykhailov 2005: 212, fig. 24
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**24**
Location Name	**Location No. 24**
Place on the map	
Placement description	South-Western shelf of the Hill
Current state	Accessible, well preserved
Description	The block is lying under an angle of 45 degrees. Its south-western part contains zoomorphic image.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic image.
Description source	Mykhailov 2005: 56

Parietal art drawings	
Drawings source	Mykhailov 2005: 208, fig. 18
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

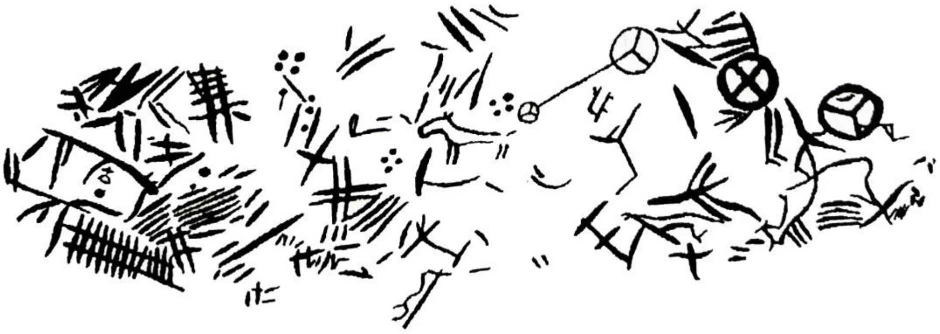
Location No.	**25**
Location Name	**Location No. 25, The Horses blocks**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible, well preserved
Description	Big blocks lie nearby the Southern slope of the Hill. Block No. 25 is oriented northwest—southeast. The ceiling has a sub-spherical shape and is highly eroded. The cave under the block contains two groups of engravings introduced by linear and geometric engravings, a picture of a wagon, a few animal images.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic images; an image of a horse; an image of a wagon
Description source	Mykhailov 2005: 56

Parietal art drawings	 
Drawings source	Mykhailov 2005: 212—213, fig. 25, 26
Attribution	Iron Age
Attribution source	Mykhailov 2005: 56
Portable art specimens	—
Portable art specimens No.	—

Location No.	**26**
Location Name	**Location No. 26, The Horses blocks**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible, well preserved
Description	Big blocks lie nearby the Southern slope of the Hill. Block No. 26 is lying vertically and oriented northwest—southeast. There are three stratigraphically different groups of images — linear ones, solar symbols, and realistic images of 7 horses and two deer.
Parietal art specimens description	Linear engravings; geometric engravings; solar symbols; zoomorphic images; images of horses and deer's.
Description source	Mykhailov 2005: 57

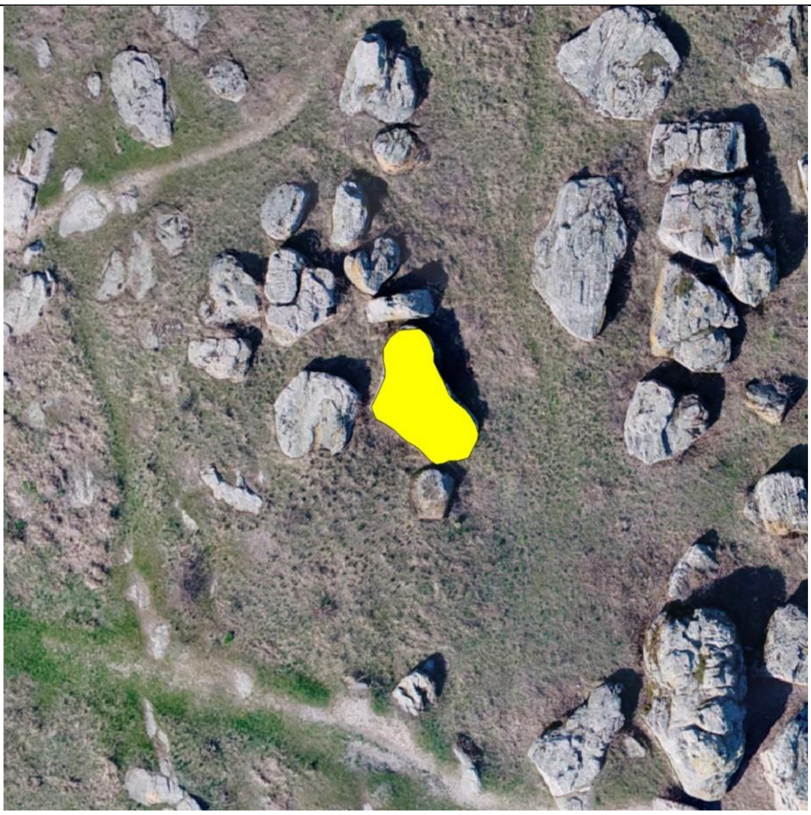
Parietal art drawings	
Drawings source	Mykhailov 2005: 213, fig. 27
Attribution	Iron Age
Attribution source	Mykhailov 2005
Portable art specimens	—
Portable art specimens No.	—

Location No.	**27**
Location Name	**Location No. 27; The Horses blocks**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Lost
Description	Big blocks lie nearby the Southern slope of the Hill. Block No. 27 lies vertically near location No. 26. The left side contains several notches grouped in different groups, crosses; the central part introduces a zoomorphic image; the right one — solar symbols. The outer surface of the stone contains polysoire noticed by M. Rudinskiy.
Parietal art specimens description	Linear engravings; geometric engravings; solar symbols; zoomorphic image.
Description source	Mykhailov 2005: 57—58

Parietal art drawings	
Drawings source	Mykhailov 2005: 213, fig. 27
Attribution	Iron Age
Attribution source	Mykhailov 2005
Portable art specimens	—
Portable art specimens No.	—

Location No.	**28**
Location Name	**Location No. 28, The Horses blocks**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible, well preserved
Description	A few images are located on the lower surface of the block. In contains linear engravings, crosses, footsteps, the image of horses, and several cupmarks.
Parietal art specimens description	Linear engravings; geometric engravings; horses images; footstep; crosses etc.
Description source	Mykhailov 2005: 58

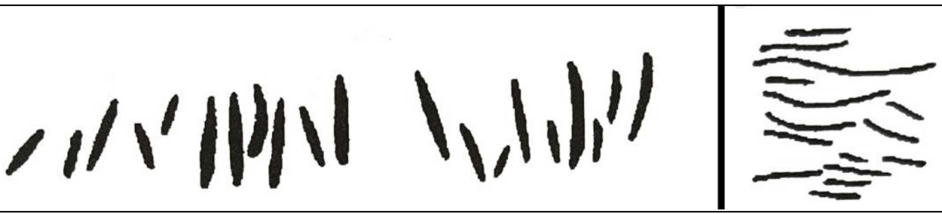
Parietal art drawings	
Drawings source	Mykhailov 2005: 214, fig. 28
Attribution	Iron Age
Attribution source	Mykhailov 2005
Portable art specimens	—
Portable art specimens No.	—

Location No.	**29**
Location Name	**Location No. 29**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible
Description	The block lies horizontally on the southwestern part of the Kamyana Mohyla shelf. Engravings are located on the western side of a block and introduced by wavy lines, cupmarks, and linear notches.
Parietal art specimens description	Linear engravings; wavy lines.
Description source	Mykhailov 2005: 58

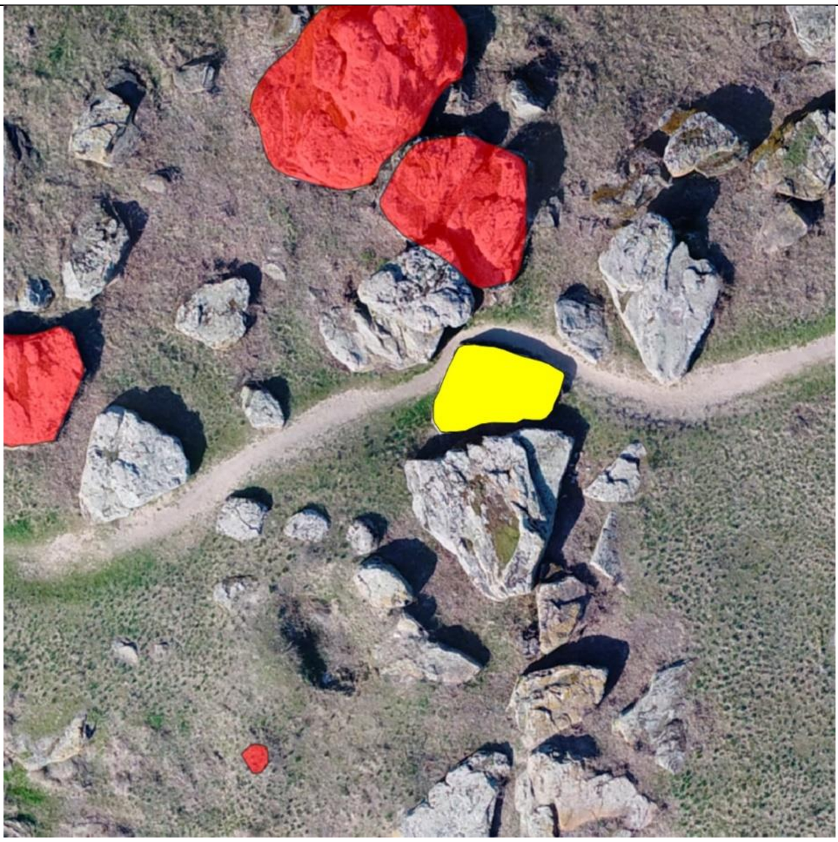
Parietal art drawings	
Drawings source	Mykhailov 2005: 215, fig. 29
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

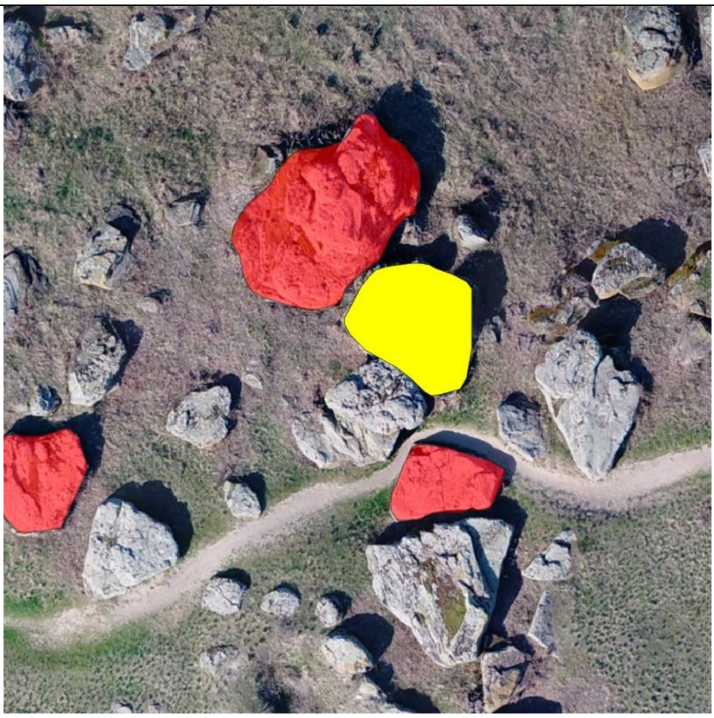
Location No.	**30**
Location Name	**Location No. 30**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible
Description	The block lies horizontally nearby the riverbed of the ancient Sekiz river. Deep and short notches introduce the engravings on the western part of the stone, sometimes combined with perpendicular lines.
Parietal art specimens description	Linear engravings; zoomorphic image.
Description source	Mykhailov 2005: 58

Parietal art drawings	
Drawings source	Mykhailov 2005: 215, fig. 29
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

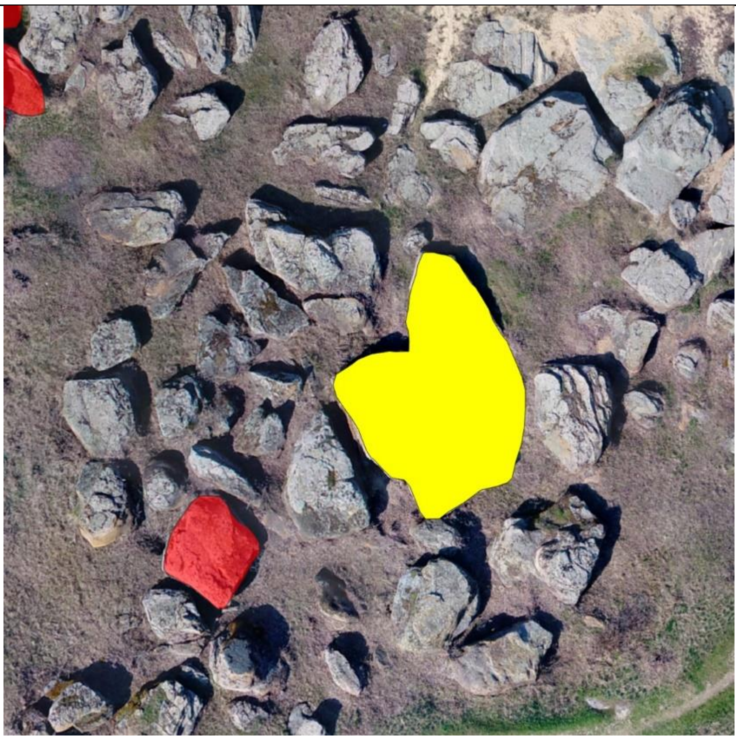
Location No.	**31**
Location Name	**Location No. 31**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Lost
Description	The small block lies horizontally in the riverbed of Sekiz river nearby the Polysoire No. 1. Short notches are located on the North side of the stone.
Parietal art specimens description	Linear engravings.
Description source	Mykhailov 2005: 58
Parietal art drawings	
Drawings source	Mykhailov 2005: 215, fig. 29

Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**32**
Location Name	**Location No. 32**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible, well preserved
Description	The stone is the left part of the so-called “dolmen”; the north side of it contains highly eroded linear and geometric engravings.
Parietal art specimens description	Linear engravings; geometric engravings
Description source	Mykhailov 2005: 58—59
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**33**
Location Name	**Location No. 33; The Bagaturs stone**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible, well preserved
Description	A part of the so-called “dolmen-like” group of blocks includes two stones covered by a huge block. The research of M. Rudinskiy revealed several images of human hands situated on the Eastern stone. The excavations held by B. Mykhailov revealed a cave with numerous engravings of hands, a boat, and an anthropomorphic figure partially covered with red ocher.
Parietal art specimens description	Linear engravings; boat; anthropomorphic figure.
Description source	Mykhailov 2005: 59

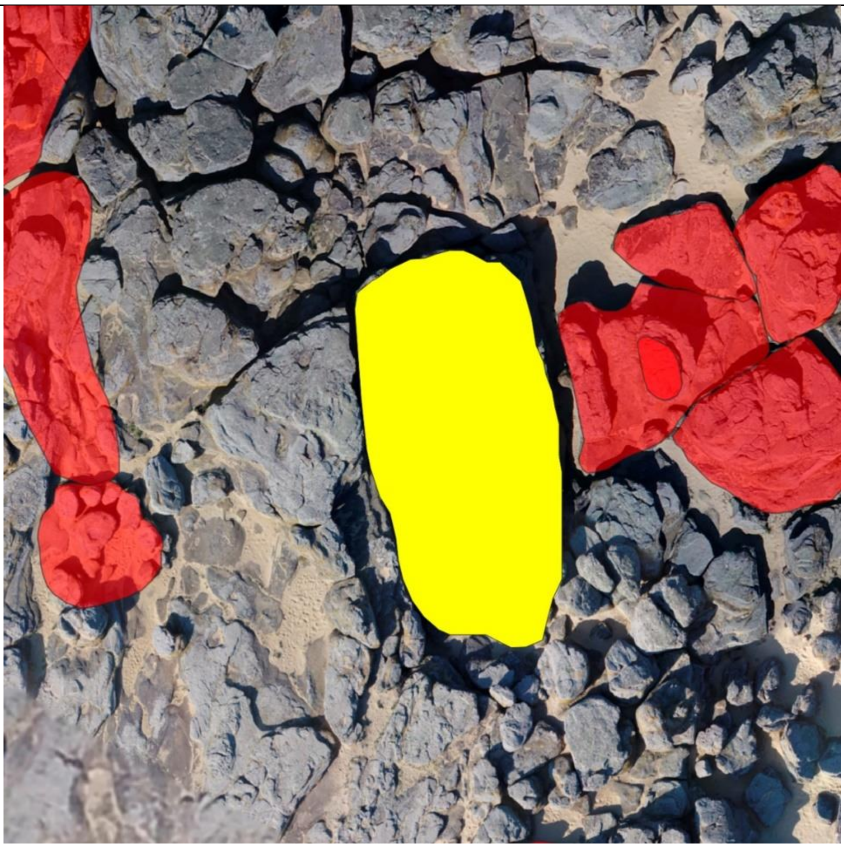
Parietal art drawings	
Drawings source	Mykhailov 2005: 215, fig. 29
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

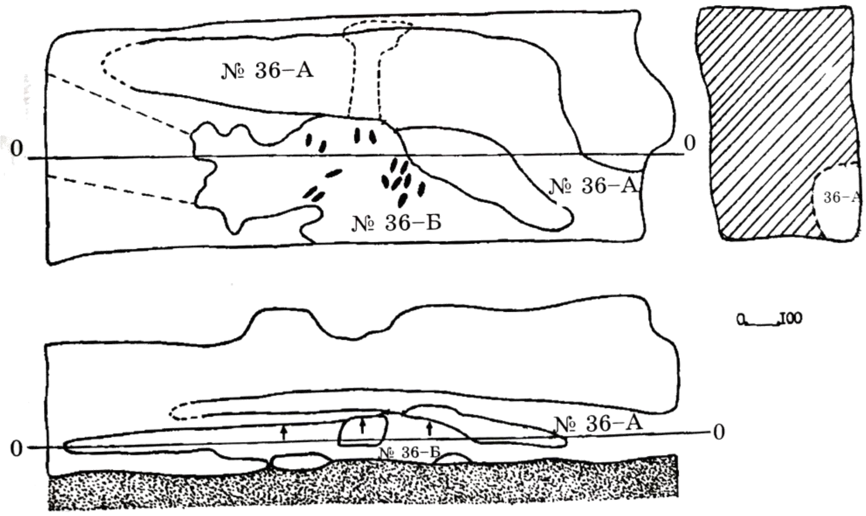
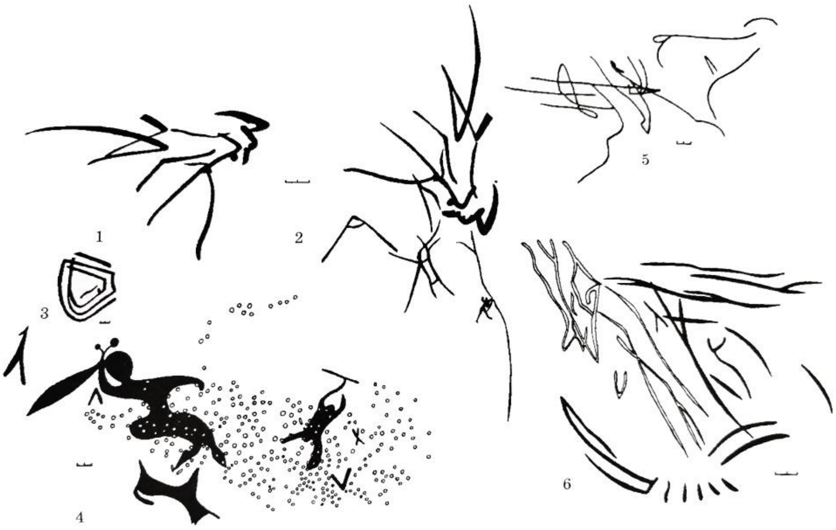
Location No.	**34**
Location Name	**Location No. 34; The Blocks of Footsteps**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description	The blocks are located on the southern shelf of Kamyana Mohyla Hill. A small and a big stone are lying horizontally. Numerous images of the footsteps and linear engravings are situated on the lower surface of the block.
Parietal art specimens description	Linear engravings; footsteps; zoomorphic creature; cupmarks.
Description source	Mykhailov 2005: 59—60

Parietal art drawings	 
Drawings source	Mykhailov 2005: 216, fig. 30, 31
Attribution	Bronze Age, Iron Age
Attribution source	Mykhailov 2005
Portable art specimens	—
Portable art specimens No.	—

Location No.	**35**
Location Name	**Location No. 35; Cabinet of M. Rudinskiy**
Place on the map	
Placement description	Southeastern slope of the Hill
Current state	Accessible, well preserved
Description	The block is situated near the slope of the hill and rises northwest with a massive canopy. Engravings are located on the lower surface of the block.
Parietal art specimens description	Linear engravings; geometric engravings.
Description source	Mykhailov 2005, 60

Parietal art drawings	
Drawings source	Mykhailov 2005: 217, fig. 32
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

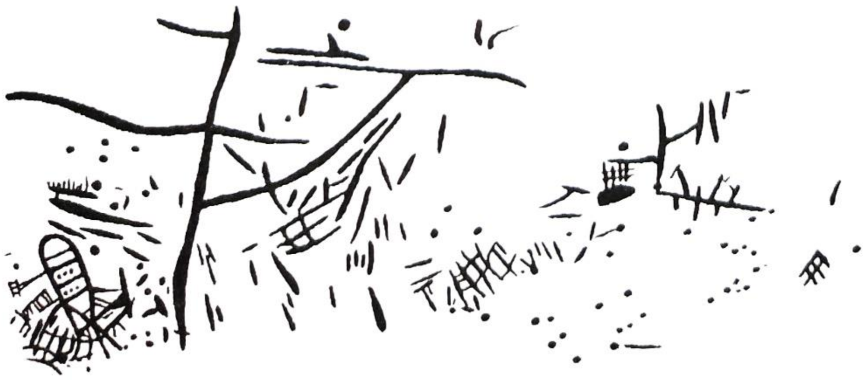
Location No.	**36**
Location Name	**Location No. 36; Bison's cave**
Place on the map	
Placement description	Central part of the Hill
Current state	Covered with sand
Description	A big grotto covered with sand contains two caves (the upper one and the lower one). Their ceiling contains numerous linear, geometric and zoomorphic engravings, divided by B. Mykhailov into six groups based on style and stratigraphy. The upper cave (36a) has been discovered by M. Rudinskiy, while B. Mykhailov has investigated the lower one (36b).
Parietal art specimens description	Linear engravings; geometric engravings; anthropomorphic images; animal images; deer's, mammoth, bison's, dogs etc.
Description source	Mykhailov 2005: 60—63

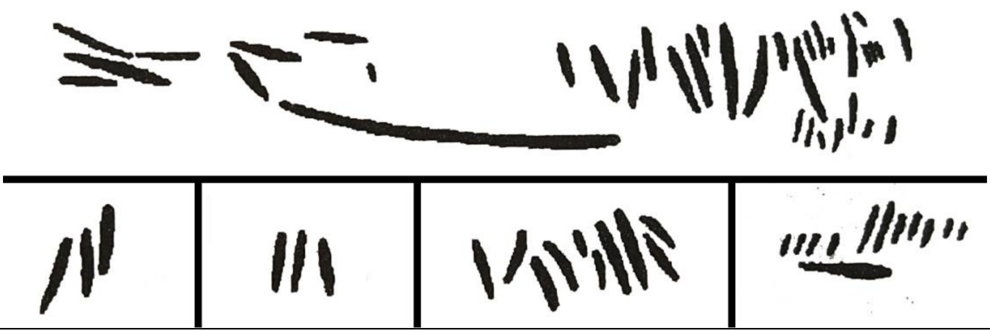
Plan and profile of the cave	
Source	Mykhailov 2005: 217, fig. 33
Parietal art drawings	 

	
Drawings source	Mykhailov 2005: 218—219, fig. 34—36
Attribution	—
Attribution source	—
Portable art specimens	32 instances of different shape (oval, amorphous, conic or subrectangular) dated back to Mesolithic—Eneolithic age by B. Mykhailov
Portable art specimens No.	The cave 36a contains 23 instances: 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 3778, 3779, 3780, 4703, 4704, 4705, 5108, 5110 and ZM3946 (two items from the City Museum of Zaporizhzhya) The cave 36b contains 9 more instances: 4695, 4696, 4697, 4698, 4699, 4700, 4701, 4702 and 5105.

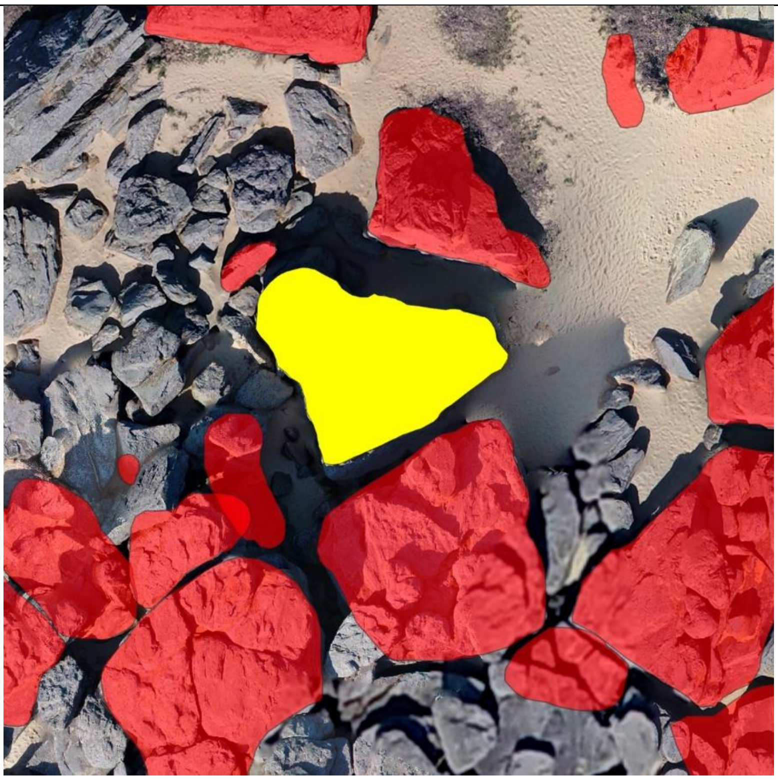
Location No.	**37**
Location Name	**Location No. 37; The Harnessed Bulls cave**
Place on the map	
Placement description	Eastern slope of the Hill
Current state	Covered with sand, well preserved
Description	The massive block is located on the Eastern slope of the Hill. The entrance into the cave is under the western part of the block. The cave widens from west to east. The ceiling is full of niches and protrusions that contain petroglyphs. The images are concentrated in three places. The cave contained a Late Bronze Age vessel founded by B. Kopylov.
Parietal art specimens description	Zoomorphic engravings; linear engravings; geometric engravings; an image of harnessed bulls and the wagon.
Description source	Mykhailov 2005: 63—64

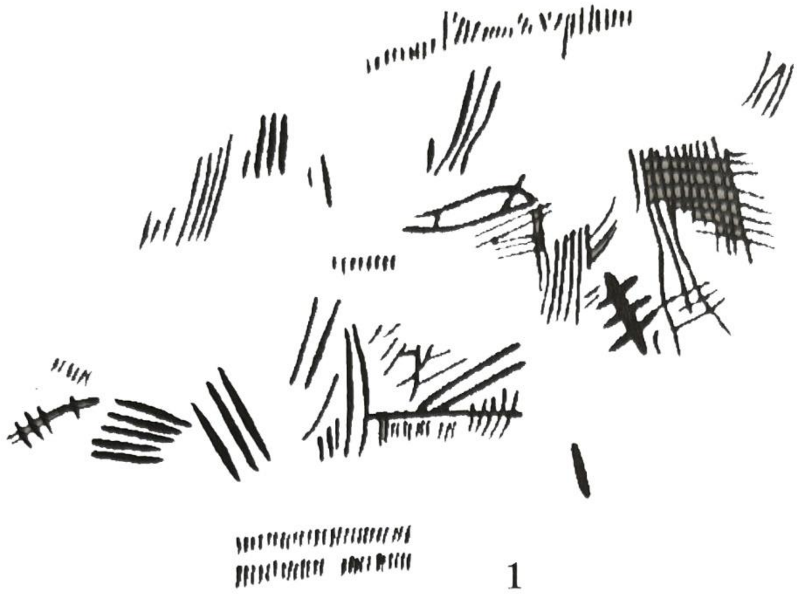
Parietal art drawings	

	  
Drawings source	Mykhailov 2005: 221, fig. 39—40
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**38**
Location Name	**Location No. 38**
Place on the map	
Placement description	Northern side of the Hill
Current state	Accessible, well preserved
Description	The block was previously connected to blocks 5, 6, and 7. Linear engravings gathered into several groups of 3, 9, and 12 notches.
Parietal art specimens description	Linear engravings.
Description source	Mykhailov 2005: 64
Parietal art drawings	

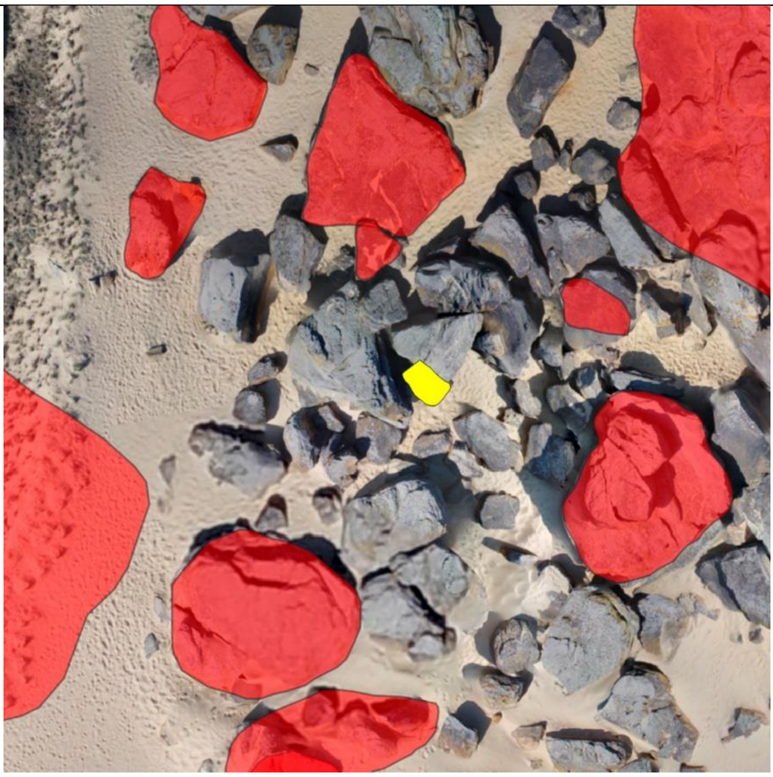
Drawings source	Mykhailov 2005: 215, fig. 29
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**39**
Location Name	**Location No. 39**
Place on the map	
Placement description	Northern slope of the Hill
Current state	The location is uncertain
Description	The engravings are probably located on block No. 6. However, Mykhailov states that the block is simultaneously nearby 37 and 38, which is impossible.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic engravings.
Description source	Mykhailov 2005: 64

Parietal art drawings	 1
Drawings source	Mykhailov 2005: 208, fig. 18
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**40**
Location Name	**Location No. 40**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, fragmented and currently stored in the funds of Institute of Archaeology of National Academy of Sciences of Ukraine, Kyiv.
Description	Small blocks are found as several fragments in a space between locations 5 and 9. The block's surface contains 'desert warnish,' geometric notches, a cross, a shake-like figure, and an image of a cow.
Parietal art specimens description	Linear engravings; geometric engravings; animal images.
Description source	Mykhailov 2005: 64

Parietal art drawings	
Drawings source	Mykhailov 2005: 222, fig. 41
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**41**
Location Name	**Location No. 41**
Place on the map	
Placement description	South-Western slope of the Hill
Current state	Accessible, well preserved
Description	The block is located between block No. 15—16 and block No. 19. Northwestern part of the block is covered with linear notches and geometric engravings.
Parietal art specimens description	Linear engravings; geometric engravings.
Description source	Mykhailov 2005, 64—65

Parietal art drawings	
Drawings source	Mykhailov 2005: 208, fig. 18
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**42**
Location Name	**Location No. 42**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible, well preserved
Description	The block (2.5 x 4.2 x 1.0 m) lies near the southwestern part of the Hill. The engravings contain two notches on the lower part of the block.
Parietal art specimens description	Linear engravings
Description source	Mykhailov 2005: 65
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

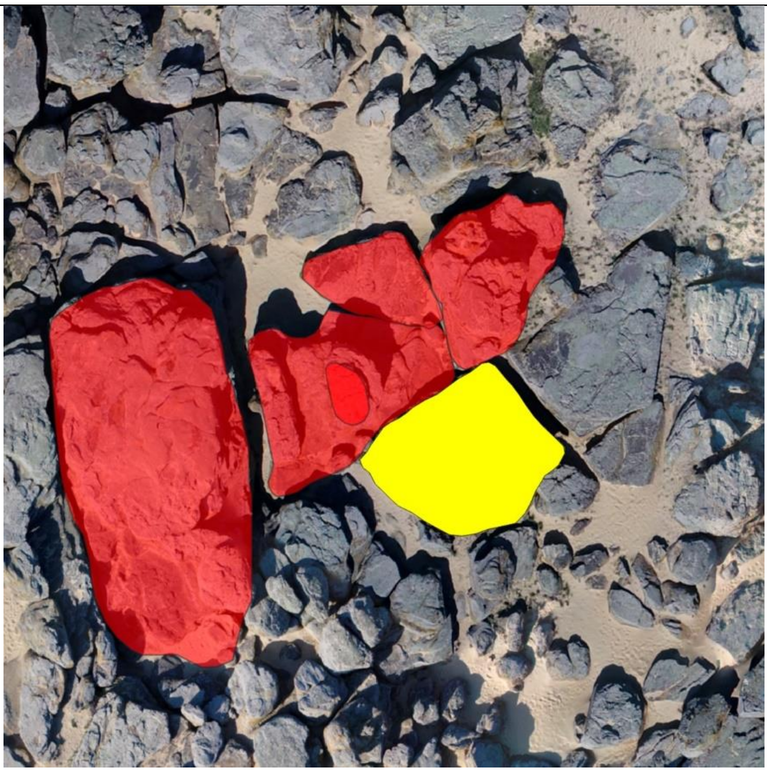
Location No.	**43**
Location Name	**Location No. 43**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible, well preserved
Description	Block (8.5 x 7 x 2 m) is located near the Southern slope of Kamyana Mohyla. Two parallel lines are engraved.
Parietal art specimens description	Linear engravings.
Description source	Mykhailov 2005: 65
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**44**
Location Name	**Location No. 44**
Place on the map	
Placement description	Southern shelf of the Hill
Current state	Accessible, well preserved
Description	A bit to the east from blocks No. 33 and 43. The block is lying horizontally on the ancient walking surface. Engravings cover 1.75 x 1 m. Three images of human footsteps are engraved. Linear notches are grouped into assets of 2, 3, 9, or more instances.
Parietal art specimens description	Linear engravings footsteps.
Description source	Mykhailov 2005: 65

Parietal art drawings	
Drawings source	Mykhailov 2005: 214, fig. 28
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**45**
Location Name	**Location No. 45**
Place on the map	
Placement description	Eastern side of the Hill
Current state	Accessible, well preserved
Description	A massive block is located on the eastern side of the Hill. The engravings are located on the northeastern side of the block and contain linear and geometric engravings, lattices.
Parietal art specimens description	Linear engravings; geometric engravings; lattices.
Description source	Mykhailov 2005: 65

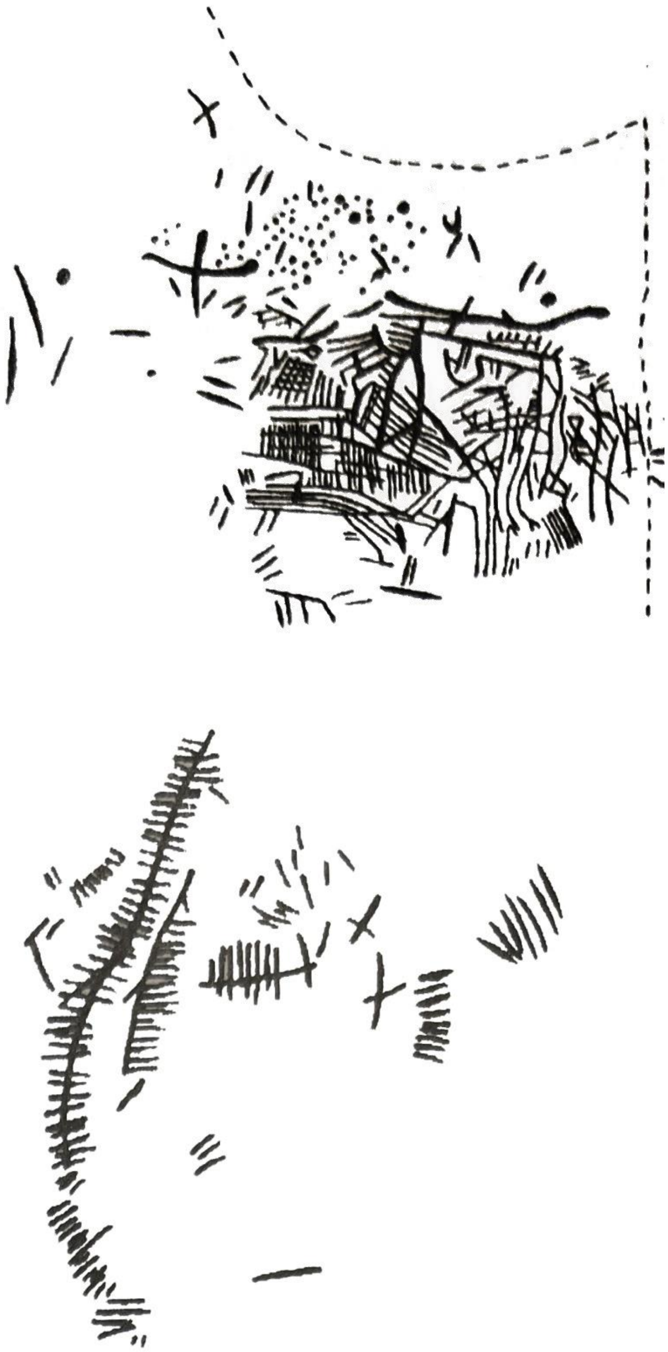
Parietal art drawings	
Drawings source	Mykhailov 2005: 214, fig. 28
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

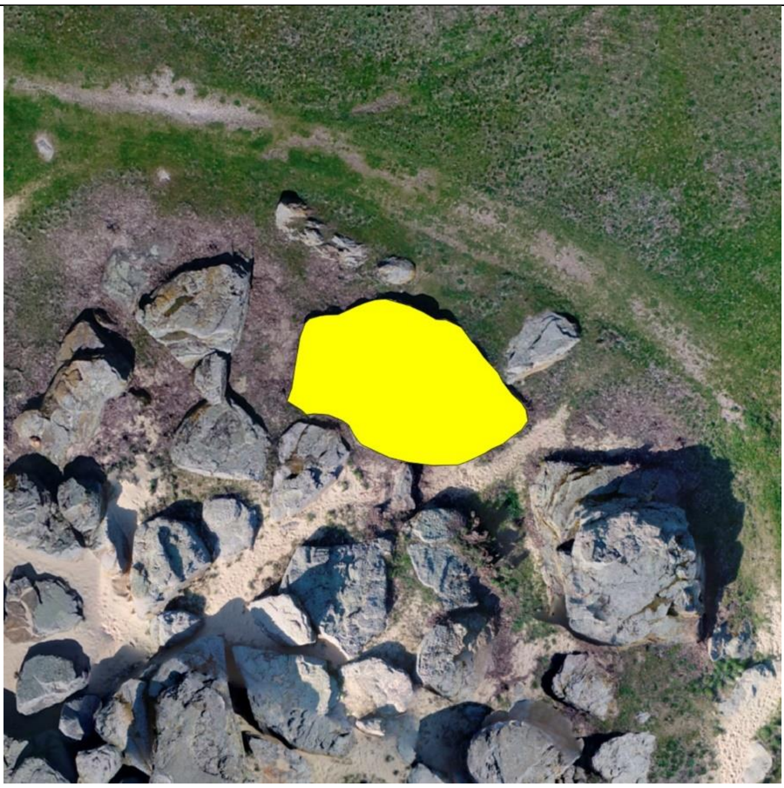
Location No.	**46**
Location Name	**Location No. 46; Harnessed Bulls cave**
Place on the map	
Placement description	Eastern slope of the Hill
Current state	Accessible, well preserved
Description	The big block is from the same group as locations No. 37 and 48. The entrance to the cave is on the eastern side of block No. 46. The wall nearby the entrance is slightly polished.
Parietal art specimens description	Stratigraphically and stylistically, five groups can be defined: 1. Two animal figures created formed by several linear notches; 2. Numerous grouped notches and engravings, linear and geometric motifs, lattices; a “tree of life” in the center of the group; 3. An image of an animal made with a wide engraved line (a bear?); 4. “The Harnessed bulls” in the deepest part of the cave; crosses, cupmarks, and short notches; an image of a snake; 5. Numerous notches, crosses, and lattices. Probably an image of a boat.
Description source	Mykhailov 2005, 65—66

Parietal art drawings	 
Drawings source	Mykhailov 2005: 222—223, fig. 42, 43
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**47**
Location Name	**Location No. 47**
Place on the map	
Placement description	Eastern slope of the Hill
Current state	Accessible, well preserved
Description	The block is east of block No. 37 and probably was a part of the latter. Linear engravings are located on the western part of the block and probably belong to the petroglyph group from block No. 37.
Parietal art specimens description	Linear engravings
Description source	Mykhailov 2005: 66
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**48**
Location Name	**Location No. 48; Harnessed Bulls cave**
Place on the map	
Placement description	Eastern slope of the Hill
Current state	Accessible, well preserved
Description	The notches group is probably part of the composition on block No. 37 though M. Rudinskiy considered it as a separate one.
Parietal art specimens description	Linear engravings.
Description source	Mykhailov 2005: 66

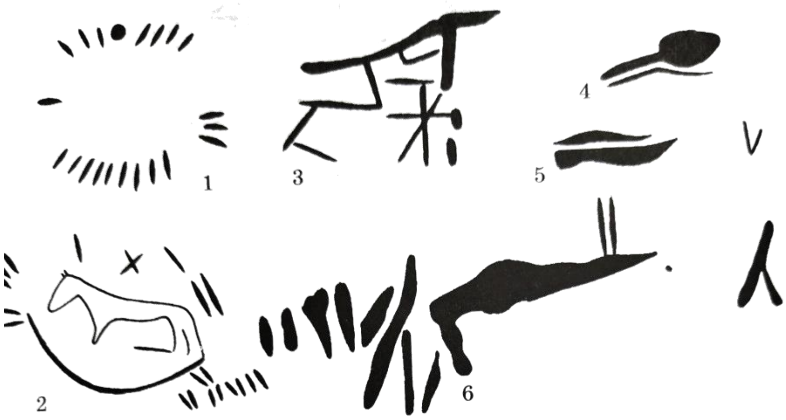
Parietal art drawings	
Drawings source	Mykhailov 2005: 208, fig. 18; 220, fig. 39,
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

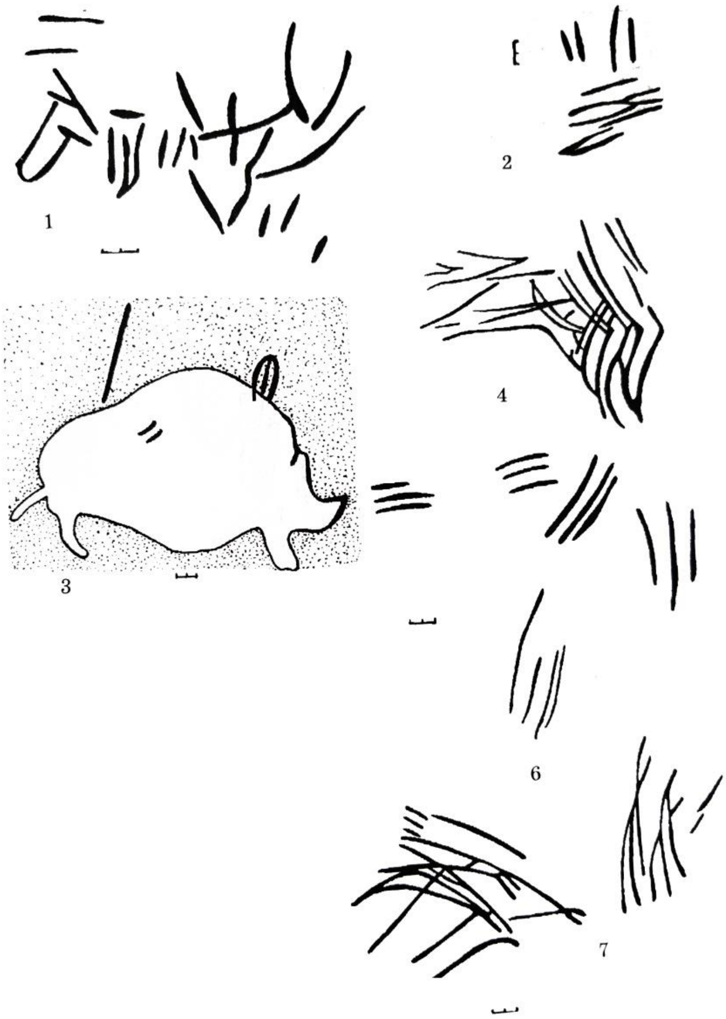
Location No.	**49**
Location Name	**Location No. 49**
Place on the map	
Placement description	Northeastern side of the Hill
Current state	Accessible, well preserved
Description	The block is highly eroded. Engravings cover a space of 2 x 2 meters. They include linear notches, two labrices, a C-like symbol, and four footsteps.
Parietal art specimens description	Linear engravings; geometric engravings; footsteps.
Description source	Mykhailov 2005: 66

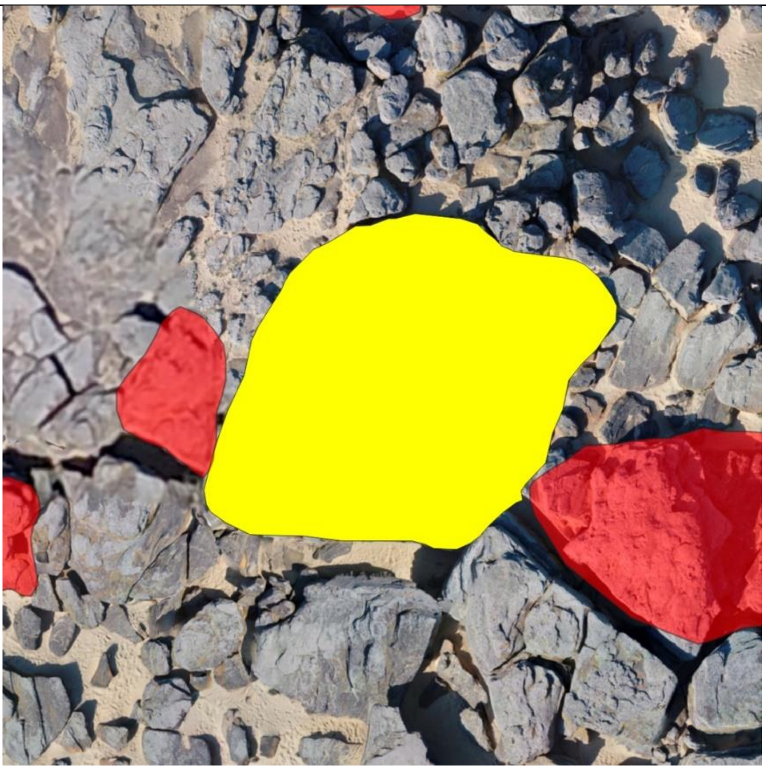
Parietal art drawings	
Drawings source	Mykhailov 2005: 214, fig. 28
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

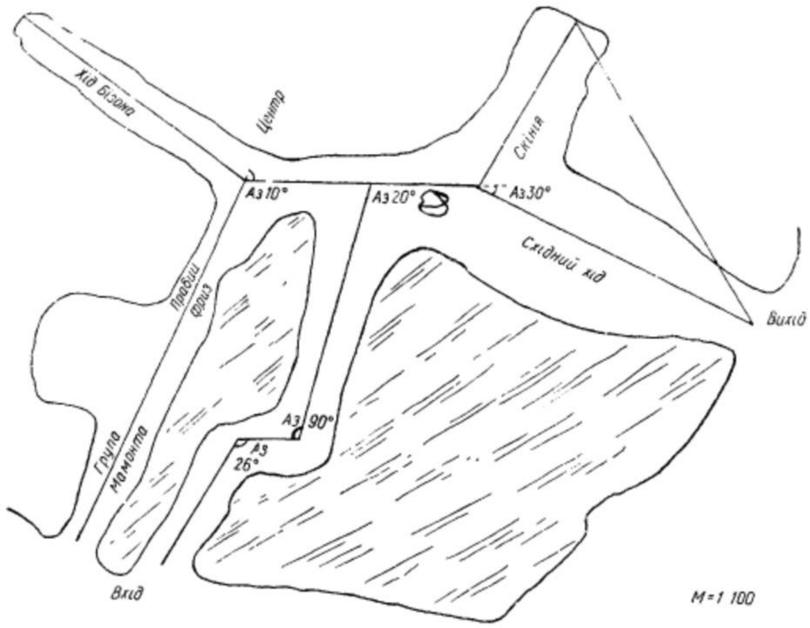
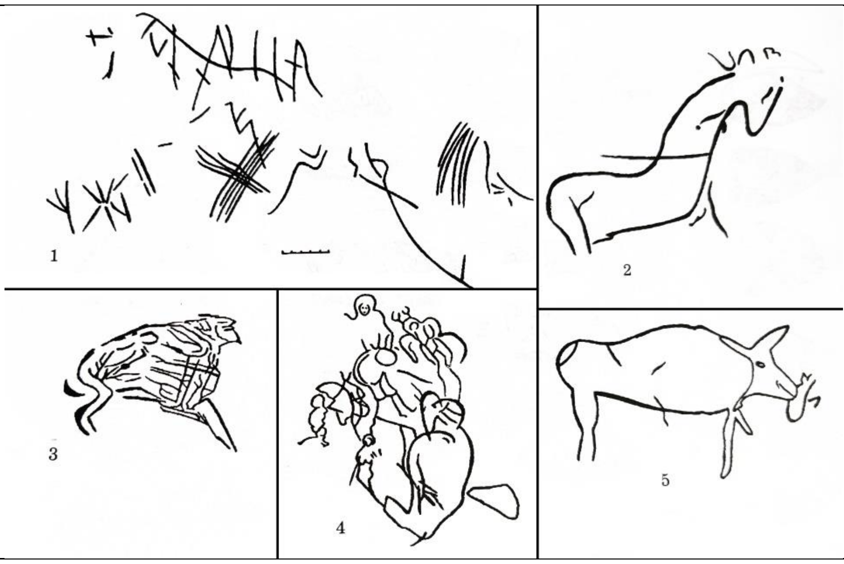
Location No.	**50**
Location Name	**Location No. 50**
Place on the map	
Placement description	Northern side of the Hill
Current state	Accessible, well preserved
Description	The block is located nearby polysoire No. 8 and block No. 38. Engravings on the lower surface contain a V-like symbol and three notches deeply under the surface (2 m).
Parietal art specimens description	Linear engravings; geometric engravings; fish-like image.
Description source	Mykhailov 2005: 66
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**51**
Location Name	**Location No. 51; Cave of Mysteries**
Place on the map	
Placement description	Western slope of the Hill
Current state	Accessible, well preserved
Description	51a is a huge cave located south of the "Bull's Cave." A canopy contains several hollow spaces. The ceiling of the cave contains several linear and geometric notches. Mykhailov claims that the block nearby is the ancient altar that contains the engravings of lattices, linear notches, and traces of a fire. The ceiling contains images of horses, linear pictograms, and an image of a bull. V. Danilenko discovered several points on flint blades, points, and arrowheads, a part of the hammer, etc. Danilenko considers this assemblage as one of Maikop culture. Cave 51b is a continuation of 51a. The ceiling of the cave is highly eroded. It contains a rock art scene 5—6 meters from the entrance to the cave. This scene contains several figures. According to B. Mykhailov, the scene contains 26 figures, mammoths, deer, horses, and anthropomorphic figures. The assemblage of flint and sandstone instances has been found in the grotto. It contains tools from Upper Paleolithic up to the Eneolithic age.

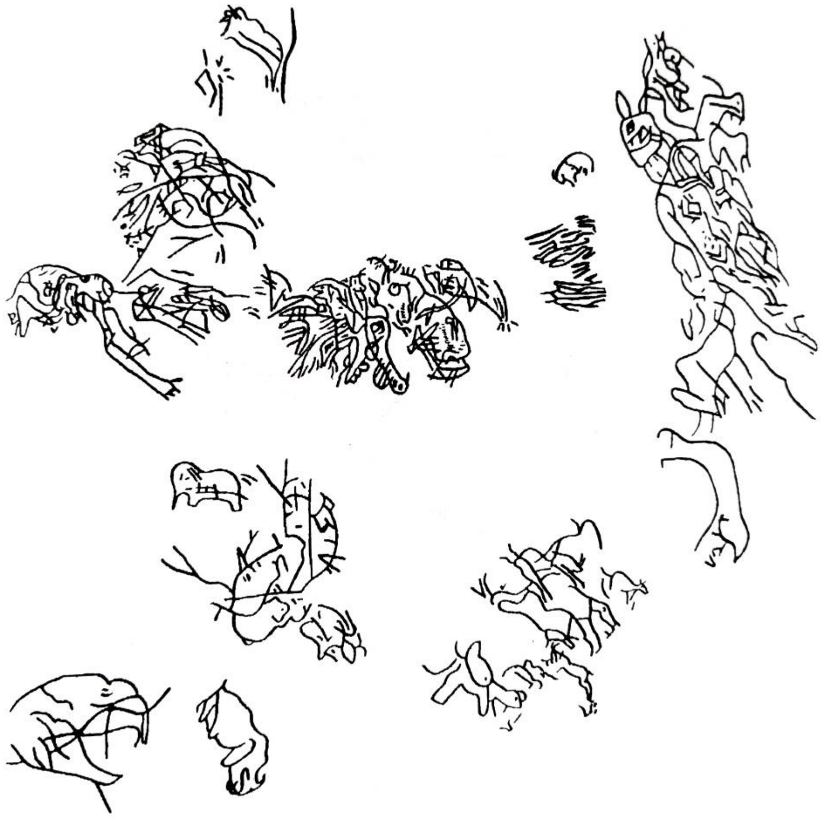
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic and anthropomorphic engravings (mammoths, deer’s, human beings, horses etc.).
Description source	Mykhailov 2005: 66—70
Parietal art drawings	
Drawings source	Mykhailov 2005: 208, fig. 18
Parietal art drawings	 
Drawings source	Mykhailov 2005: 224, fig. 45—46

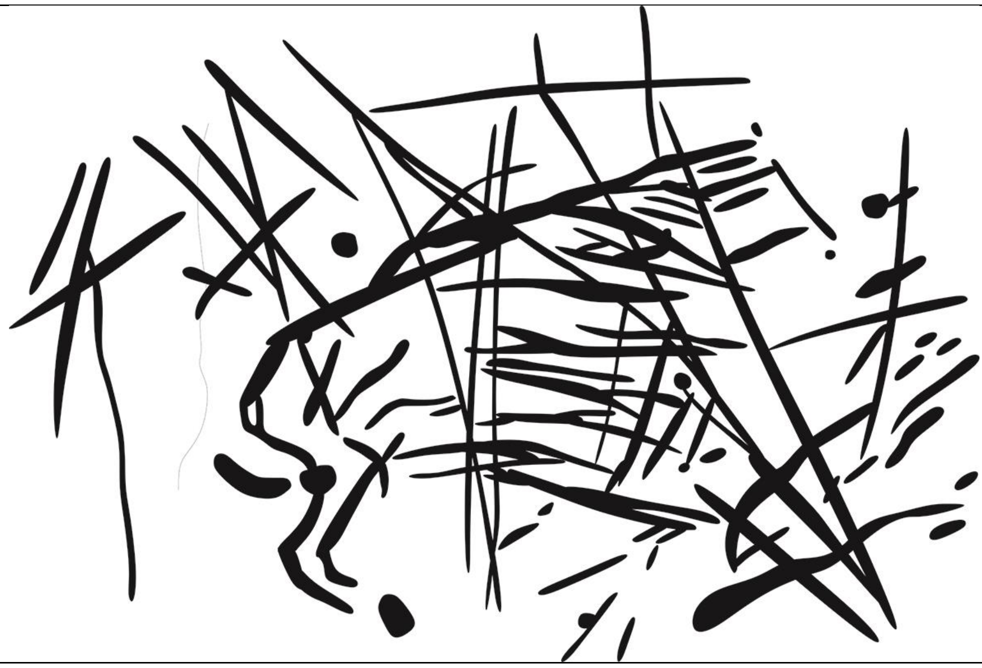
Parietal art drawings	
Drawings source	Mykhailov 2005: 225, fig. 47
Attribution	—
Attribution source	—
Portable art specimens	Two churingas have been found inside the grotto and interpreted by B. Mykhailov as Upper Paleolithic ones. An instance No. 2805 was found in 1994. It has a subrectangular shape and was considered by B. Mykhailov as a fish-like one. An instance No. 3784 was found in 1985 and interpreted as an image of a fish covered with linear and geometric engravings.
Portable art specimens No.	2805; 3784

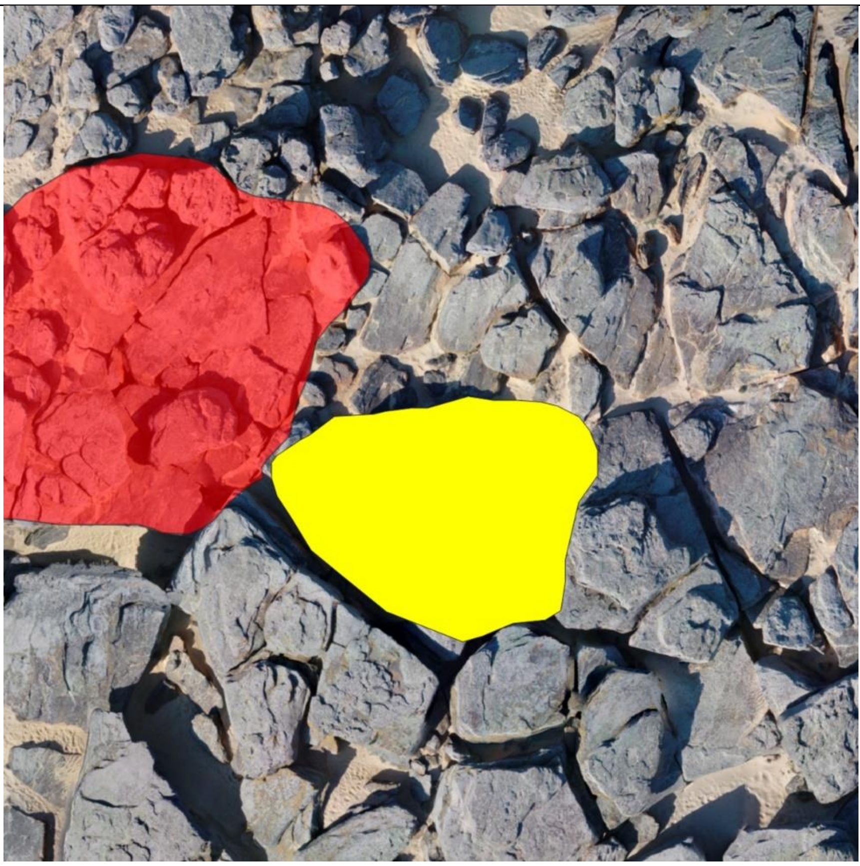
Location No.	**52**
Location Name	**Location No. 52; Wizard’s Cave**
Place on the map	
Placement description	Southern slope of the Hill
Current state	Accessible, partially preserved
Description	The cave as been found by V. Danilenko in 1973. Several petroglyphs and portable art objects have been found there and interpreted by V. Danilenko as Upper Paleolithic ones. Some of these objects are considered to be found in situ; however, they are out of stratigraphic context. A cave contains many rock art images of animals and human beings — mammoths, rhinoceros, elks, bison, etc. The cave's name comes from the image of a man in a state of animalistic transformation. The cave and the portable art instances were described by V. Danilenko (1986) with the accuracy and reliability that corresponds to the Ukrainian rock art science of that time. V. Danilenko states that most of these 28 Upper Paleolithic (according to his interpretation) portable art instances have been found on a sandstone floor of the cave in a room called "Skinia." The burial of the Iron Age (Hun's time) has been found inside the cave. It contains a Roman Age glass and a number of pottery instances.

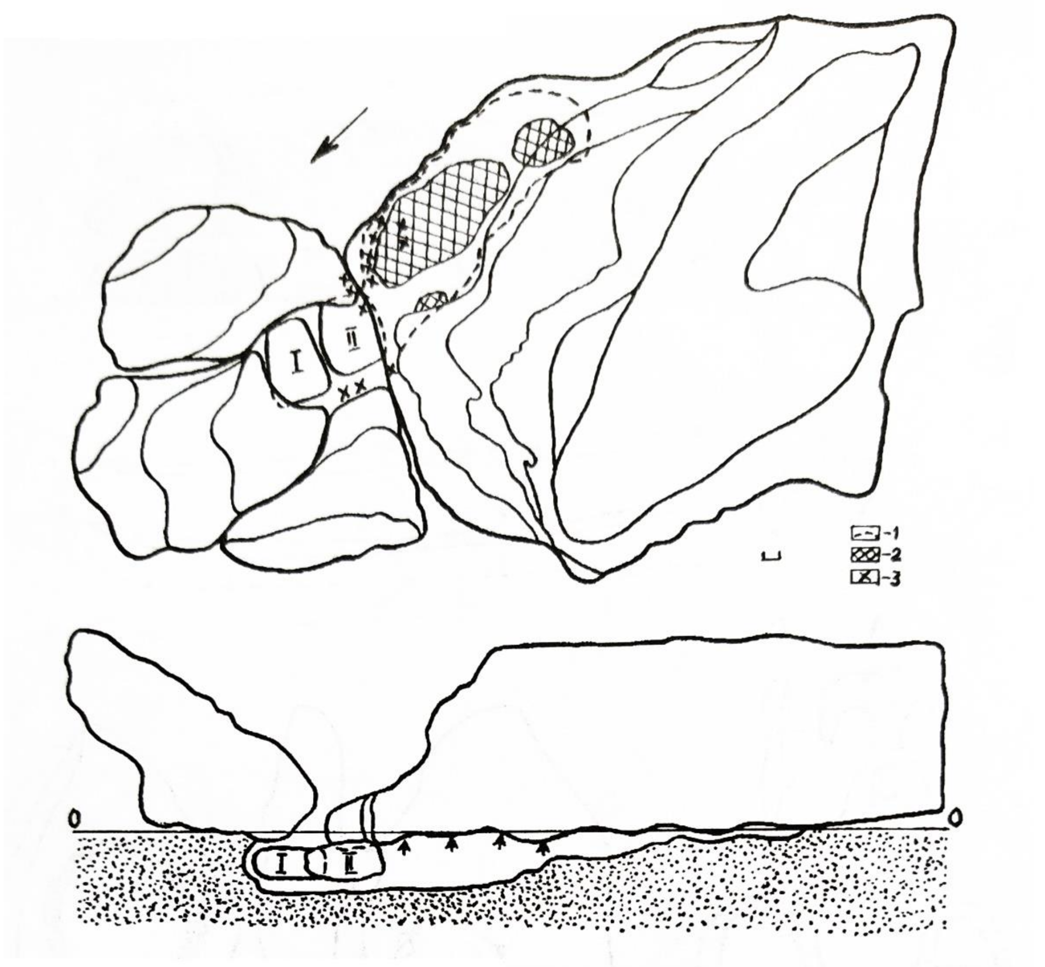
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic engravings; anthropomorphic engravings; mammoths; horses; bull's; bison's; deer's; human beings — wizards, woman etc.
Description source	Mykhailov 2005: 71—73
Plan of the cave	
Source	Danilenko 1986: 79, fig. 30
Parietal art drawings	
Drawings source	Mykhailov 2005: 228, fig. 51

Parietal art drawings	
Drawings source	Mykhailov 2005: 229, fig. 52
Parietal art drawings	
Drawings source	Danilenko 1986: 82, fig. 33

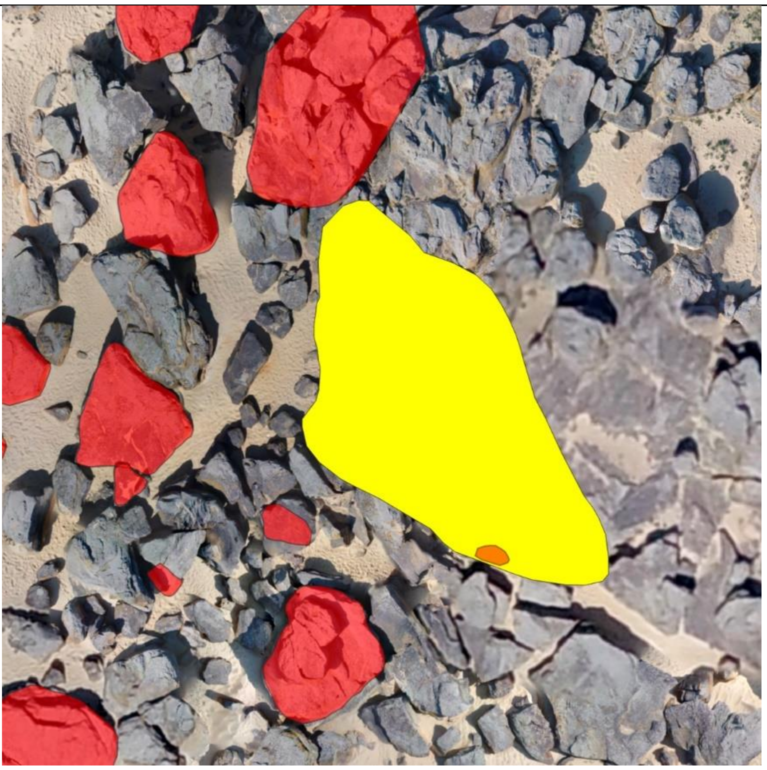
Parietal art drawings	
Drawings source	Mykhailov 2005: 231, fig. 54
Parietal art drawings	

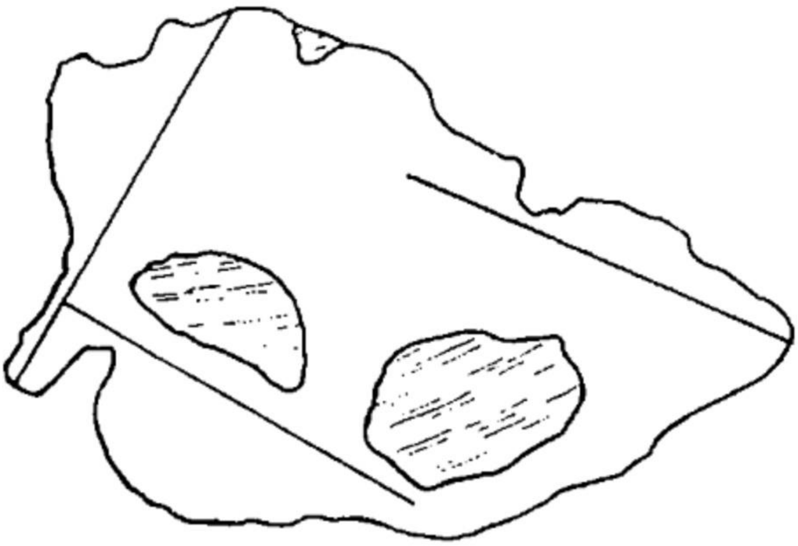
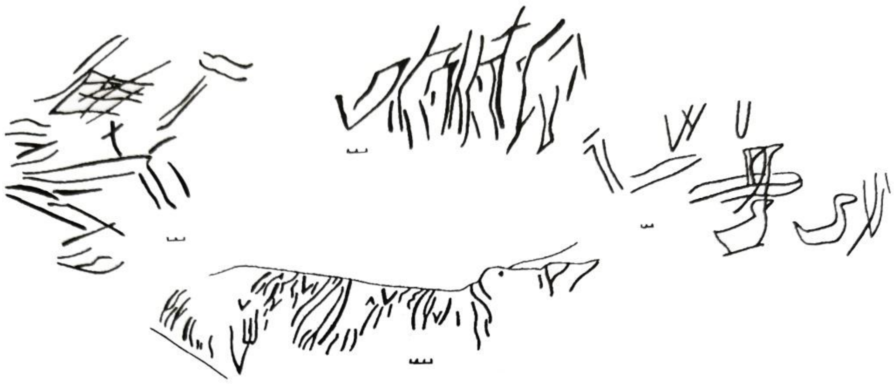
Drawings source	Mykhailov 2005: 232, fig. 55—56 (after Danilenko 1986: 89—94)
Parietal art drawings	
Drawings source	Drawing made by S. Radchenko
Attribution	Upper Paleolithic
Attribution source	Danilenko 1986: 135—137
Portable art specimens	V. Danilenko publishes 86 churingas found in Wizard Cave during 1973—1974 field season. 28 of these specimens has been published and described only after his death in the book “Kamyana Mohyla” (Danilenko 1986).
Portable art specimens No.	No. KM74—1, KM74—2, KM74—4, KM74—5, KM74—6, KM74—7, KM74—8, KM74—9, KM74—10, KM74—11, KM74—13, KM74—14, KM74—15, KM74—16, KM74—17, KM74—18, KM74—19, KM74—20, KM74—21, KM74—22, KM74—23, KM74—24, KM74—25, KM74—26, KM74—27, KM74—28, 278, 283, 284, 285, 287, 288, 291, 293, 295, 296, 297, 298, 299, 300, 302, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 317, 318, 319, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 341a, 341b, 342, 363, two specimens without a number

Location No.	**53**
Location Name	**Location No. 53, the Horseshoe cave**
Place on the map	
Placement description	Southern part of the Hill
Current state	Accessible, well preserved
Description	The entrance is in the southern wall of the big cavern, covered with two blocks. In the sand nearby the entrance B. Mykhailov founds an iron arrowhead and two pieces of iron tools dated back to IX—XI century AD. The cave is oriented from Southwest to Northeast. The ceiling contains several stylistically different images. The first group consists of footsteps, linear and geometric engravings, phallic images, etc. The second contains several footsteps, an anthropomorphic image, and several animals (unclear). The third one is several linear and geometric lines, lattices etc. The sand in the cave was excavated, and several items have been found (only churingas, a piece of sandstone, and ocher fragments).
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic engravings; anthropomorphic engravings; footsteps.

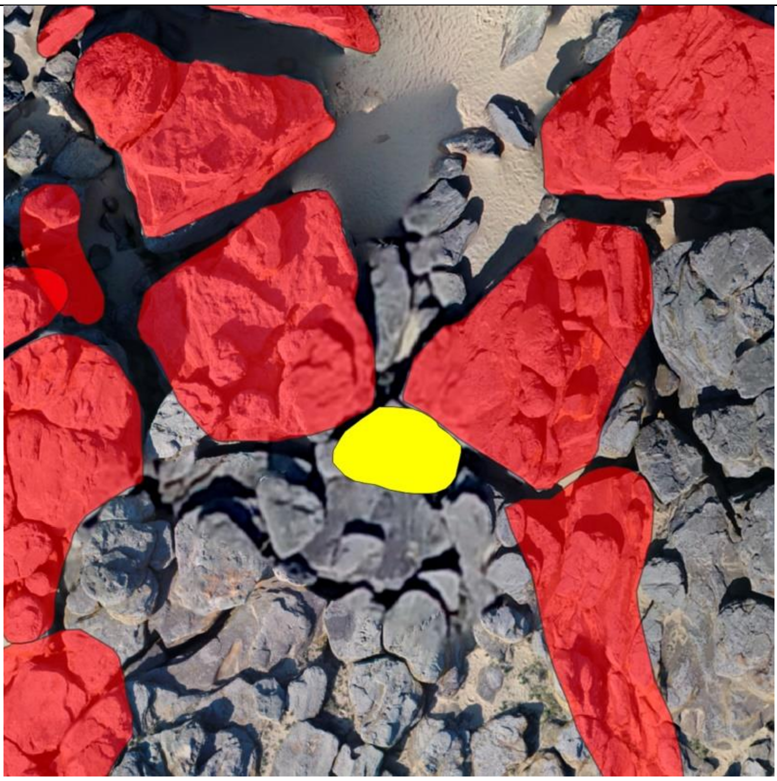
Description source	Mykhailov 2005: 73—75
Plan and profile of the cave	
Source	Mykhailov 2005: 236, fig. 60
Parietal art drawings	

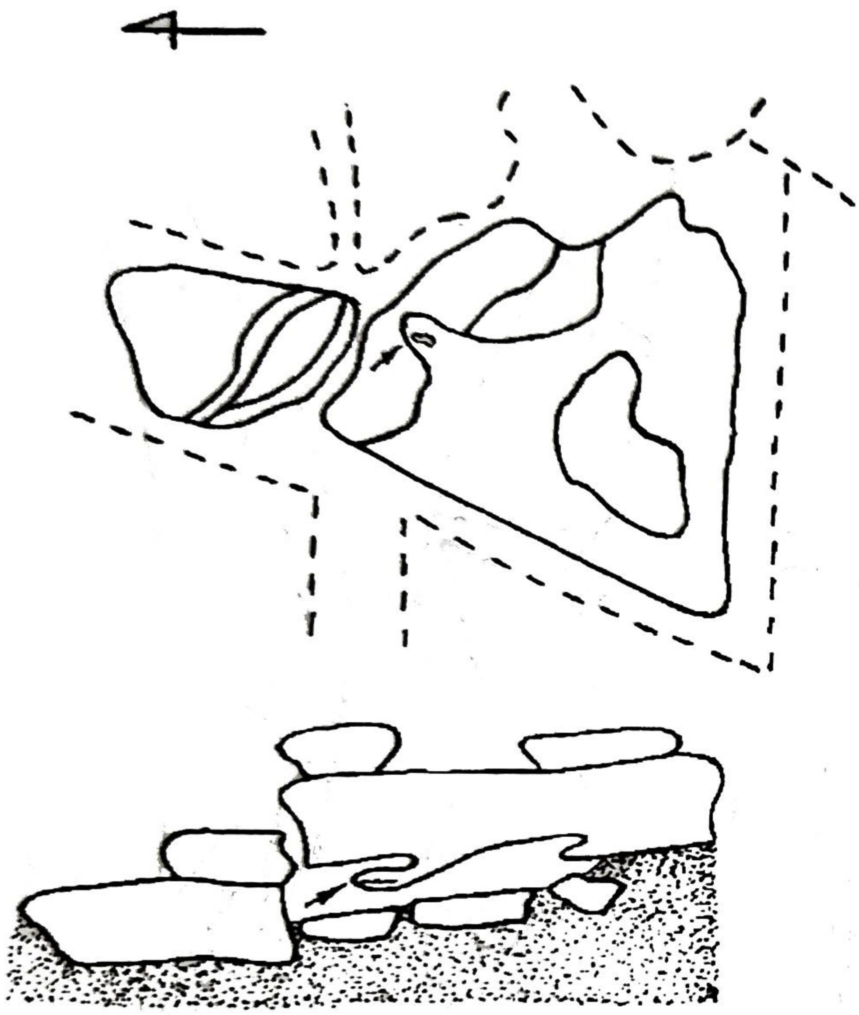
Drawings source	Mykhailov 2005: 237, fig. 63
Attribution	—
Attribution source	—
Portable art specimens	5 instances of different shape were found by B. Mykhailov. He interprets them as produced during III—II millennia BC.
Portable art specimens No.	No. 11, 12, 13, 14, 21

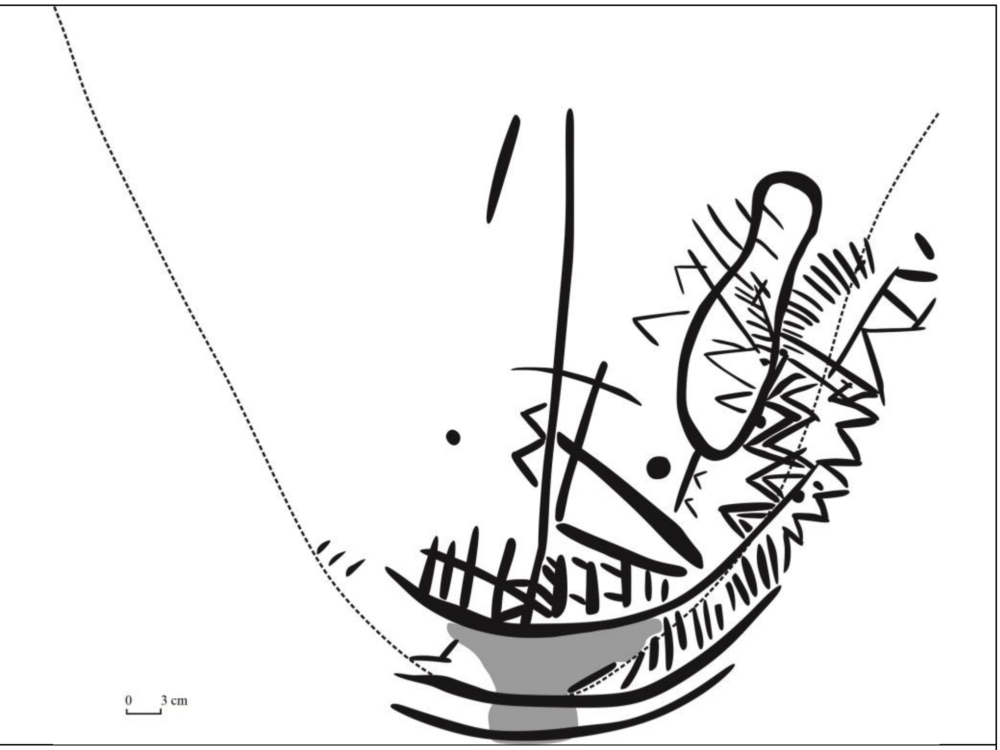
Location No.	**54**
Location Name	**Location No. 54, Cave of Churingas**
Place on the map	
Placement description	Western part of the Hill
Current state	Accessible, well preserved
Description	V. Danilenko discovered the cave in 1973. He states that this cave does not contain parietal art objects. He also mentions "up to 40 objects" and describes 20 of them in his book (1986, 118—130). Most of these instances were interpreted as fish-like ones and dated back to the Mesolithic—Neolithic Age. Later, B. Mykhailov discovered the cave's eastern room ('skinia'), which was previously unknown. It also contains a kind of sandstone table, where several portable art instances have been found. The cave's ceiling contains four scenes with 'realistic' and geometric engravings.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic engravings; anthropomorphic engravings; a several birds (probably ducks?).
Description source	Mykhailov 2005: 75—77

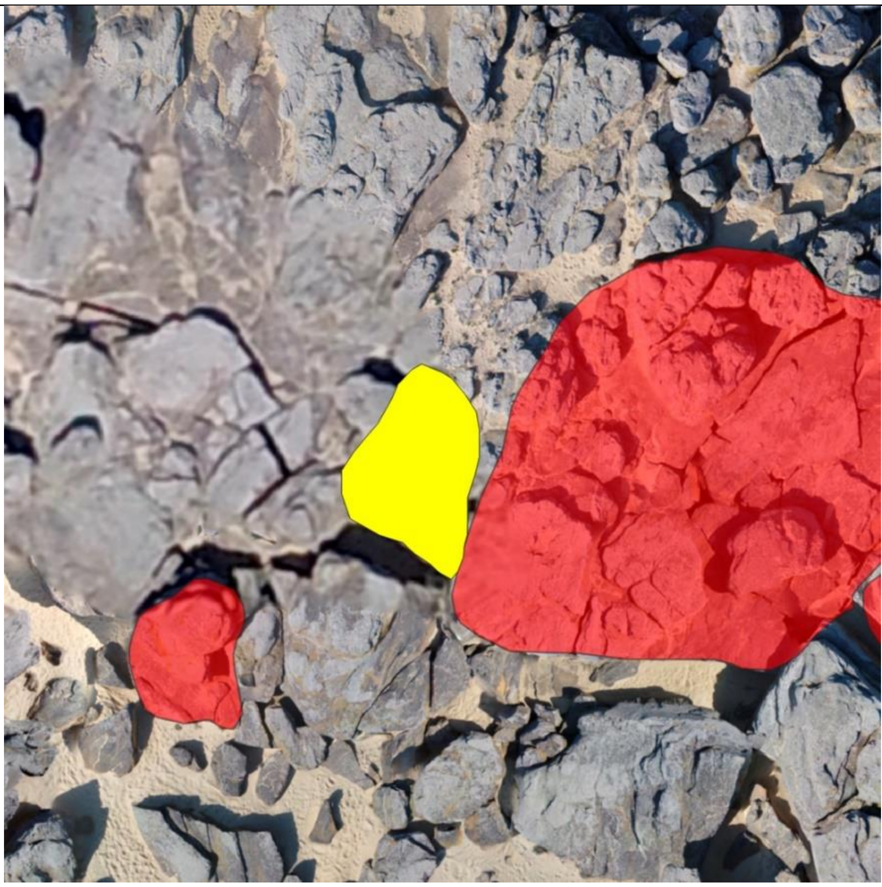
Plan of the cave	
Source	Danilenko 1986: 78, fig. 29
Parietal art drawings	
Drawings source	Mykhailov 2005: 238, fig. 64
Attribution	Mesolithic Age
Attribution source	Radchenko 2022
Portable art specimens	14 specimens were found by B. Mykhailov in 1985—1986. Though in his book he describes 15 of them, only 14 are currently located in the funds of Kamyana Mohyla Reserve. They are of different shape, mostly dated back to III millennia BC. 55 specimens were found by V. Danilenko during the 1973—1974 fieldworks and now stored in the Institute of Archaeology of National Academy of Sciences of Ukraine. However, in his book (Danilenko 1986), V. Danilenko mentions “up to 40 churingas” (Danilenko 1986: 118).

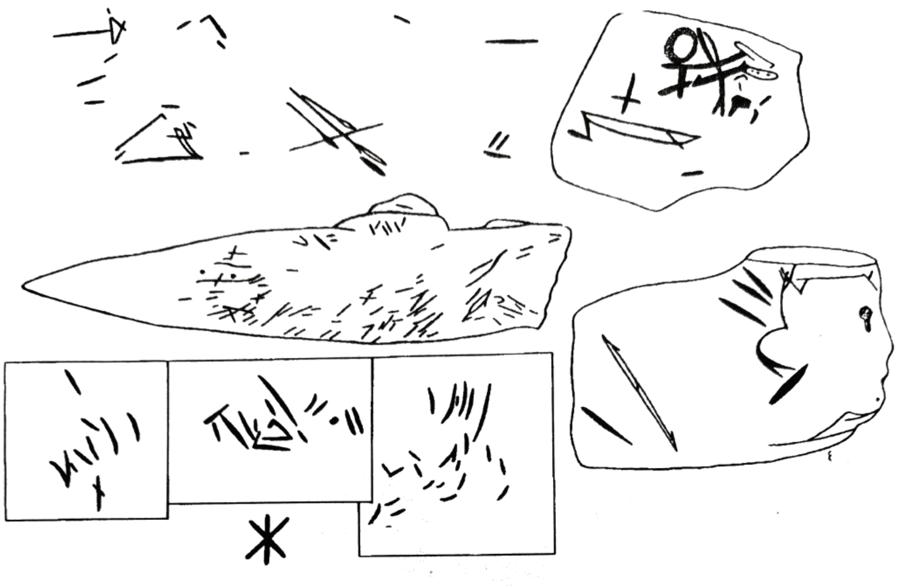
Portable art specimens No.	No. 70, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 224, 225, 226, 227, 228, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 271, 272, 273, 275, 292, 355, 356, 359, 360, 361, 397, 213a, 246a, 248a, 436, 437, 438, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 3853

Location No.	**55**
Location Name	**Location No. 55, Dragon's cave**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, partially preserved
Description	An asset of sandstone blocks used to form a single monolith ceiling of the cave. An oval-shaped ellipsoid protrusion inside the grotto has been decorated with linear and geometric engravings, footsteps, etc. The decorated protrusion has been interpreted as a figure of a chthonic Dragon (Yamnaya culture). Contemporary interpretation (see Radchenko et al. 2020a) assumes that the figure is multilayered and belongs to Mesolithic and Early Bronze Age times. The ceiling contains lattices and linear notches.
Parietal art specimens description	Linear engravings; geometric engravings; an image of a fish; lattices.
Description source	Mykhailov 2005: 77—78

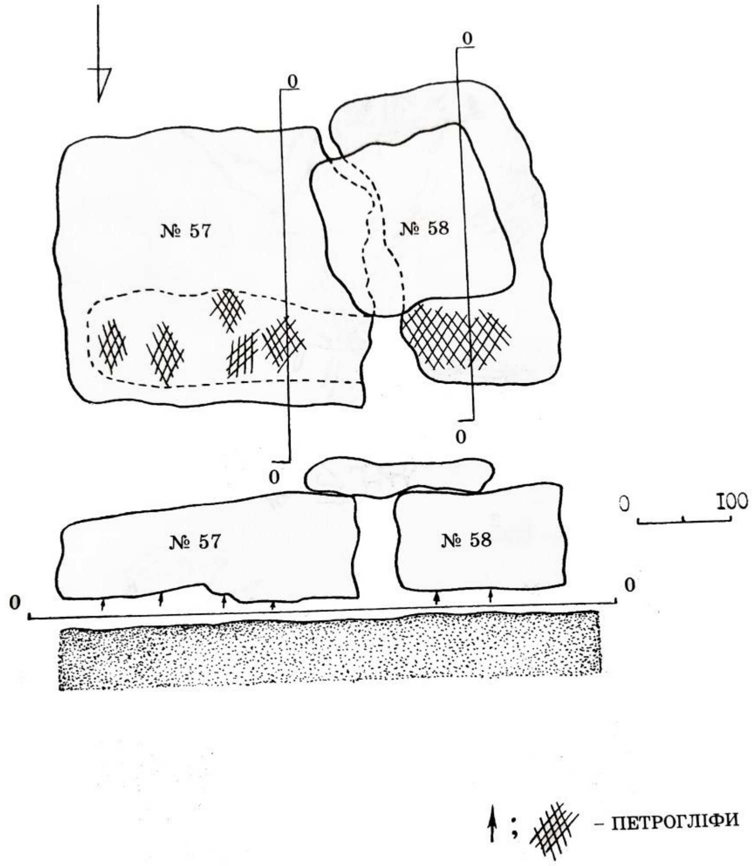
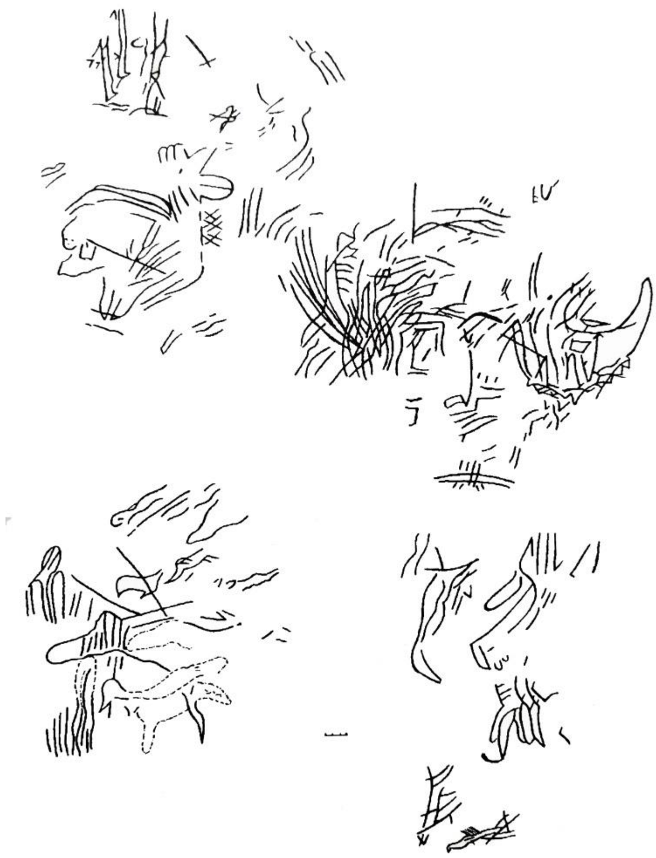
Plan and profile of the cave	
Source	Mykhailov 2005: 240, fig. 66
Parietal art drawings	
Drawings source	Mykhailov 2005: 240, fig. 66

Parietal art drawings	
Drawings source	Radchenko et al. 2020: 170, fig. 8
Attribution	Late Mesolithic; Early Bronze Age
Attribution source	Radchenko et al. 2020
Portable art specimens	—
Portable art specimens No.	—

Location No.	**56**
Location Name	**Location No. 56, Cave of a Fish**
Place on the map	
Placement description	Southern slope of the Hill
Current state	Accessible, well preserved
Description	The blocks located nearby the Wizard grotto under a big almond-shape stone lying with an angle of 30—35°. A ceiling and several canopies contain zoomorphic images, an image of a boat, and linear engravings. The cave floor contains a massive image of a fish and several geometric engravings. Though B. Mykhailov states that two portable art instances have been found in the cave, their current location remains unknown.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic images; an image of a boat; an image of a fish.
Description source	Mykhailov 2005: 78—79

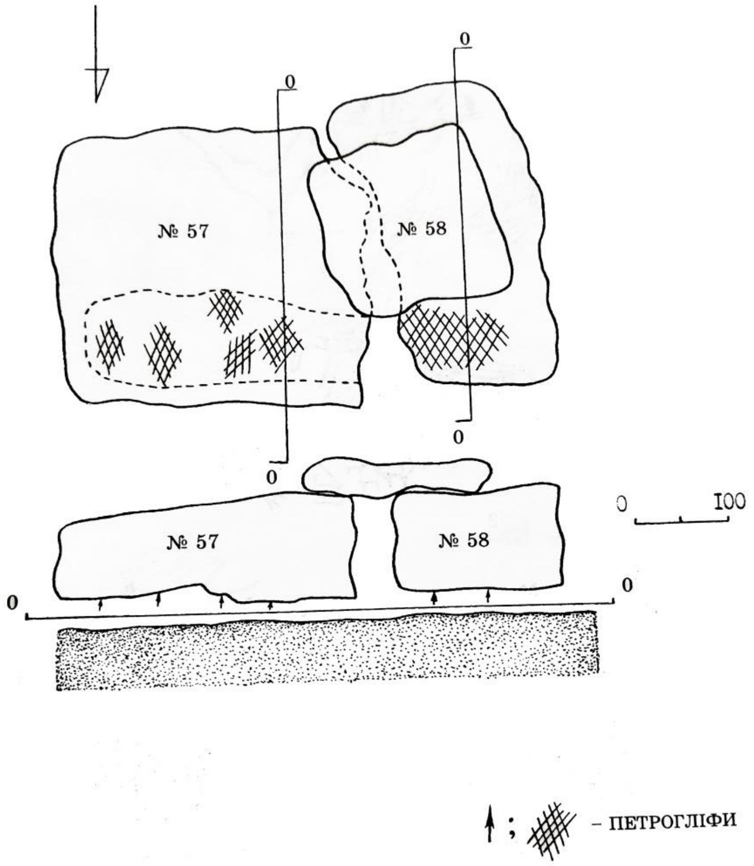
Parietal art drawings	
Drawings source	Mykhailov 2005: 242, fig. 68
Parietal art image	
Image source	Mykhailov 2005: 242, fig. 69
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**57**
Location Name	**Location No. 57**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description	A massive block is located northwest of the Bull grotto. The cave under this block has a shape of a corridor and a room with a tan-covered ceiling. It contains several zoomorphic engravings (elks, bulls, etc.), a horned man (shaman) figure, and other anthropomorphic images. An assemblage of flints, obsidian, and pottery (probably Neolithic) has been found here, together with a few polished or shaped sandstone pieces.
Parietal art specimens description	Linear engravings; geometric engravings; anthropomorphic images; zoomorphic images.
Description source	Mykhailov 2005: 79—81

Plan and profile of the location	
Source	Mykhailov 2005: 243, fig. 70
Parietal art drawings	
Drawings source	Mykhailov 2005: 245, fig. 72

Parietal art drawings	
Drawings source	Mykhailov 2005: 244, fig. 71
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

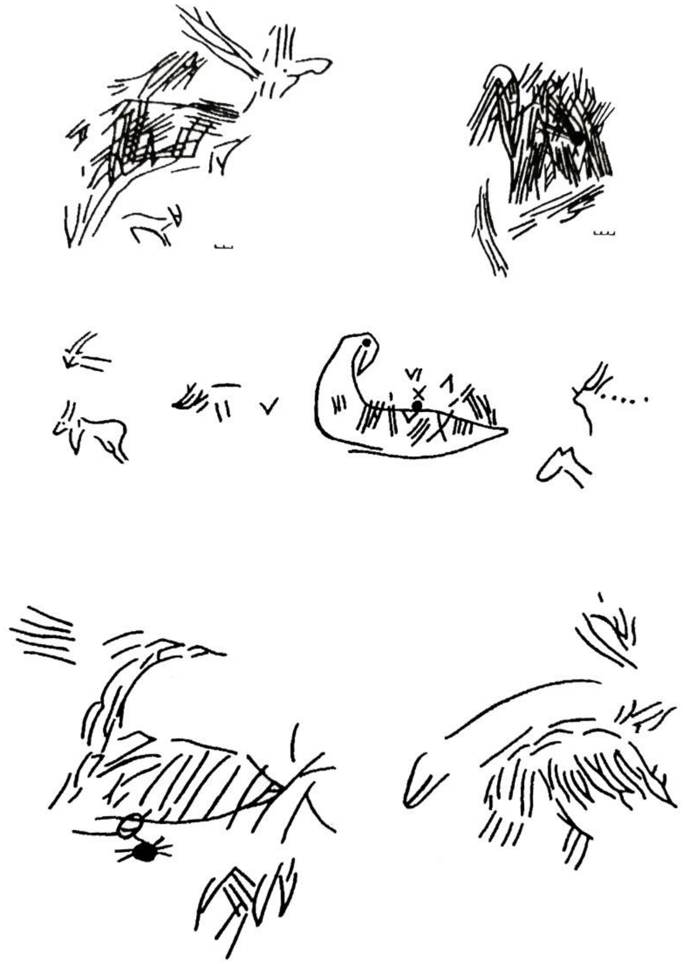
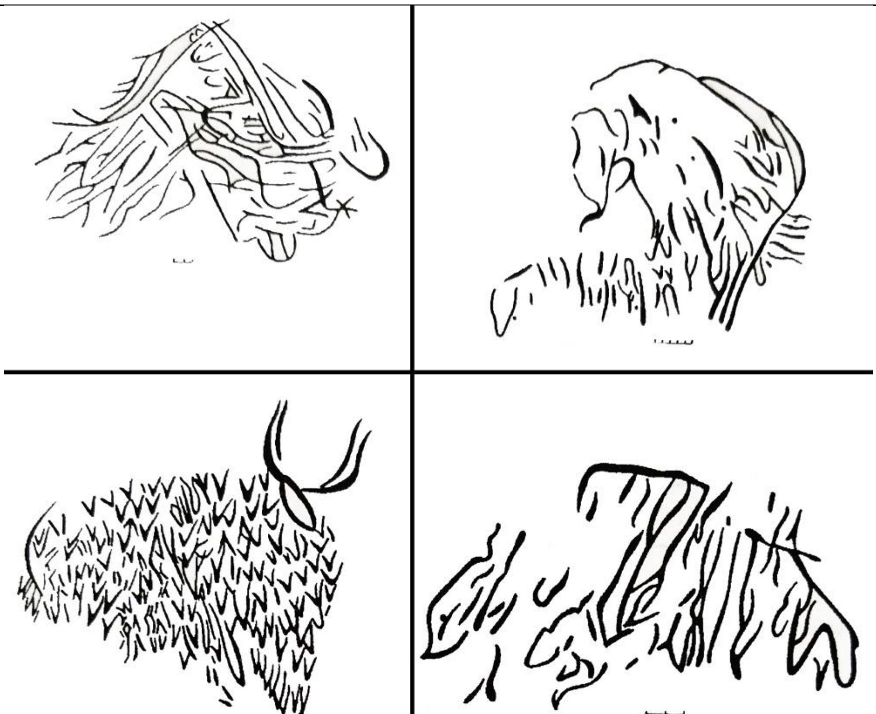
Location No.	**58**
Location Name	**Location No. 58**
Place on the map	
Placement description	Accessible, well preserved
Current state	Not accessible
Description	A massive block is located nearby block No. 57. An assemblage of flint, granite, and sandstone objects has been found under the stone. The lower part of the block (the ceiling of the cave) contains several zoomorphic images (12 figures), primarily bulls.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic images; images of animals (bulls)
Description source	Mykhailov 2005: 81—82

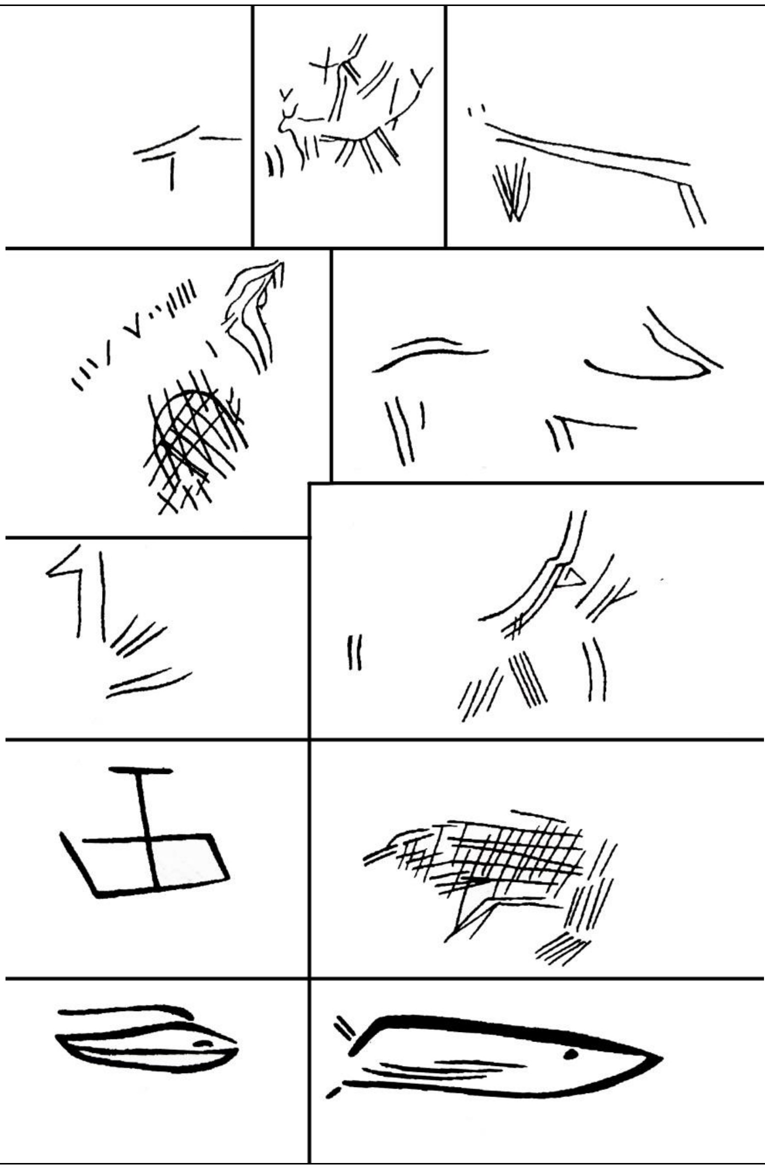
Plan and profile of the location	
Source	Mykhailov 2005: 243, fig. 70
Parietal art drawings	
Drawings source	Mykhailov 2005: 248, fig. 76
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**59**
Location Name	**Location No. 59**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description	The block is to the left from the entrance to the Bull grotto. The lower part of the stone contains a canopy with numerous notches that form a figure (a bear?). Linear engravings are grouped into assets of 15 or 16 elements. A portable rock art instance is declared by B. Mykhailov, though its current location is unknown.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic engravings
Description source	Mykhailov 2005: 82—83

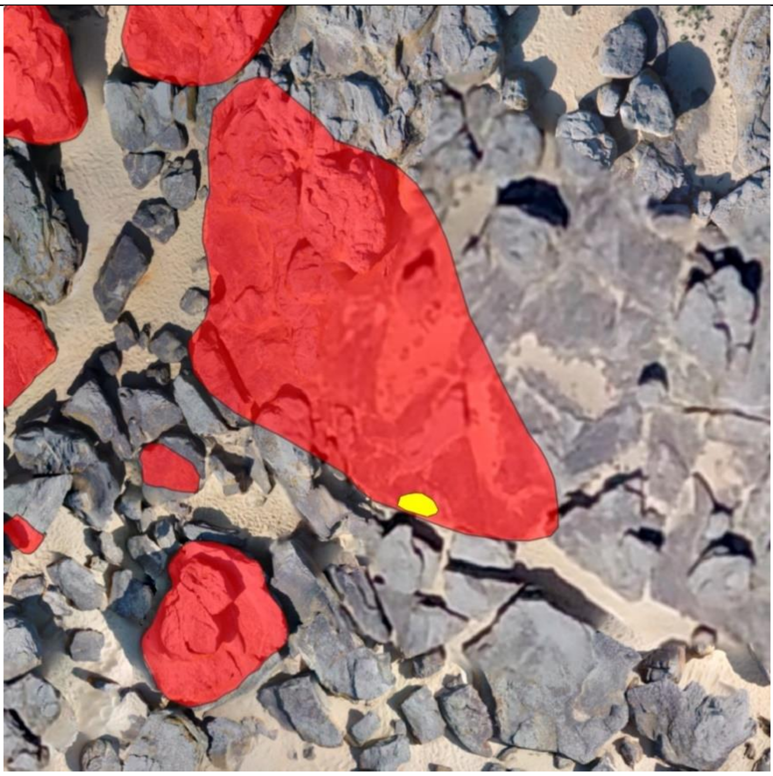
Parietal art drawings	
Drawings source	Mykhailov 2005: 248, fig. 77
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

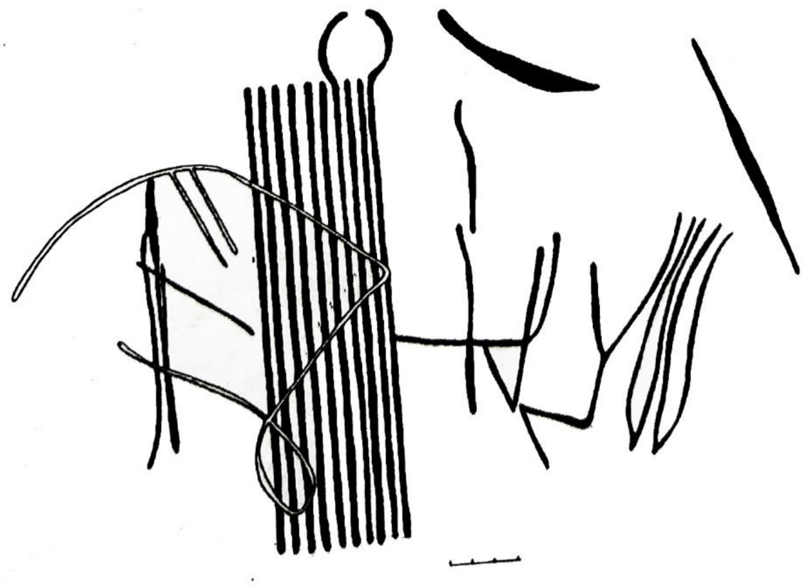
Location No.	**60**
Location Name	**Location No. 60; cave of a Goat**
Place on the map	
Placement description	Central part of the Hill
Current state	Accessible, well preserved
Description	The location is a long cave with an entrance to the Hill's Northern slope. Engravings are located on the ceiling and numerous canopies. According to fund records of Kamyana Mohyla Reserve, 144 portable art instances were found in the cave in 1985. However, in his book B. Mykhailov mentions "62 blocks and ten sculptures" (2005, 83). Eighteen rock art scenes are located inside the grotto and reveal images of human beings, shamans, zoomorphic images, mammoths, bulls, and birds.
Parietal art specimens description	Linear engravings; geometric engravings; zoomorphic images; horned humans (shamans (?)); birds.
Description source	Mykhailov 2005: 83—89

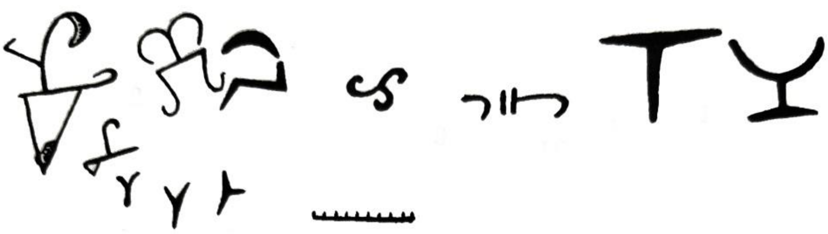
Parietal art drawings	
Drawings source	Mykhailov 2005: 249, fig. 78
Parietal art drawings	
Drawings source	Mykhailov 2005: 251, fig. 80

Parietal art drawings	
Drawings source	Mykhailov 2005: 250, fig. 79
Parietal art drawings	
Drawings source	Drawing by S. Radchenko

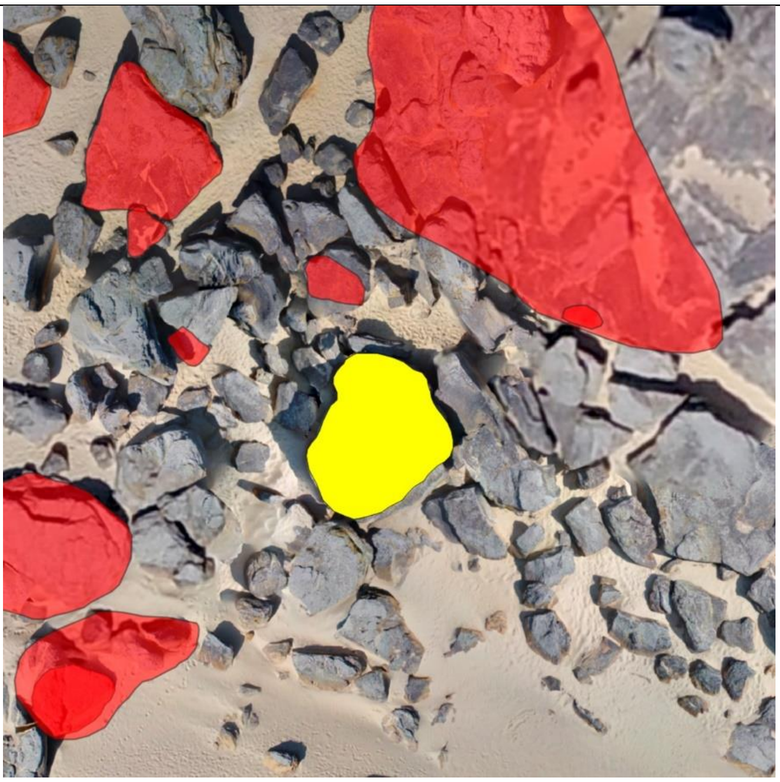
Attribution	—
Attribution source	—
Portable art specimens	144 instances of different shape dated back to the time laps from Upper Paleolithic to Eneolithic age.
Portable art specimens No.	3781, 3787, 3833, 3834, 3838, 3839, 3840, 3841, 3842, 3843, 3844, 3845, 3846, 3847, 3856, 3857, 3858, 3859, 3861, 3862, 3863, 3868, 3869, 3870, 3871, 3872, 3873, 3874, 3875, 3876, 3877, 3878, 3879, 3880, 3881, 3882, 3883, 3884, 3885, 3886, 3887, 3888, 3889, 3890, 3891, 3892, 3893, 3894, 3895, 3896, 3897, 3898, 3899, 4706, 4707, 4708, 4709, 4710, 4711, 4712, 4713, 4714, 4715, 4716, 4717, 4718, 4719, 4720, 4721, 4722, 4723, 4724, 4725, 4726, 4727, 4728, 4729, 4730, 4731, 4732, 4733, 4734, 4735, 4736, 4737, 4738, 4739, 4740, 4741, 4742, 4743, 4744, 4745, 4746, 4747, 4748, 4749, 4750, 4751, 4752, 4753, 4754, 4755, 4756, 4757, 4758, 4759, 4760, 4761, 4762, 4763, 4764, 4765, 4766, 4767, 4768, 4769, 4770, 4771, 4772, 4773, 4774, 4775, 4776, 4777, 4778, 4779, 4780, 4783, 4784, 4785, 4786, 4793, 4794, 4795, 4796, 4797, 4798, 4799, 4800, 4801, 5104, 5106, 5107, 5109

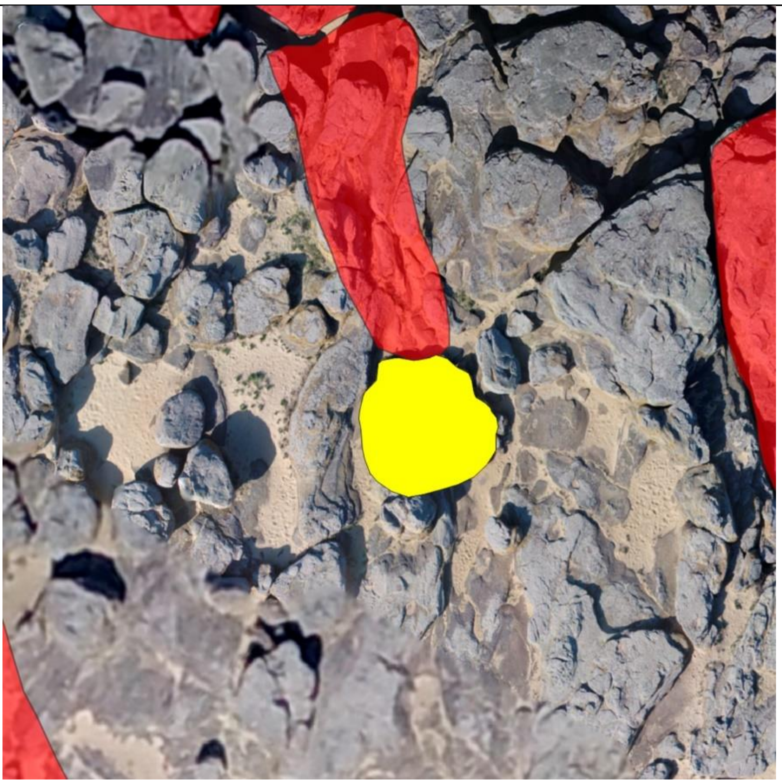
Location No.	**61**
Location Name	**Location No. 61**
Place on the map	
Placement description	Western slope of the Hill
Current state	Accessible, well preserved
Description	Engravings are located on the flat surface of a canopy. The first group contains a boar and two hunters in dynamic postures. The second one consists of linear and geometric engravings.
Parietal art specimens description	Linear engravings; geometric engravings; a hunting scene with a boar and two hunters
Description source	Mykhailov 2005: 89—90

Parietal art drawings	
Drawings source	Mykhailov 2005: 257, fig. 91
Parietal art drawings	
Drawings source	Mykhailov 2005: 257, fig. 92
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**62**
Location Name	**Location No. 62**
Place on the map	
Placement description	Eastern slope of the Hill
Current state	Accessible, well preserved
Description	It is a block that lies on stone No. 37. After the stone has been upturned, several engravings have been revealed. It contains a row of 13 “tamgas” (Sarmatian heraldic symbols).
Parietal art specimens description	Sarmatian tamgas — heraldic or dynastic symbols of steppe nomads.
Description source	Mykhailov 2005: 90
Parietal art drawings	

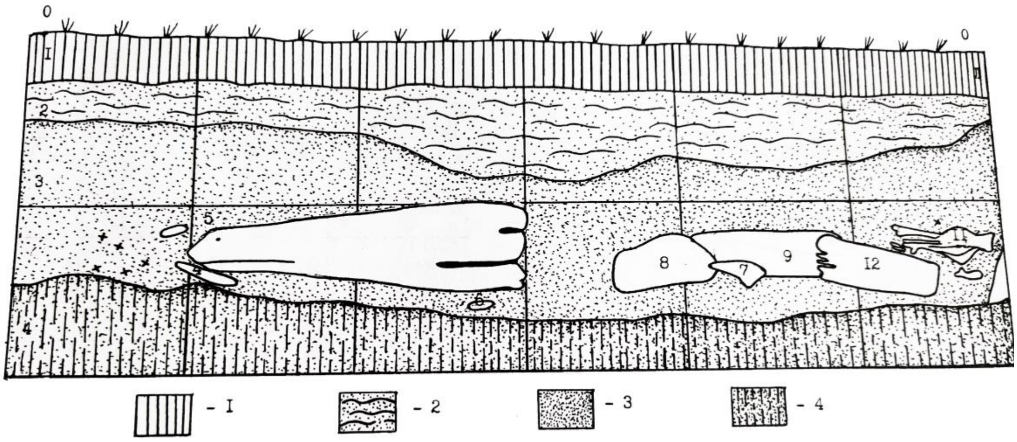
Drawings source	Mykhailov 2005: 258, fig. 93
Attribution	Iron Age (Sarmatian times).
Attribution source	Mykhailov 2005
Portable art specimens	—
Portable art specimens No.	—

Location No.	**63**
Location Name	**Location No. 63**
Place on the map	
Placement description	Southwestern slope of the Hill
Current state	Accessible, well preserved
Description	A location has been discovered in 1990 in a small hollow space. Writing symbols are placed on a vertical wall.
Parietal art specimens description	Writing symbols.
Description source	Mykhailov 2005: 90
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

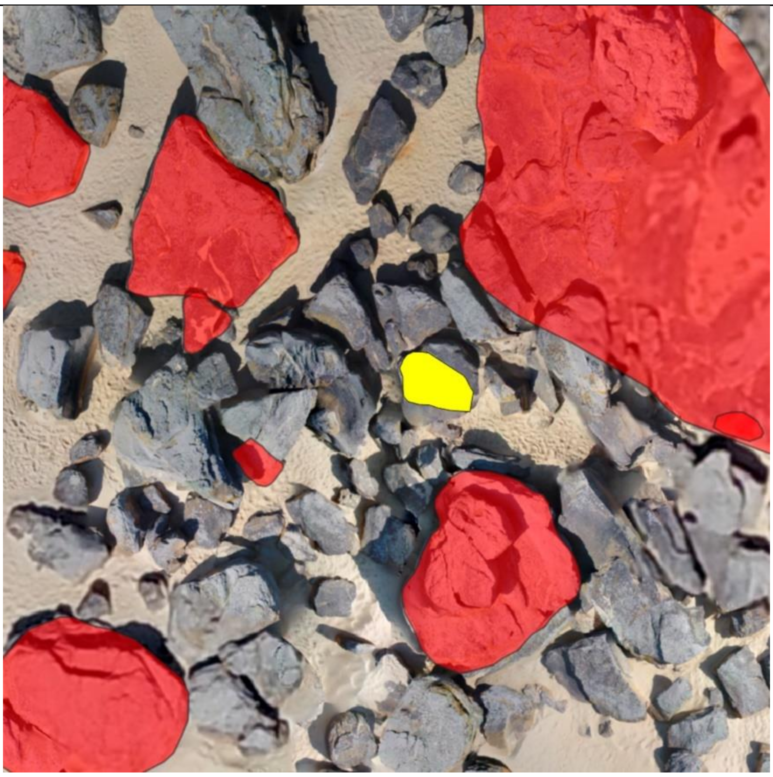
Location No.	**64**
Location Name	**Location No. 64**
Place on the map	
Placement description	Central part of the Hill
Current state	Accessible, well preserved
Description	A complex of four small stones that form a circle with a fifth stone in the circle's center. Considered a sacrificial location.
Parietal art specimens description	—
Description source	Mykhailov 2005: 90—91

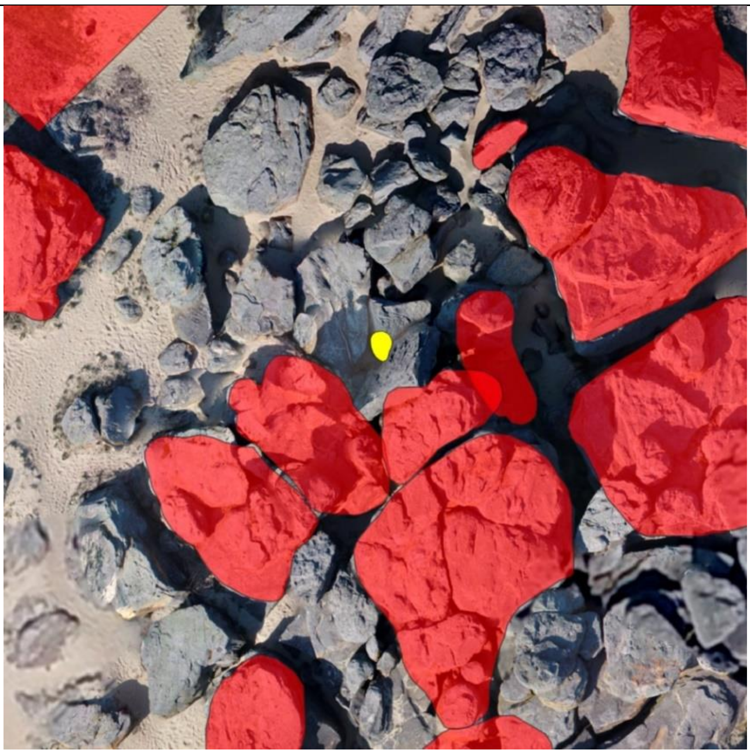
Location image	
Source	Mykhailov 2005: 258, fig. 94
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**65**
Location Name	**Location No. 65**
Place on the map	
Placement description	Northern periphery of the Hill
Current state	Covered with soil
Description	The only stratified ritual location is situated nearby the slopes of Kamyana Mohyla Hill, which has been excavated so far. The location has been chosen due to the surface material of probably Neolithic Age flints. The area of 40 square meters was excavated. The stratigraphy is as follows: humus layer (0—30 cm); black soils (10—30 cm); Middle-Sarmatian redeposited gray sands (40—50 cm); Middle-Sarmatian yellow sands (60—80 cm). An assemblage in the third layer contains zoomorphic sculptures and other sandstone concretions; the fourth layer contains flint and sandstone tools — flakes, blades, etc. Though some of the flint instances have been described as Paleolithic ones, the location, in general, has been labeled by B. Mykhailov as a Neolithic ritual location.
Parietal art specimens description	—

Description source	Mykhailov 2005: 91—93
Plan of the location	
Source	Mykhailov 2005: 259, fig. 95
Profile of the location	
Source	Mykhailov 2005: 260, fig. 96
Attribution	—
Attribution source	—
Portable art specimens	6 portable rock art instances, mostly amorphous, dated back from Upper Paleolithic to Neolithic. It has been found during the excavation in 1999. Contains zoomorphic and fish-like sculptures.
Portable art specimens No.	3875, 3900, 4343, 4344, 4349, 5103

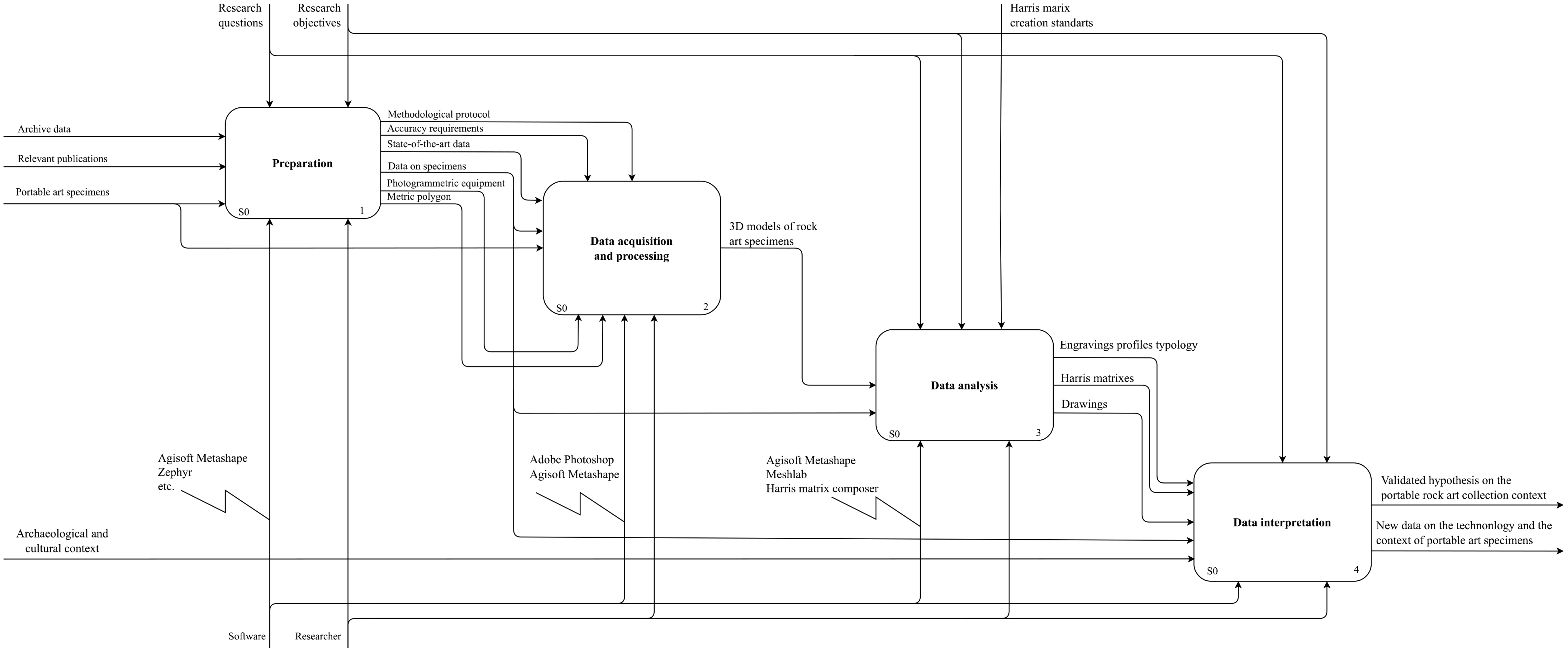
Location No.	**66**
Location Name	**Location No. 66**
Place on the map	
Placement description	Southern slope of the Hill
Current state	Accessible, well preserved
Description	An asset of linear and geometric engravings on the lower part and canopies of a block
Parietal art specimens description	Linear engravings; geometric engravings
Description source	Mykhailov, B., the storage list of Kamyana Mohyla National Reserve
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

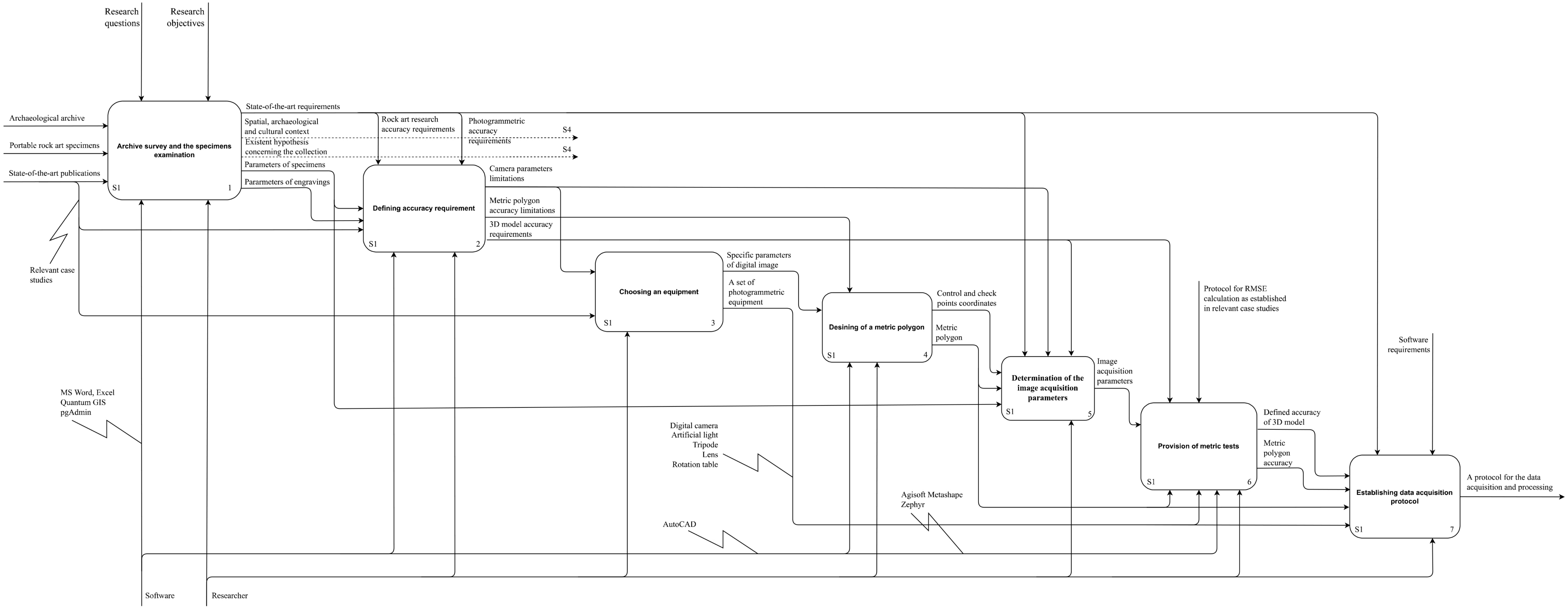
Location No.	**67**
Location Name	**Location No. 67**
Place on the map	
Placement description	Southwestern slope of the Hill
Current state	Accessible, well preserved
Description	An assets and circles of linear engravings, solar symbols etc. have been found on upper parts of horizontal surfaces.
Parietal art specimens description	Linear engravings; geometric engravings; calendars.
Description source	Mykhailov, B., the storage list of Kamyana Mohyla National Reserve
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

Location No.	**68**
Location Name	**Location No. 68**
Place on the map	
Placement description	Northern slope of the Hill
Current state	Accessible, well preserved
Description	An asset of linear and geometric engravings that probably form a calendar, lattices on the wall, and the canopies of a massive block near the Bull's cave entrance.
Parietal art specimens description	Linear engravings; geometric engravings.
Description source	Mykhailov, B., the storage list of Kamyana Mohyla National Reserve
Attribution	—
Attribution source	—
Portable art specimens	—
Portable art specimens No.	—

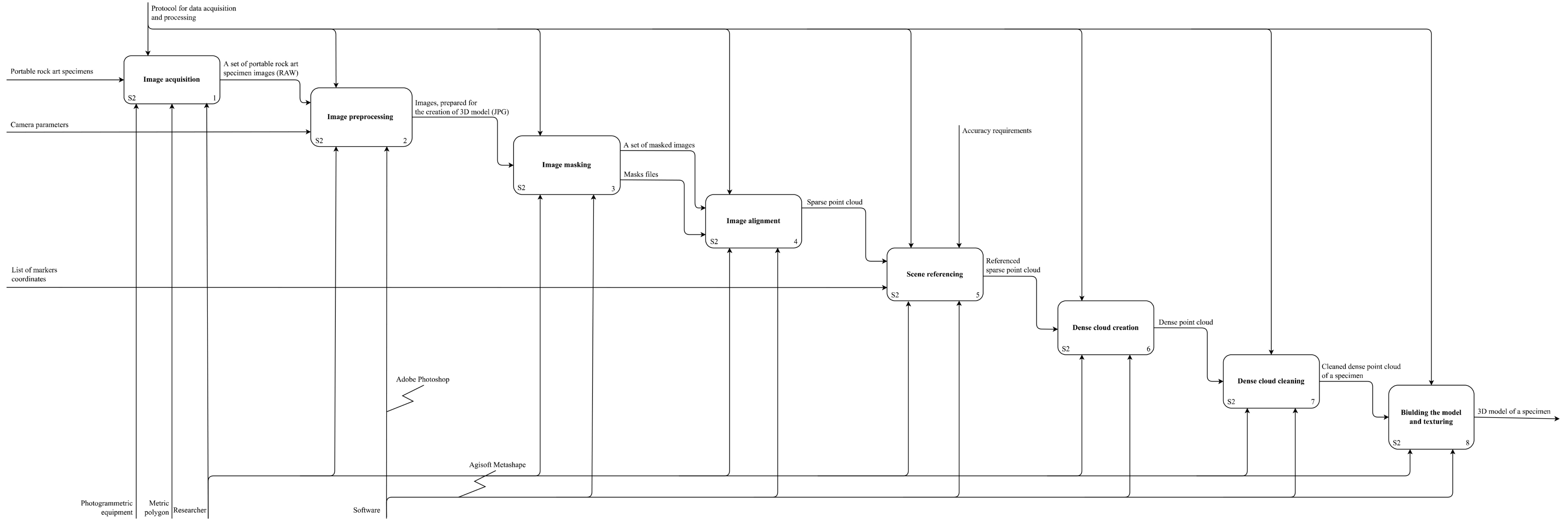
Annex B

The IDEF0-diagrams and flowcharts explaining the research workflow

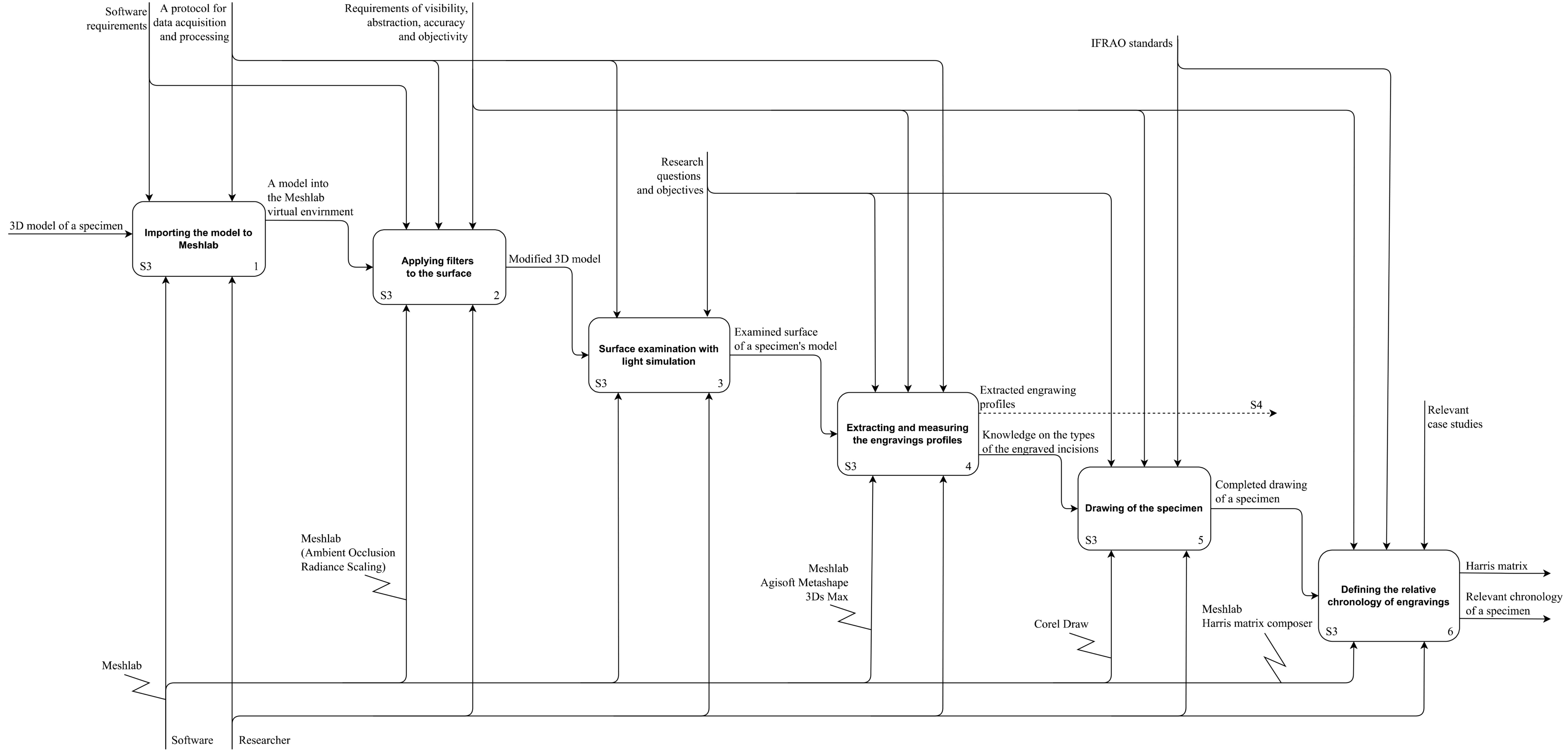

Research questions
Research objectives
Harris marix creation standarts
Archive data
Relevant publications
Portable art specimens
Preparation
S0
1
Methodological protocol
Accuracy requirements
State-of-the-art data
Data on specimens
Photogrammetric equipment
Metric polygon
Data acquisition and processing
S0
2
3D models of rock art specimens
Data analysis
S0
3
Engravings profiles typology
Harris matrixes
Drawings
Data interpretation
S0
4
Validated hypothesis on the portable rock art collection context
New data on the techonlogy and the context of portable art specimens
Agisoft Metashape
Zephyr
etc.
Adobe Photoshop
Agisoft Metashape
Agisoft Metashape
Meshlab
Harris matrix composer
Archaeological and cultural context
Software
Researcher

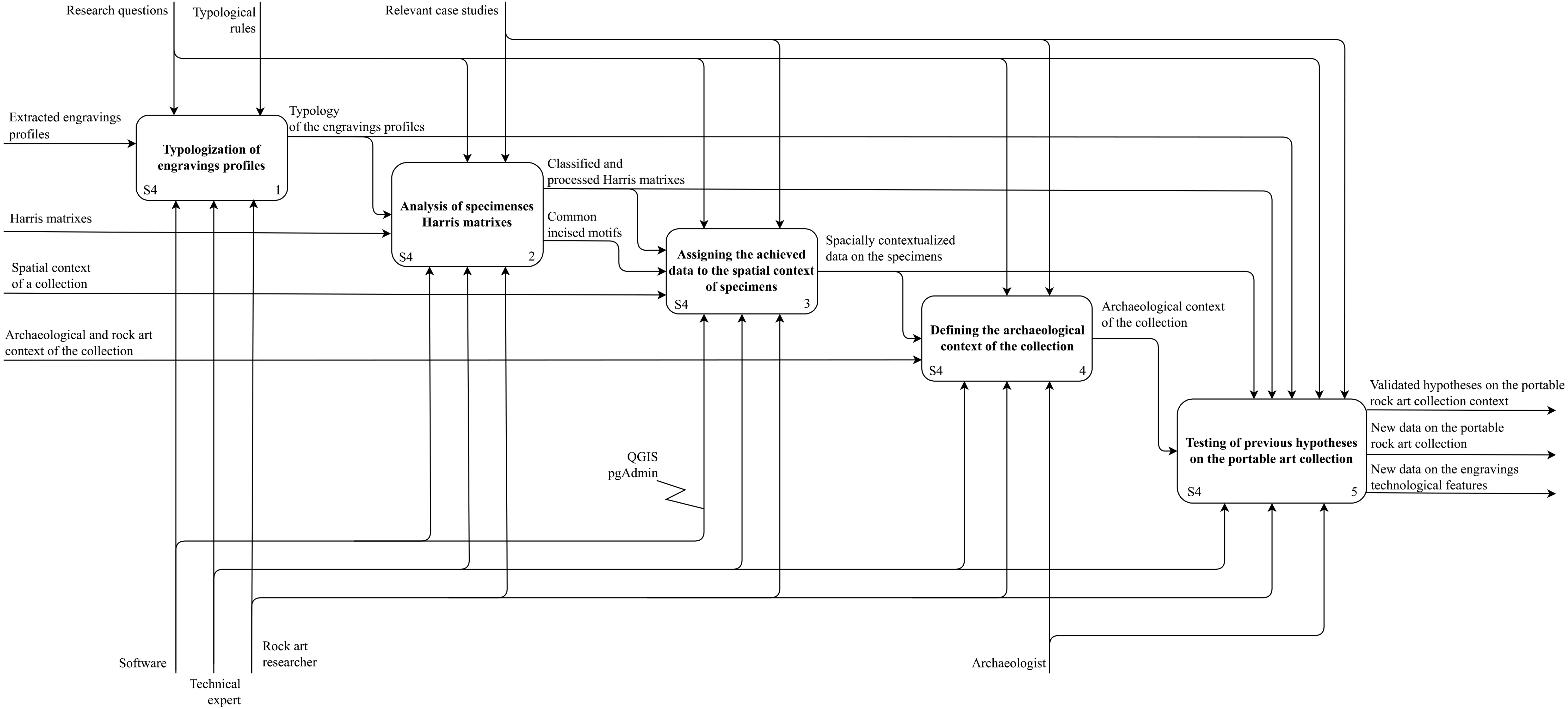


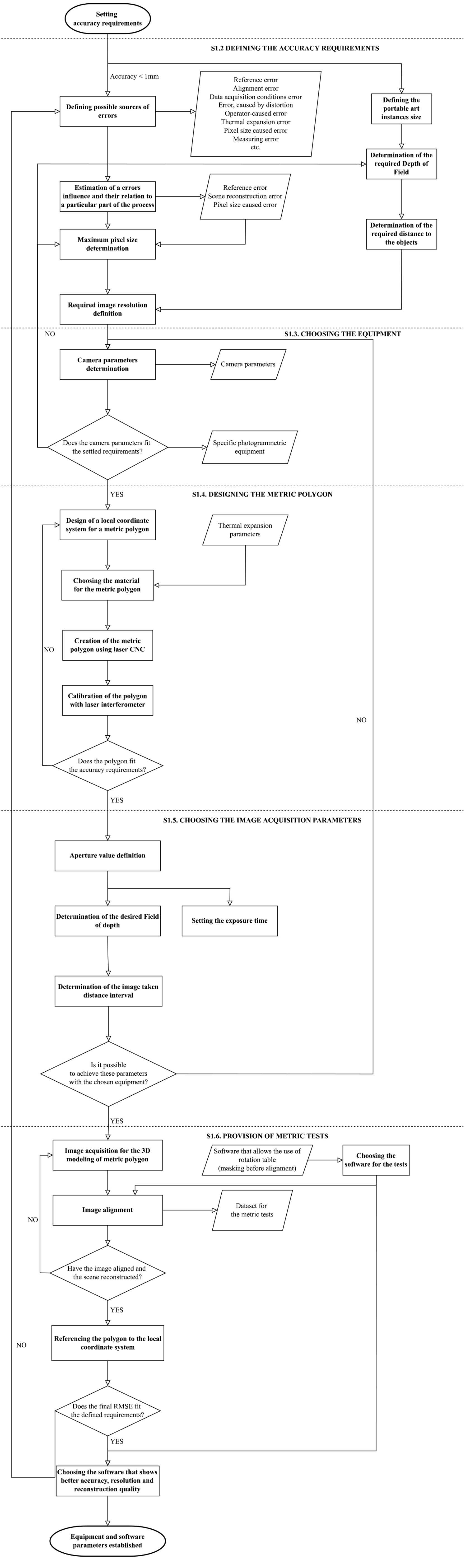
Research questions
Research objectives
Archaeological archive
Portable rock art specimens
State-of-the-art publications
Archive survey and the specimens examination
S1
1
State-of-the-art requirements
Spatial, archaeological and cultural context
Existent hypothesis concerning the collection
Parameters of specimens
Pararmeters of engravings
Rock art research accuracy requirements
Photogrammetric accuracy requirements
S4
S4
Relevant case studies
Defining accuracy requirement
S1
2
Camera parameters limitations
Metric polygon accuracy limitations
3D model accuracy requirements
Choosing an equipment
S1
3
Specific parameters of digital image
A set of photogrammetric equipment
Desining of a metric polygon
S1
4
Control and check points coordinates
Metric polygon
Determination of the image acquisition parameters
S1
5
Image acquisition parameters
Protocol for RMSE calculation as established in relevant case studies
Provision of metric tests
S1
6
Defined accuracy of 3D model
Metric polygon accuracy
Software requirements
Establishing data acquisition protocol
S1
7
A protocol for the data acquisition and processing
MS Word, Excel
Quantum GIS
pgAdmin
Digital camera
Artificial light
Tripode
Lens
Rotation table
AutoCAD
Agisoft Metashape
Zephyr
Software
Researcher

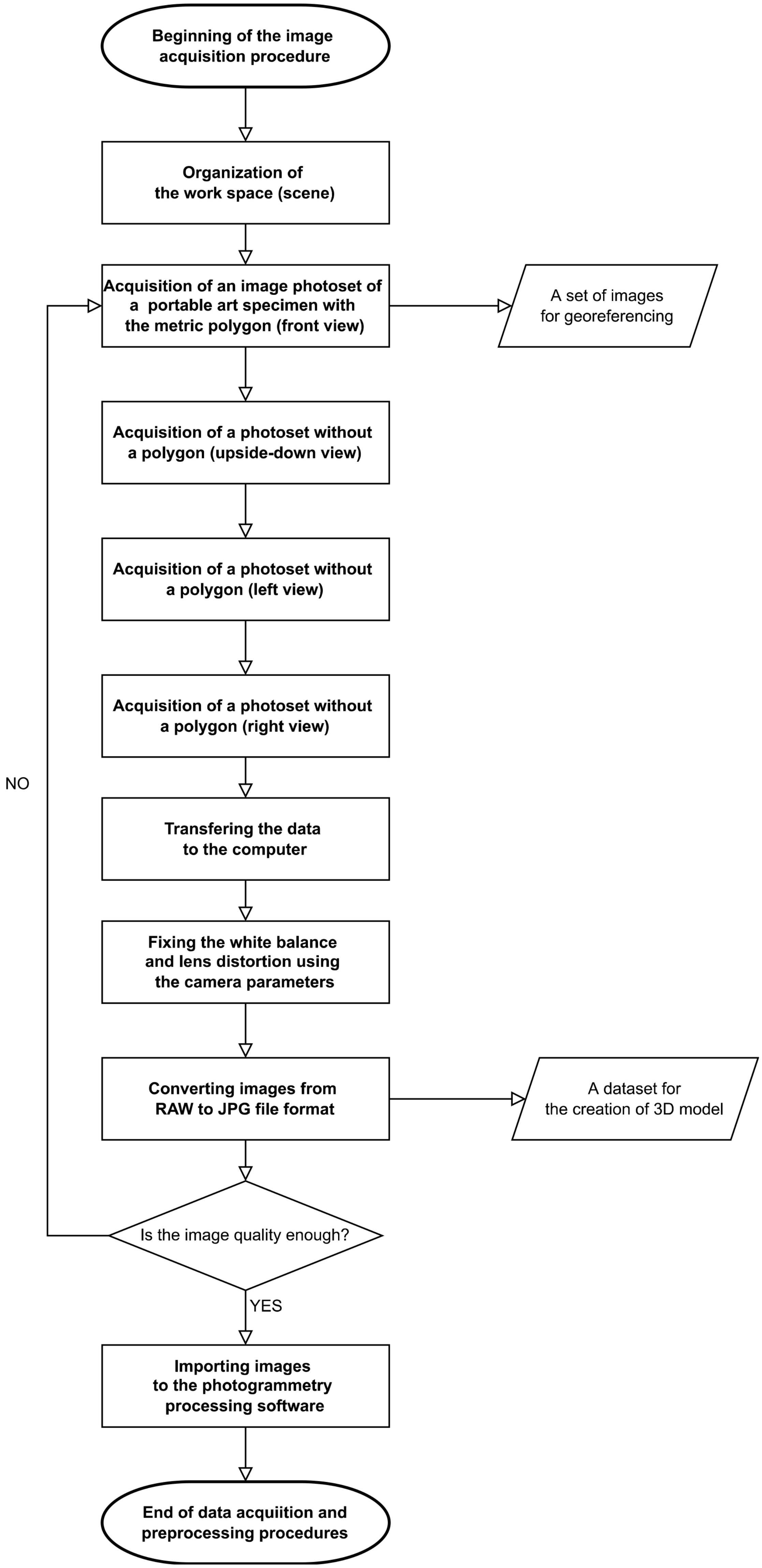


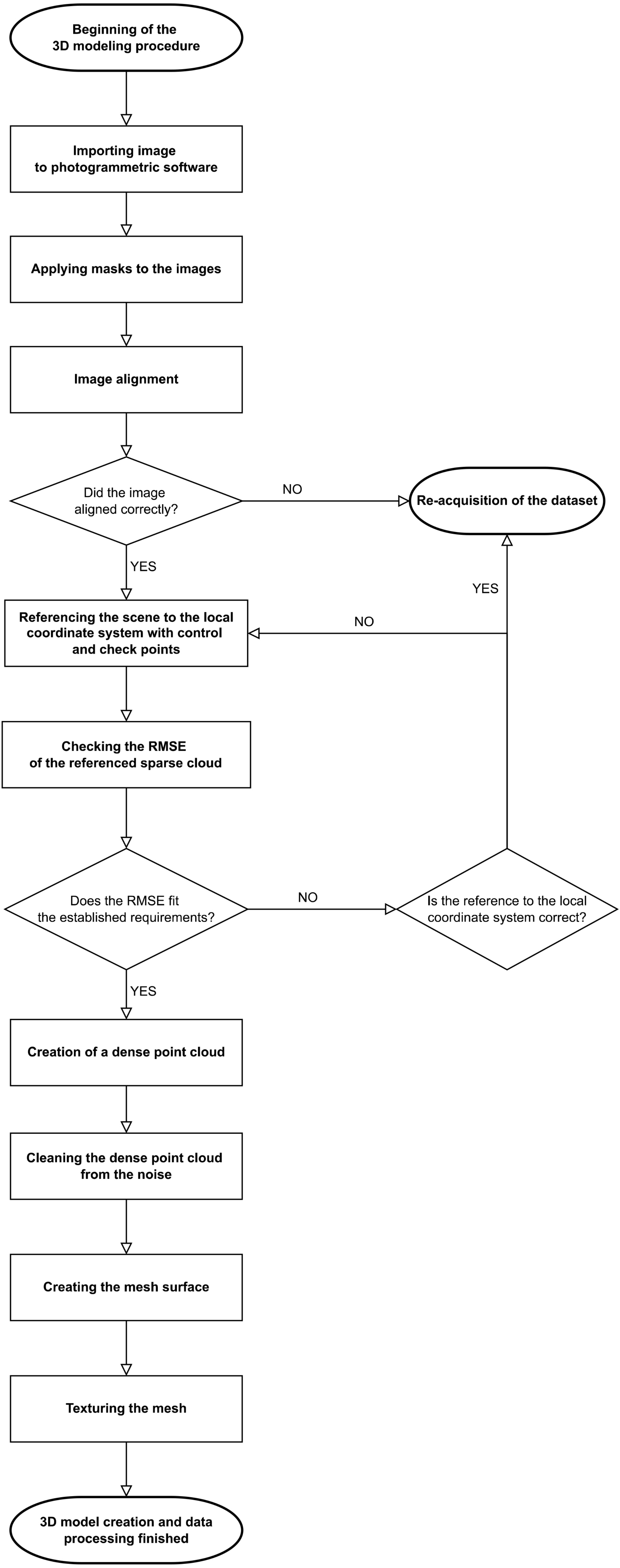
Protocol for data acquisition
and processing
Portable rock art specimens
Image acquisition
S2
1
A set of portable rock art
specimen images (RAW)
Image preprocessing
S2
2
Camera parameters
Images, prepared for
the creation of 3D model (JPG)
Image masking
S2
3
A set of masked images
Masks files
Image alignment
S2
4
Sparse point cloud
Accuracy requirements
List of markers
coordinates
Scene referencing
S2
5
Referenced
sparse point cloud
Dense cloud creation
S2
6
Dense point cloud
Dense cloud cleaning
S2
7
Cleaned dense point cloud
of a specimen
Biulding the model
and texturing
S2
8
3D model of a specimen
Adobe Photoshop
Agisoft Metashape
Photogrammetric
equipment
Metric
polygon
Researcher
Software


Software requirements
A protocol for data acquisition and processing
Requirements of visibility, abstraction, accuracy and objectivity
IFRAO standards
Research questions and objectives
3D model of a specimen
Importing the model to Meshlab
S3
1
A model into the Meshlab virtual envirnment
Applying filters to the surface
S3
2
Modified 3D model
Surface examination with light simulation
S3
3
Examined surface of a specimen's model
Extracting and measuring the engravings profiles
S3
4
Extracted engrawing profiles
S4
Knowledge on the types of the engraved incisions
Drawing of the specimen
S3
5
Completed drawing of a specimen
Relevant case studies
Defining the relative chronology of engravings
S3
6
Harris matrix
Relevant chronology of a specimen
Meshlab (Ambient Occlusion Radiance Scaling)
Meshlab
Agisoft Metashape
3Ds Max
Corel Draw
Meshlab
Harris matrix composer
Meshlab
Software
Researcher


Research questions
Typological rules
Relevant case studies
Extracted engravings profiles
Typology of the engravings profiles
Typologization of engravings profiles
S4
1
Classified and processed Harris matrixes
Analysis of specimenses Harris matrixes
S4
2
Harris matrixes
Common incised motifs
Spatial context of a collection
Assigning the achieved data to the spatial context of specimens
S4
3
Spacially contextualized data on the specimens
Archaeological and rock art context of the collection
Defining the archaeological context of the collection
S4
4
Archaeological context of the collection
Validated hypotheses on the portable rock art collection context
Testing of previous hypotheses on the portable art collection
S4
5
New data on the portable rock art collection
New data on the engravings technological features
QGIS
pgAdmin
Software
Technical expert
Rock art researcher
Archaeologist


Setting accuracy requirements
S1.2 DEFINING THE ACCURACY REQUIREMENTS
Accuracy < 1mm
Defining possible sources of errors
Reference error
Alignment error
Data acquisition conditions error
Error, caused by distortion
Operator-caused error
Thermal expansion error
Pixel size caused error
Measuring error
etc.
Defining the portable art instances size
Determination of the required Depth of Field
Estimation of a errors influence and their relation to a particular part of the process
Reference error
Scene reconstruction error
Pixel size caused error
Maximum pixel size determination
Determination of the required distance to the objects
Required image resolution definition
NO
S1.3. CHOOSING THE EQUIPMENT
Camera parameters determination
Camera parameters
Does the camera parameters fit the settled requirements?
Specific photogrammetric equipment
YES
S1.4. DESIGNING THE METRIC POLYGON
Design of a local coordinate system for a metric polygon
Thermal expansion parameters
Choosing the material for the metric polygon
NO
Creation of the metric polygon using laser CNC
Calibration of the polygon with laser interferometer
NO
Does the polygon fit the accuracy requirements?
YES
S1.5. CHOOSING THE IMAGE ACQUISITION PARAMETERS
Aperture value definition
Determination of the desired Field of depth
Setting the exposure time
Determination of the image taken distance interval
Is it possible to achieve these parameters with the chosen equipment?
YES
S1.6. PROVISION OF METRIC TESTS
Image acquisition for the 3D modeling of metric polygon
Software that allows the use of rotation table (masking before alignment)
Choosing the software for the tests
Image alignment
Dataset for the metric tests
NO
Have the image aligned and the scene reconstructed?
YES
Referencing the polygon to the local coordinate system
NO
Does the final RMSE fit the defined requirements?
YES
Choosing the software that shows better accuracy, resolution and reconstruction quality
Equipment and software parameters established


Beginning of the image acquisition procedure
Organization of the work space (scene)
Acquisition of an image photoset of a portable art specimen with the metric polygon (front view)
A set of images for georeferencing
Acquisition of a photoset without a polygon (upside-down view)
Acquisition of a photoset without a polygon (left view)
Acquisition of a photoset without a polygon (right view)
NO
Transfering the data to the computer
Fixing the white balance and lens distortion using the camera parameters
Converting images from RAW to JPG file format
A dataset for the creation of 3D model
Is the image quality enough?
YES
Importing images to the photogrammetry processing software
End of data acquiition and preprocessing procedures


Beginning of the
3D modeling procedure
Importing image
to photogrammetric software
Applying masks to the images
Image alignment
Did the image
aligned correctly?
NO
Re-acquisition of the dataset
YES
YES
Referencing the scene to the local
coordinate system with control
and check points
NO
Checking the RMSE
of the referenced sparse cloud
Does the RMSE fit
the established requirements?
NO
Is the reference to the local
coordinate system correct?
YES
Creation of a dense point cloud
Cleaning the dense point cloud
from the noise
Creating the mesh surface
Texturing the mesh
3D model creation and data
processing finished

Annex C

The parameters of image processing and 3D models creation

Parameters of PC used for image processing and 3D modeling procedures

Processor	Intel Core i7-6700HQ
Clock rate	2.60 GHz
RAM	32 Gb
Visual processor	Nvidia Ge Force GTX 950m
Operational system	Windows 10, 64bit
Software	Agisoft Metashape v. 1.5.4 build 8885

Parameters of alignment and sparse point cloud

No	Number of images taken / aligned	Tie points	Accuracy	Matching time	Alignment time	Control points error, mm	Check points error, mm	Control points error, pix	Check points error, pix
Rudinskiy	101 / 104	71 571	High	17m 55s	1m 28s	0.377	0.435	1.548	0.784
213	90 / 90	109 906	Highest	17m 43s	36s	0.428	0.415	0.247	0.272
214	93 / 93	75 795	Highest	51m 9s	24s	0.27	0.302	0.705	0.543
218	92 / 92	98 358	Highest	18m 49s	1m 7s	0.454	0.387	0.318	0.365
220	83 /83	68 412	Highest	38m 19s	32s	0.223	0.256	0.581	0.402
225	108 / 108	59 853	Highest	2m 3s	12s	0.201	0.249	0.822	0.65
228	72 / 74	28 796	Highest	3m 48s	11s	0.216	0.235	0.706	0.675
245	141 / 143	178 451	Highest	28m 1s	1m 49s	0.277	0.337	1.952	1.633
247	125 / 128	136 080	Highest	37m 6s	1m 14s	0.275	0.401	1.232	1.816
248	180 / 181	206 842	Highest	45m 12s	2m 8s	0.208	0.319	0.45	0.253
249	151 / 151	165 667	Highest	32m 34s	54s	0.226	0.265	0.65	0.3
252	153 / 153	173 786	Highest	2h 52m	1m 13s	0.269	0.385	4.406	3.926
254	123 / 123	132 958	Highest	1h 31m	40s	0.278	0.477	0.957	1.345
257	89 / 102	5 204	Highest	1h 5m	8s	0.321	0.407	0.609	0.417
258	111 / 111	81 733	Highest	1h 9m	1m 23s	0.335	0.398	2.918	2.291
259	86 / 87	93 452	Highest	25m 51s	56s	0.321	0.48	0.898	0.476
260	84 / 84	2 517	High	49m 11s	9s	0.325	0.396	1.122	0.801

261	106 / 106	85 165	High	36m 18s	1m 47s	0.294	0.463	0.653	0.432
265	90 / 90	112 353	Highest	18m 13s	41s	0.401	0.458	0.241	0.271
268	94 / 101	5 926	Highest	1h 10m	8s	0.303	0.361	0.521	0.402
273	86 / 86	113 955	Highest	8m 25s	10s	0.239	0.419	0.883	0.362
276	86 / 86	95 717	Highest	9m 11s	8s	0.282	0.429	1.025	0.454
277	140 / 140	170 831	Highest	15m 53s	32s	0.296	0.423	0.736	0.494
278	163 / 163	183 405	Highest	18m 30s	32s	0.107	0.171	0.272	0.249
283	120 / 121	164 361	Highest	12m 58s	1m 5s	0.191	0.27	0.798	0.295
284	228 / 231	227 481	Highest	3h 45m	2m 26s	0.235	0.308	0.659	0.549
287	74 / 74	62 871	Highest	5m 52s	27s	0.294	0.29	0.653	0.486
298	144 / 144	9 229	Highest	2h 12m	6s	0.263	0.315	0.475	0.265
300	92 / 92	87 405	Highest	1h 23m	1m 15s	0.282	0.421	0.703	0.413
302	100 / 126	89 066	Highest	2h 1m	57s	0.267	0.34	0.668	0.331
306	115 / 117	92 616	Highest	1h 22m	50s	0.215	0.429	0.903	0.414
307	83 / 83	88 483	Highest	44m 30s	37s	0.268	0.475	0.885	0.392
308	148 / 148	2 535	Highest	2h 11m	9s	0.275	0.463	0.511	0.365
309	131 / 135	28 556	Highest	1h 28m	29s	0.357	0.465	1.462	1.079
310	137 / 151	161 097	Highest	1h 1m	36s	0.234	0.309	0.601	0.368
317	127 / 127	121 723	Highest	54m 9s	45s	0.29	0.368	0.836	0.526
321	111 / 114	91 486	Highest	18m 24s	1m 1s	0.252	0.273	0.736	0.684
324	79 / 84	76 089	Highest	4m 33s	28s	0.226	0.271	0.81	0.67
328	107 / 107	112 056	Highest	1h 5m	56s	0.267	0.474	0.781	0.683
329	138 / 138	134 560	Highest	1h 40m	1m 55s	0.28	0.312	0.902	0.332
331	89 / 89	45 863	Highest	8m 56s	1m 4s	0.291	0.382	1.006	0.945
332	107 / 136	72 494	High	13m 9s	2m 42s	0.32	0.434	0.826	0.552
335	104 / 104	80 667	Highest	24m 10s	1m 17s	0.208	0.254	0.662	0.675
336	95 / 95	64 719	Highest	8h 48m	1m 2s	0.345	0.492	0.853	0.818
338	91 / 93	69 526	Highest	42m 57s	56s	0.191	0.298	0.766	0.593

341	99 / 99	85 077	Highest	53m 44s	51s	0.234	0.267	0.697	0.556
341a	70 / 70	57 312	Highest	30m 32s	46s	0.258	0.272	0.759	0.561
342	86 / 86	82 598	Highest	39m 8s	38s	0.328	0.416	0.825	0.401
343	104 / 104	99 398	Highest	52m 8s	40s	0.241	0.488	0.88	0.494
344	122 / 123	121 106	Highest	1h 21m	1m 7s	0.236	0.344	0.697	0.765
356	121 / 121	106 452	Highest	10m 53s	49s	0.235	0.256	0.838	0.732
360	73 / 73	75 919	Highest	27m 58s	55s	0.308	0.343	0.647	0.42
KM74—1	139 / 139	32 061	Highest	2h 42m	16s	0.427	0.465	0.601	0.567
KM74—2	116 / 119	105 905	Highest	1h 25m	47s	0.129	0.166	0.661	0.521
KM74—4	98 / 100	7 928	Highest	1h 6m	6s	0.444	0.456	0.547	0.564
KM74—6	123 / 123	131 806	Highest	49m 10s	1m 40s	0.439	0.397	0.6	0.525
KM74—7	84 / 95	5 761	Highest	1h 23m	12s	0.431	0.42	0.567	0.525
KM74—8	85 / 85	99 453	Highest	16m 15s	1m 4s	0.423	0.404	0.317	0.282
KM74—9	80 / 85	80 412	Highest	23m 48s	1m 26s	0.421	0.389	0.457	0.407
KM74—11	95 / 95	99 805	Highest	20m 16s	43s	0.497	0.483	0.494	0.354
KM74—13	92 / 92	14 528	Highest	1h 12m	13s	0.455	0.462	0.495	0.452
KM74—15	86 / 87	67 459	Highest	18m 26s	21s	0.383	0.396	0.474	0.384
KM74—16	89 / 89	49 373	Highest	18m 12s	22s	0.436	0.406	0.625	0.549
KM74—17	136 / 136	188 532	Highest	28m 23s	1m 10s	0.433	0.371	0.764	0.528
KM74—18	87 / 90	7 088	Highest	40m 51s	6s	0.426	0.408	0.53	0.574
KM74—19	77 / 77	76 857	Highest	35m 13s	24s	0.115	0.107	0.41	0.467
KM74—20	79 / 79	74 213	Highest	31m 37s	31s	0.425	0.396	0.342	0.302
KM74—21	166 / 166	203 912	Highest	30m 47s	2m 58s	0.409	0.378	0.398	0.352
KM74—23	197 / 198	202 860	Highest	42m 34s	1m 21s	0.448	0.445	0.529	0.558
KM74—24	141 / 141	186 903	Highest	28m 17s	1m 11s	0.42	0.437	0.648	0.566
KM74—27	94 / 97	92 455	Highest	1h 1m	51s	0.425	0.46	0.313	0.244

Parameter of dense point cloud and mesh reconstruction

No	Dense cloud points	Quality	Filtering mode	Depth map generation time	Dense cloud generation parameters	Number of faces	Interpolation	Processing time
Rudinskiy	2 301 347	High	Mild	26m 50s	19m 5s	5 531 870	Enabled	7m 46s
213	1 296 685	High	Mild	29m 27s	17m 14s	3 211 940	Enabled	3m 56s
214	2 594 929	High	Mild	15m 46s	19m 1s	6 415 272	Enabled	7m 15s
218	1 619 404	High	Moderate	19m 42s	15m 13s	3 972 400	Enabled	6m 28s
220	768 099	High	Mild	7m 3s	9m 29s	1 943 932	Enabled	2m 12s
225	927 119	High	Mild	6m 21s	12m 22s	1 300 729	Enabled	36s
228	905 647	High	Mild	4m 32s	7m 17s	2 194 208	Enabled	1m 6s
245	4 909 803	High	Mild	58m 57s	52m 43s	8 000 000	Enabled	23m 59s
247	2 722 855	High	Mild	47m 9s	30m 49s	6 583 466	Enabled	8m 30s
248	9 979 771	High	Mild	5h 24m	8h 48m	8 000 000	Enabled	28m 18s
249	10 798 845	High	Mild	3h 37m	1h 18m	8 000 000	Enabled	29m 10s
252	5 804 940	High	Mild	2h 4m	1h 9m	8 000 0000	Enabled	16m 44s
254	3 135 240	High	Mild	20m 38s	15m 23s	6 988 732	Enabled	1m 45s
257	3 627 670	High	Mild	33m 5s	11m 26s	8 000 000	Enabled	1m 47s
258	2 875 135	High	Mild	1h 13m	31m 47s	3 911 210	Enabled	12m 18s
259	1 953 268	High	Mild	7m 7s	7m 8s	4 744 318	Enabled	1m 3s
260	2 193 861	High	Mild	5m 16s	2m 58s	5 278 796	Enabled	1m 13s
261	799 154	High	Mild	15m 20s	15m 7s	1 999 862	Enabled	27s
265	4 491 116	High	Mild	21m 54s	11m 34s	7 025 328	Enabled	2m 29s

268	3 913 530	High	Mild	12m 27s	10m 13s	8 000 000	Enabled	1m 59s
273	2 540 292	High	Mild	10m 59s	7m 28s	6 000 000	Enabled	1m 14s
276	4 064 351	High	Mild	17m 33s	11m 22s	8 000 000	Enabled	14m 19s
277	6 146 815	High	Mild	1h 16m	36m 29s	7 000 000	Enabled	3m 0s
278	7 443 239	High	Mild	1h 48m	39m 41s	8 000 000	Enabled	3m 35s
283	7 998 902	High	Mild	35m 18s	25m 40s	8 000 000	Enabled	3m 53s
284	7 836 796	High	Mild	1h 51m	1h 6m	8 000 000	Enabled	3m 55s
287	2 053 935	High	Mild	9m 26s	5m 7s	5 090 782	Enabled	1m 5s
298	6 464 931	High	Mild	45m 12s	26m 15s	8 000 000	Enabled	3m 3s
300	5 823 547	High	Mild	19m 36s	13m 37s	8 000 000	Enabled	2m 50s
302	4 857 447	High	Mild	24m 17s	16m 18s	8 000 000	Enabled	2m 27s
306	1 991 052	High	Mild	9m 39s	13m 6s	4 842 340	Enabled	53s
307	1 511 620	High	Mild	8m 16s	5m 54s	3 693 450	Enabled	41s
308	1 640 954	High	Mild	11m 34s	9m 28s	4 093 034	Enabled	44s
309	6 403 864	High	Mild	16m 41s	22m 11s	8 000 000	Enabled	3m 10s
310	9 523 224	High	Mild	1h 4m	35m 33s	8 000 000	Enabled	4m 36s
317	2 471 881	High	Mild	17m 34s	37m 34s	6 102 146	Enabled	1m 37s
321	1 538 644	High	Mild	12m 3s	34m 58s	3 659 932	Enabled	53s
324	1 873 765	High	Mild	4m 39s	9m 15s	4 638 760	Enabled	1m 5s
328	5 161 456	High	Mild	26m 6s	17m 49s	8 000 000	Enabled	2m 41s
329	9 134 619	High	Mild	50m 3s	30m 26s	8 000 000	Enabled	4m 45s
331	1 436 217	High	Mild	4m 1s	6m 12s	3 506 842	Enabled	39s
332	1 809 486	High	Mild	5m 31s	7m 34s	4 456 214	Enabled	1m 4s
335	2 056 148	High	Mild	5m 5s	13m 35s	5 125 782	Enabled	1m 16s
336	4 476 288	High	Mild	7m 4s	17m 18s	8 000 000	Enabled	3m 0s
338	5 179 741	High	Mild	8m 29s	18m 48s	8 000 000	Enabled	3m 25s
341	4 126 851	High	Mild	8m 30s	20m 51s	8 000 000	Enabled	2m 47s
341a	2 427 567	High	Mild	3m 15s	6m 12s	5 909 194	Enabled	1m 30s

342	2 006 132	High	Mild	7m 59s	9m 37s	4 918 076	Enabled	1m 10s
343	7 317 212	High	Mild	10m 18s	20m 29s	8 000 000	Enabled	4m 49s
344	9 355 931	High	Mild	13m 50s	33m 20s	8 000 000	Enabled	6m 26s
356	2 500 240	High	Mild	7m 51s	18m 18s	6 154 258	Enabled	1m 36s
360	844 580	High	Mild	44m 2s	17m 44s	2 108 378	Enabled	41s
KM74—1	4 918 950	High	Mild	3h 12m	1h 3m	6 000 000	Enabled	16m 21s
KM74—2	10 926 983	High	Mild	1h 24m	53m 29s	6 000 000	Enabled	28m 49s
KM74—4	3 461 515	High	Mild	42m 40s	26m 33s	6 000 000	Enabled	11m 28s
KM74—6	2 723 344	High	Mild	31m 51s	32m 16s	6 000 000	Enabled	9m 10s
KM74—7	2 025 037	High	Mild	15m 44s	12m 0s	5 000 744	Enabled	6m 49s
KM74—8	774 673	High	Mild	18m 15s	14m 29s	1 903 862	Enabled	2m 52s
KM74—9	1 459 220	High	Mild	14m 11s	14m 0s	3 605 772	Enabled	5m 1s
KM74—11	8 615 180	High	Mild	55m 17s	2h 55m	6 000 000	Enabled	25m 19s
KM74—13	5 074 151	High	Mild	41m 53s	25m 27s	6 000 000	Enabled	18m 4s
KM74—15	2 557 370	High	Mild	20m 26s	19m 45s	6 000 000	Enabled	7m 43s
KM74—16	1 452 867	High	Mild	12m 27s	12m 20s	3 607 494	Enabled	4m 17s
KM74—17	1 407 919	High	Mild	21m 35s	19m 16s	3 394 504	Enabled	3m 40s
KM74—18	4 382 074	High	Mild	28m 6s	26m 48s	8 000 000	Enabled	12m 57s
KM74—19	4 777 885	High	Mild	19m 44s	21m 44s	8 000 000	Enabled	13m 34s
KM74—20	697 991	High	Mild	7m 22s	7m 12s	1 712 092	Enabled	2m 19s
KM74—21	603 401	High	Mild	22m 43s	23m 19s	1 476 446	Enabled	1m 57s
KM74—23	1 790 066	High	Mild	1h 13m	1h 4m	4 409 740	Enabled	5m 32s
KM74—24	3 320 739	High	Mild	44m 31s	41m 36s	8 000 000	Enabled	10m 17s
KM74—27	4 012 423	High	Mild	1h 21m	24m 39s	8 000 000	Enabled	12m 50s

Annex D

A catalogue of Kamyana Mohyla portable art specimens

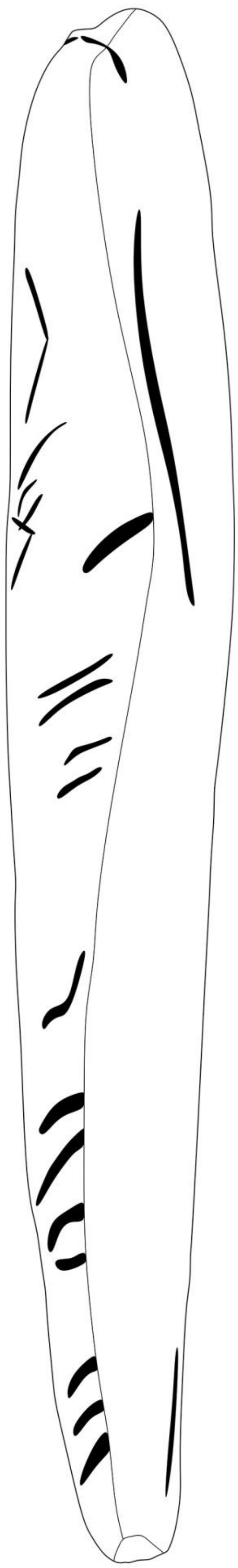
discovered by V. Danilenko

Specimen's ID	Rudinskiy 1
Image front	
Image back	
Image top	
Image bottom	
Length, cm	34.9
Width, cm	8
Weight, g	1742
Volume, m^3	0.000836
Density, kg / m^3	2083.73206
Date of discovery	1952
Finder	M. Rudinskiy
Location	A place on the Hill near the Cave of Churingas

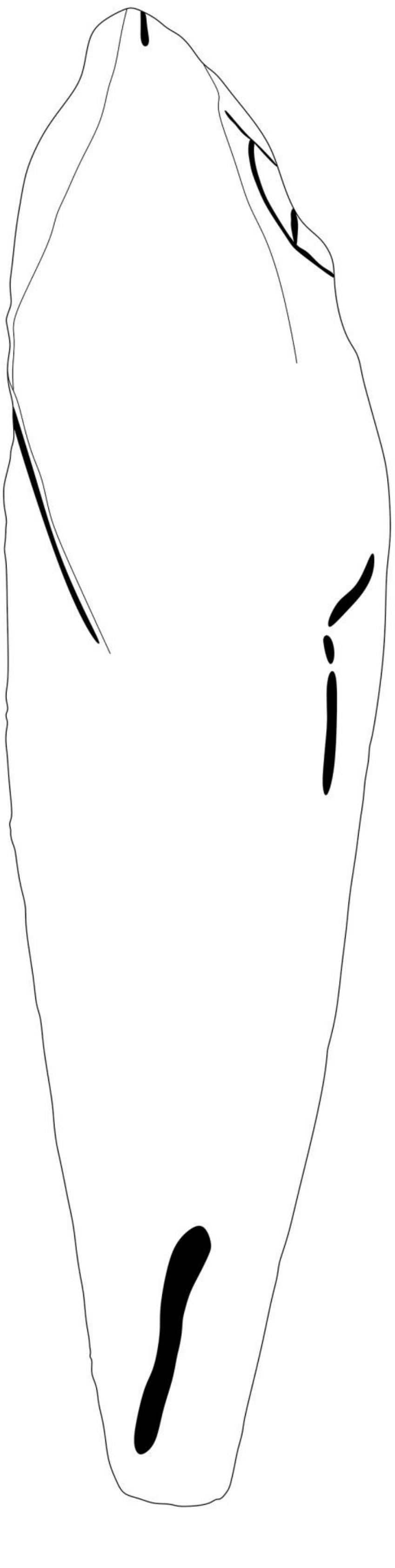
Current location	Institute of Archaeology, Kyiv
Description	Churinga, which was found in 1952, is very close to the shape of a catfish. It is covered with notches and a complex rhombic figure from one side. These engravings are intended to show the fish scale. A big mouth and an eye of a rhombic shape are engraved. The other side of churinga contains the same symbols in a very simplified manner. The space of this second side is covered with two zoomorphic symbols — a snake and the creature with a rhombic head, wings, and a long tail (which might be one of the dragon variants). A thin side of churinga is interesting because the incision shows a kind of the second mouth. The churinga is similar to the image of a catfish from the Northern grotto. Both are pretty similar to the stone fishes of Siberia and the "vishaps" of Transcaucasia. These symbols are usually connected with the water and the underworld.
Description source	Danilenko 1986: 65—66
Note	The whole surface of a specimen is processed to the shape of a cigar or a fish. It contains linear engravings from all sides. Most of them are pretty shallow and almost invisible, but some are recognizable quite well. This may be caused either by their original shape or the state of preservation. The top part of the figure contains the number of parallel diagonal notches. The figure is covered with a conservation glue to prevent the destruction of sandstone and the crumbling of sand pieces.

Technological drawing front

Technological drawing top

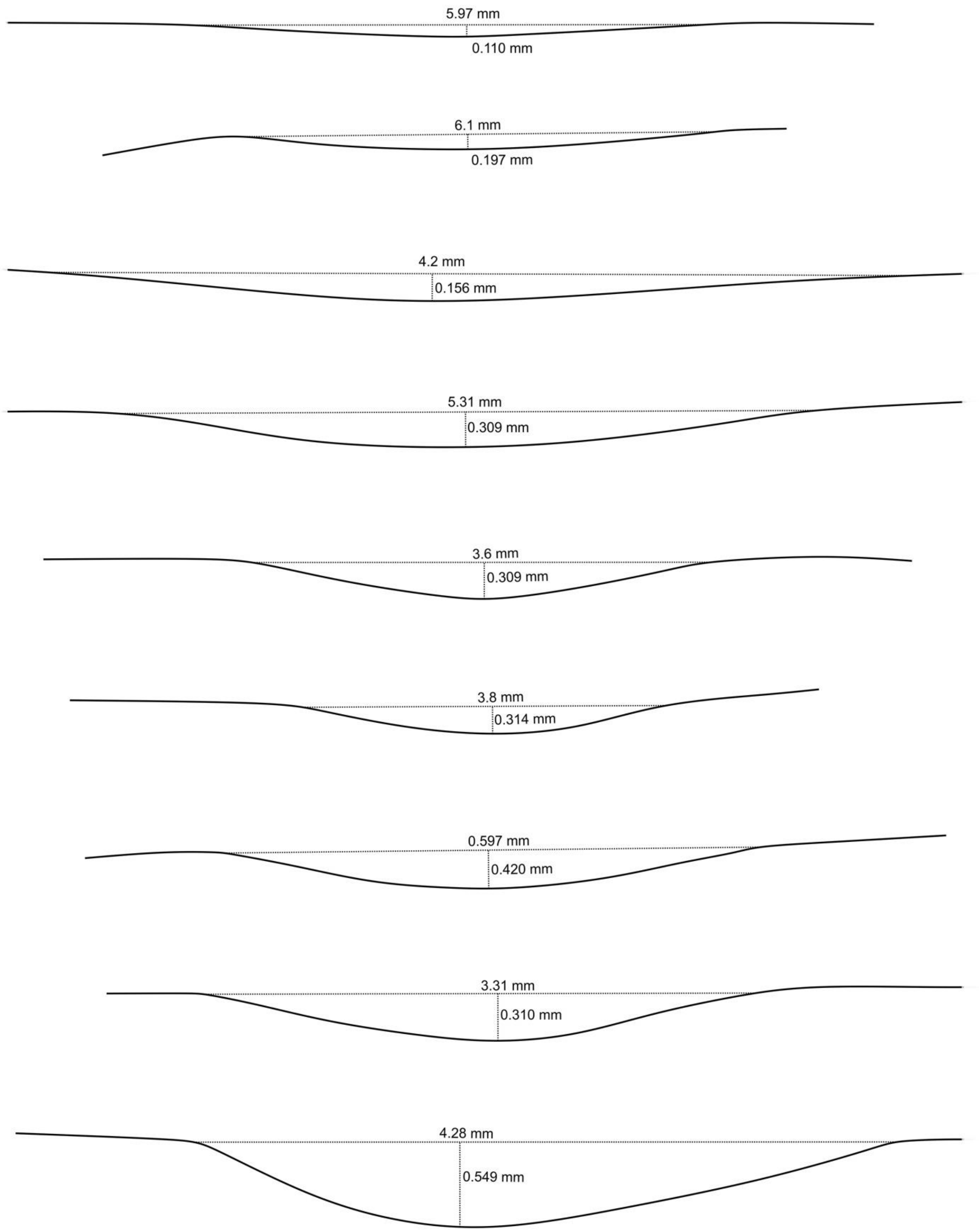


Technological drawing back



Technological drawing bottom

Profiles list

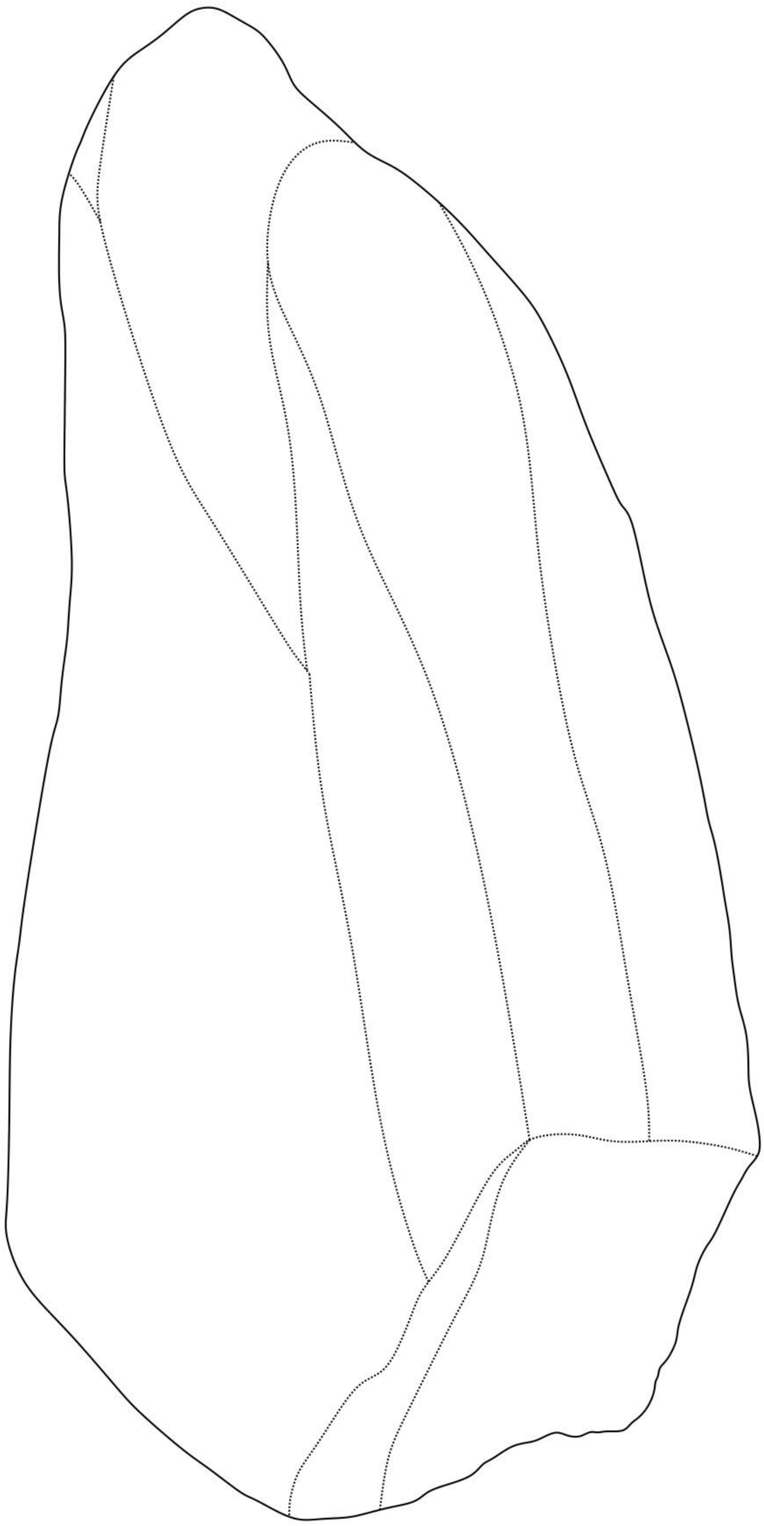


Specimen's ID	213
Image front	
Image left	
Image back	
Image right	
Length, cm	12
Width, cm	8.5
Weight, g	458
Volume, m^3	0.000167
Density, kg / m^3	2742.51497

Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The block was not described in any book or archaeological report. Its number and initial location are known from the index on the block. The geology of this specimen is unusual due to the number of layers of different colors (and different geological structures). The block was not polished or engraved. It has probably been considered a churinga according to the place where it was found and later reconsidered by V. Danilenko during the laboratory processing of the data.

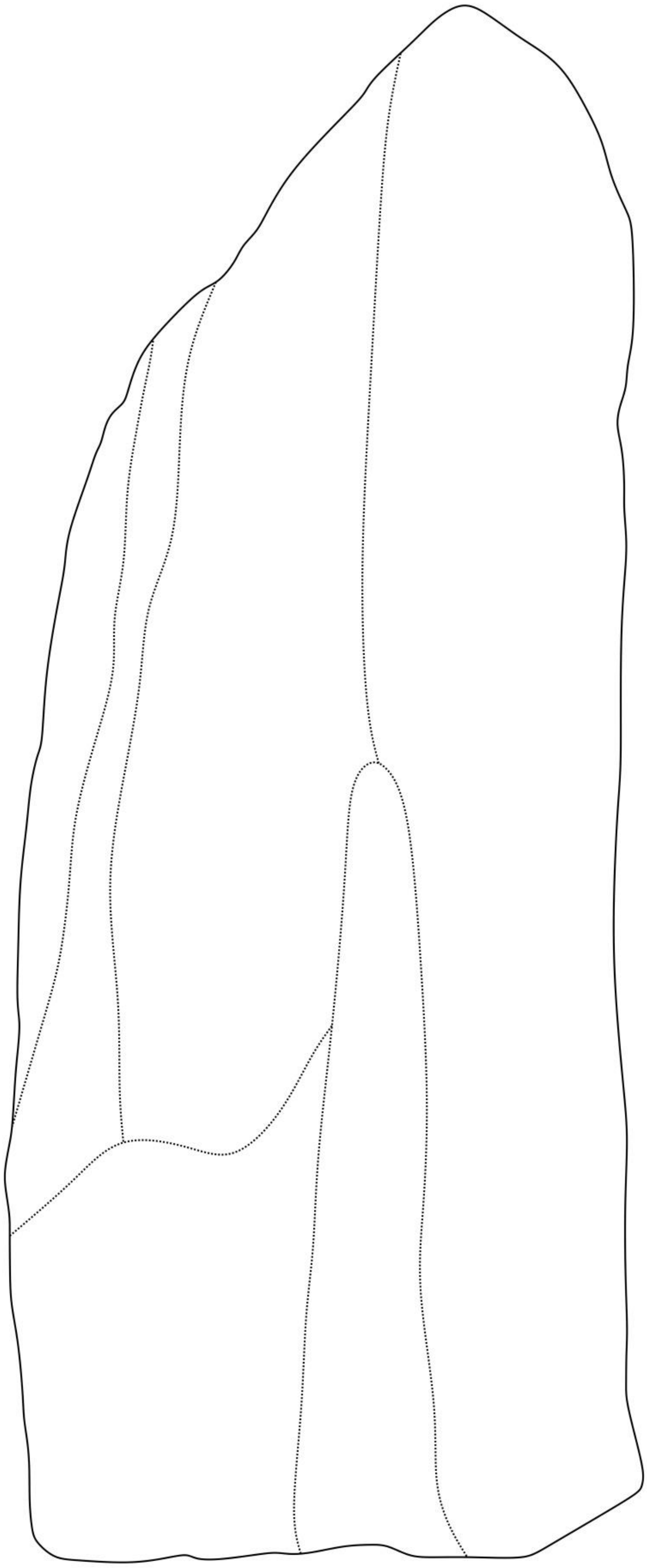
Technological drawing front

Technological drawing left



Technological drawing back

Technological drawing right

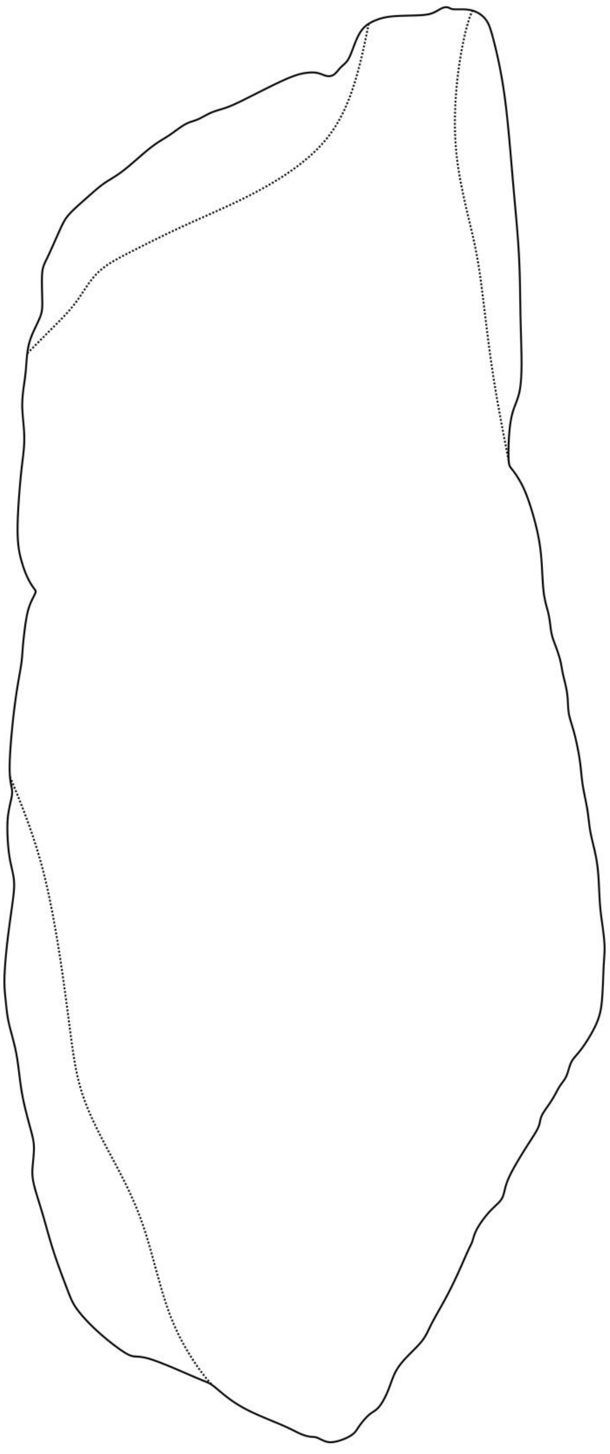


Specimen’s ID	214
Image front	
Image left	
Image back	

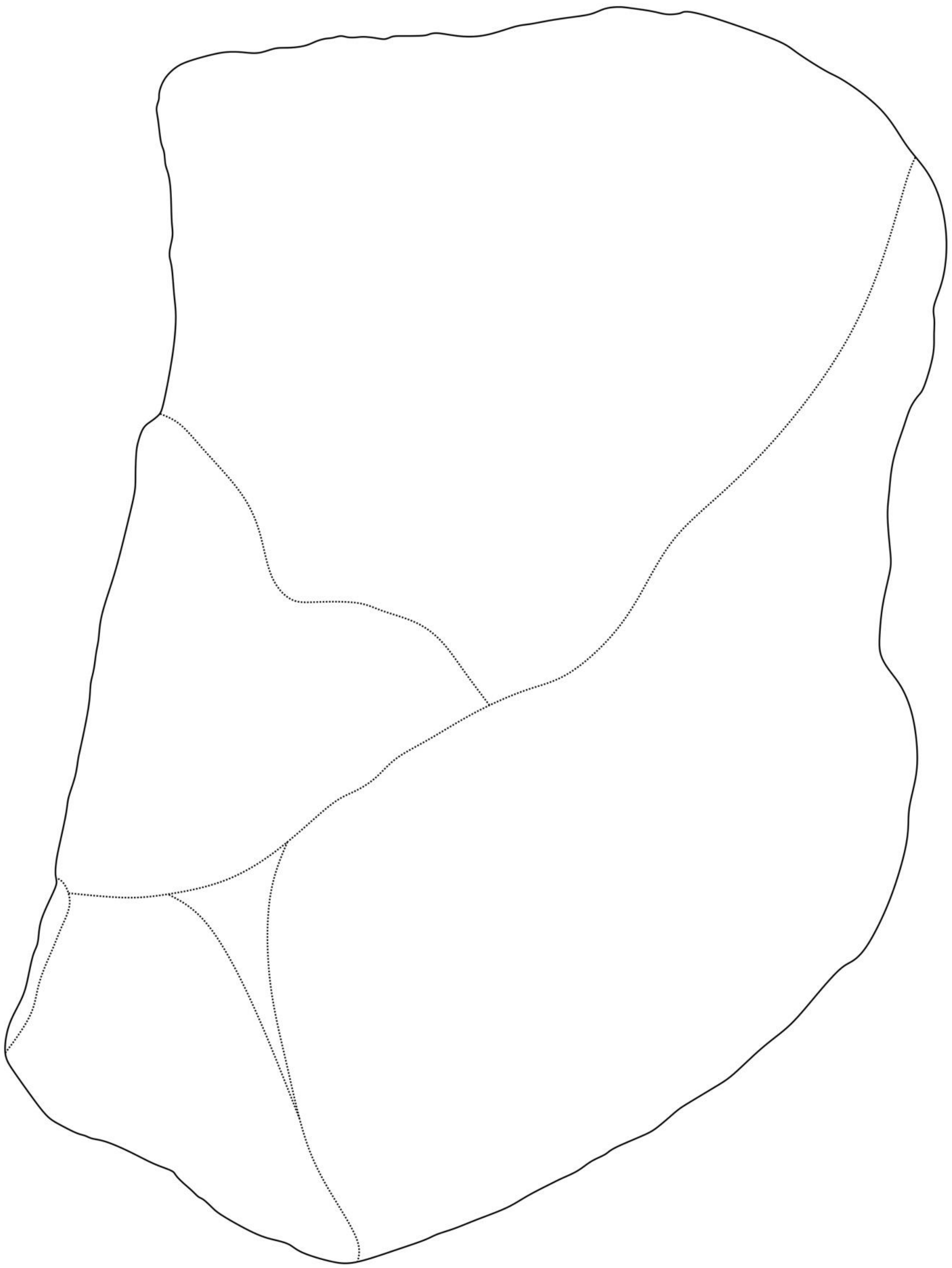
Image right	
Length, cm	9.95
Width, cm	6.8
Weight, g	312
Volume, m^3	0.000124
Density, kg / m^3	2516.12903
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The block was not described in any book or archaeological report. Its number and initial location are known from the index on the block. The stone does not contain any signs of engraving or polishing. It has probably been considered a churinga according to the place where it was found and later reconsidered by V. Danilenko during the laboratory processing of the data. The geology of this specimen is unusual due to the number of layers of different colors (and different geological structures).

Technological drawing front

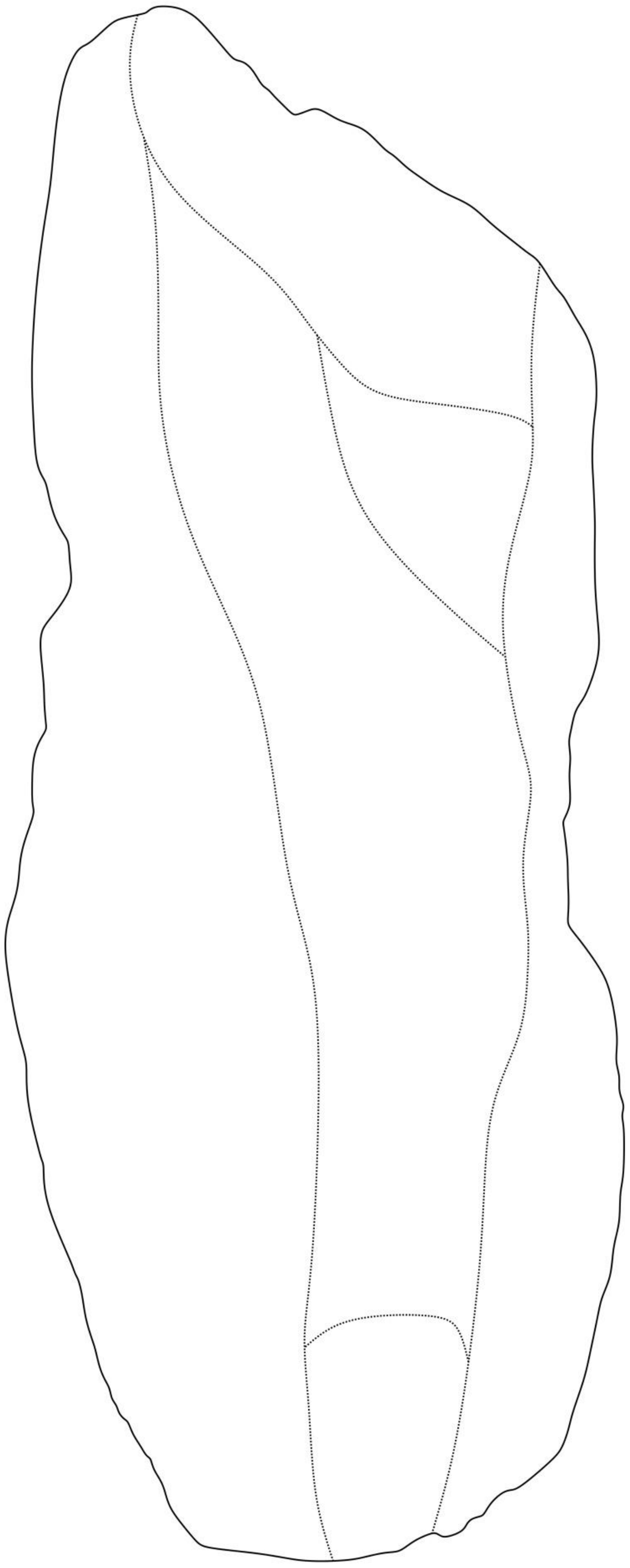
Technological drawing left



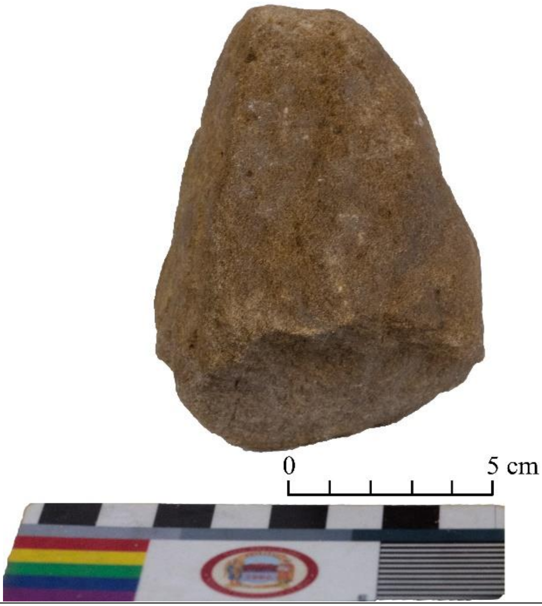
Technological drawing back



Technological drawing right



Specimen's ID	215
Image front	
Image back	
Length, cm	12.5
Width, cm	12.5
Weight, g	1445
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is not processed or modified from any side

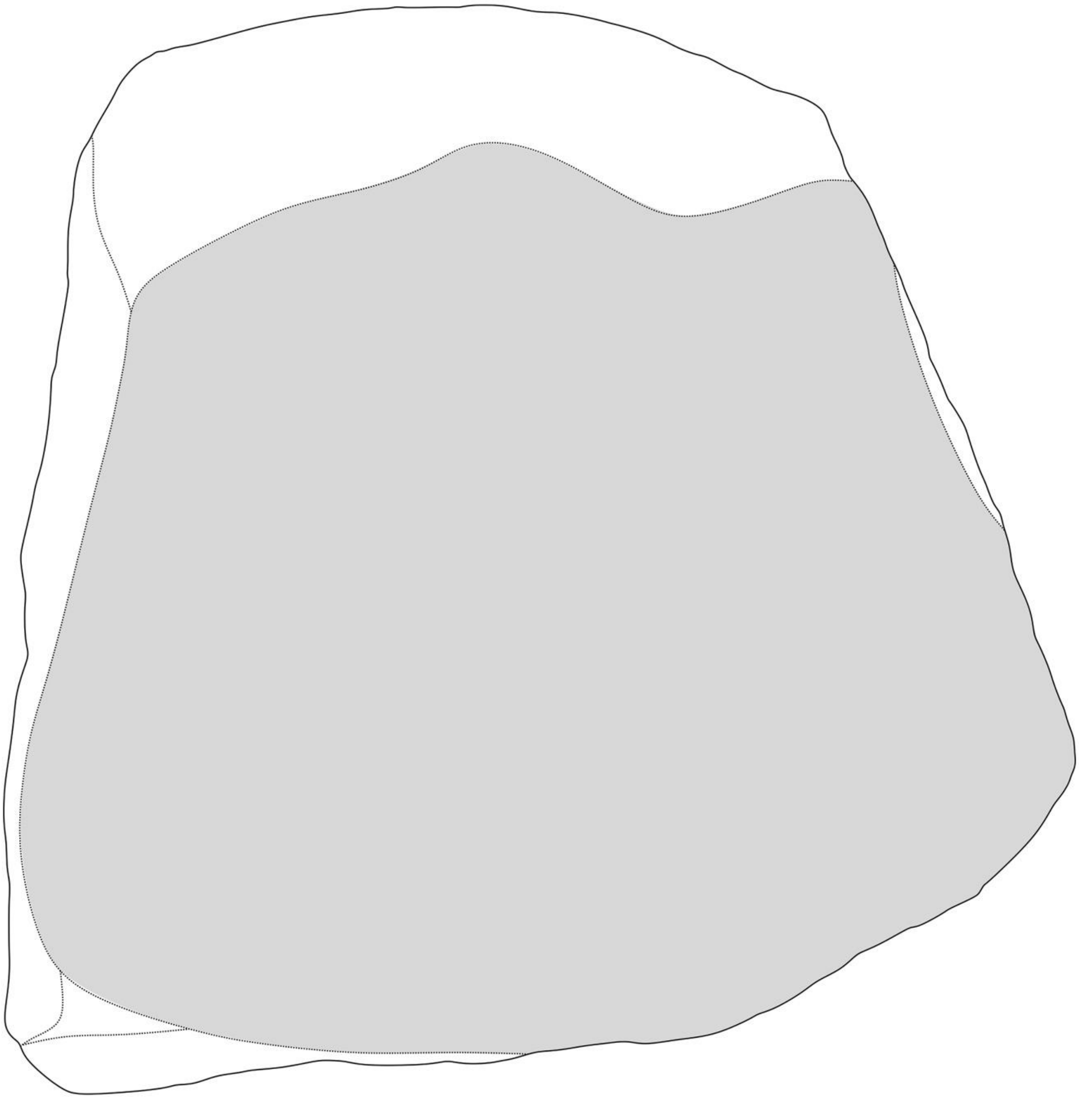
Specimen’s ID	216
Image front	
Image back	
Length, cm	10.2
Width, cm	7.5
Weight, g	967
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is not processed or modified from any side

Specimen's ID	217
Image front	
Image back	
Length, cm	8.5
Width, cm	6.5
Weight, g	188
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is polished both from the front and back sides

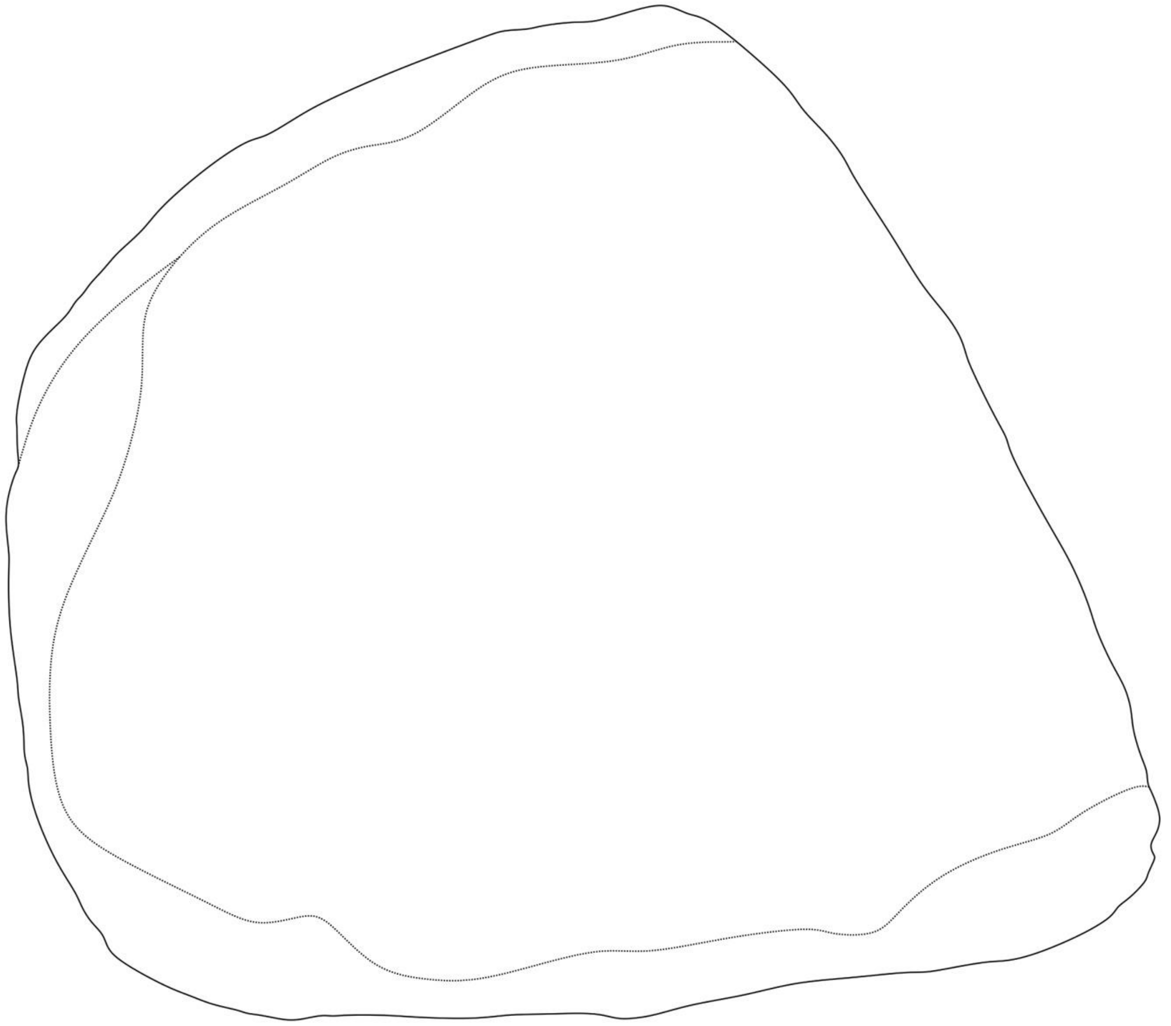
Specimen's ID	218
Image front	
Image back	
Length, cm	6.5
Width, cm	6
Weight, g	223
Volume, m^3	0.000090
Density, kg / m^3	2477.77778
Date of discovery	1973
Finder	V. Danilenko

Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The block was not described in any book or archaeological report. Its number and initial location are known from the index on the block. The stone has been polished from the top side. It may be considered either a tool to polish the churinga’s surface or a churinga itself. The stone does not contain any kind of notches or incisions.

Technological drawing front



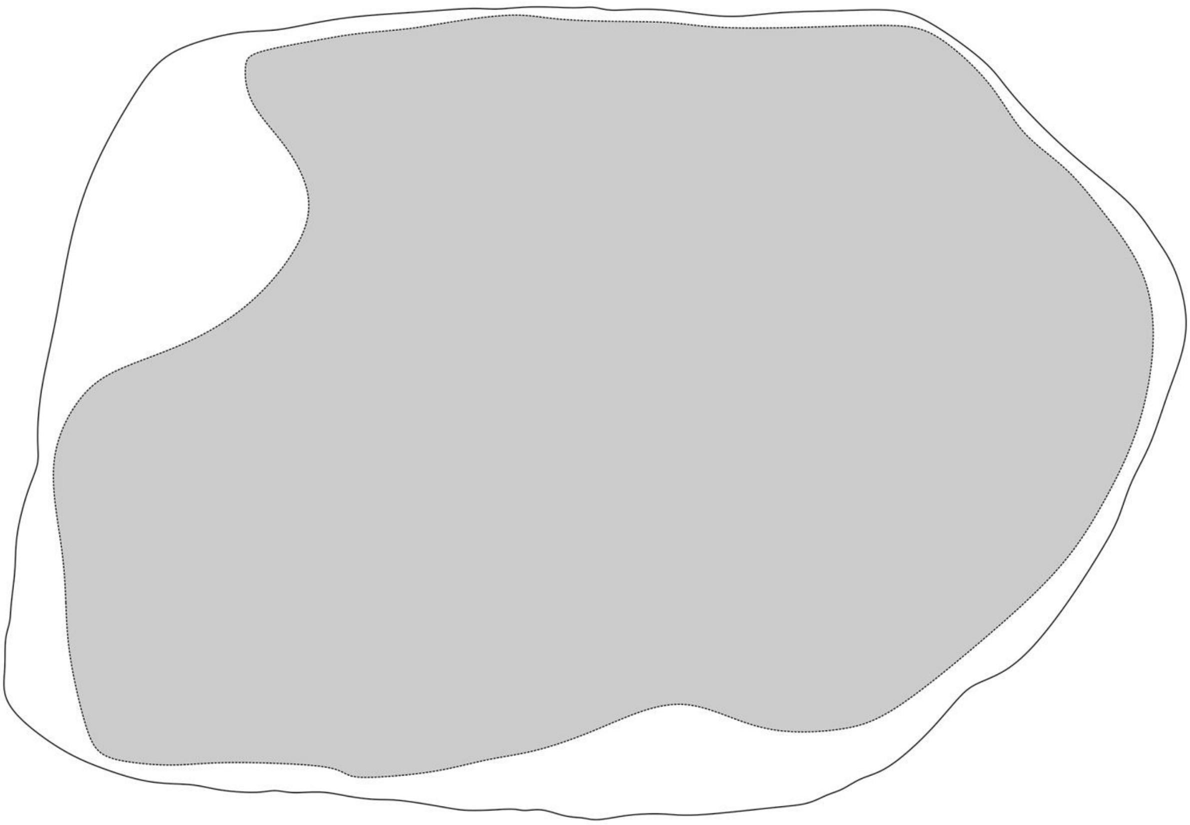
Technological drawing back



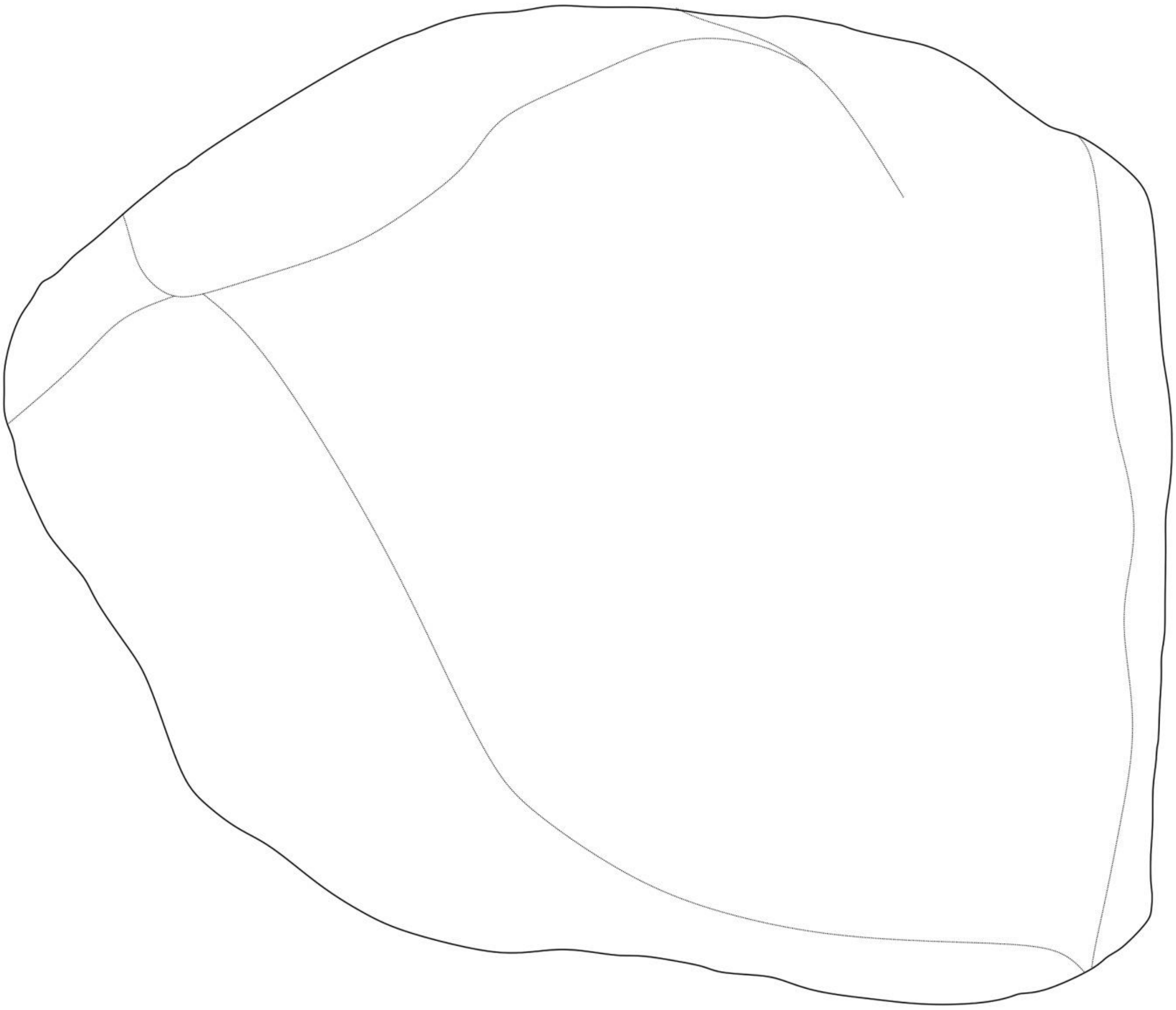
Specimen's ID	219
Image front	
Image back	
Image bottom	
Length, cm	6.5
Width, cm	6.3
Weight, g	99
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The stone is intensively polished from the front side

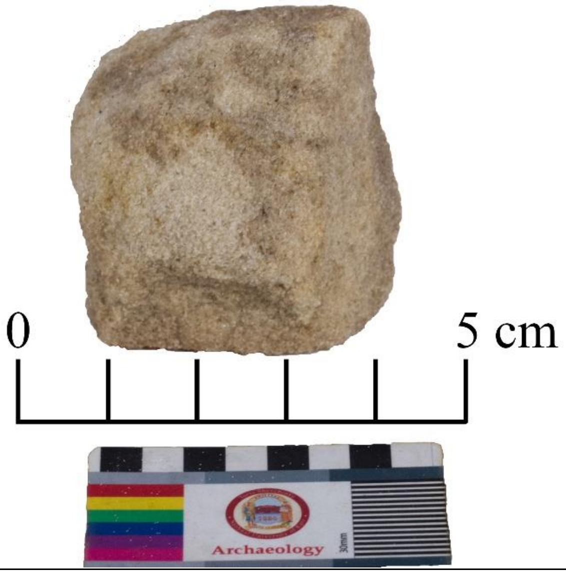
Specimen’s ID	220
Image front	
Image back	
Length, cm	6.4
Width, cm	5.1
Weight, g	188
Volume, m^3	0.000075
Density, kg / m^3	2506.66667
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The block was not described in any book or archaeological report. Its number and initial location are known from the index on the block. The stone has been polished from the top side. It may be considered either a tool to polish the churinga’s surface or a churinga itself. The stone does not contain any kind of notches or incisions.

Technological drawing front

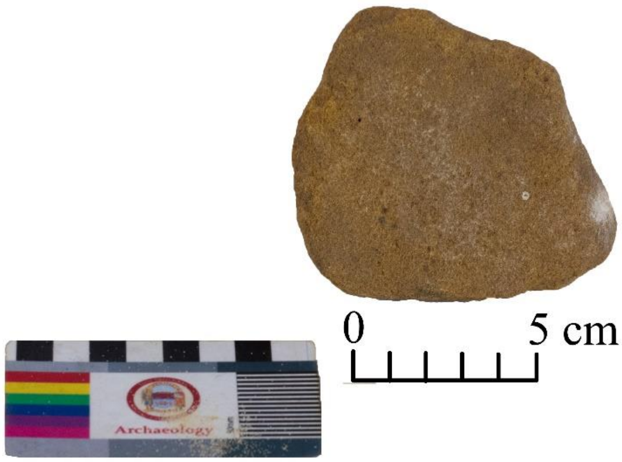


Technological drawing back



Specimen’s ID	221
Image front	
Image back	
Length, cm	3.6
Width, cm	3.3
Weight, g	61
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is intensively polished from the front side

Specimen's ID	222
Image front	
Image back	
Length, cm	5.7
Width, cm	5.8
Weight, g	108
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is intensively polished from the front side

Specimen’s ID	223
Image front	
Image back	
Length, cm	10
Width, cm	10
Weight, g	223
Date of discovery	1974
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is intensively polished from both sides

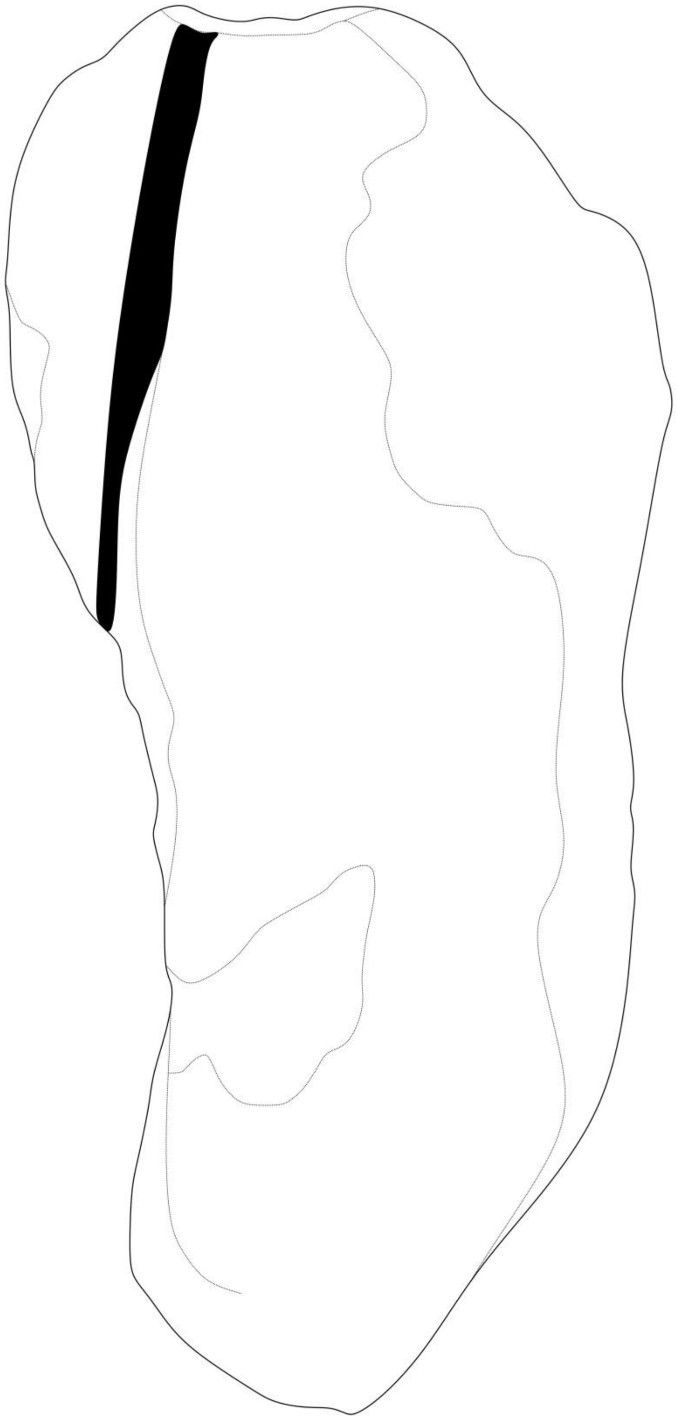
Specimen’s ID	224
Image front	
Image back	
Length, cm	6.4
Width, cm	6.3
Weight, g	121
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The stone is intensively polished from the front side

Specimen’s ID	225
Image front	
Image right	
Image back	
Length, cm	4.5
Width, cm	5.9
Weight, g	88
Volume, m^3	0.000044
Density, kg / m^3	2000.0000
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—

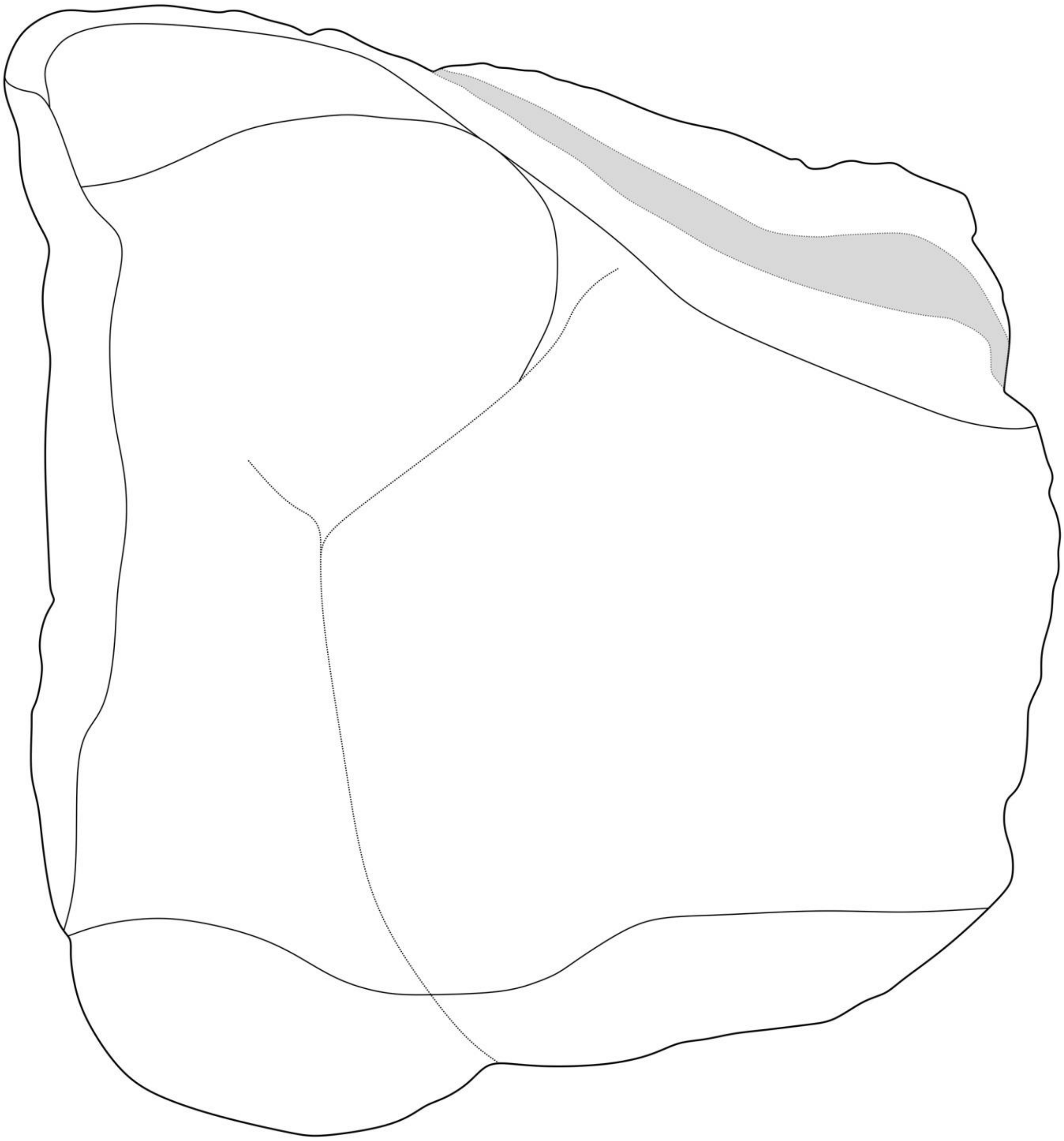
Description source	—
Note	The block is not described in the archaeological report or books of V. Danilenko and B. Mykhailov. It contains a series of linear engravings that create some kind of reticulated ornament. Five of them are parallel, and one is perpendicular. The engravings are deep; the shape of their profiles is subrectangular. The block was broken in two parts and glued by V. Danilenko after 1973. The stone is not polished and covered with desert varnish from its front side.

Technological drawing front

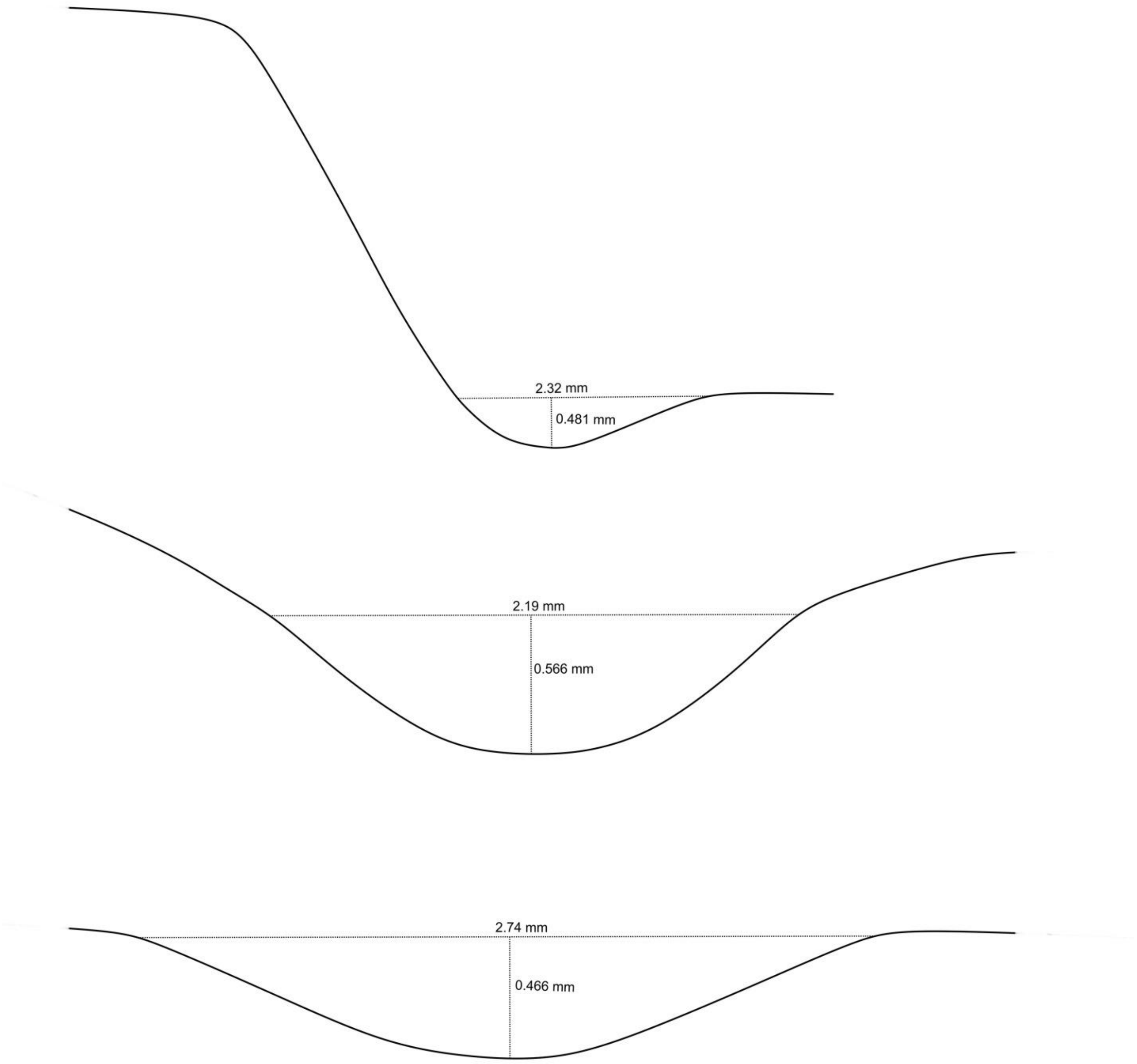
Technological drawing right

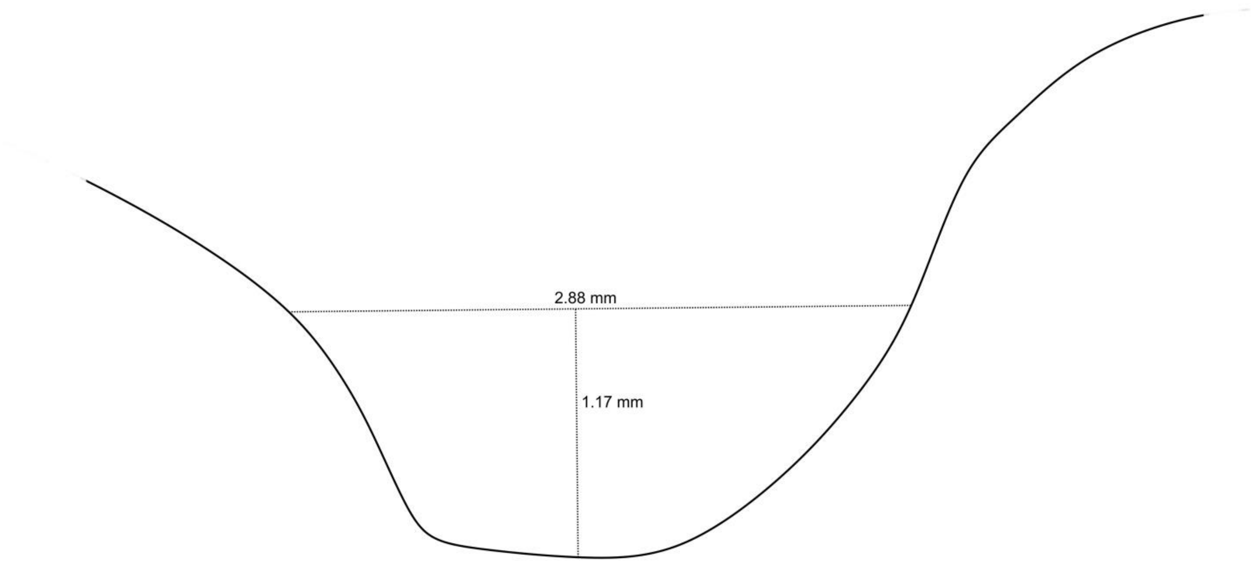


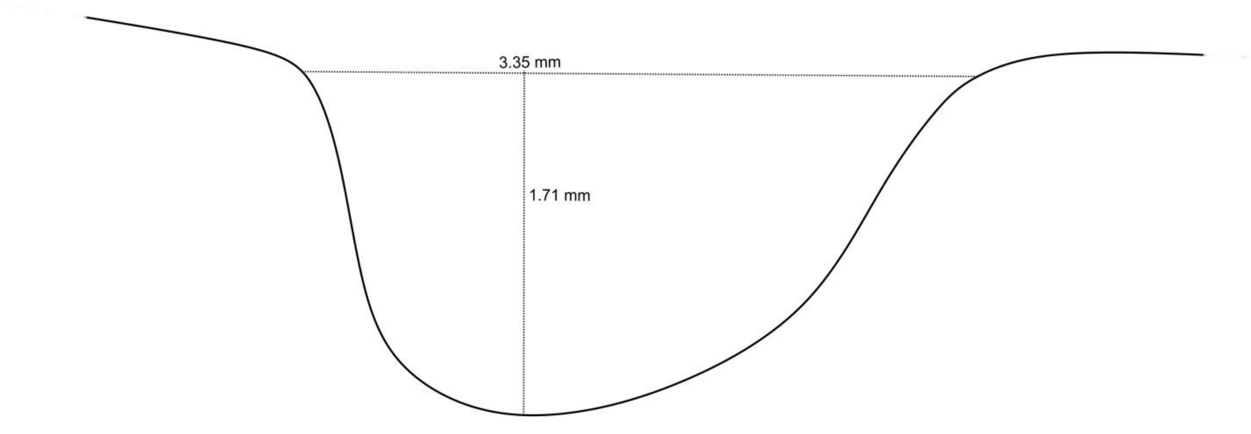
Technological drawing back



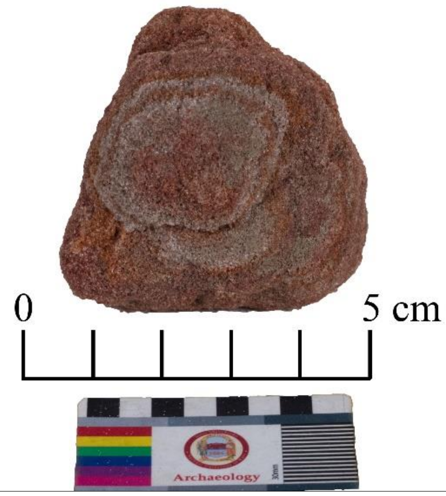
Profiles list




2.88 mm
1.17 mm


3.35 mm
1.71 mm

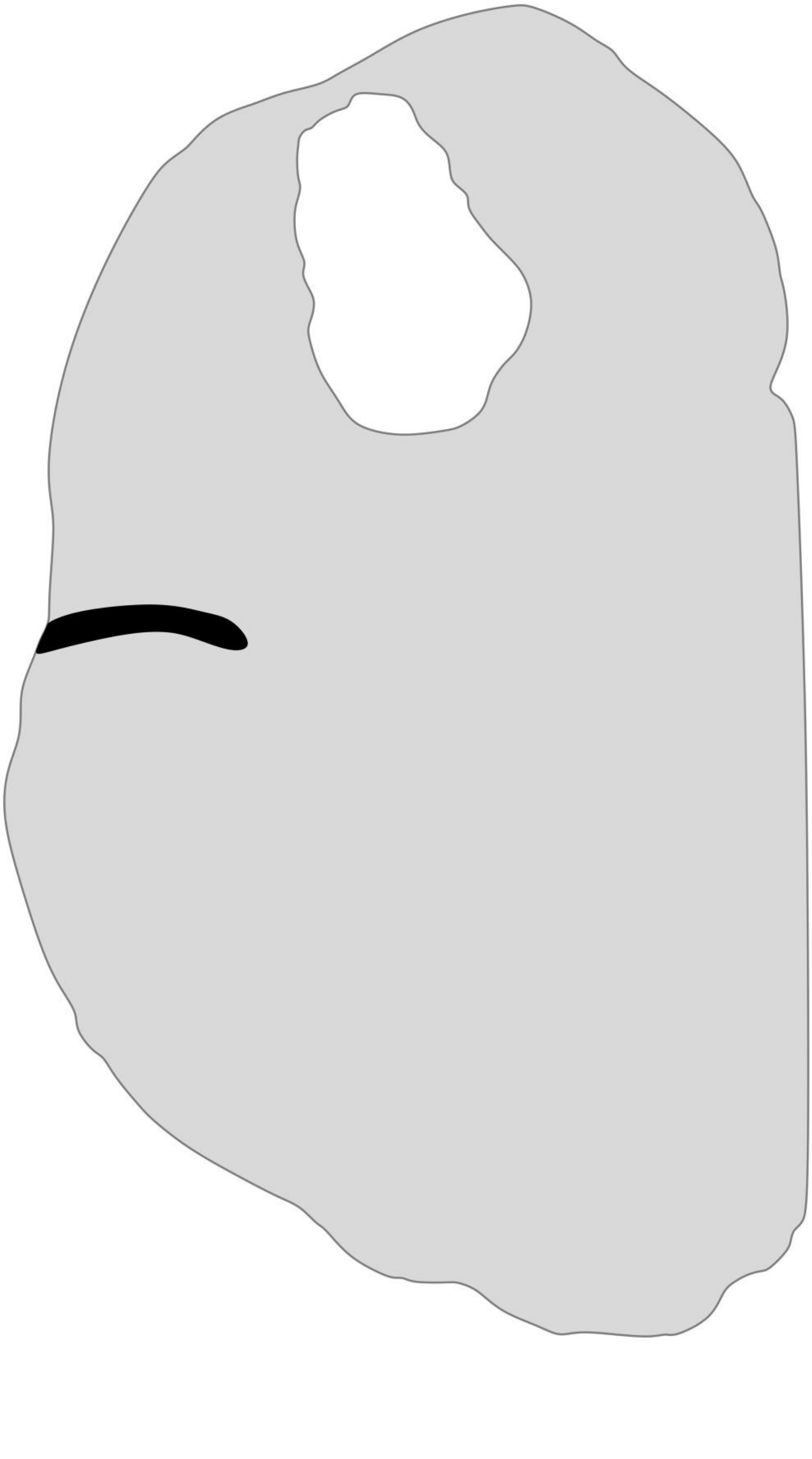
Specimen's ID	226
Image front	
Image back	
Length, cm	5
Width, cm	4.3
Weight, g	126
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is slightly polished from the sides. It is intensively crumbling and falling apart. The signs of engravings on the surface are absent.

Specimen's ID	227
Image front	
Image back	
Length, cm	4
Width, cm	4.3
Weight, g	75
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is polished from the back side. It is intensively crumbling and falling apart. The signs of engravings on the surface are absent.

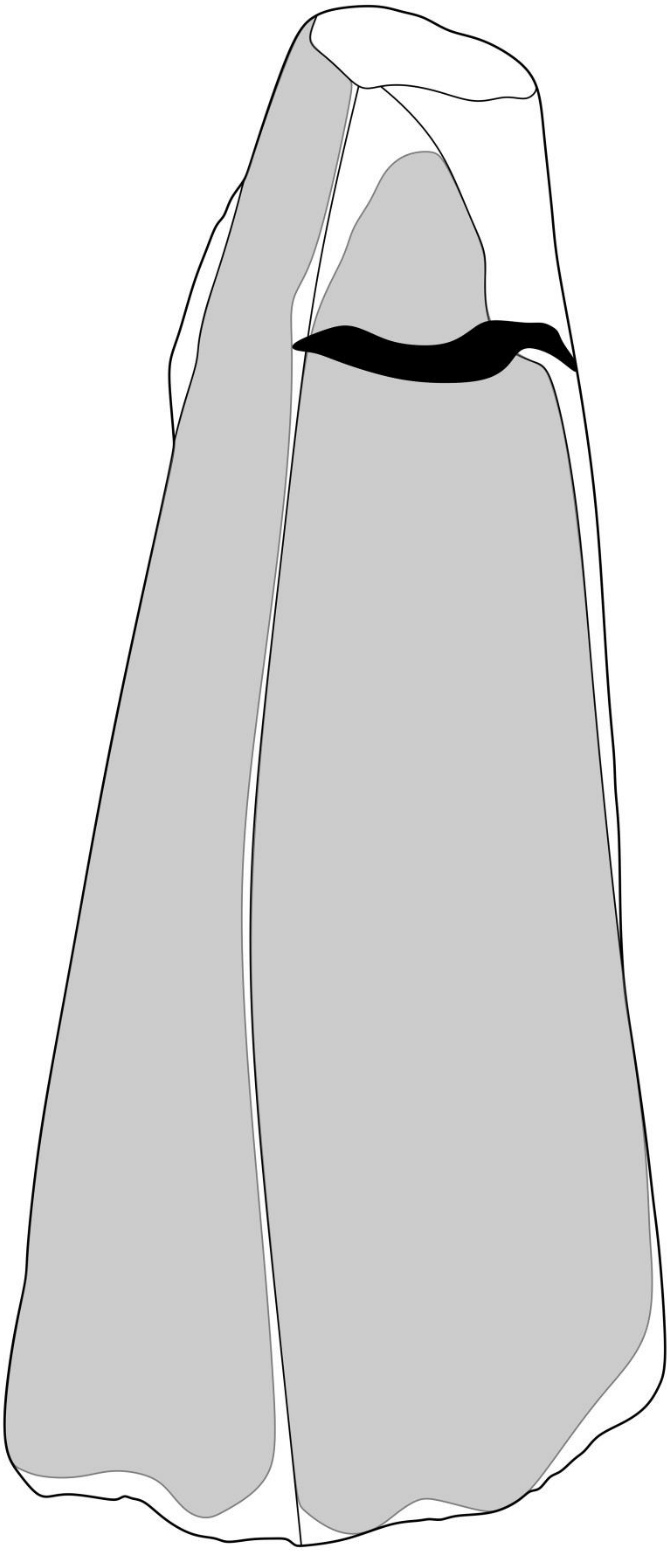
Specimen’s ID	228
Image front	
Image right	
Image back	
Length, cm	5.7
Width, cm	4.2
Weight, g	70
Volume, m^3	0.000029
Density, kg / m^3	2413.79310

Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The block is not described in the archaeological report or books of V. Danilenko and B. Mykhailov. The stone is unique due to its unusual red color. The sandstone is intensively crumbling. The block is polished from the front and right side and contains a few natural cracks.

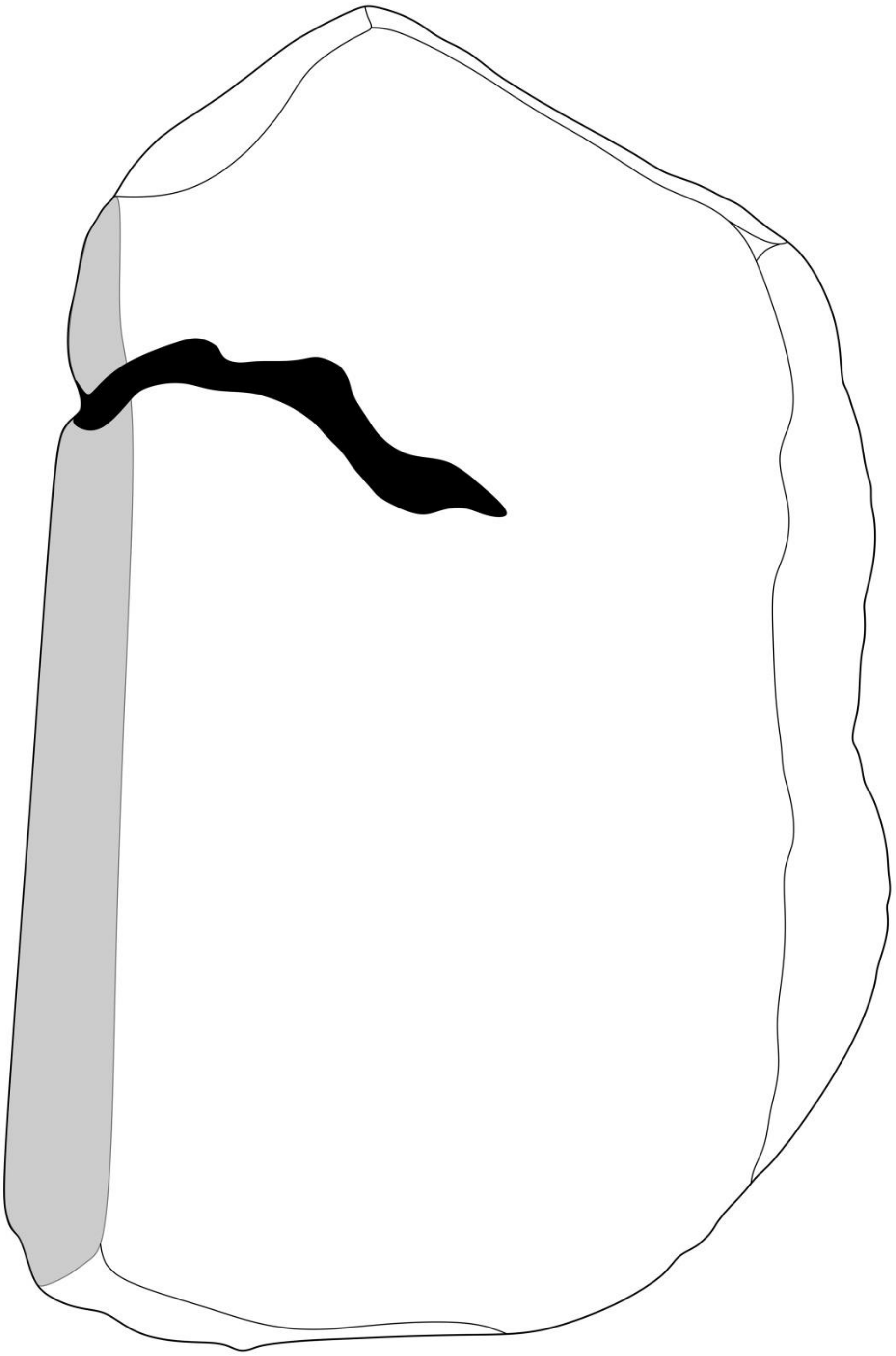
Technological drawing front



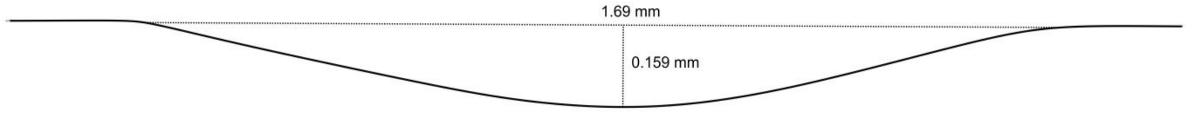
Technological drawing right



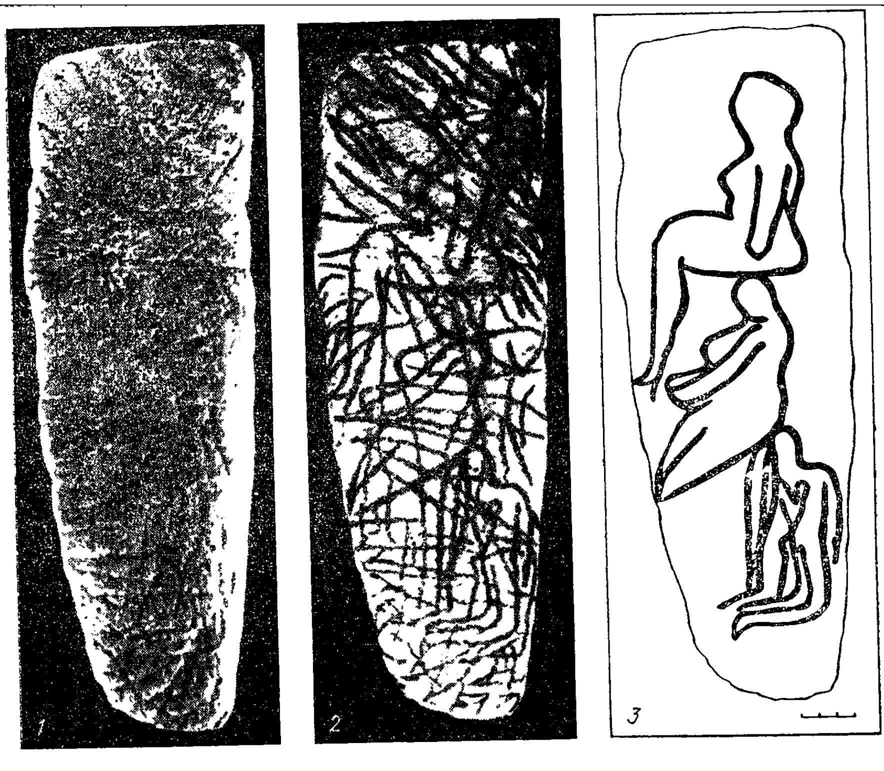
Technological drawing back



Profiles list



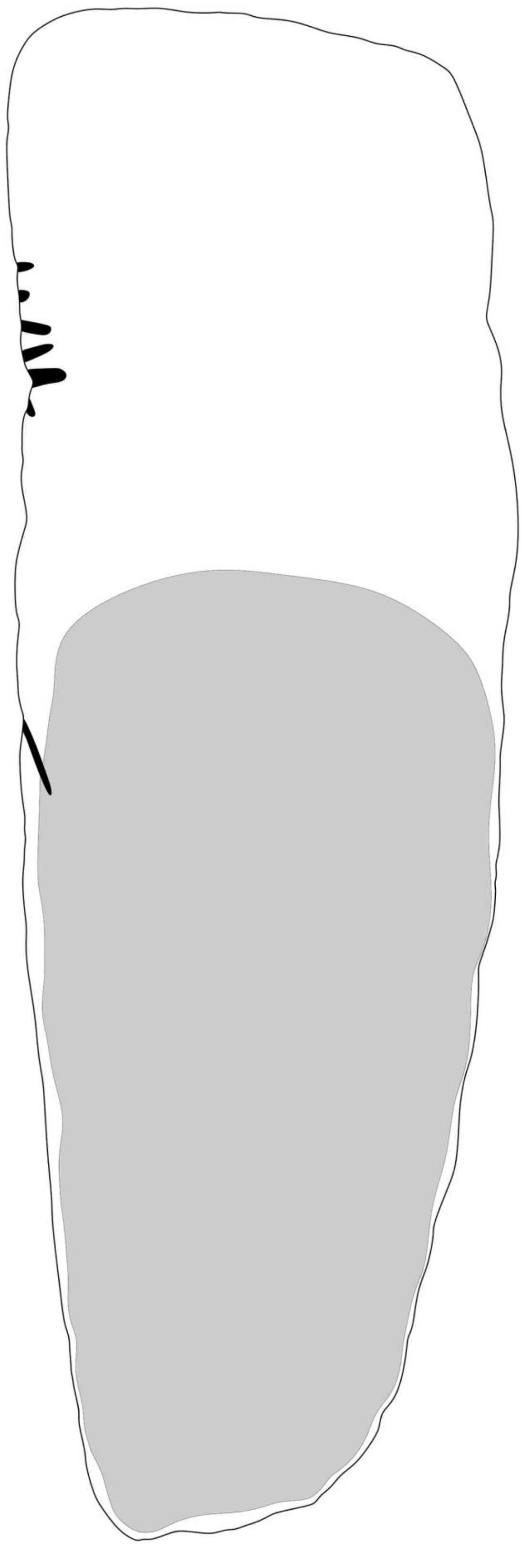
Specimen's ID	245
Image front	
Image back	
Length, cm	40.3
Width, cm	13.9
Weight, g	2513
Volume, m^3	0.001297
Density, kg / m^3	1937.54819
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Oblong stone of a fish-like shape. One side of it is smoothly broken. The linear and geometric engravings are located on the darker and fractured side
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Only the distant part of the concretion survived. The maximum length —is 40.3 cm, width — is 13.9 cm. Images are located on one side and are not too

	dense. Thus the interpretation of the composition meaning is simplified. The upper part of the churinga is the part of its smooth break, and the lower side — is a naturally rounded distal end. The figure of an adult woman occupies more than the upper third part of the churinga. Her face turned left. She is sitting; her legs are bent at the hips and knees. The object her sitting at is not depicted. It is intended to be imagined. The middle part of the churinga is occupied with the image of another woman who is thicker. She is also sitting. Her breaths and legs are hypertrophied. He bears signs of pregnancy. Hands are under the stomach. The lower part contains the third woman figure. She is staying on her knees. Her face is turned right. Her hands are close to her hips. Hair is loose and falls on the back in waves. Other space is occupied with deep horizontal and diagonal engravings.
Descriptive image	
Description source 2	Danilenko 1986: 127—128
Note	The block has been polished from the back side, where it does not contain any engravings except a few linear incisions. The front side is covered with desert varnish. Most notches are shallow and almost invisible, while the surface is highly damaged. The stone might be considered as one in a shape of a fish. However, this requires additional archaeological interpretation. All of the meaningful engravings described by V. Danilenko (the images of women)

	are invisible. Some parts of them might be found in linear engravings on the figure. Most are not evident. The destruction of the notches is barely possible as it would damage the painting by V. Danilenko. Thus, these images should be considered overinterpretation.

Technological drawing front

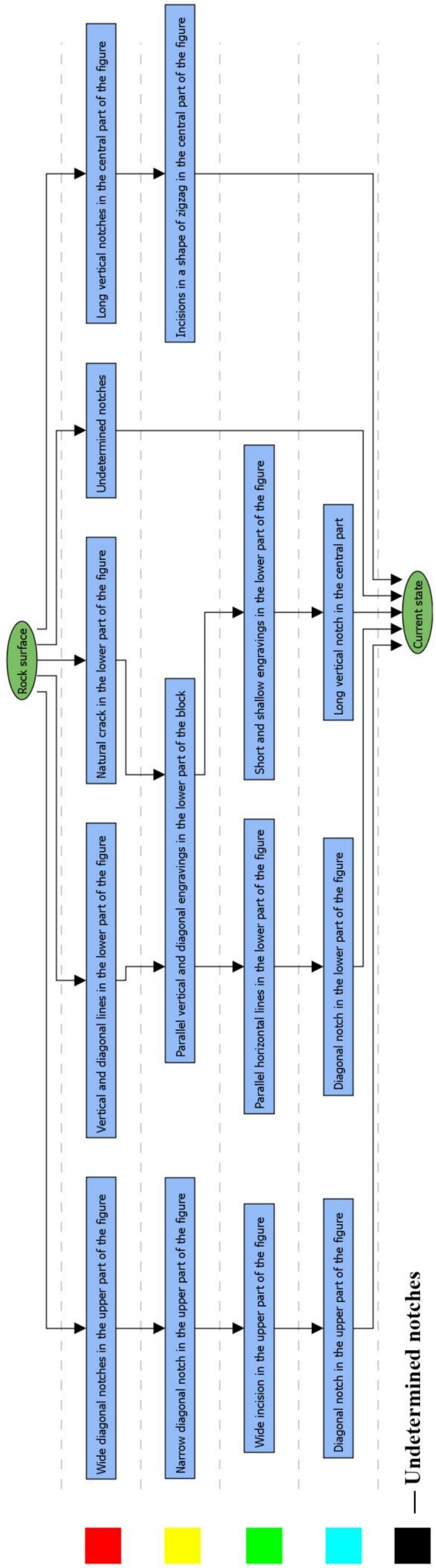
Technological drawing back



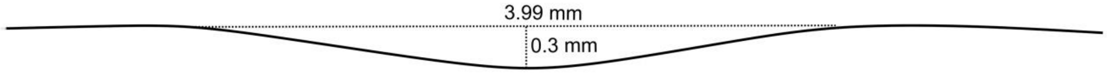
The incisions interpreted by V. Danilenko as parts of semantic composition

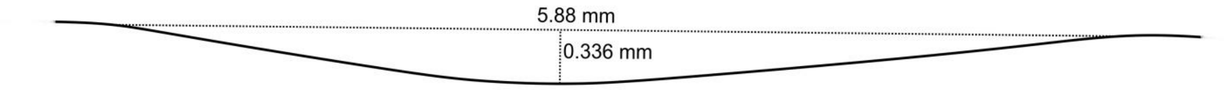
Relative chronology drawing front

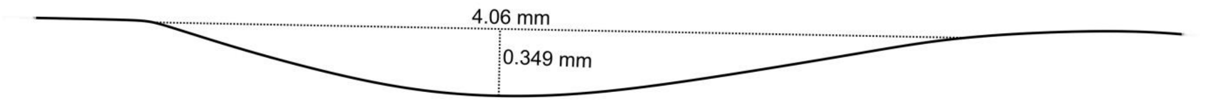
Harris matrix front

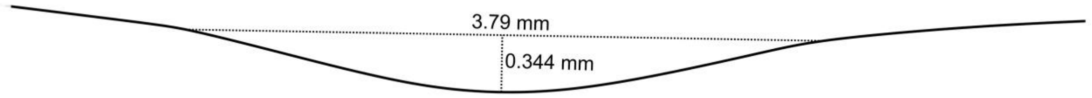


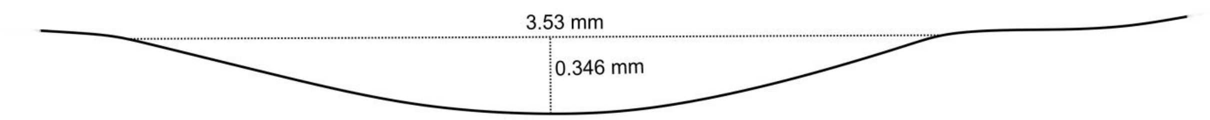
Profiles list

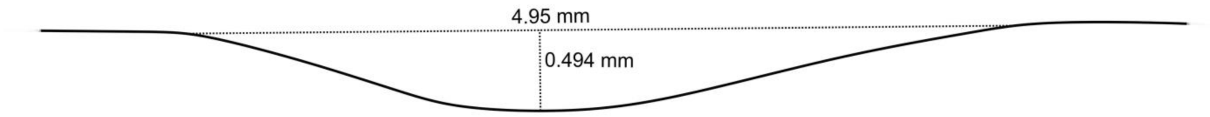


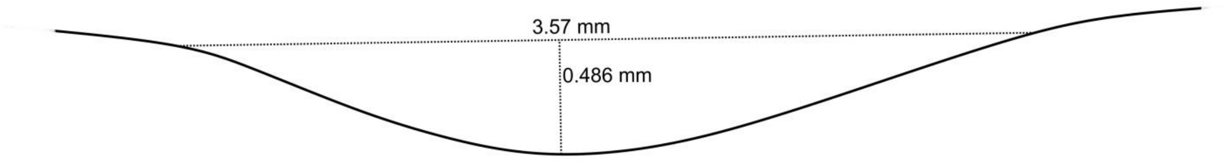


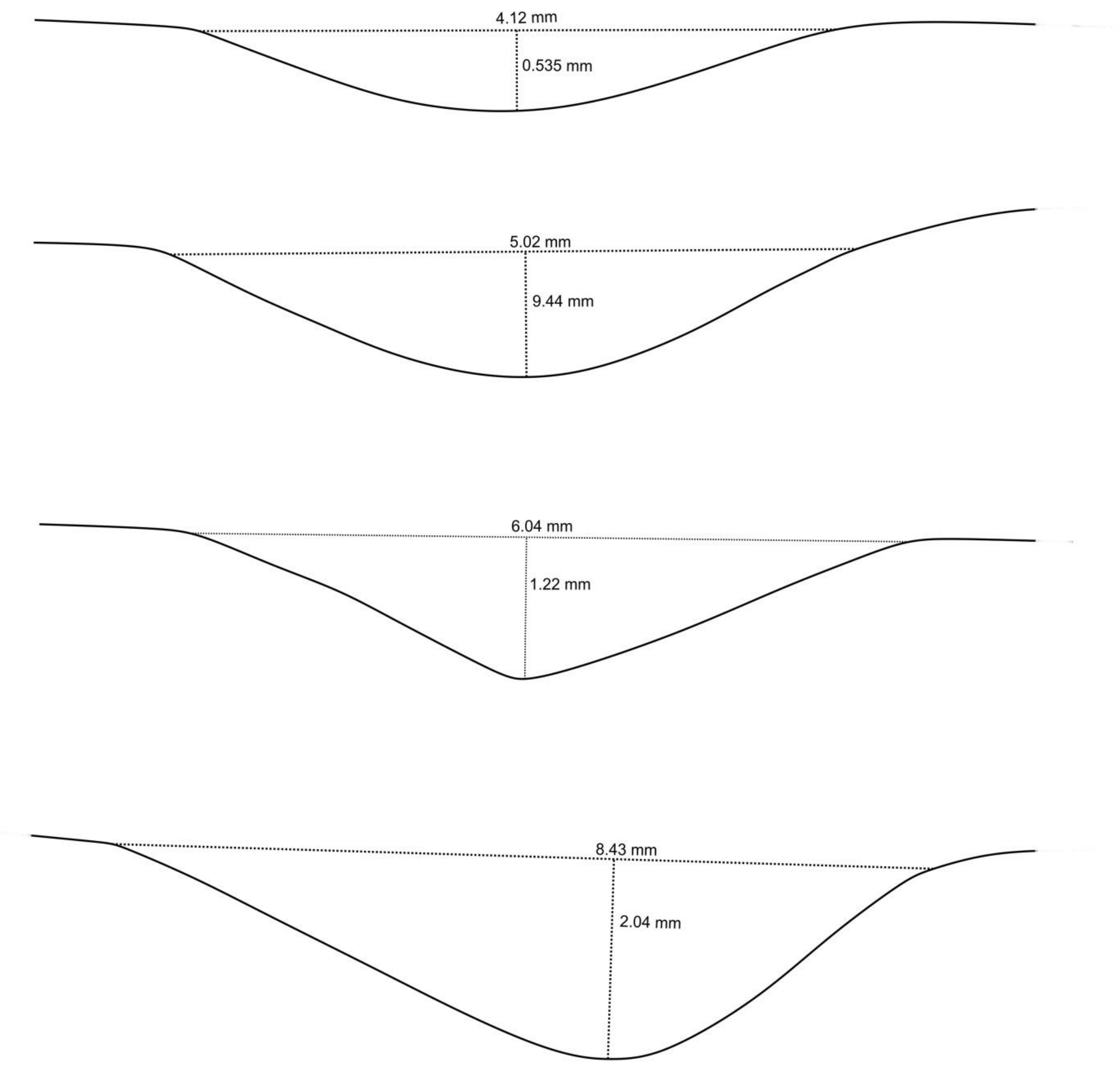




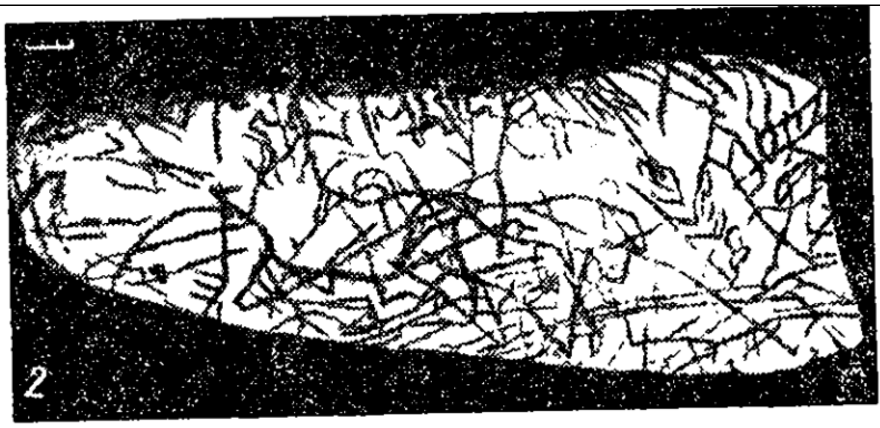
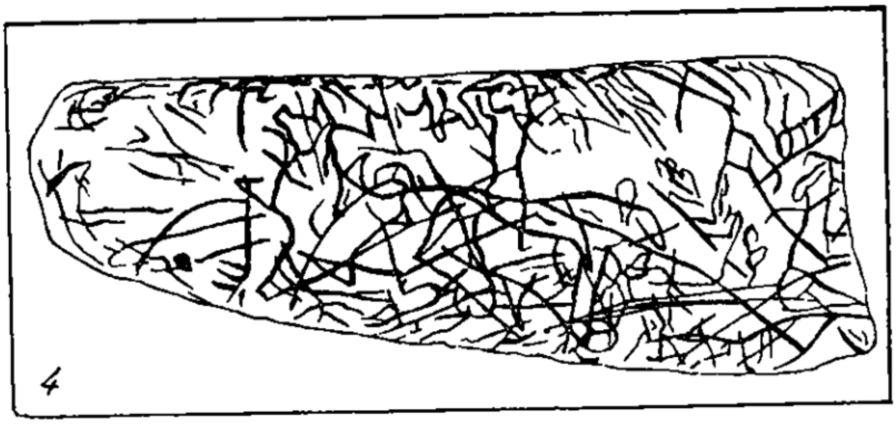




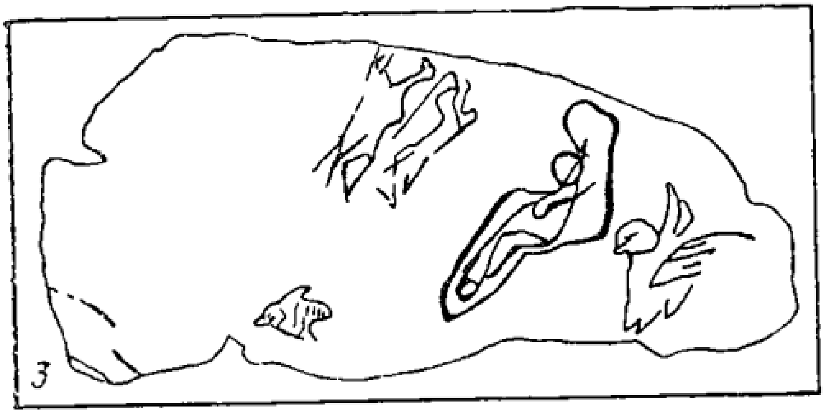



4.12 mm
0.535 mm
5.02 mm
9.44 mm
6.04 mm
1.22 mm
8.43 mm
2.04 mm

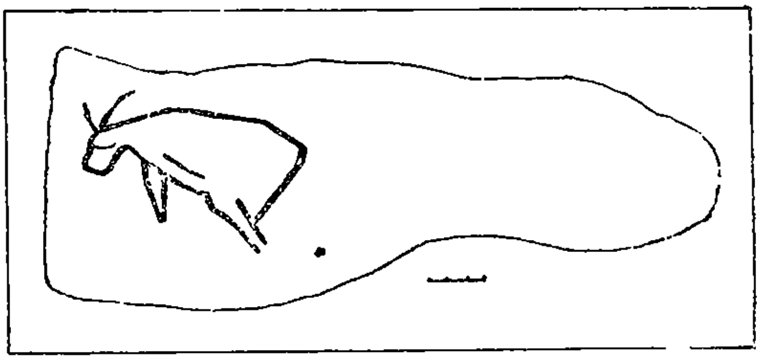
Specimen’s ID	246
Image front	
Image back	
Length, cm	36.8
Width, cm	17.5
Weight, g	5507
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga of oblong shape, similar to a fish. Probably catfish. Consists of three parts. Linear engravings on the front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Stone No. 246 consists of two parts that are 109.5 cm in length and 26.7 cm in width (when joined). The engravings are on the front side. They were created during a limited time lap. However, their creation happened in several episodes. Therefore we are forced not to go over the description of the ornamentation’s particular elements in series. Definition of the up and down sides of the stone is defined following the position of the woman figure (fig. 87: 2, 4). Close to the upper part of the churinga left side is a figure similar to a plant, maybe a spikelet. The group of three hoofed animals is also depicted. The left one is probably a bull, turned left. The right one is also a bull. Its head turned to the right. The middle part of this group includes another figure of an animal that turned right. The head is schematic and can barely be considered a bull’s one. Under the group of these creatures, an artist depicted an anthropomorphic figure. Generally, the ornament of churinga’s sides is reticulated and cannot be explicitly interpreted.
Description source 2	Danilenko 1986: 126—128

Descriptive image	 
Note	The stone consists of three parts and covered with desert varnish from both sides (the front side is darker). The engravings are on the front side.

Specimen's ID	246a
Image front	
Image back	
Length, cm	107
Width, cm	27
Weight, g	13600
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of prolongated ellips. It is similar to a catfish, consists of two parts. Engravings are one-sided, the ornament is reticulated
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Stone No. 246 consists of two parts that are 109.5 cm in length and 26.7 cm in width (when joined). The engravings are on the front side (fig. 87: 1, 3). They were created during a limited time lap. However, their creation happened in several episodes. Therefore we are forced not to go over the description of the ornamentation's particular elements in series. Definition of the up and downsides of the stone is defined following the position of the woman figure. The woman figure that is situated in the right part of the stone is pictured in a sitting posture. The object she is sitting on is not depicted. The woman is pictured from the side, turned left, and the head is slightly turned to the right. The left hand of the figure is located near the knees. A rounded object

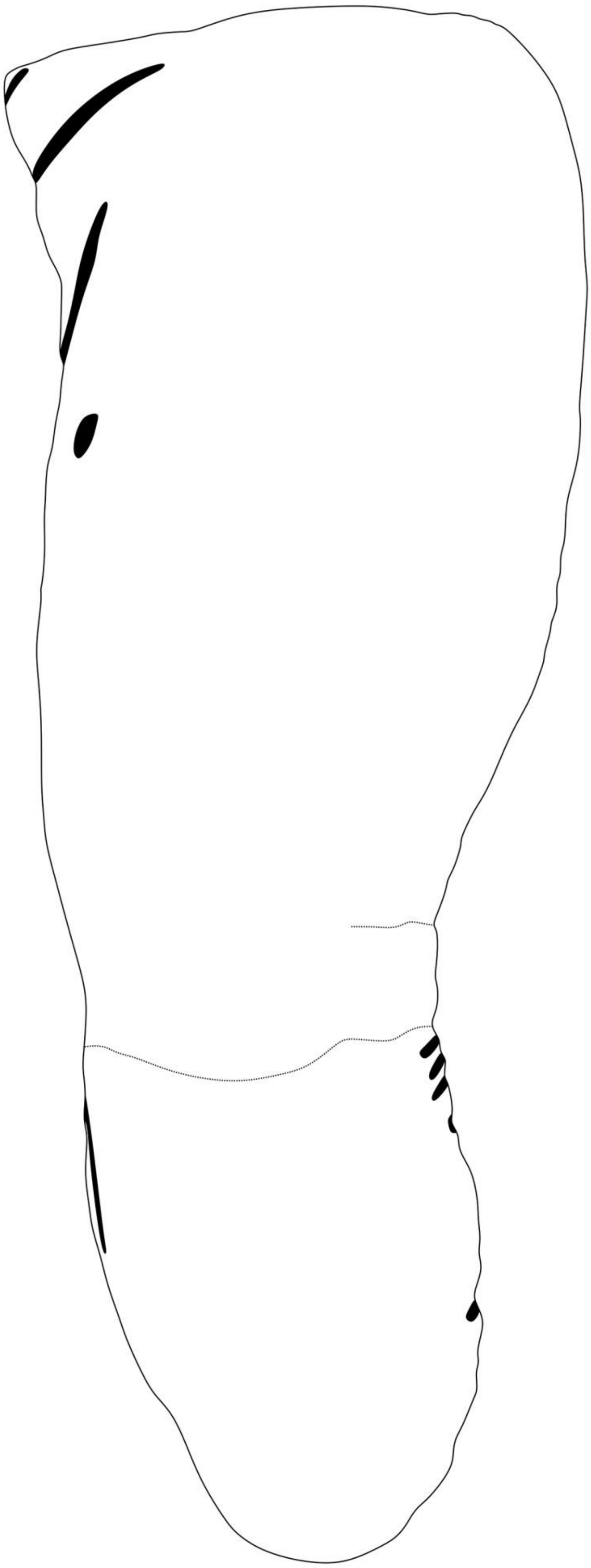
	is located under the figure’s face. It might be considered as a woman’s breath or the head of the baby. Closer to the borders of the composition, other figures are located — a group of people with their heads turned down and a woman’s figure moving left. Some figures of the group might be considered women. The lower edge of this part of the churinga also contains a primitive image of a bird flying to the left (located to the right and slightly lower from the first woman’s figure). Generally, the ornament of churinga’s both sides is reticulated and cannot be explicitly interpreted.
Description source 2	Danilenko 1986: 126—128
Descriptive image	 
Note	Churinga is covered with desert varnish, mainly from the front side. V. Danilenko considered stones No. 246 and No. 246a as two parts of one big churinga. This appears to be a misinterpretation.

Specimen's ID	247
Image front	
Image back	
Length, cm	38
Width, cm	13.5
Weight, g	3172
Volume, m^3	0.001515
Density, kg / m^3	2093.72937
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of a catfish. It consists of two parts. The head is a convex part of a concretion fused with the base of a tile. It is a whole with the churinga No. 4. Linear and geometric images on a convex dark part of a figure.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Churinga consists of two parts. Its front side is covered with reticulated ornament without any clear semantic motifs. However, the central part of the

	incised fragment contains the figurative image of an ungulate profile turned left. It is probably a bull, according to the thick shape of its head. It has two legs and a schematically depicted bottom. The composition of a similar style has already been noticed in the Wizard's cave. The reticulated ornament may mean the net that was used to catch a fish.
Descriptive image	 
Description source 2	Danilenko 1986: 123—126
Note	The block has been polished from the back side, where it does not contain any engravings except a few linear incisions. The front side is covered with desert varnish. Most notches are shallow and almost invisible, while the surface is highly damaged. The stone might be considered as one in a shape of a fish. However, this requires additional archaeological interpretation. All of the meaningful engravings described by V. Danilenko (the image of a bull) are invisible. Some parts of them might be found in linear engravings on the figure. Most are not evident. The destruction of the notches is barely possible as it would damage the painting by V. Danilenko. Thus, these images should be considered overinterpretation. The relative chronology of the notches shows that the natural cracks appeared after the engravings were made. However, it is mostly not informative. The parallel notches usually occupy the same chronological position. Most of them were made after the shallow singular notches. Some are partially destroyed.

Technological drawing front

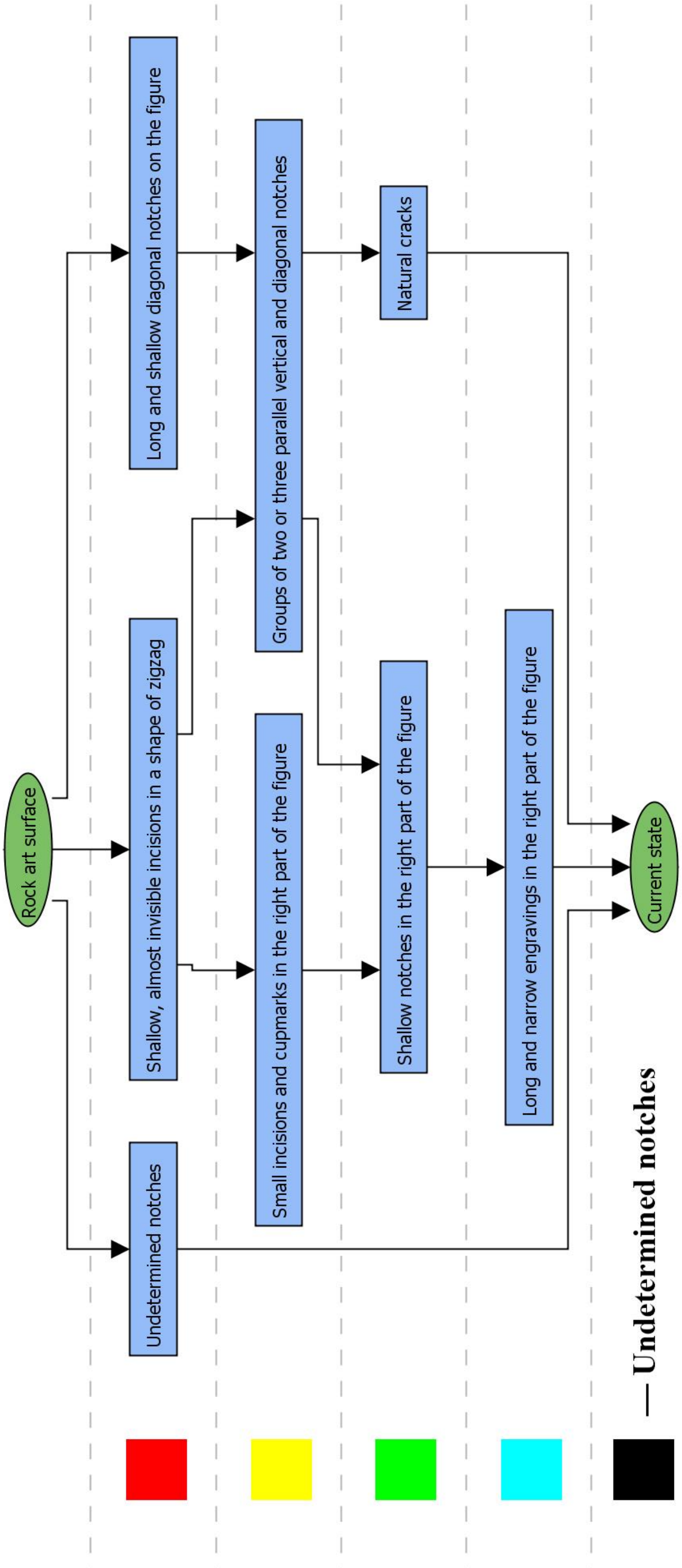
Technological drawing back



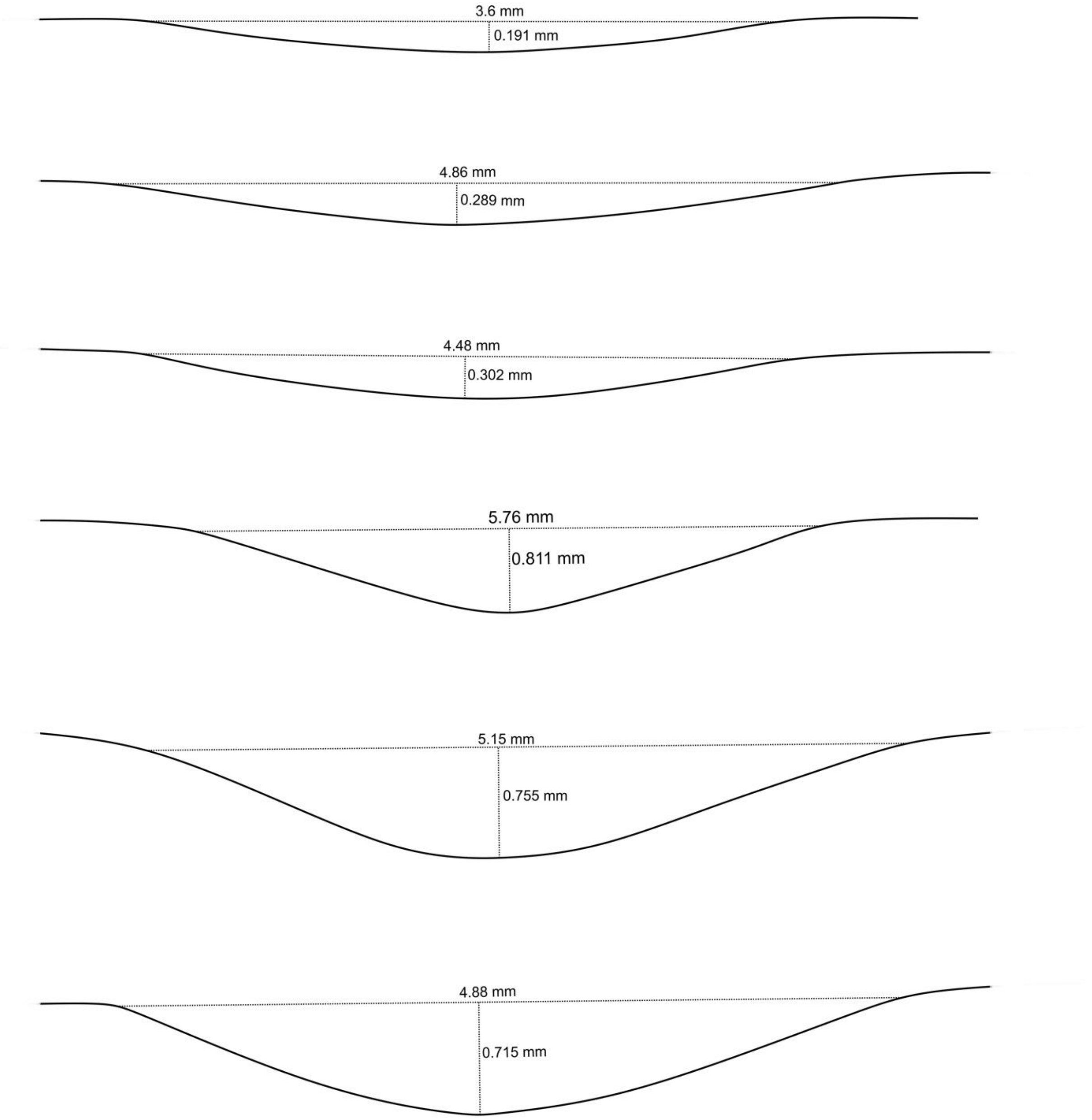
The incisions interpreted by V. Danilenko as parts of semantic composition

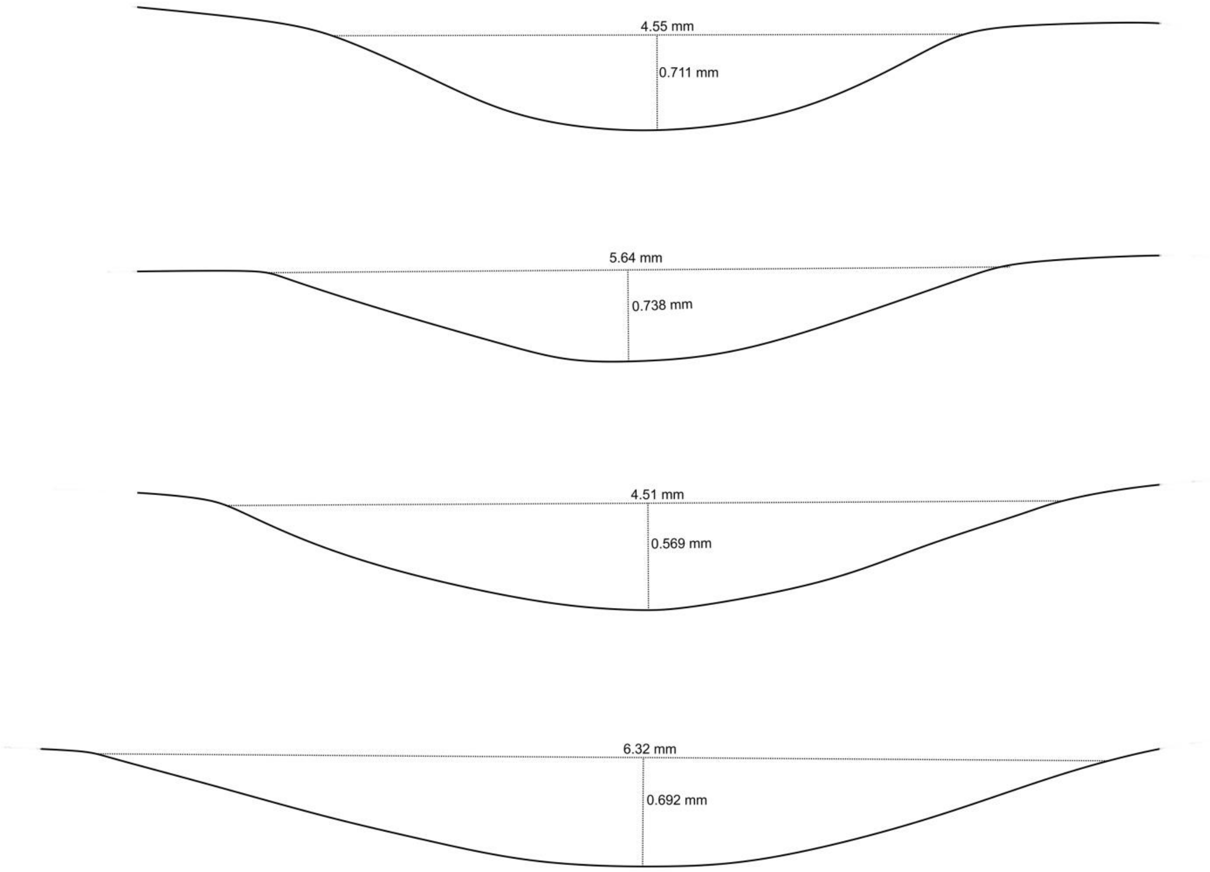
Relative chronology drawing front

Harris matrix front

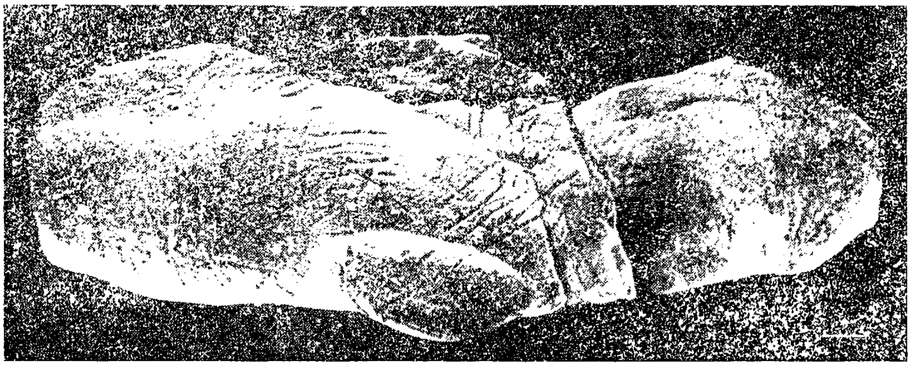


Profiles list




4.55 mm
0.711 mm
5.64 mm
0.738 mm
4.51 mm
0.569 mm
6.32 mm
0.692 mm

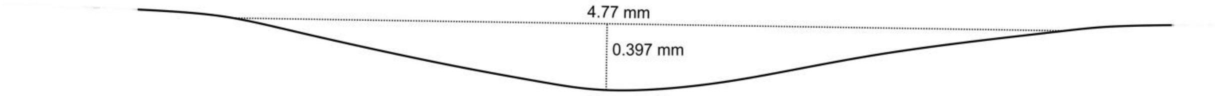
Specimen’s ID	248
Image front	
Image back	
Length, cm	59.5
Width, cm	23
Weight, g	6800
Volume, m^3	0.003057
Density, kg / m^3	2224.40301
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of a fish. Look similar to a catfish, but lacks the tail. Consists of three parts.
Description source	The storage list of Institute of Archaeology in Kyiv

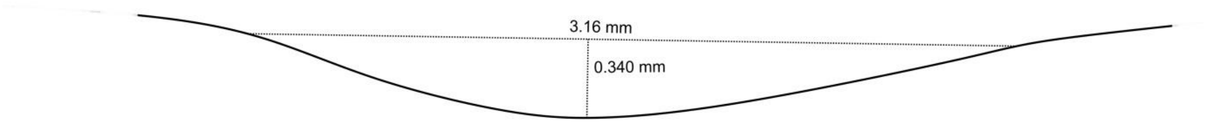
Description 2	 
Descriptive image	The figure can't be definitely interpreted to any type of a shape. Its total length is 58.3 cm. The important feature of this figure is the reticulated ornament.
Description source 2	Danilenko 1986: 121—122
Note	The block has been polished from the back side, where it does not contain any engravings except a few linear incisions. The front side is covered with desert varnish and is quite eroded. The figure contains a reticulated ornament. Most notches are shallow and almost invisible, while the surface is highly damaged. The relative chronology is not informative. The stone might be considered as one in a shape of a fish. However, this is dubious and requires additional archaeological interpretation. The long parallel incisions are more profound than the singular ones and might be considered as having a natural origin.

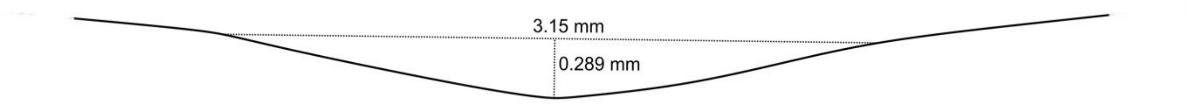
Technological drawing front

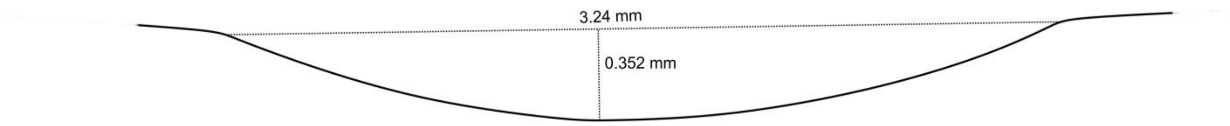
Technological drawing back

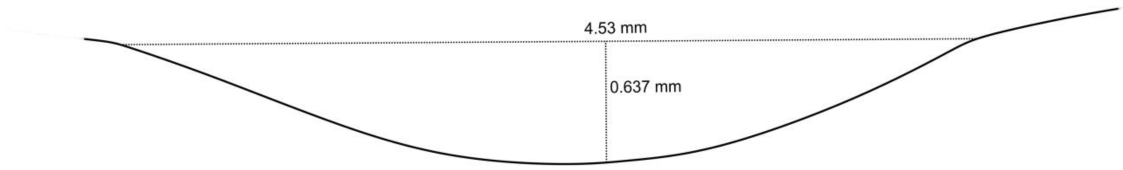
Profiles list

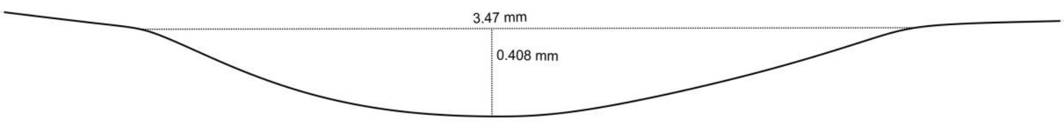


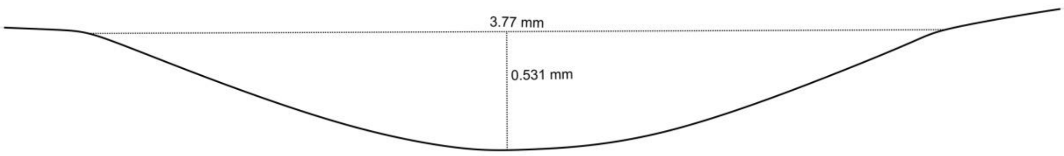


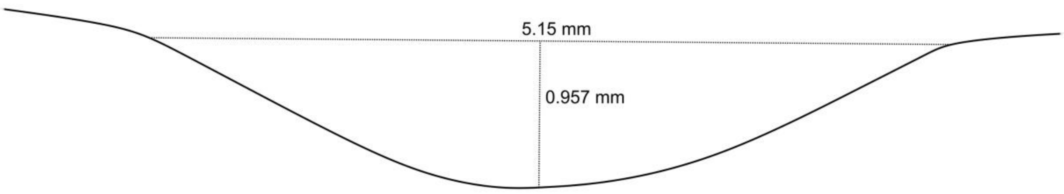


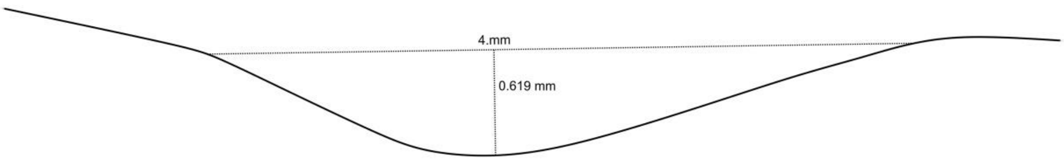





3.47 mm
0.408 mm


3.77 mm
0.531 mm


5.15 mm
0.957 mm

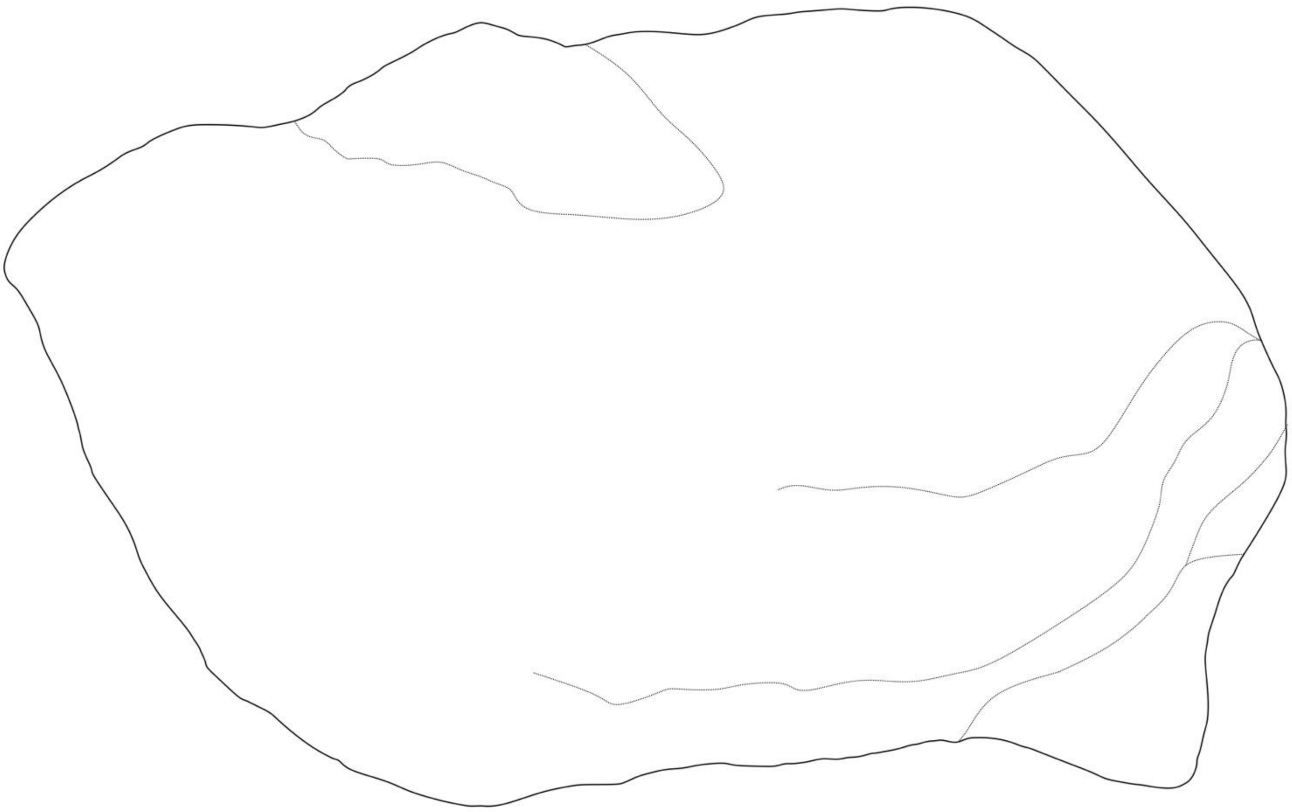

4.mm
0.619 mm

Specimen’s ID	249
Image front	
Image back	
Length, cm	42
Width, cm	25
Weight, g	9300
Volume, m^3	0.004132
Density, kg / m^3	2250.72604
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of a fish similar to a flounder. The protuberant and dark

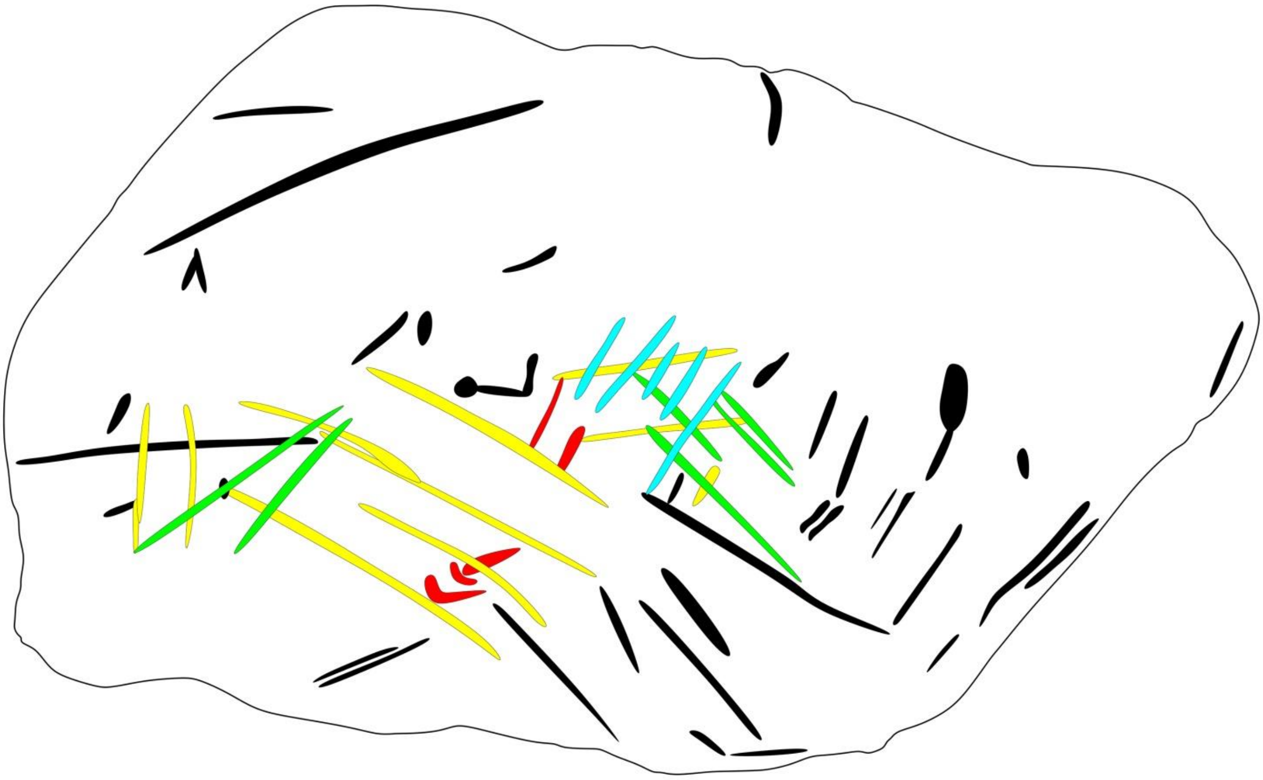
	side contains the linear and geometric engravings.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block has been slightly polished from the back side, which contains no engravings. The front side is covered with desert varnish. Most notches are shallow and almost invisible, while the surface is highly damaged. The incisions create a kind of reticulated ornament. The series of parallel notches show the precise sequence of their creation and might be considered as originating due to animal activity. Parallel notches usually occupy the same chronological position. The relative chronology is mostly non-informative.

Technological drawing front

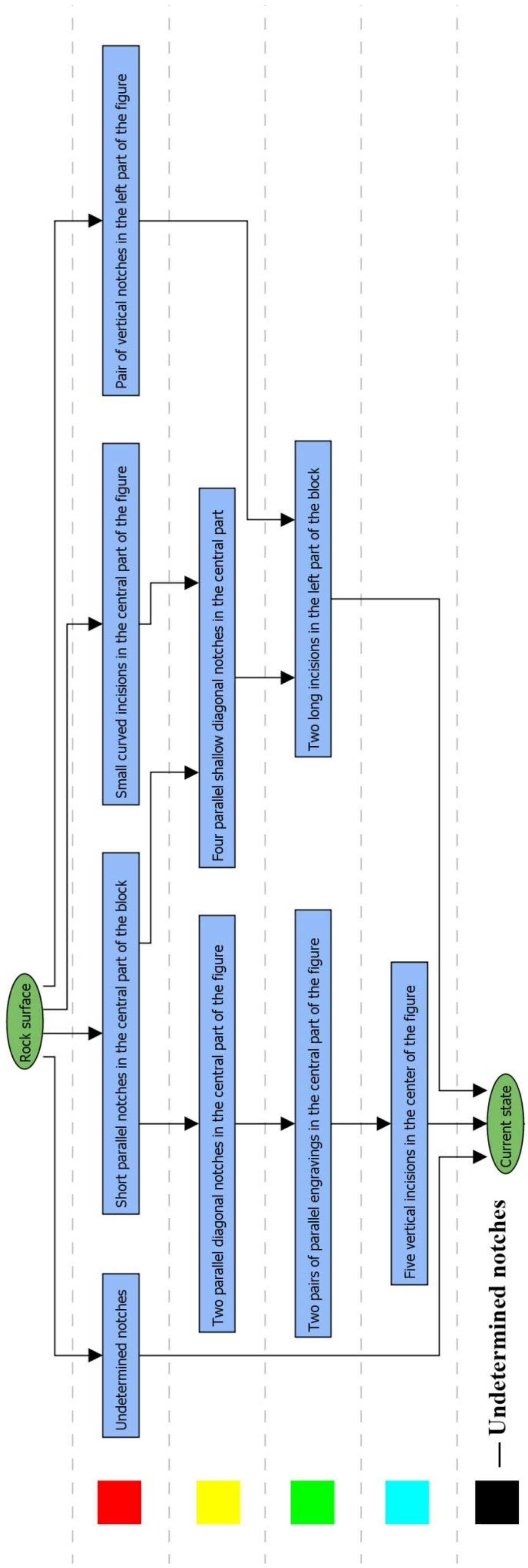
Technological drawing back



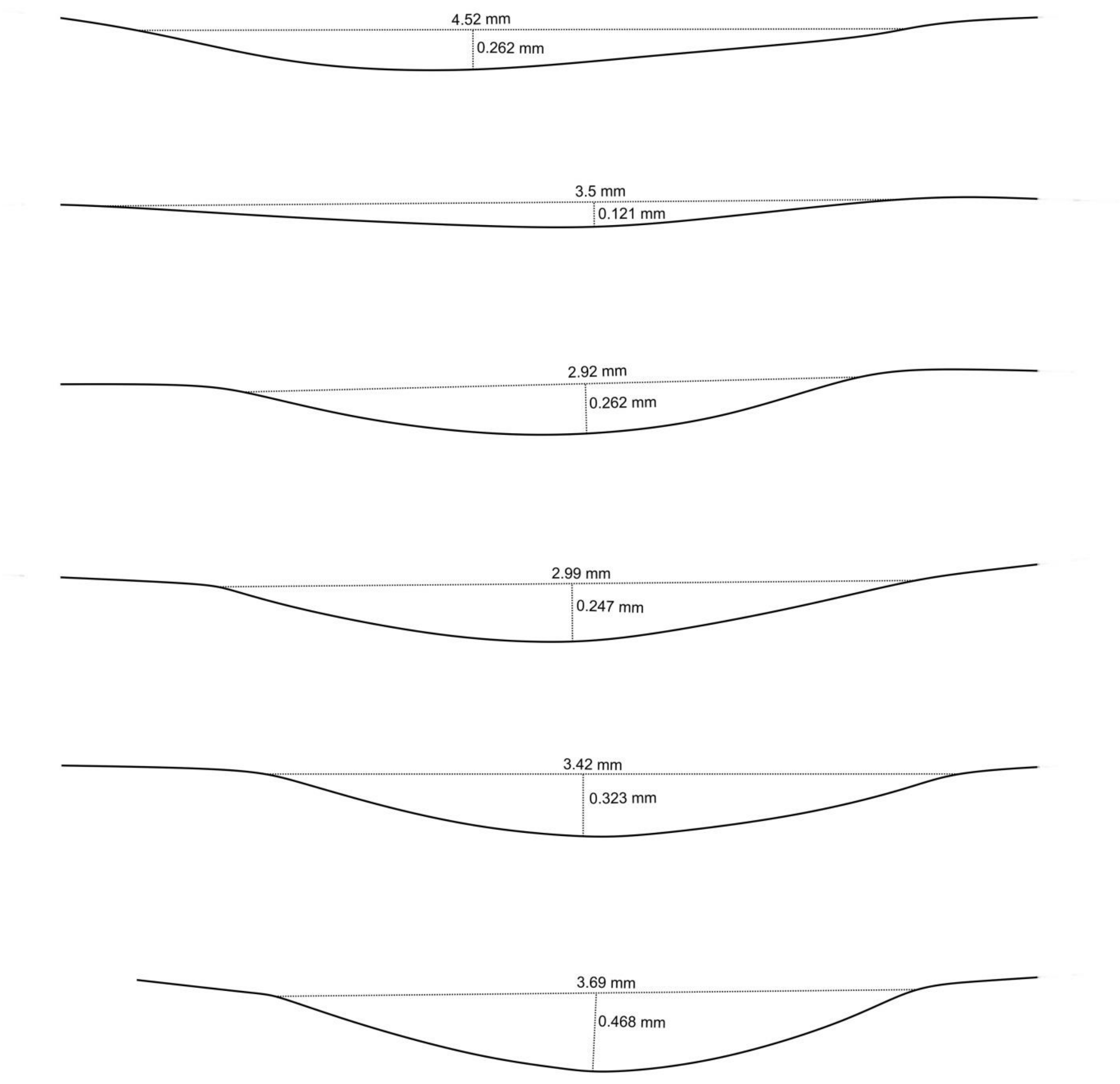
Relative chronology drawing front

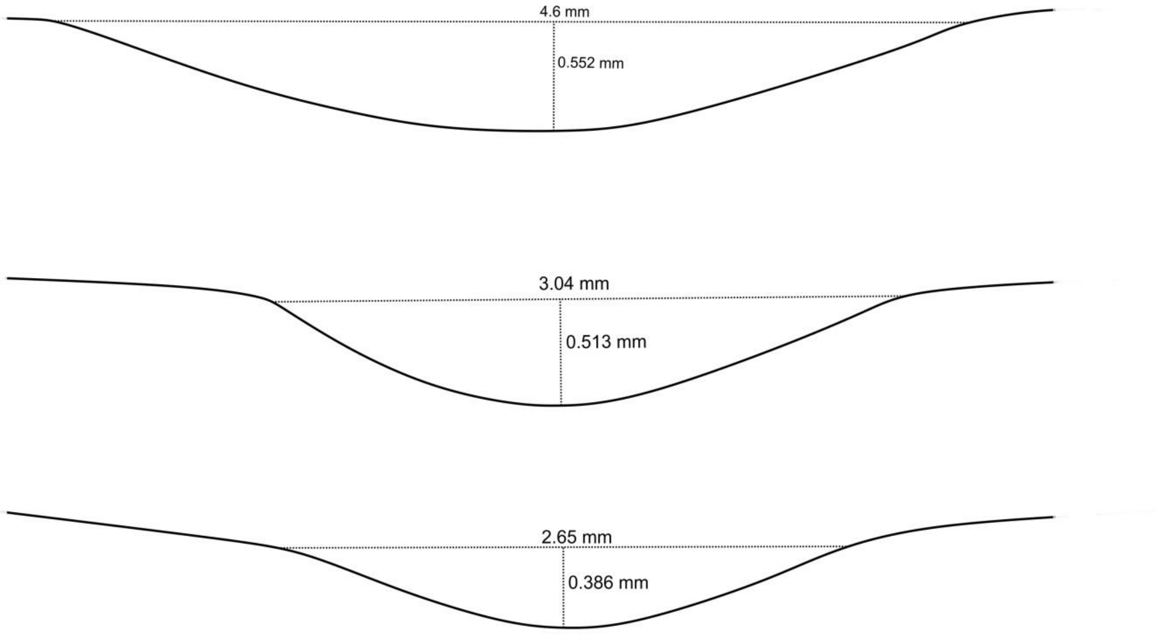


Harris matrix front



Profiles list

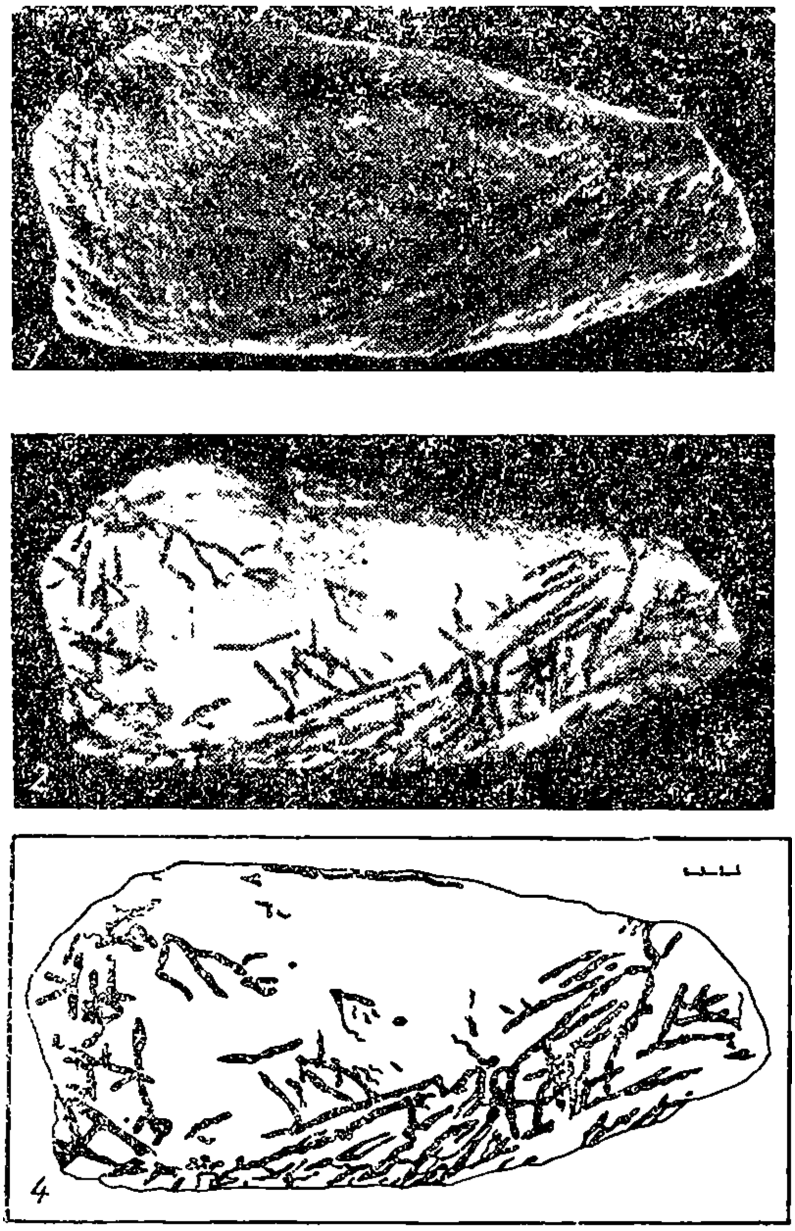



4.6 mm
0.552 mm
3.04 mm
0.513 mm
2.65 mm
0.386 mm

Specimen's ID	850
Image front	
Image back	
Length, cm	26.5
Width, cm	17.5
Weight, g	3338
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga is in a shape of a fish, similar to flatfish. Engravings are on the front side, which is darker and covered with desert varnish. The ornament is reticulated.
Description source	The storage list of Institute of Archaeology in Kyiv
Descriptive image	—
Note	The stone is slightly covered with desert varnish from the front side

Specimen’s ID	251
Image front	
Image back	
Length, cm	42
Width, cm	17
Weight, g	4576
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga is on the part of concretion. In a shape of a fish (chebak). The reticulated ornament is on the convex and darker side. The flat side (near the head of the fish) contains a few diagonal engravings, two dark curved lines, and a point painted with an ocher of different colors.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	A big block fell apart in three pieces, two of which are stored in Kyiv. Both sides are covered with desert varnish. Engravings on the front side except for three parallel lines on the back one.

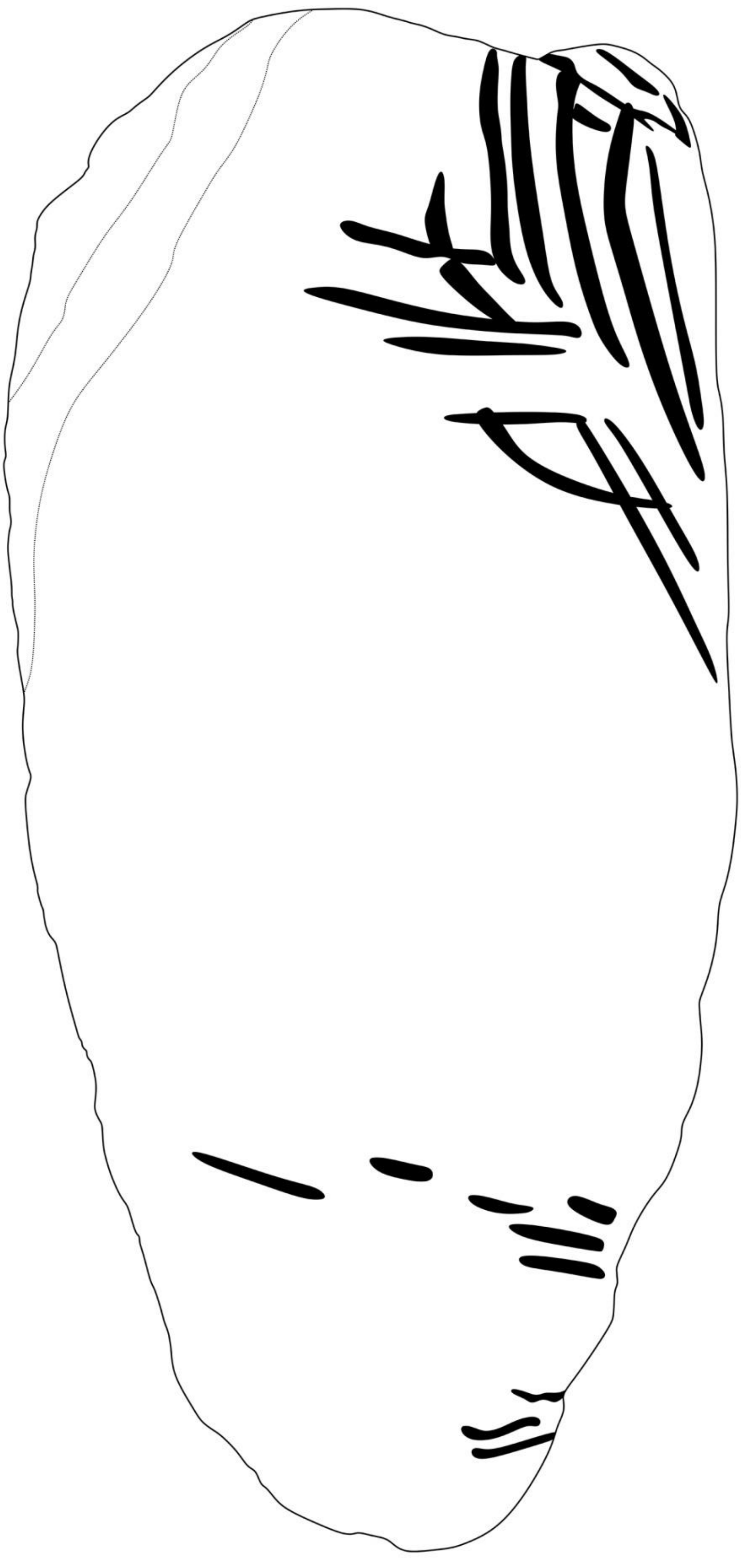
Specimen’s ID	252
Image front	
Image back	
Length, cm	42
Width, cm	19
Weight, g	4190
Volume, m^3	0.002131
Density, kg / m^3	1966.21305
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Oblong stone of a fish-like shape. The shape is similar to a *rutilus lacustris*. Linear and geometric engravings on front and back sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Churinga is related to the group of figures that are similar to a shape of an *Abramis brama*. Ornamented on one side, mostly on its wide part. The image is somehow

	similar to the fish gills. The incisions in a figure's “tail part” are not so evident and cannot be interpreted (fig. 73).
Descriptive image	

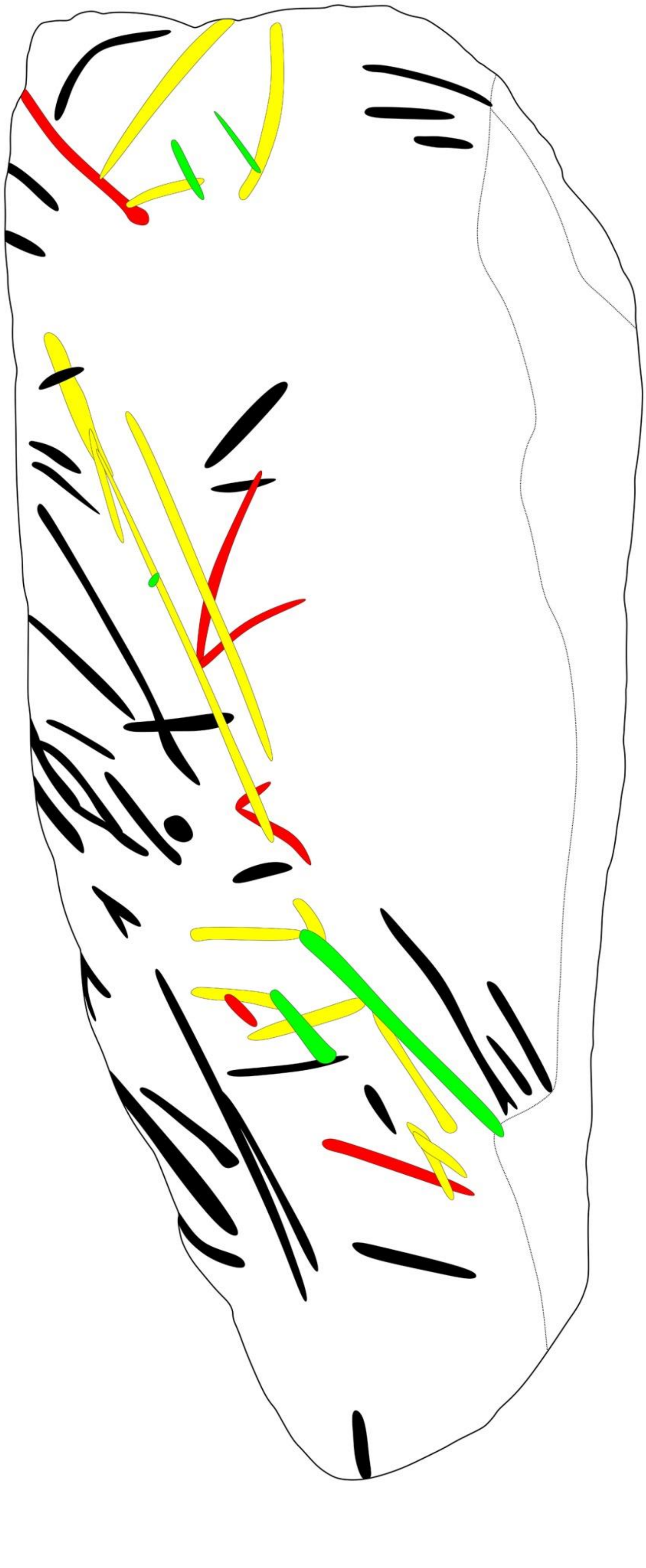
	 
Description source 2	Danilenko 1986: 119, 124 (fig. 73)
Note	The context of the churinga is not defined. According to the code on the stone, it has been found in the Cave of Churingas (No. 54). Same is stated in the book of V. Danilenko (1986, 118, fig. 73). However, on page 124, Danilenko mentioned the Wizard’s Cave as the place where the figure has been found. According to the context of the publication and the figure's place in the text, the Cave of Churingas is the most probable location for the finding of this stone. The block has been slightly polished from the front side and covered with desert varnish. The stone might be considered as one in a shape of a fish. However, this requires additional archaeological interpretation.

Technological drawing front

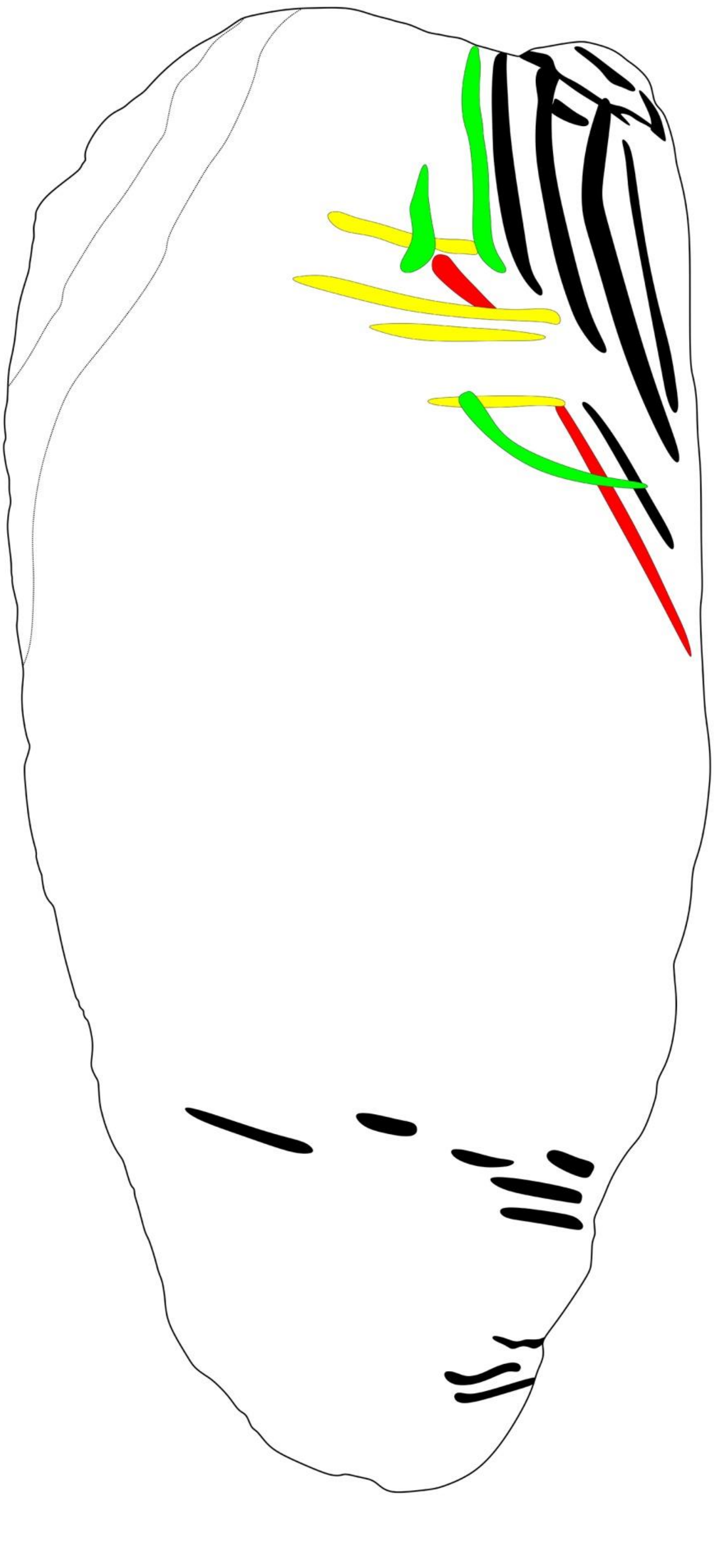
Technological drawing back



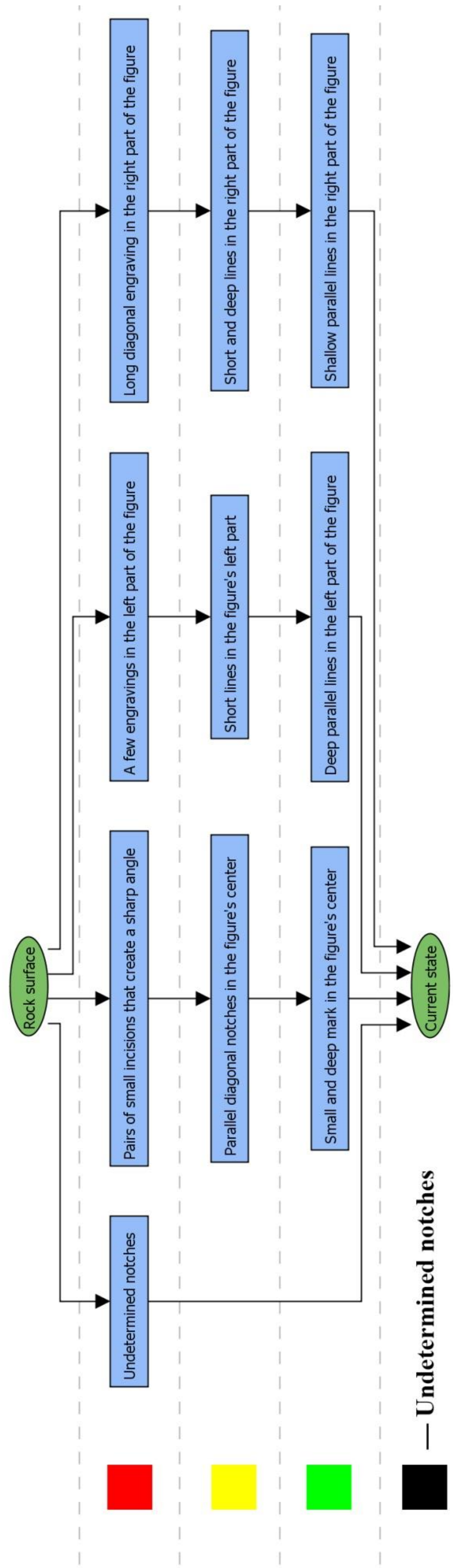
Relative chronology drawing front



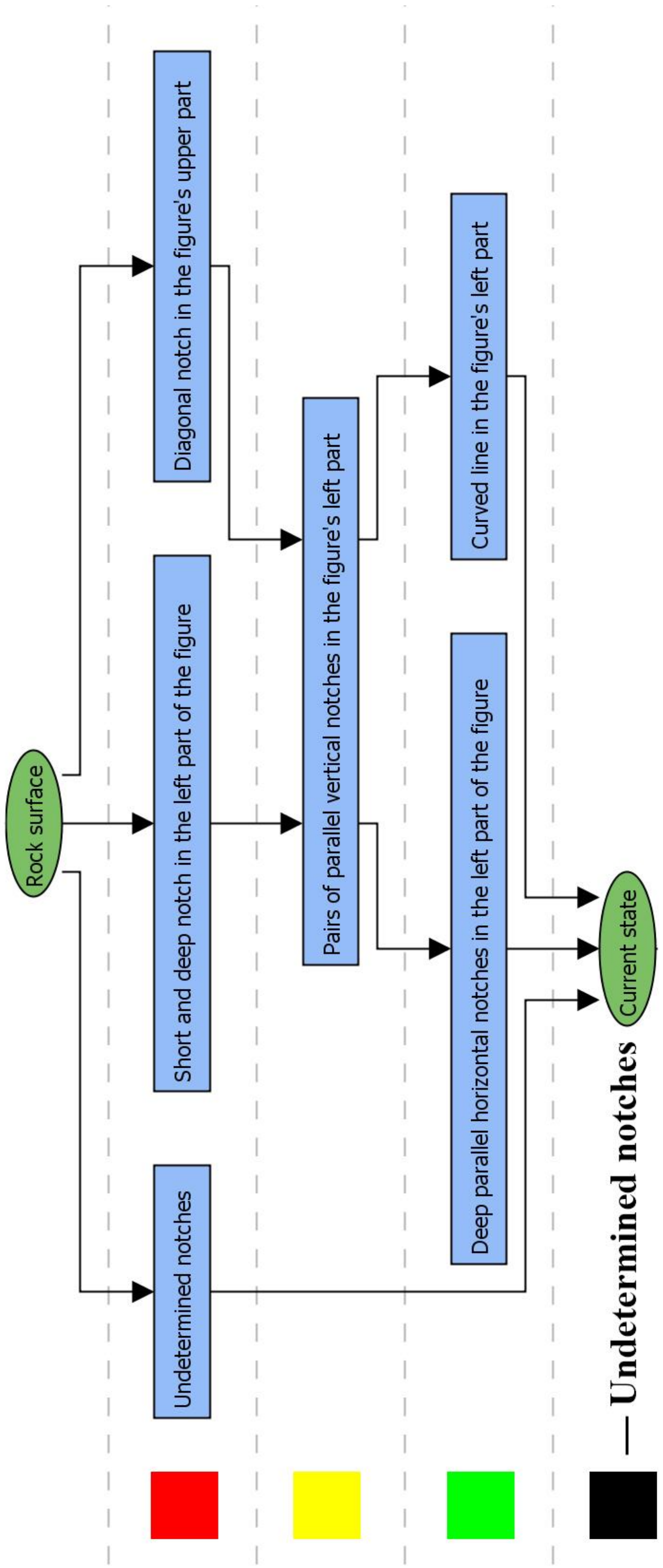
Relative chronology drawing back



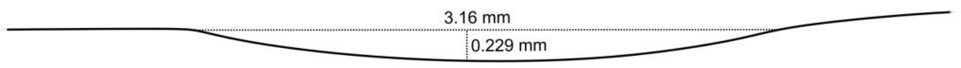
Harris matrix front

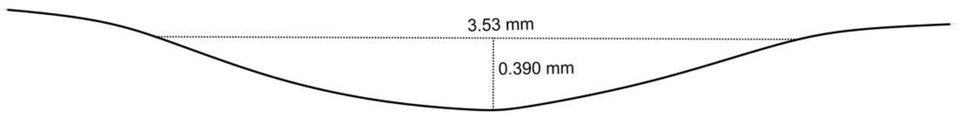


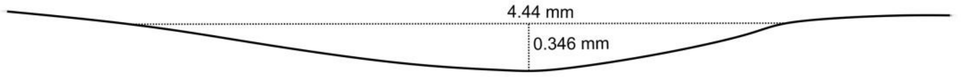
Harris matrix back

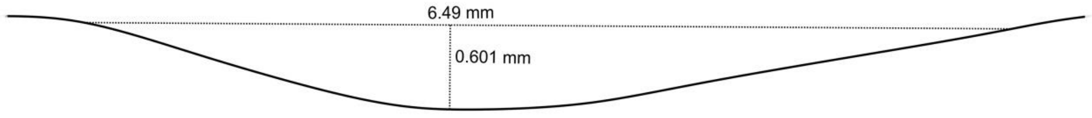


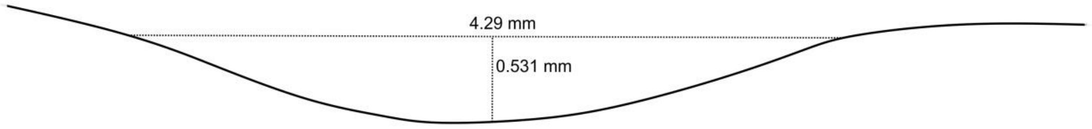
Profiles list

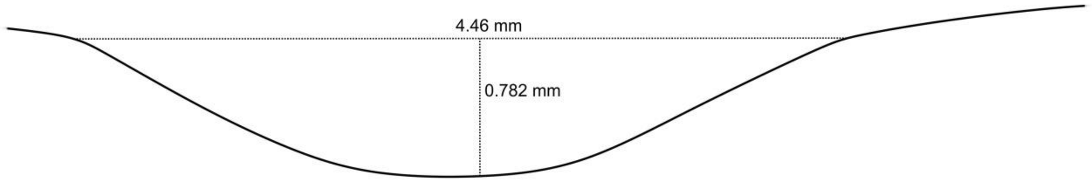


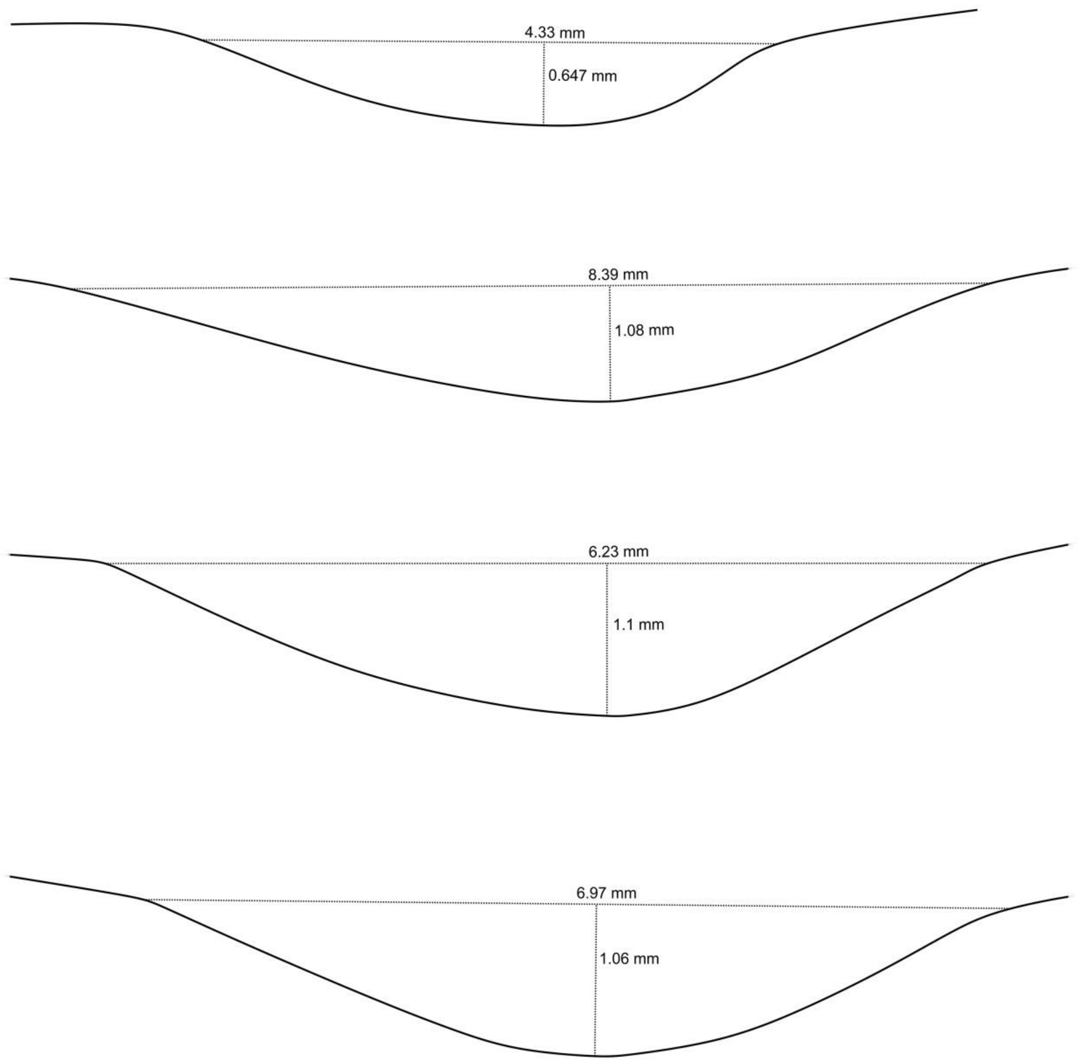




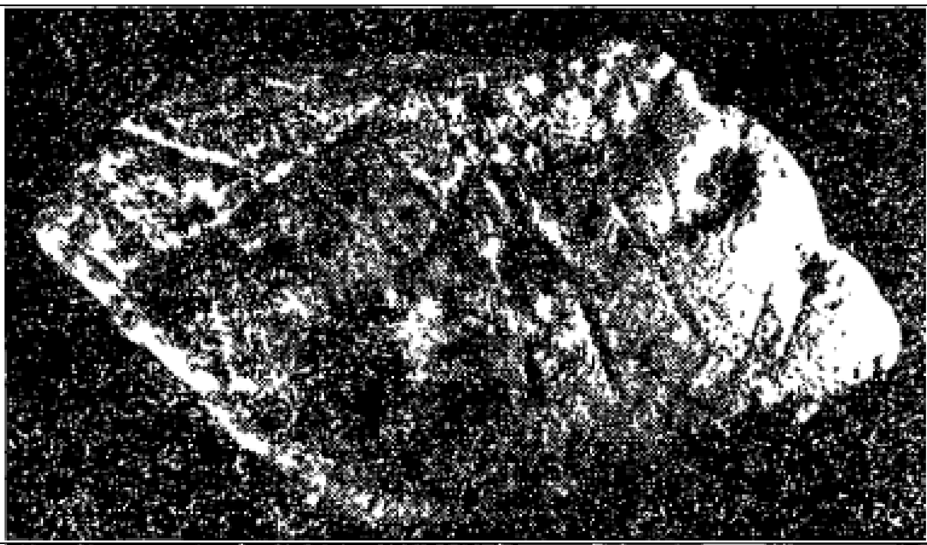
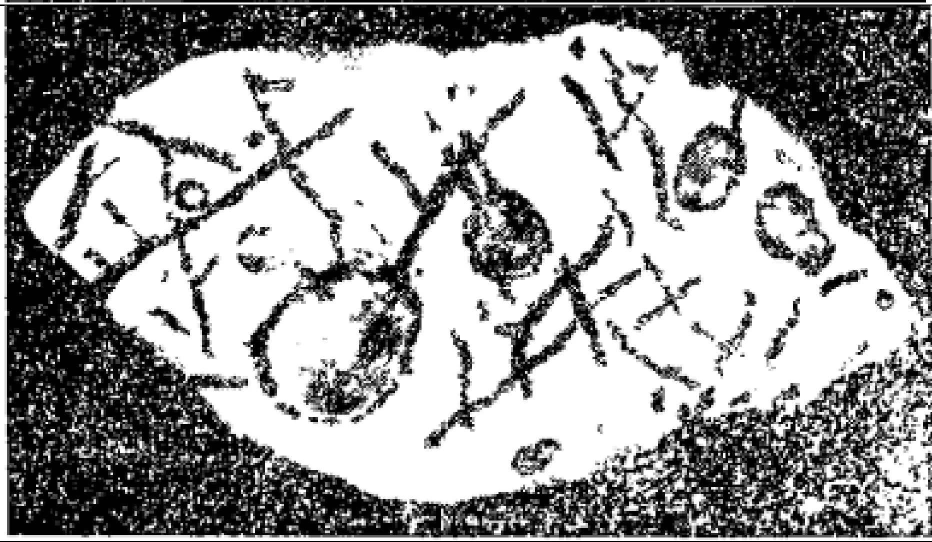






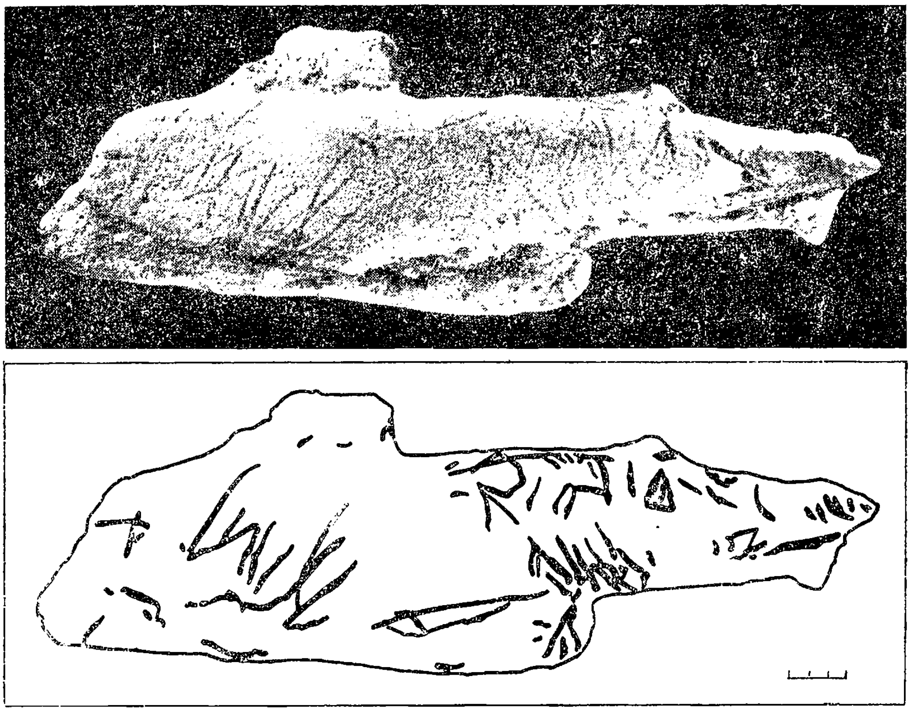

4.33 mm
0.647 mm
8.39 mm
1.08 mm
6.23 mm
1.1 mm
6.97 mm
1.06 mm

Specimen's ID	253
Image front	
Image back	
Length, cm	17
Width, cm	9
Weight, g	405
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Chutinga is on the part of a concretion in a shape of a fish, similar to a crucian carp. Reticulated engravings are placed on the both sides of a stone.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Churinga is similar to No. 252 in its shape. The stone is almost deprived of any recognizable ornamentation.
Description source 2	Danilenko 1986: 127

Descriptive image	
Descriptive image 2	
Descriptive image 3	
Note	The round points are the cupmarks of different shapes that were perforated by a long and flat tool. The front side is covered with desert varnish and non-figurative engravings.

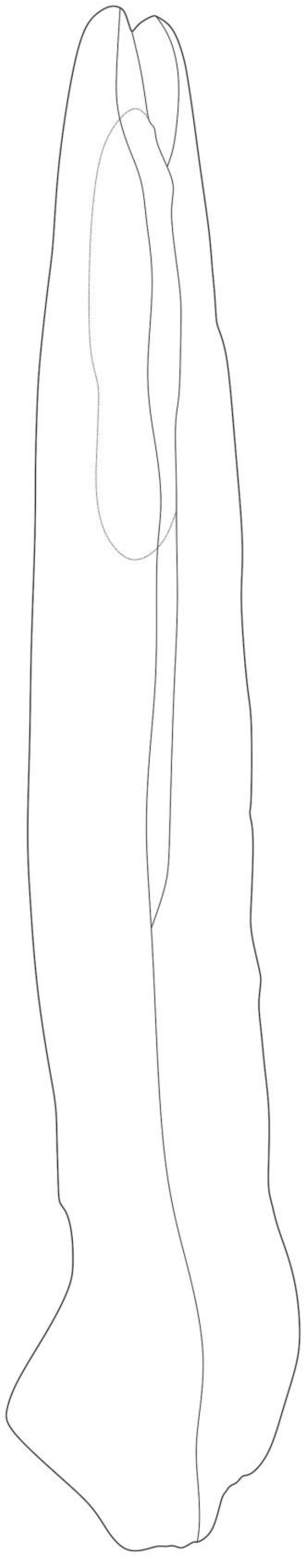
Specimen's ID	254
Image front	
Image right	
Image back	
Image left	

Image top	
Image bottom	
Length, cm	45
Width, cm	14
Weight, g	3800
Volume, m^3	0.001642
Density, kg / m^3	2314.2509
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	The churinga is in a shape of a fish, similar to a starlet. Its head is closer to the dolphin one. Several protrusions are similar to the fins, including the tail ones. The engravings from the front side are linear and geometric.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Without any doubt is a noticeable specimen of fish-like churingas. The natural concretion is exceptionally close to the dolphin or a ganoid by its shape. The body is spindle-like, with fins on its back, stomach, and tail. The body of the fish contains deep linear and angular compositions.

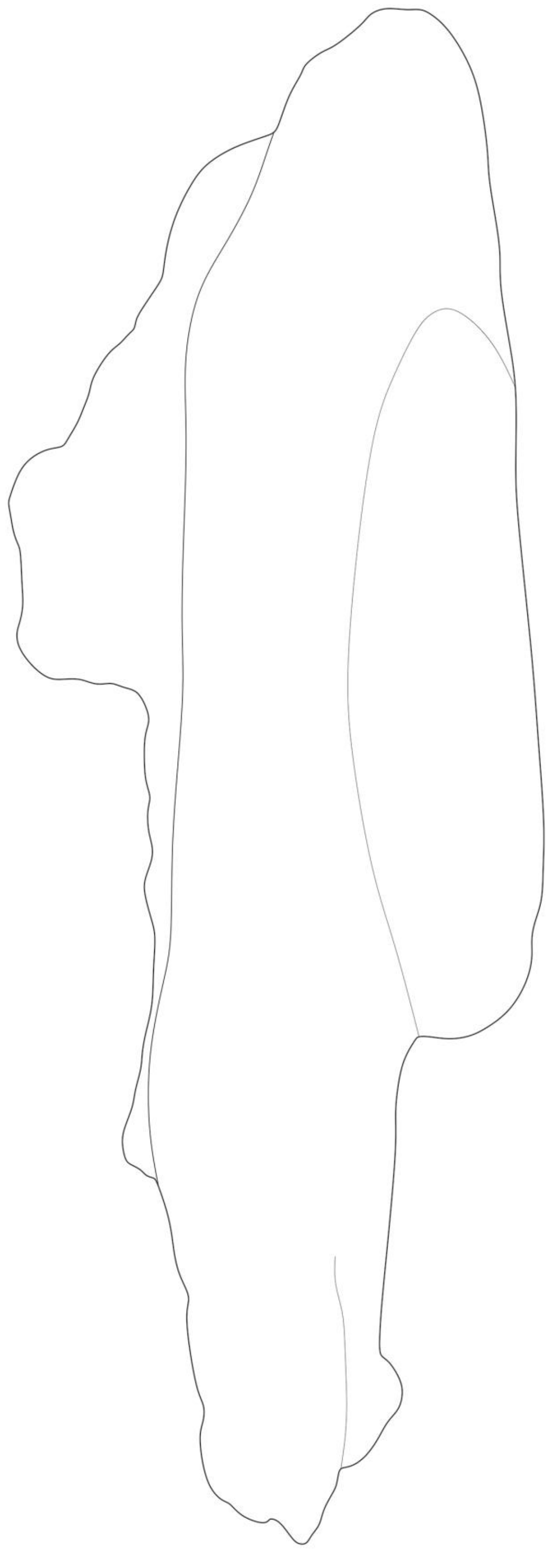
Descriptive image	
Description 2 source	Danilenko 1986: 118—119.
Note	The figure seems to be shaped to the shape of a fish. However, the general shape of the stone remains natural. The engravings on the front side are pretty shallow and barely visible. The natural protrusions are similar to the fish fins. The ornament is reticulated or has the shape of a zigzag. The relative chronology of the engravings is non-informative due to the lack of visible intersections.

Technological drawing front

Technological drawing top

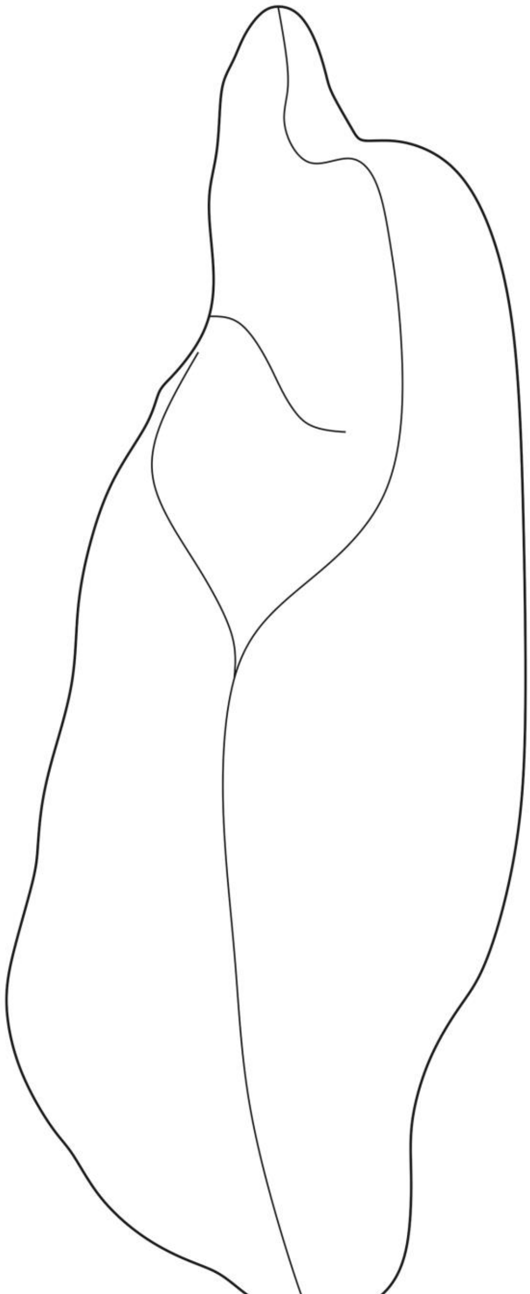


Technological drawing back

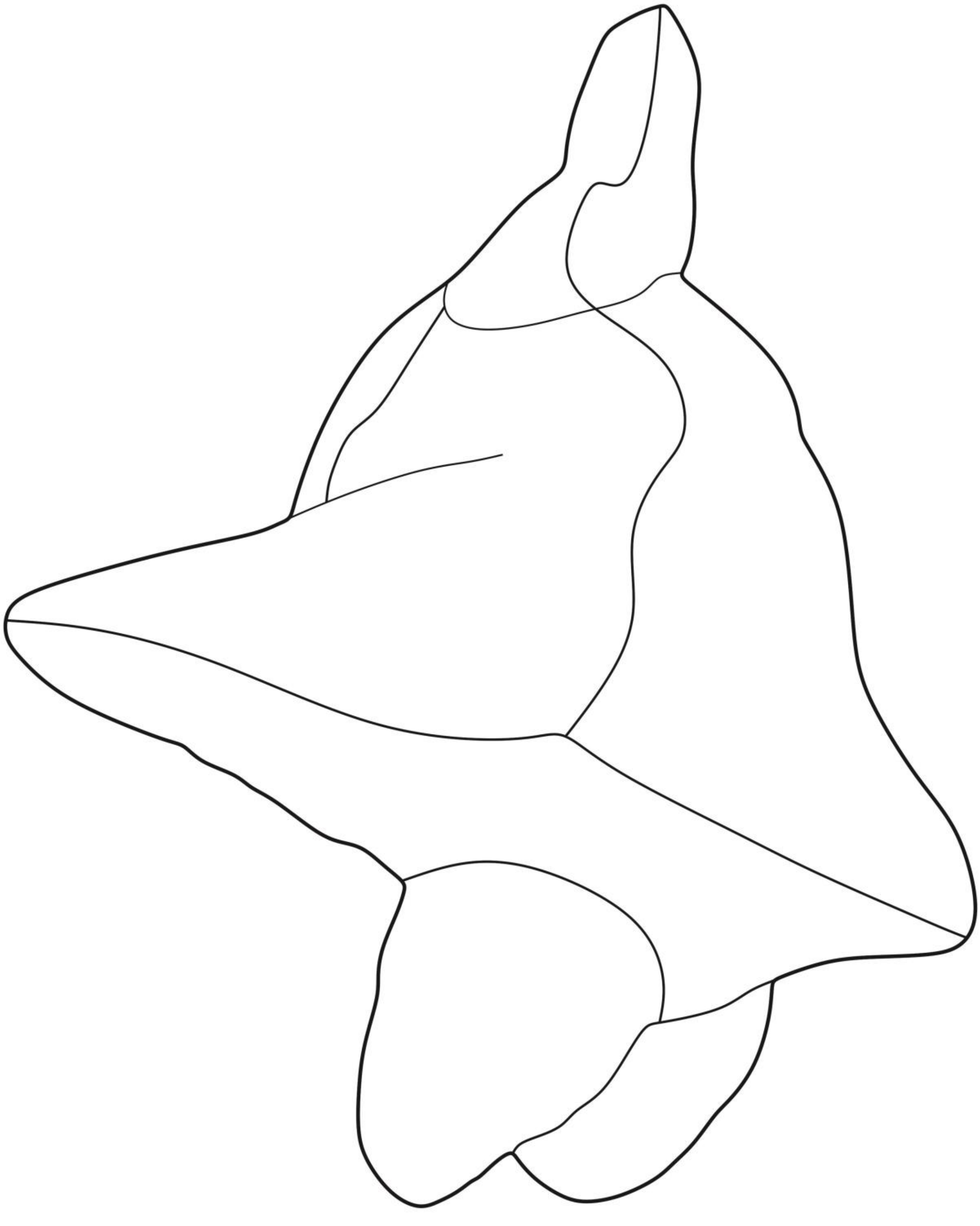


Technological drawing bottom

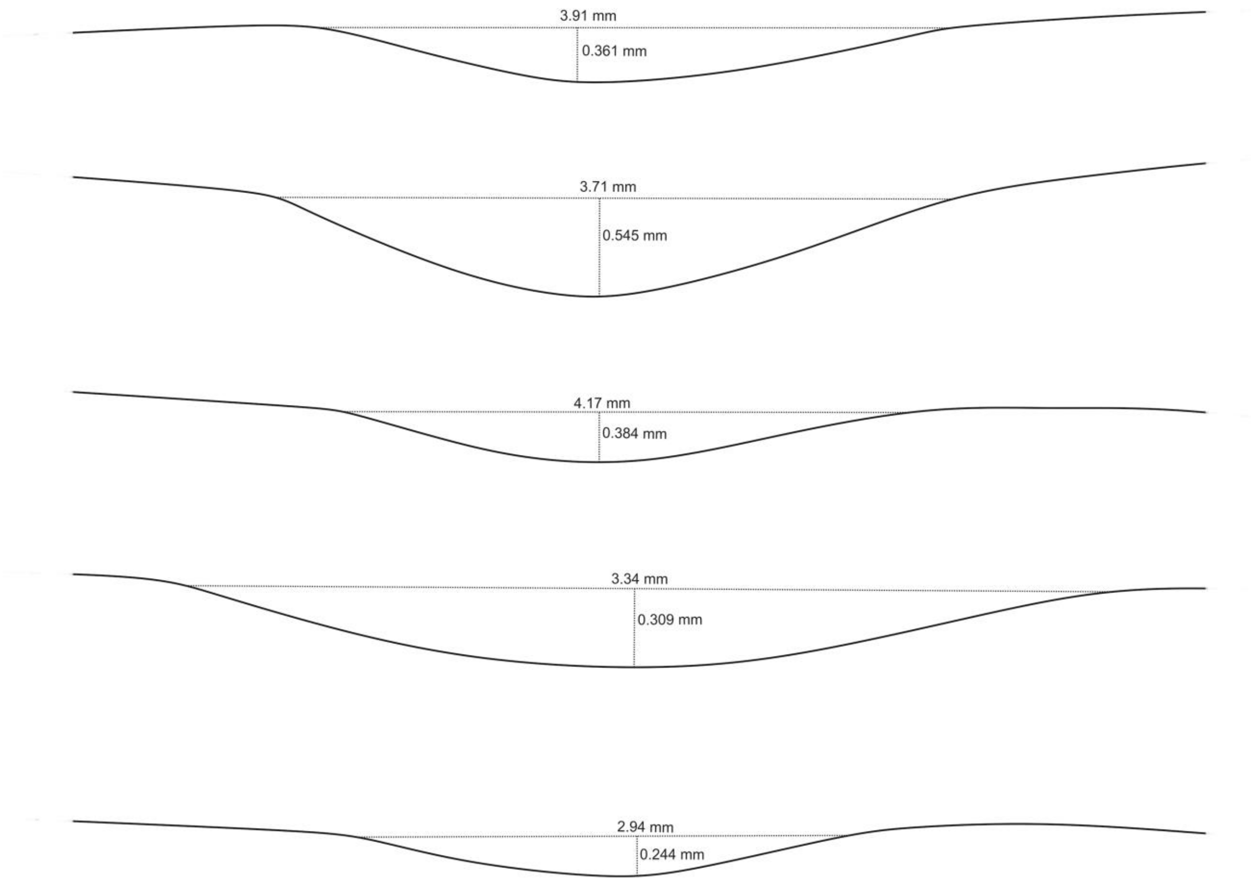
Technological drawing left

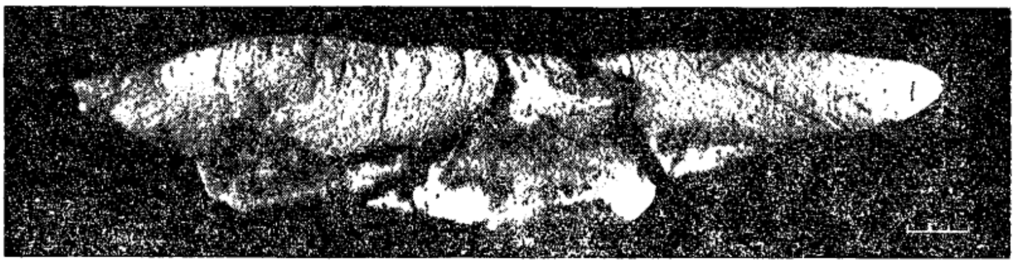


Technological drawing right



Profiles list



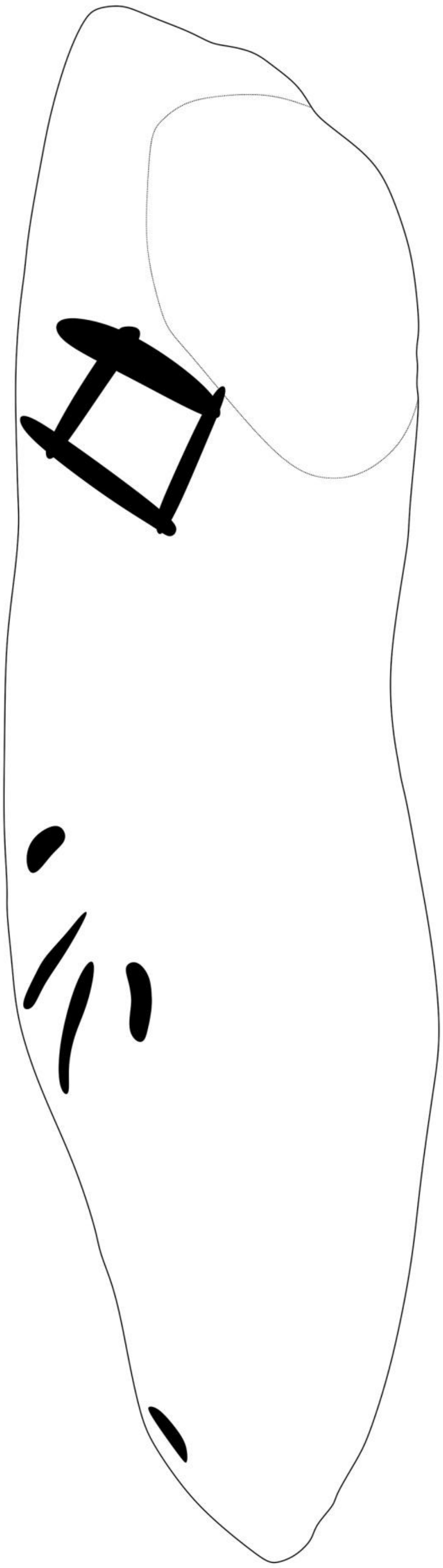
Specimen's ID	255
Image front	
Image back	
Length, cm	42
Width, cm	10
Weight, g	1515
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of a fish, similar to a sterlet. Made of a concretion, it consists of two different parts. Simple reticulated ornamentation is on the brighter front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	The middle part contains a protrusion in a shape of a fin. It also contains engravings and linear and geometric images of non-recognized meaning.
Description source 2	Danilenko 1986: 121
Descriptive image	
Descriptive image 2	
Note	—

Specimen’s ID	256
Image front	
Image back	
Length, cm	32.5
Width, cm	8.5
Weight, g	1083
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of a fish, similar to a sterlet. One line represents the mouth. A fin is a natural protrusion. The origin of engravings is not clear
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Almost the center of a stone contains a protrusion similar to a fin. Any kind of engraved image is not clear.
Description source 2	Danilenko 1986: 118
Descriptive image	
Note	Churinga consists of two parts. Both are covered with engravings and desert varnish from all sides.

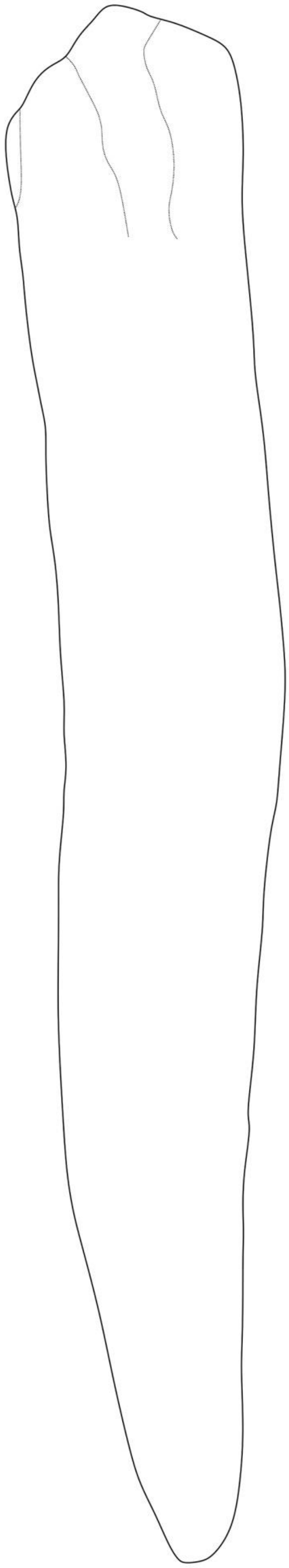
Specimen’s ID	257
Image front	
Image top	
Image back	
Image bottom	
Length, cm	32
Width, cm	9
Weight, g	1317
Volume, m^3	0.000625
Density, kg / m^3	2107.2
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of a fish, similar to sterlet without any evidential artificial notches.
Description source	The storage list of Institute of Archaeology in Kyiv

Description 2	Churingas No. 263, 262, 258, and 257 have 25.5, 11.5, 23, and 33 cm lengths, respectively. They have a shape of a spindle (or a cigar) and characterized by the absence of fins or any, even the most primitive, ornament.
Description 2 source	Danilenko 1986: 120.
Note	The figure has been definitely processed to its form, close to a cigar's long and thin shape. It does not have any engravings and is slightly covered with desert varnish from the front side. It is one of the brightest examples of fish-like figures in the Kamyana Mohyla collection.

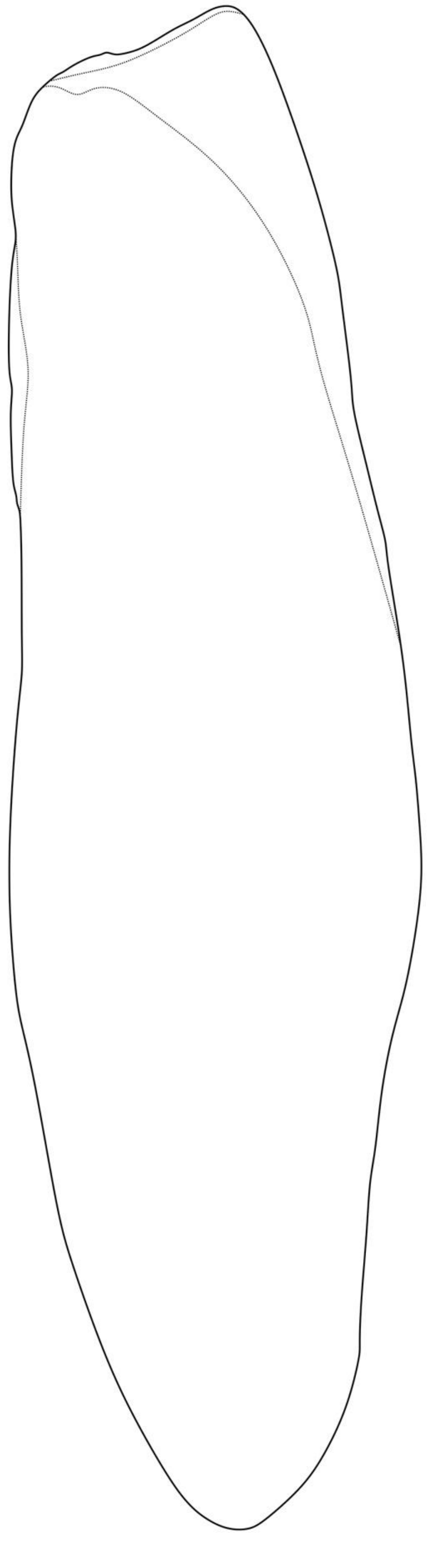
Technological drawing front



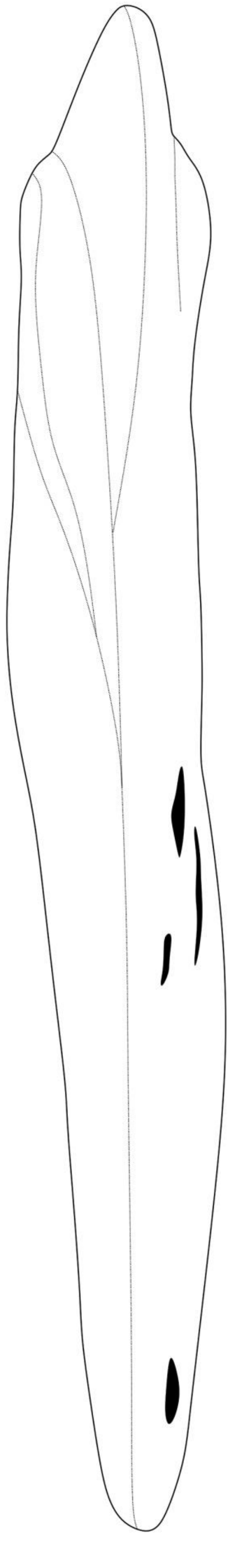
Technological drawing top



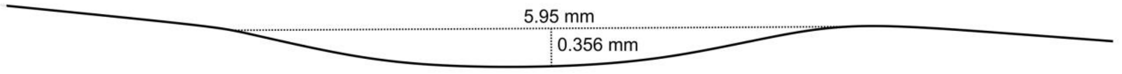
Technological drawing back

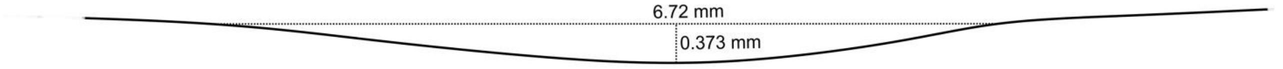


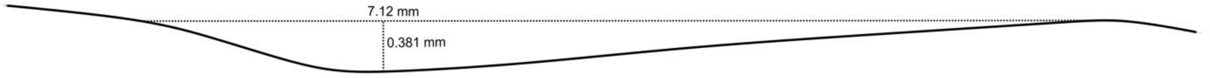
Technological drawing bottom



Profiles list



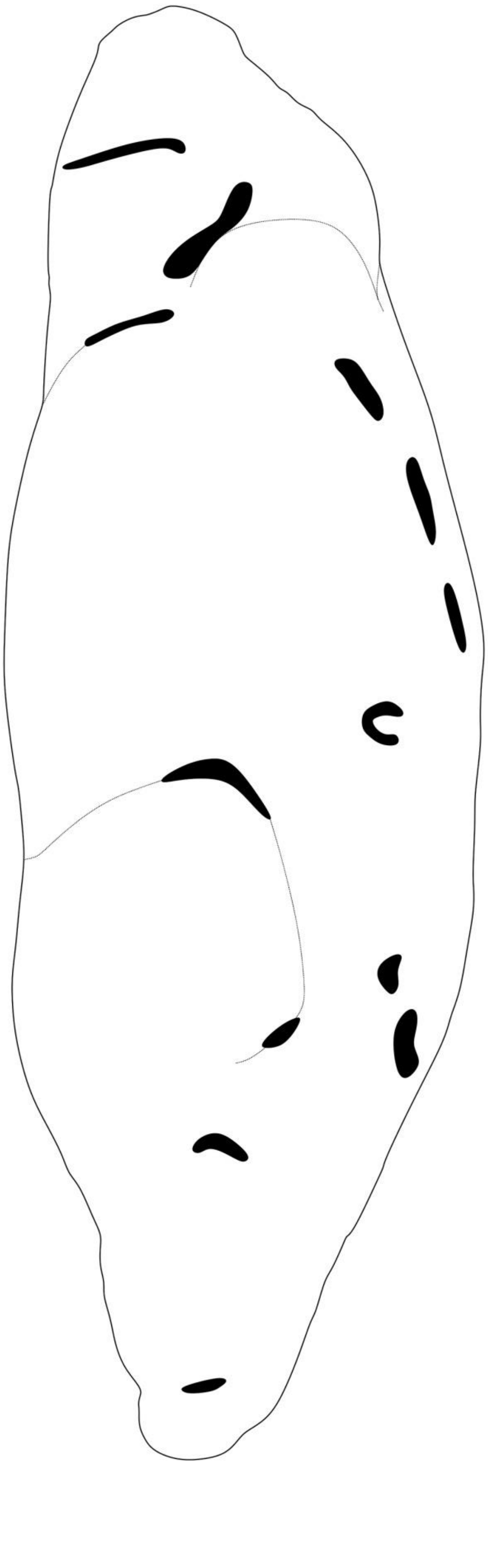




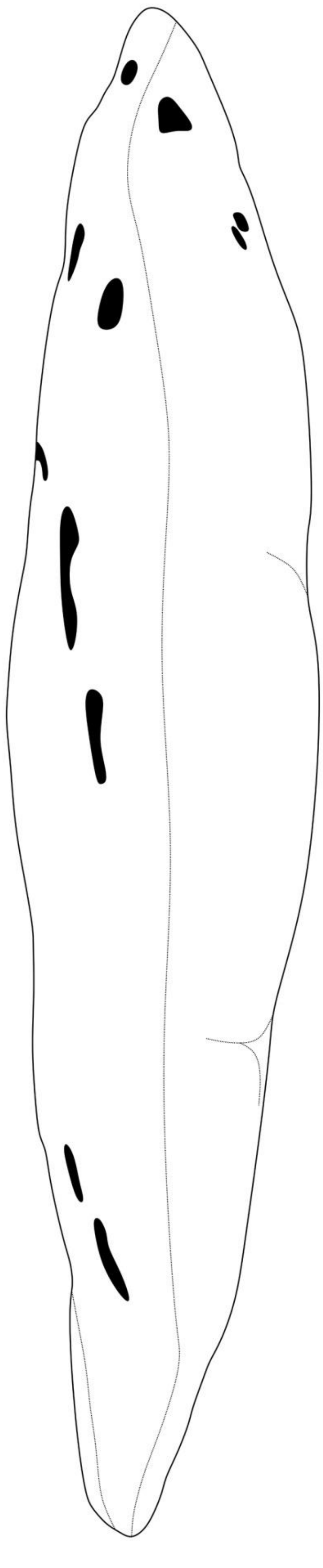
Specimen's ID	258
Image front	
Image top	
Image back	
Image bottom	
Length, cm	25
Width, cm	8
Weight, g	806
Volume, m^3	0.000347
Density, kg / m^3	2322.76657
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga is in a shape of a fish, similar to a sterlet. Probably, the mouth

	and nose are drawn from one side. The “tail” is broken and reconstructed with another piece of sandstone.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	The group of churingas No. 263, 262, 258, and 257 the lengths of 25.5, 11.5, 23, and 33 cm, respectively. They have a shape of a spindle (or a cigar) and are characterized by the absence of fins or any, even the most primitive, ornament.
Descriptive image	
Description 2 source	Danilenko 1986: 120.
Note	The figure has been processed to its form, close to a cigar's long and thin shape. It has a few notches that might be considered modified natural cracks; a specimen is not covered with desert varnish from any side. According to V. Danilenko, it is one of the brightest examples of fish-like figures in the Kamyana Mohyla collection.

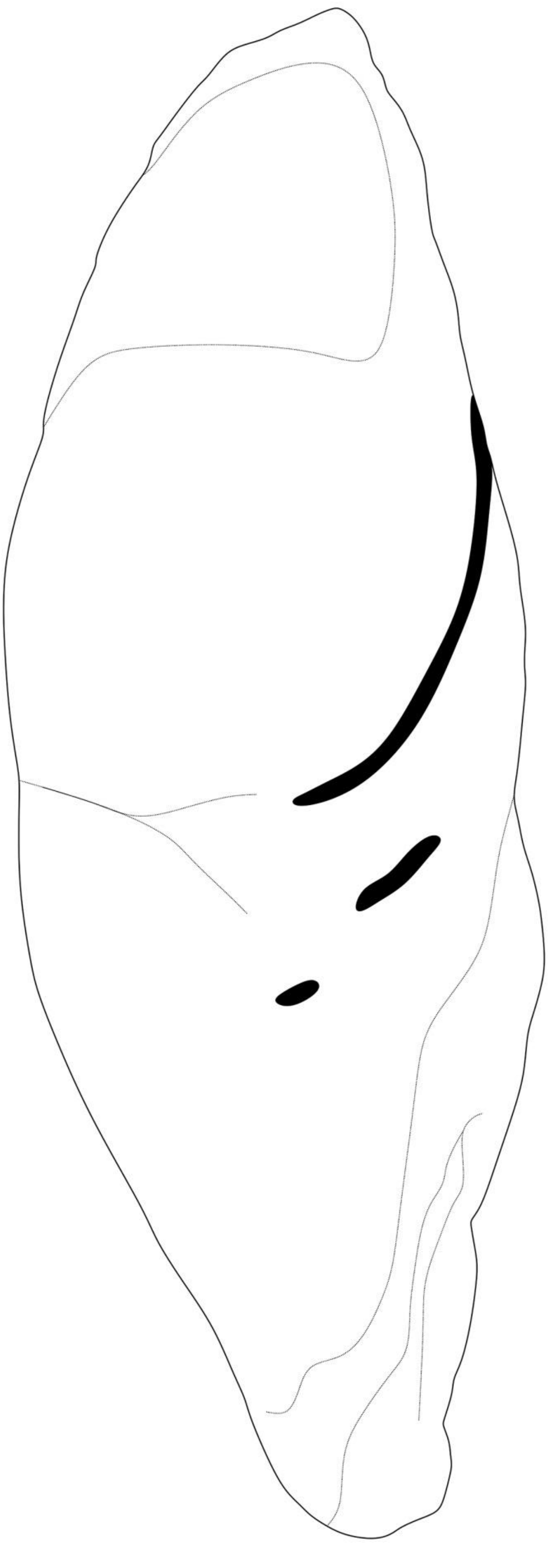
Technological drawing front



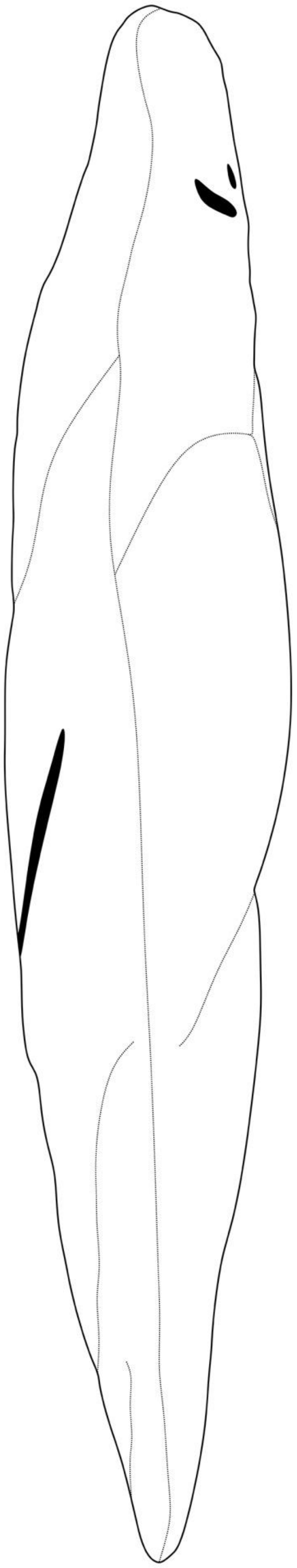
Technological drawing top



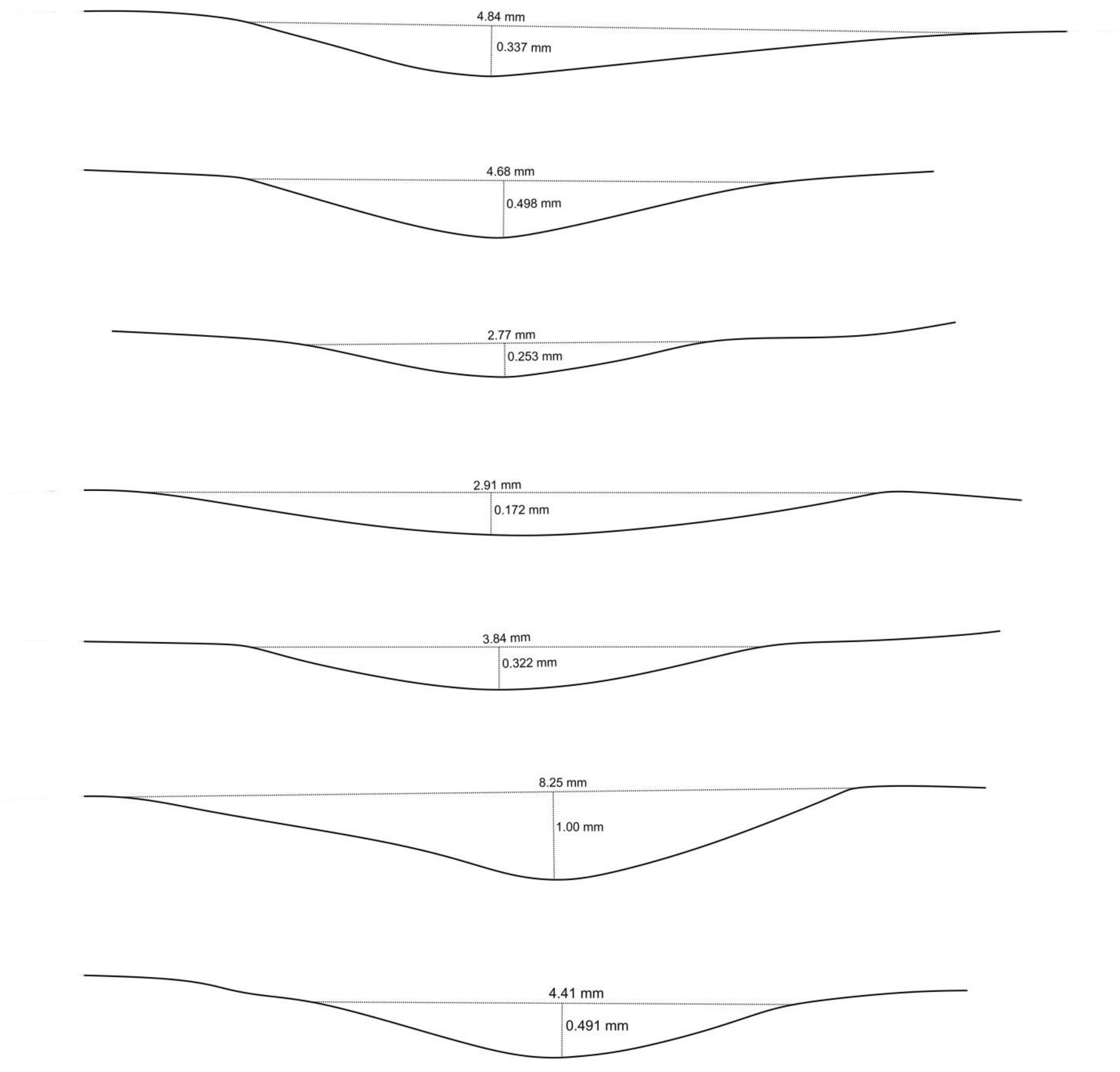
Technological drawing back



Technological drawing bottom

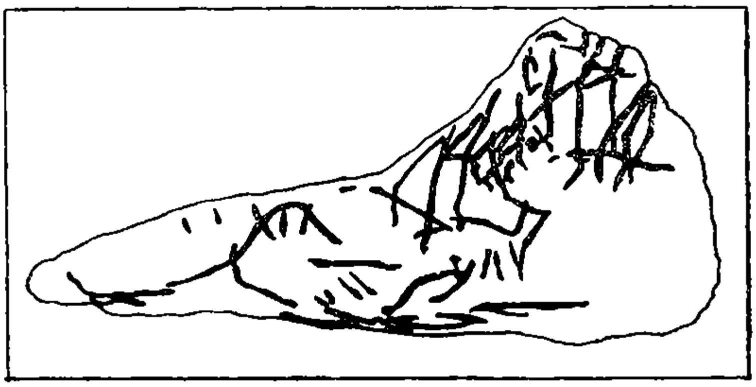


Profiles list

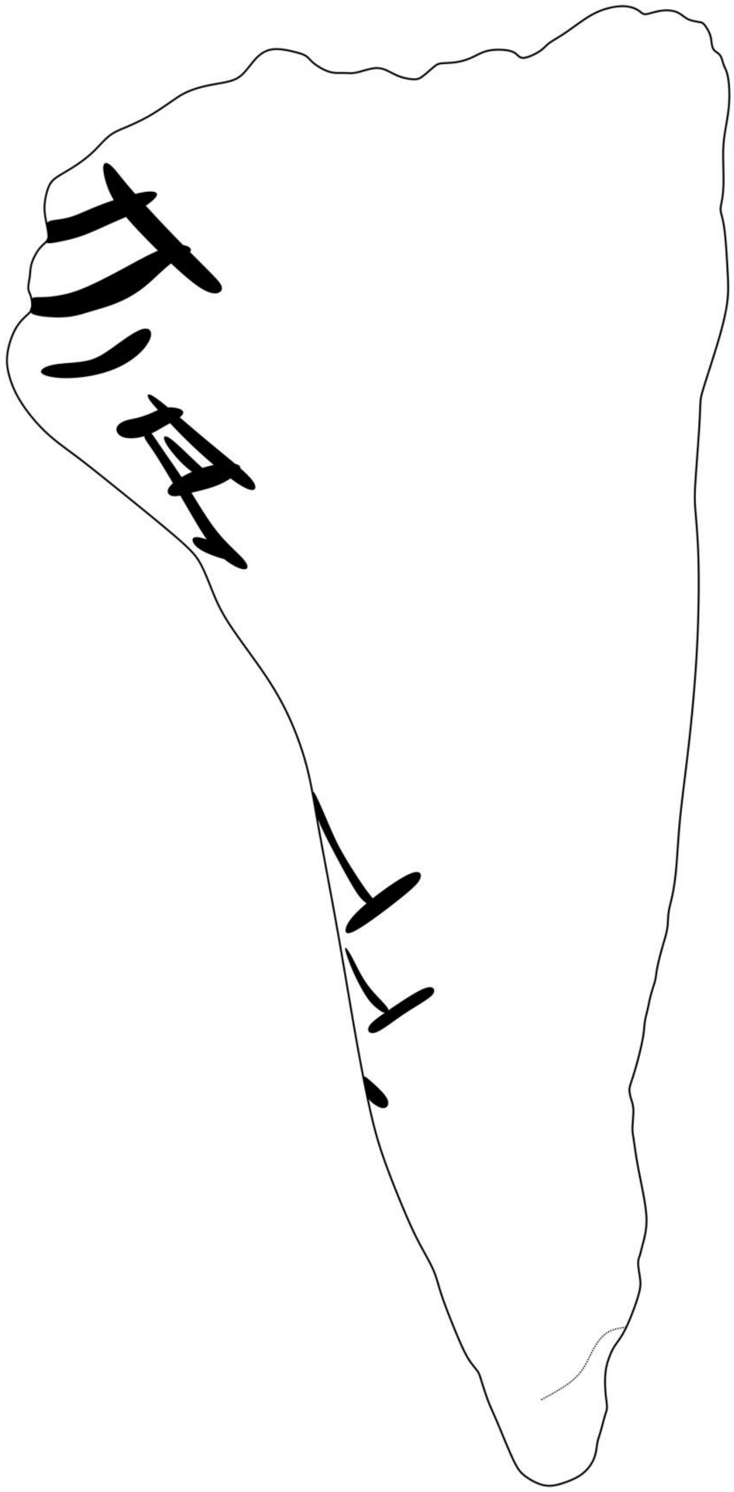


Specimen's ID	259
Image front	
Image top	
Image back	
Image bottom	

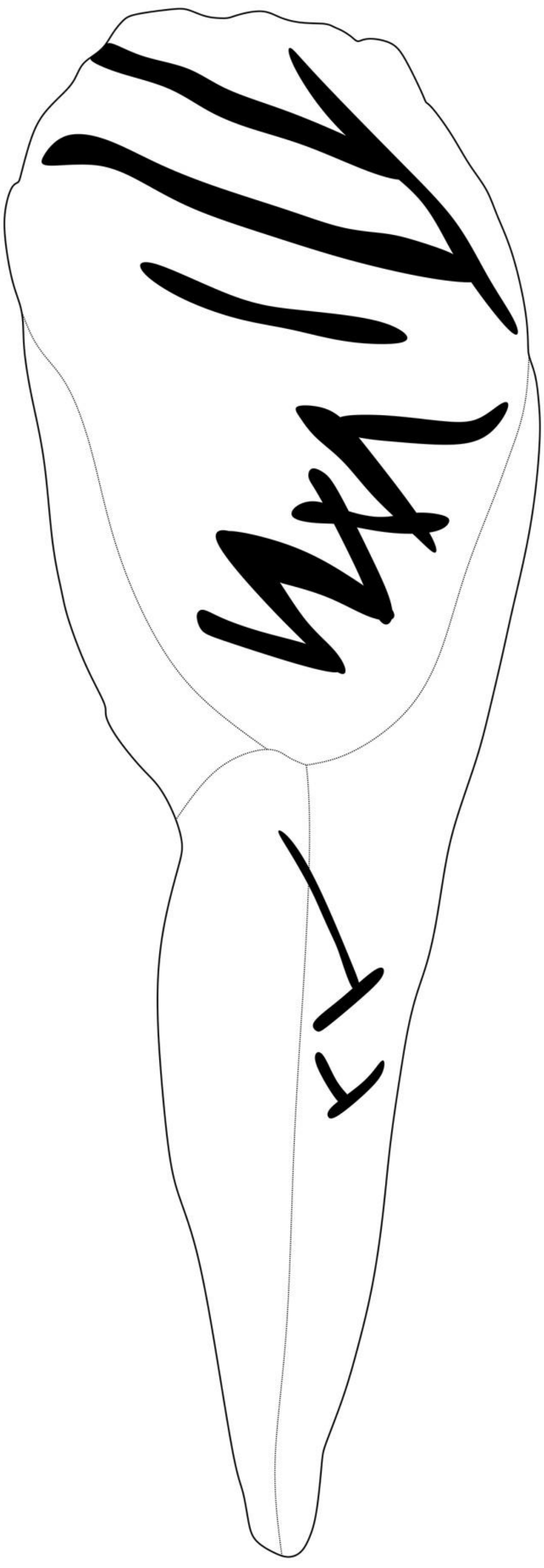
Image right	
Length, cm	30
Width, cm	10
Weight, g	2032
Volume, m^3	0.000936
Density, kg / m^3	2170.94017
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of a fish, similar to *Gobiiformes*. Simple linear and geometric engravings on the more protuberant side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	One of the surfaces of this churinga (total length 29.5 cm) is covered with linear engraved ornament. Its motif or sematic meaning of that stage of research is undeterminable (fig. 75).

Descriptive image	  
Description 2 source	Danilenko 1986: 118—120.
Note	The figure has been partially manufactured and used to be interpreted as a shape of a fish. It contains a number of linear engravings on its top. Three deep parallel lines might be considered zoogenic. Others are shallow and form several zigzag-like ornaments.

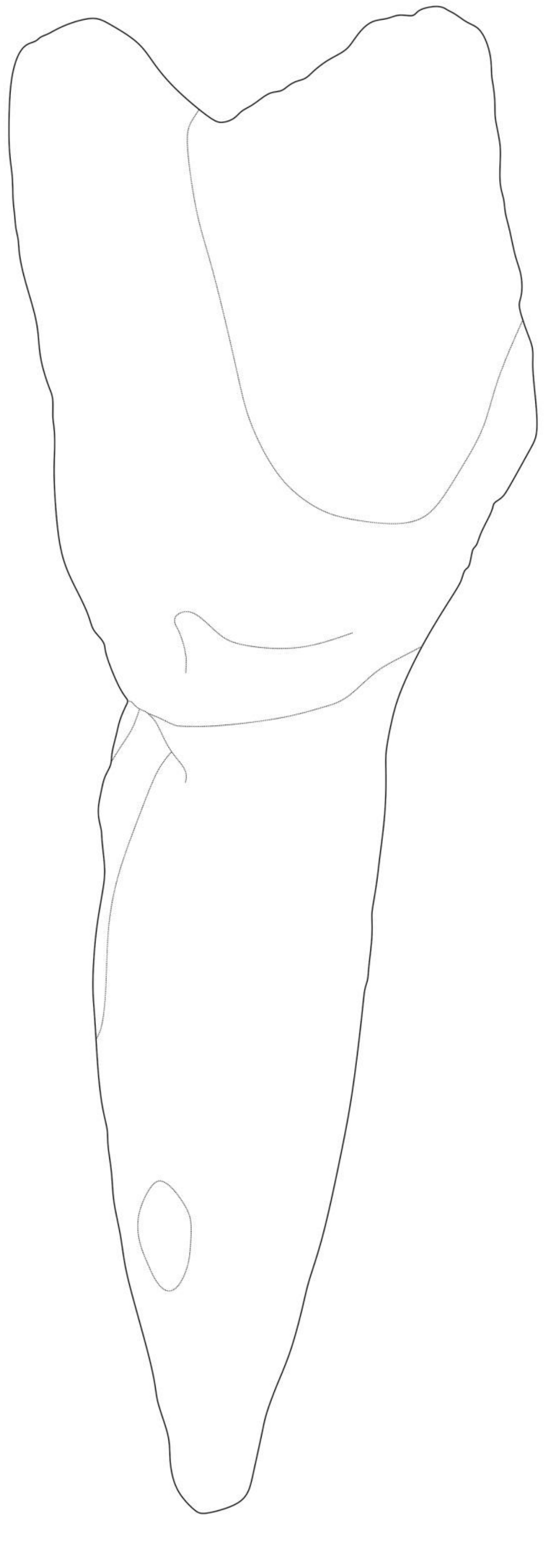
Technological drawing front



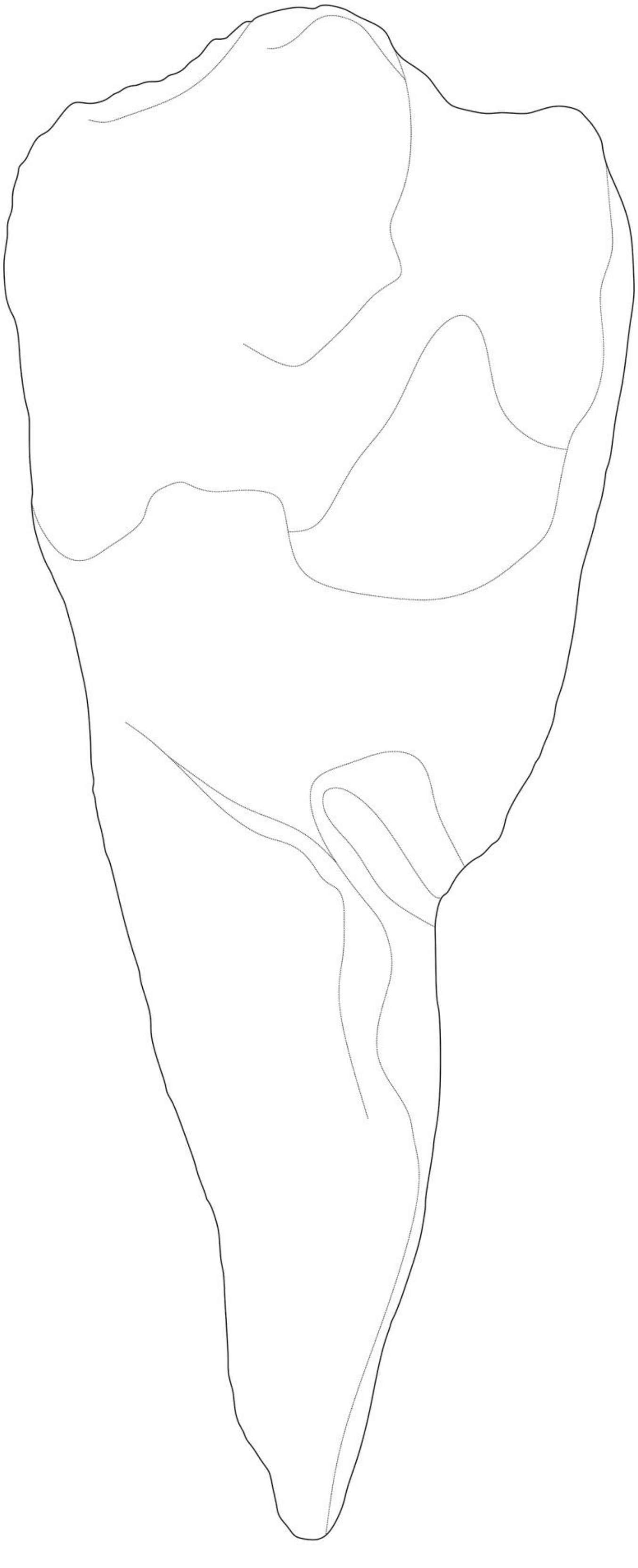
Technological drawing top



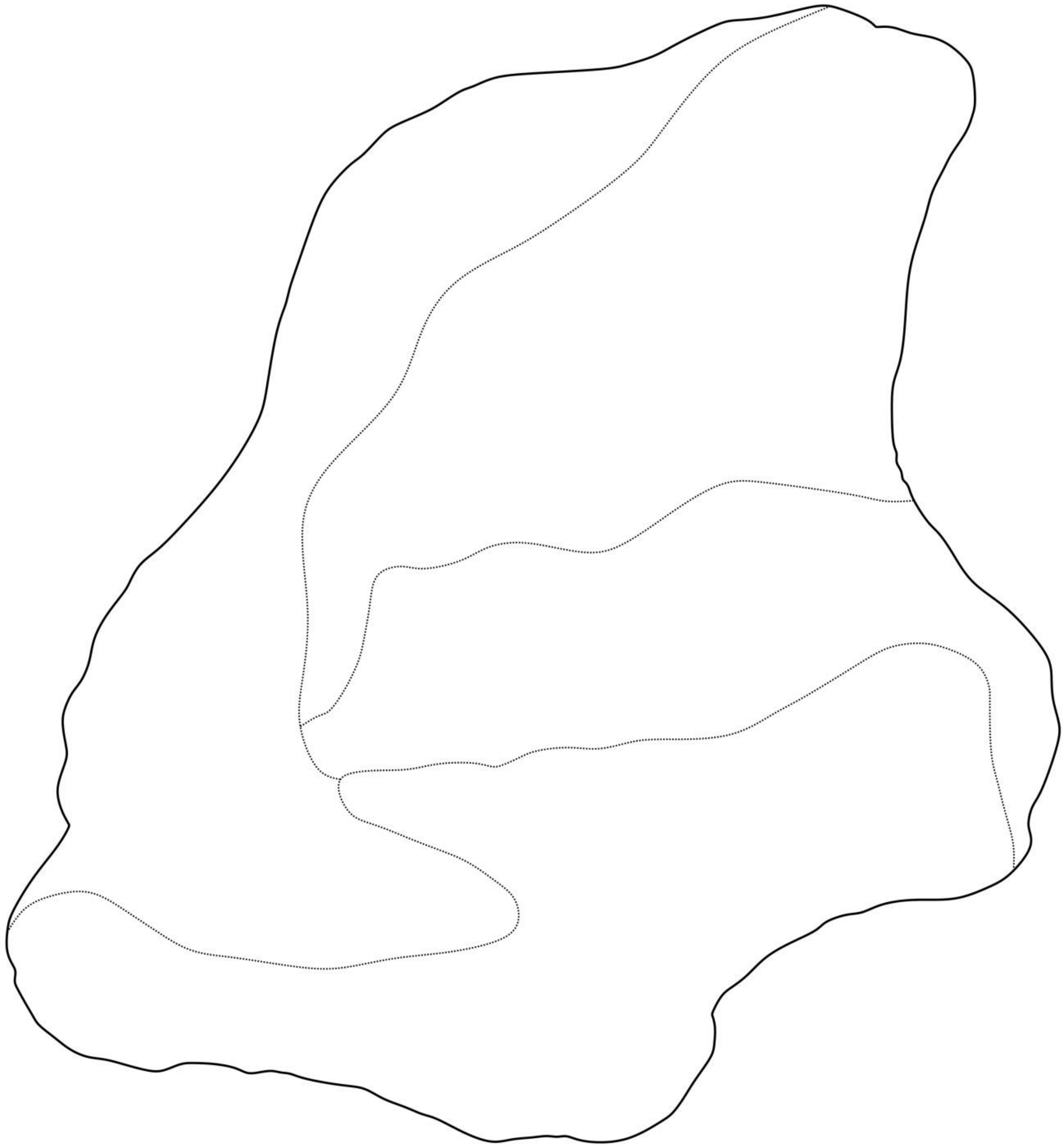
Technological drawing back



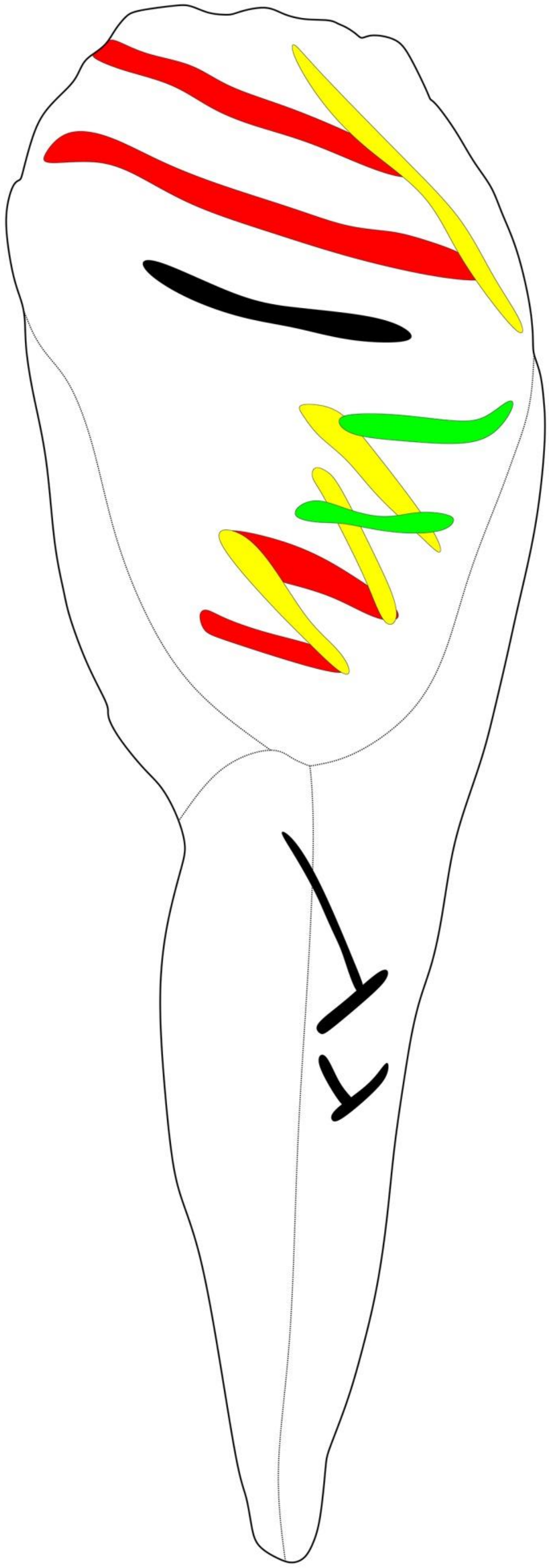
Technological drawing bottom



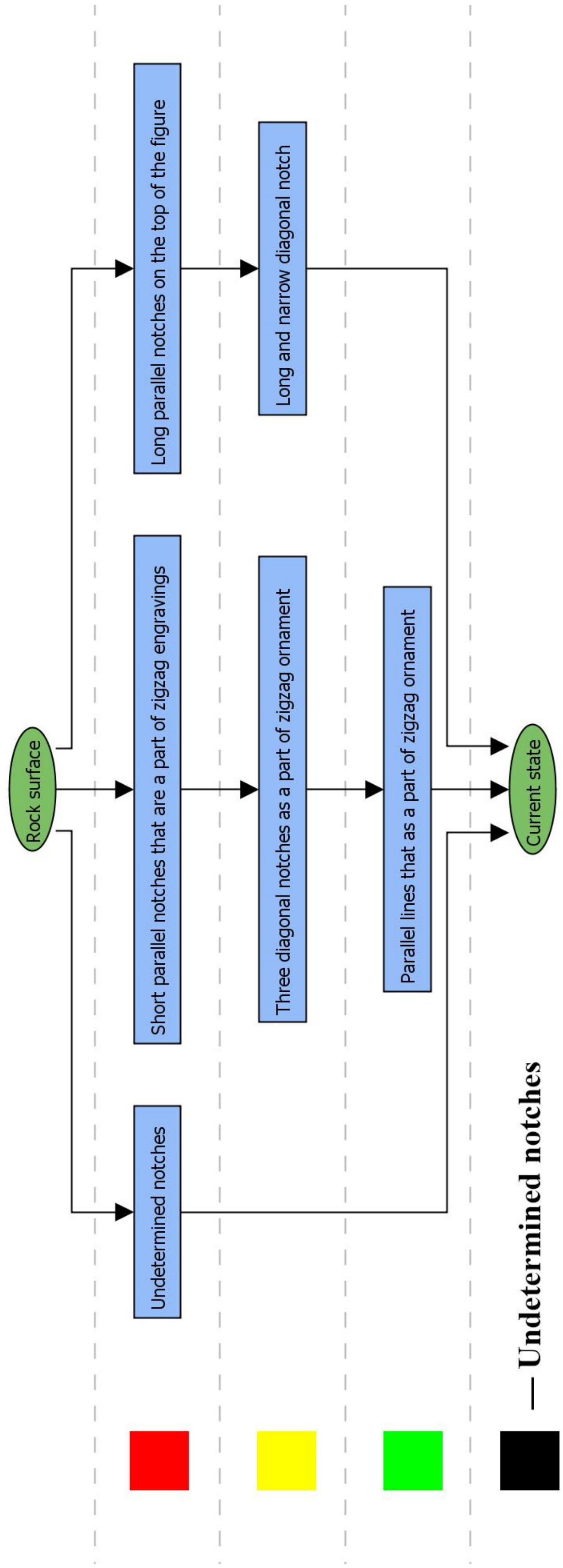
Technological drawing right



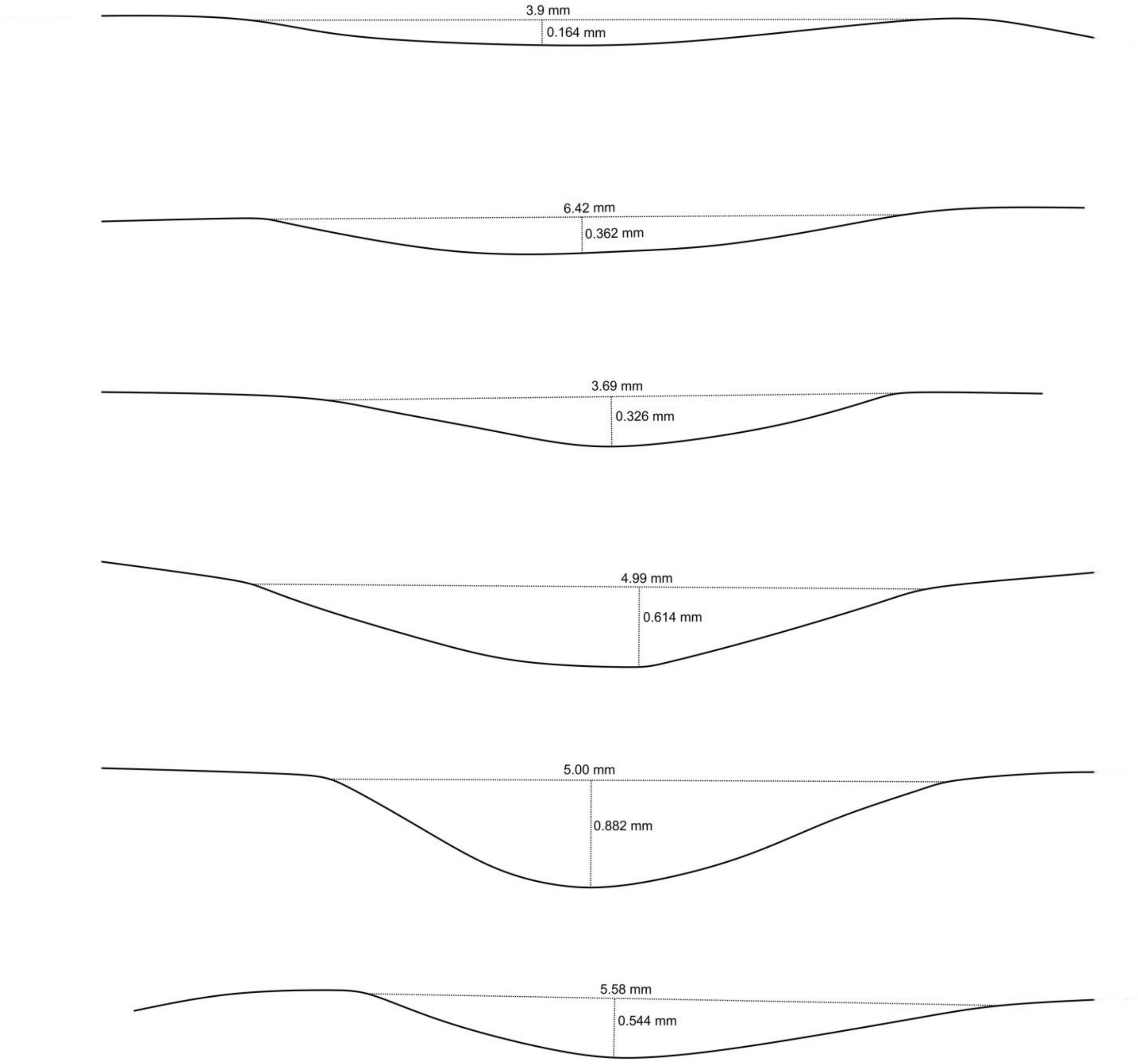
Relative chronology top



Harris matrix top



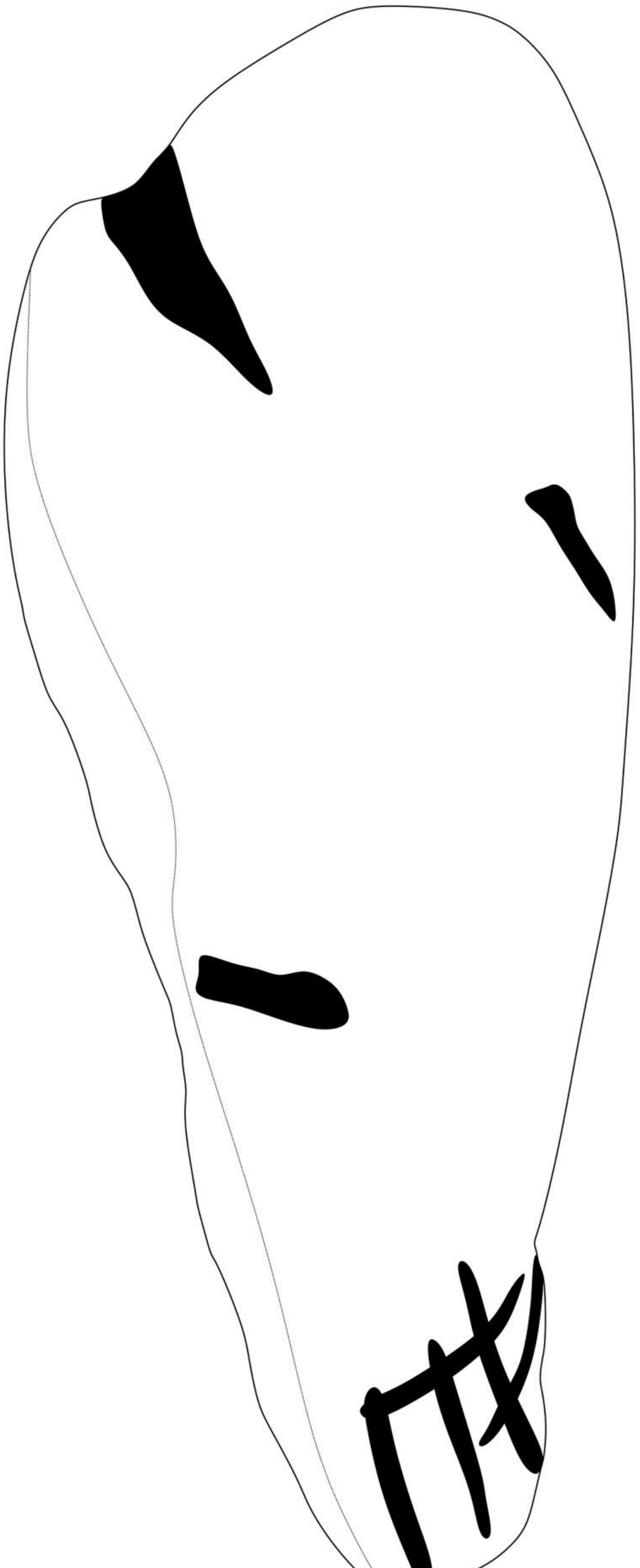
Profiles list



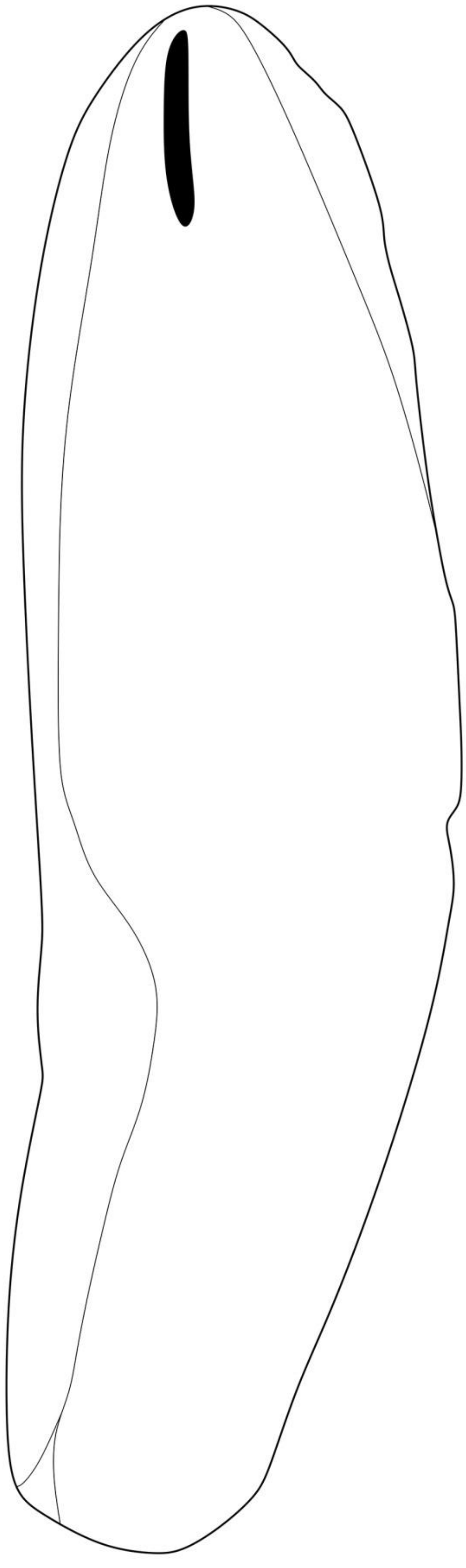
Specimen’s ID	260
Image front	
Image top	
Image back	
Image bottom	
Image right	
Length, cm	13
Width, cm	6
Weight, g	216
Volume, m^3	0.000112
Density, kg / m^3	1928.57143

Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga in a shape of a fish, similar to *Gobiiformes*. Linear and geometric engravings indicate mouth, nose and a tail.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	The churinga belongs to the group of fish-like churingas. Its length is no more than 13 cm. Its main feature is the thickening of a “head” part, which makes the shape of churinga similar to that of *Gobiiformes*. Both surfaces are covered with linear and angular ornament. Its meaning is not defined yet.
Descriptive image	
Description 2 source	Danilenko 1986: 120—122
Note	The figure has been shaped like what V. Danilenko considers a fish. It contains a few linear engravings in the figure's top and “tail” parts. Few deep and wide engravings with irregular profiles were probably done with direct or indirect strikes. The more intensive desert varnish is on the front side of the figure.

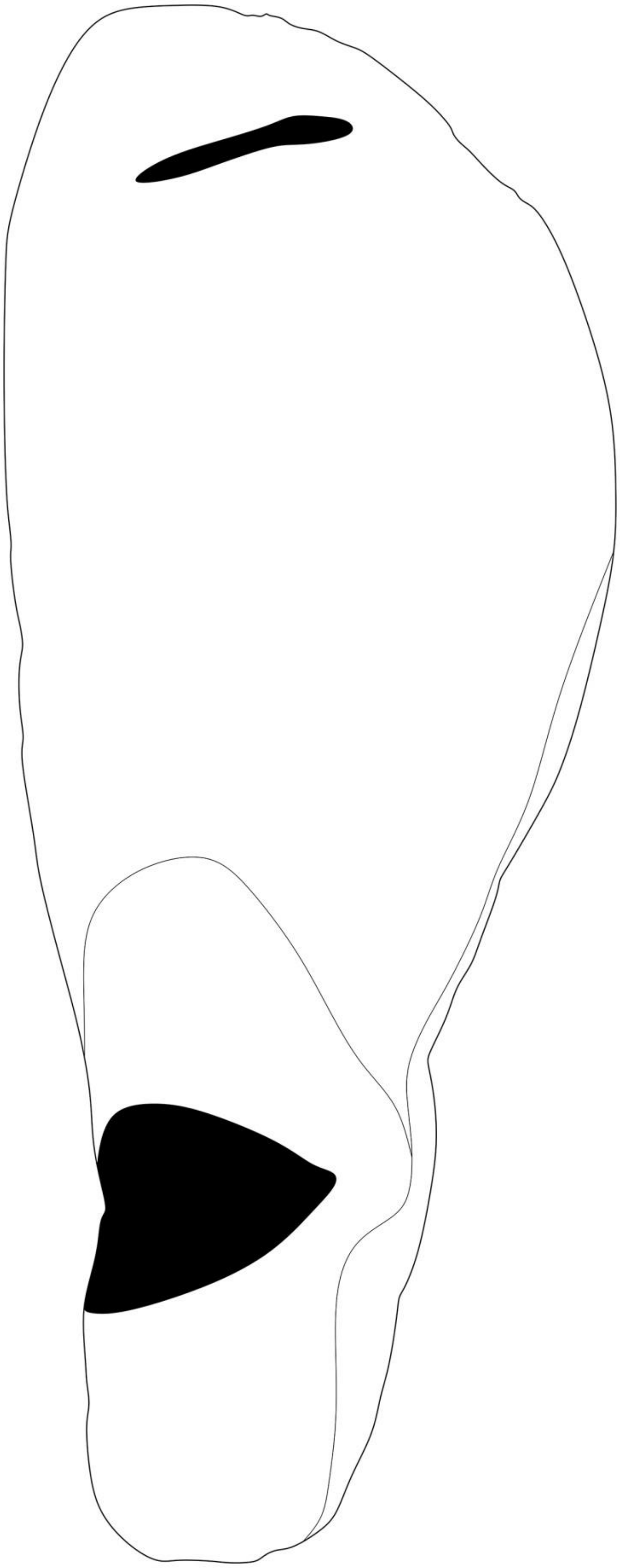
Technological drawing front



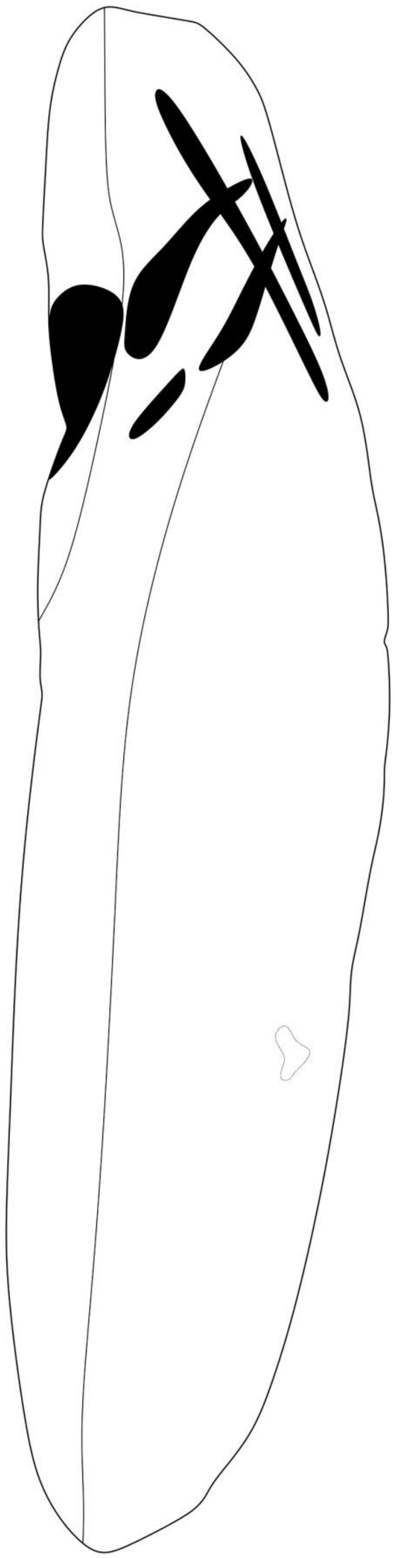
Technological drawing top



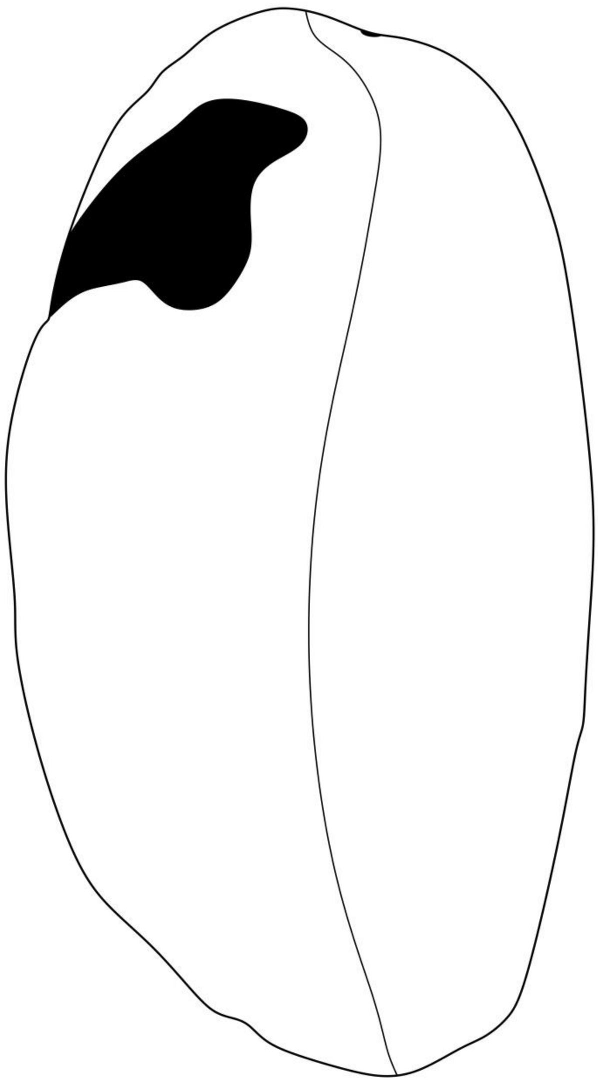
Technological drawing back



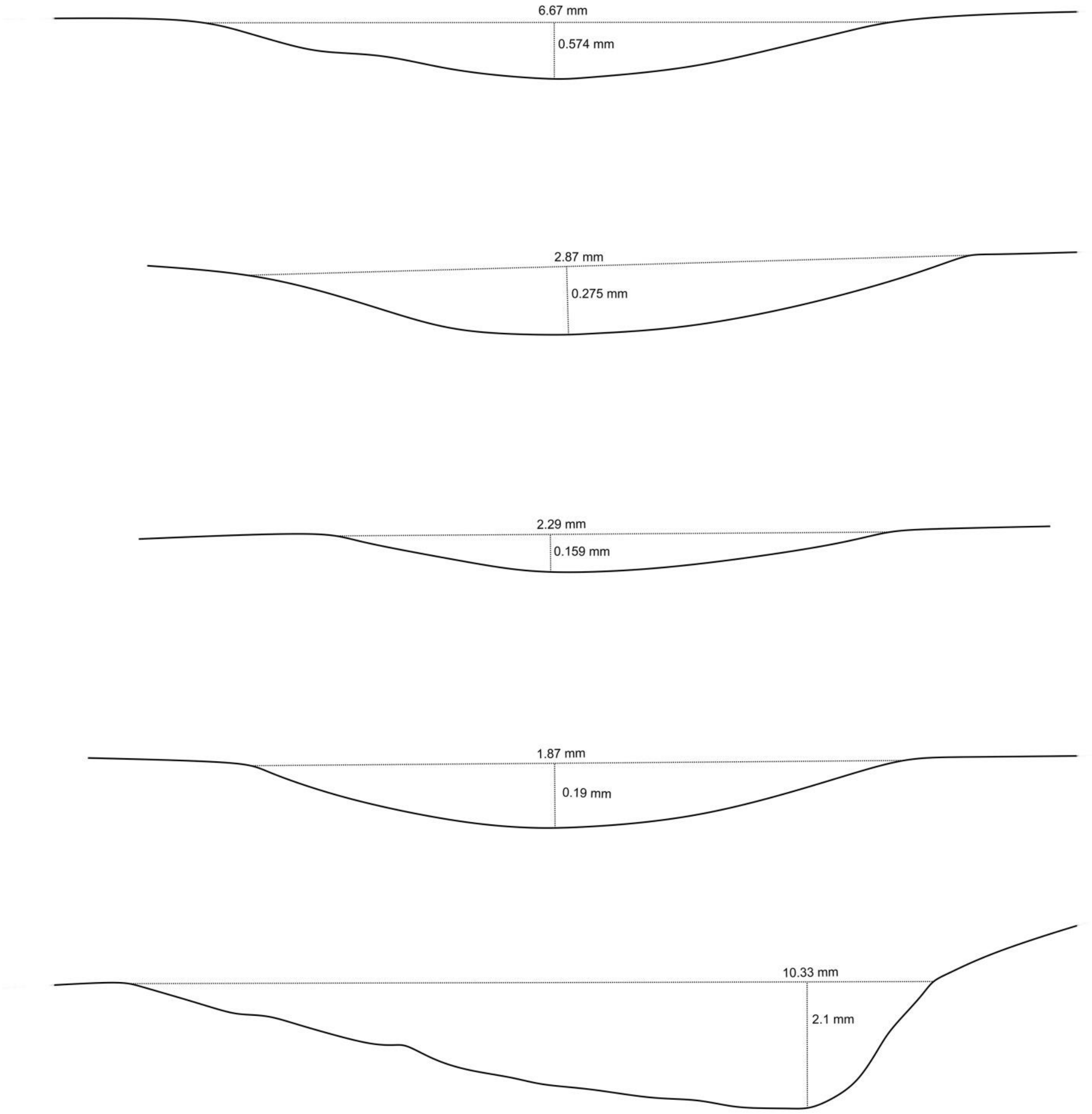
Technological drawing bottom

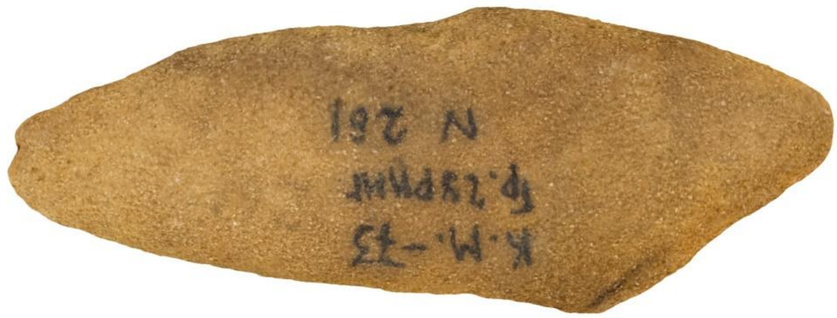


Technological drawing right



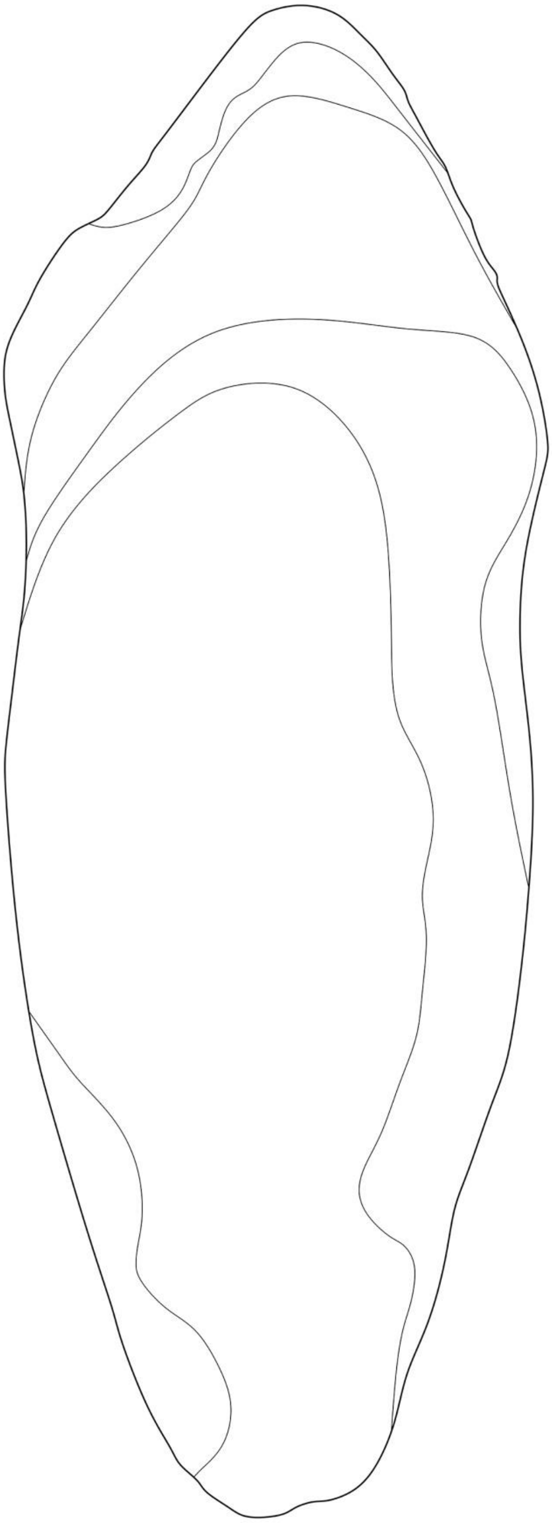
Profiles list



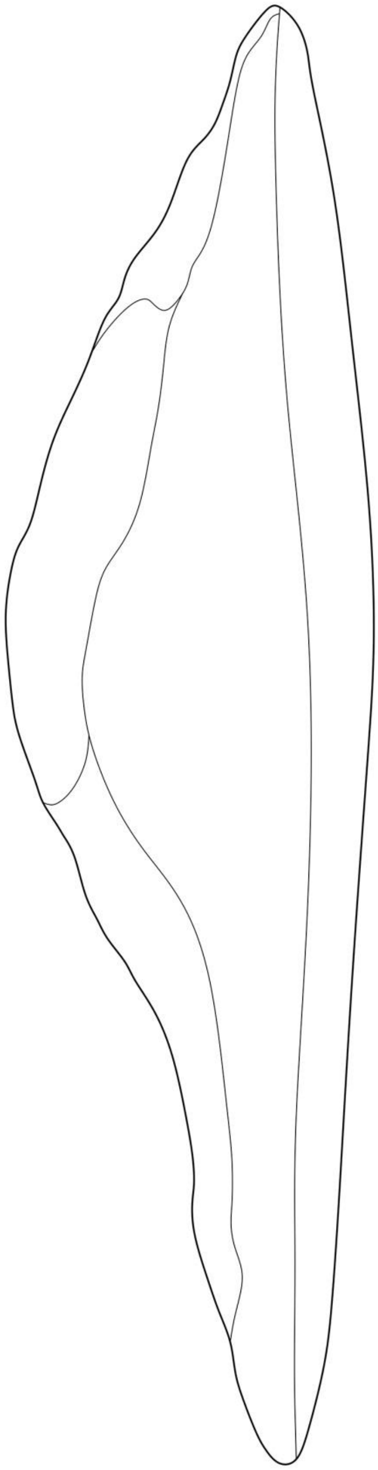
Specimen's ID	261
Image front	
Image top	
Image back	
Image bottom	
Length, cm	12
Width, cm	4
Weight, g	135
Volume, m^3	0.000065
Density, kg / m^3	2076.92308
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	The fish-like churinga without visible incisions

Description source	The storage list of Institute of Archaeology in Kyiv
Note	Although V. Danilenko marks a few places as engraved ones, he later mentions that the churinga does not contain any noticeable incisions. Probably, he painted the specimens first and then studied them to provide the final interpretation. The figure was interpreted as a fish-like one. The back side of the figure might have been slightly polished, although to define this, additional traceological studies are required.

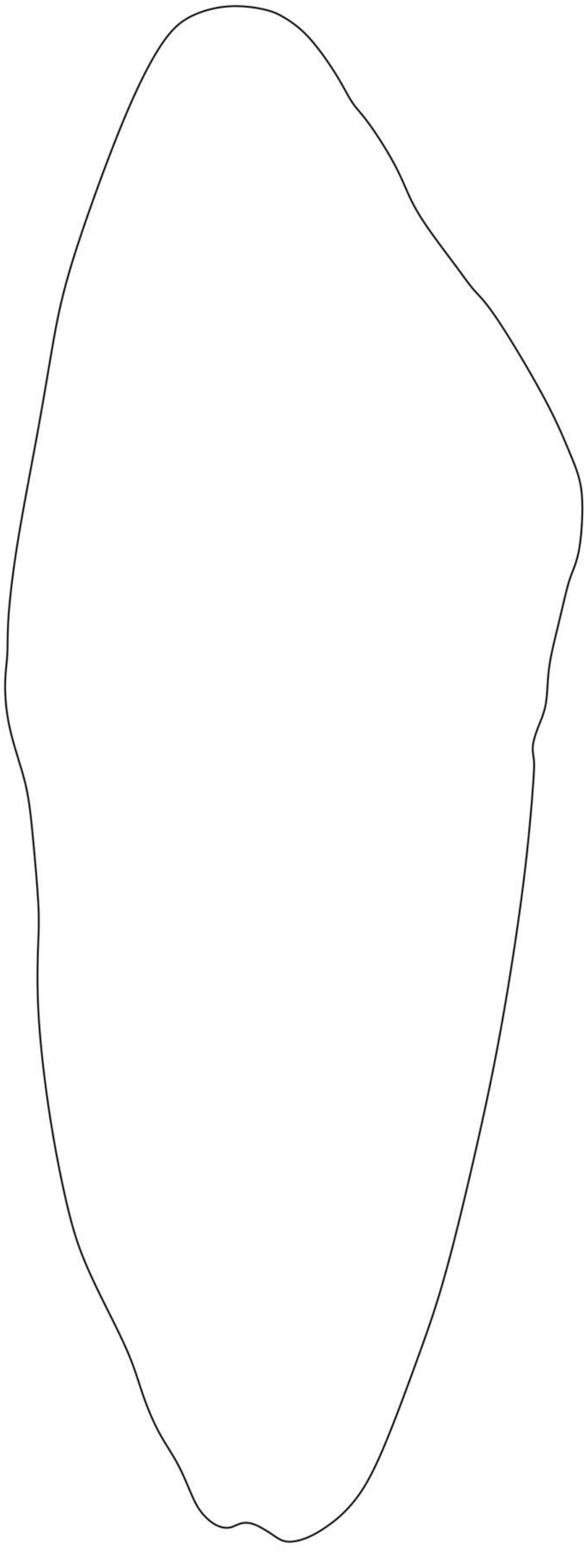
Technological drawing front



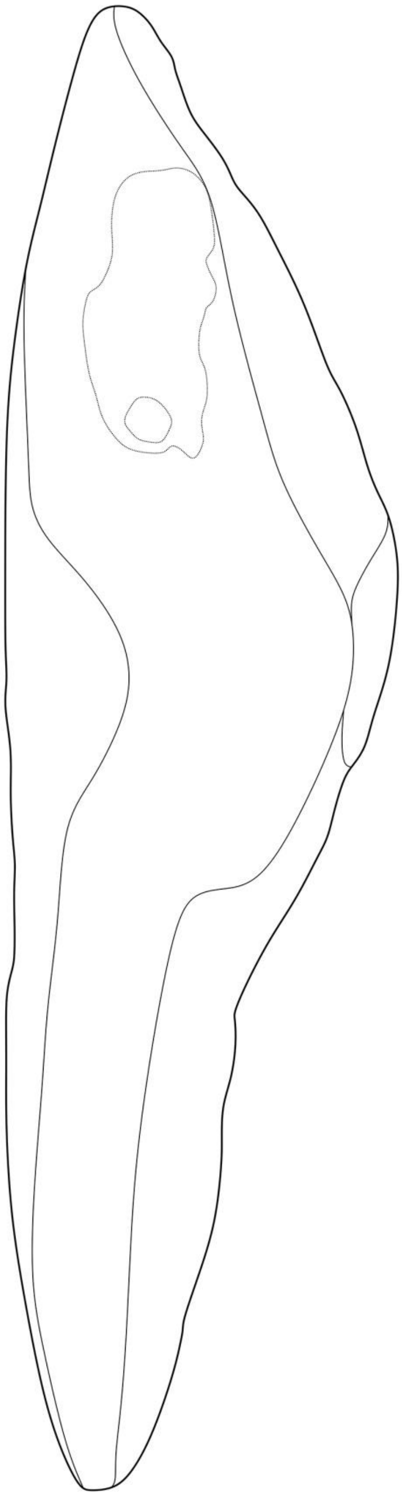
Technological drawing top



Technological drawing back



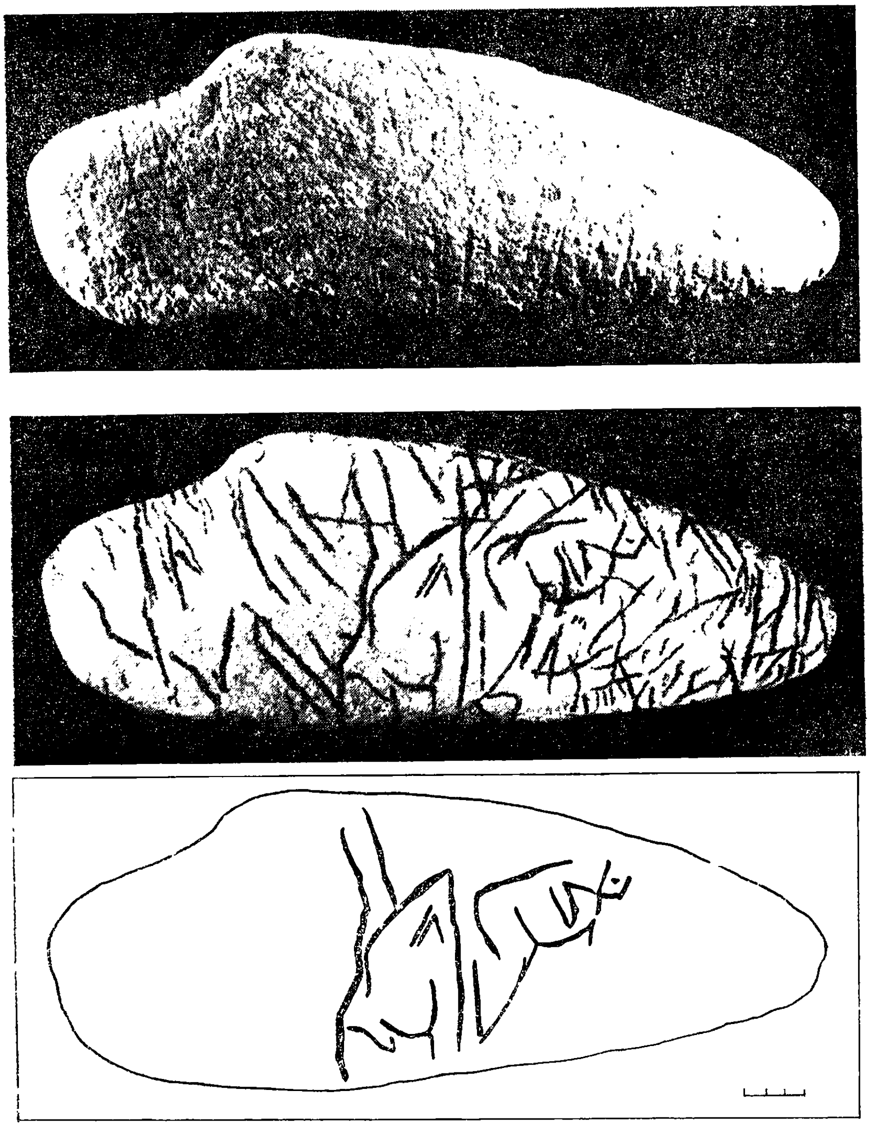
Technological drawing bottom



Specimen’s ID	262
Image front	
Image back	
Length, cm	11.2
Width, cm	4.5
Weight, g	196
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga has a shape of a fish without any evident engravings.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Churinga has a prolongated shape of a cigar or a spindle. The stone is not featured with fins or any kind of primitive ornament.
Descriptive image	Danilenko 1986: 120
Note	—

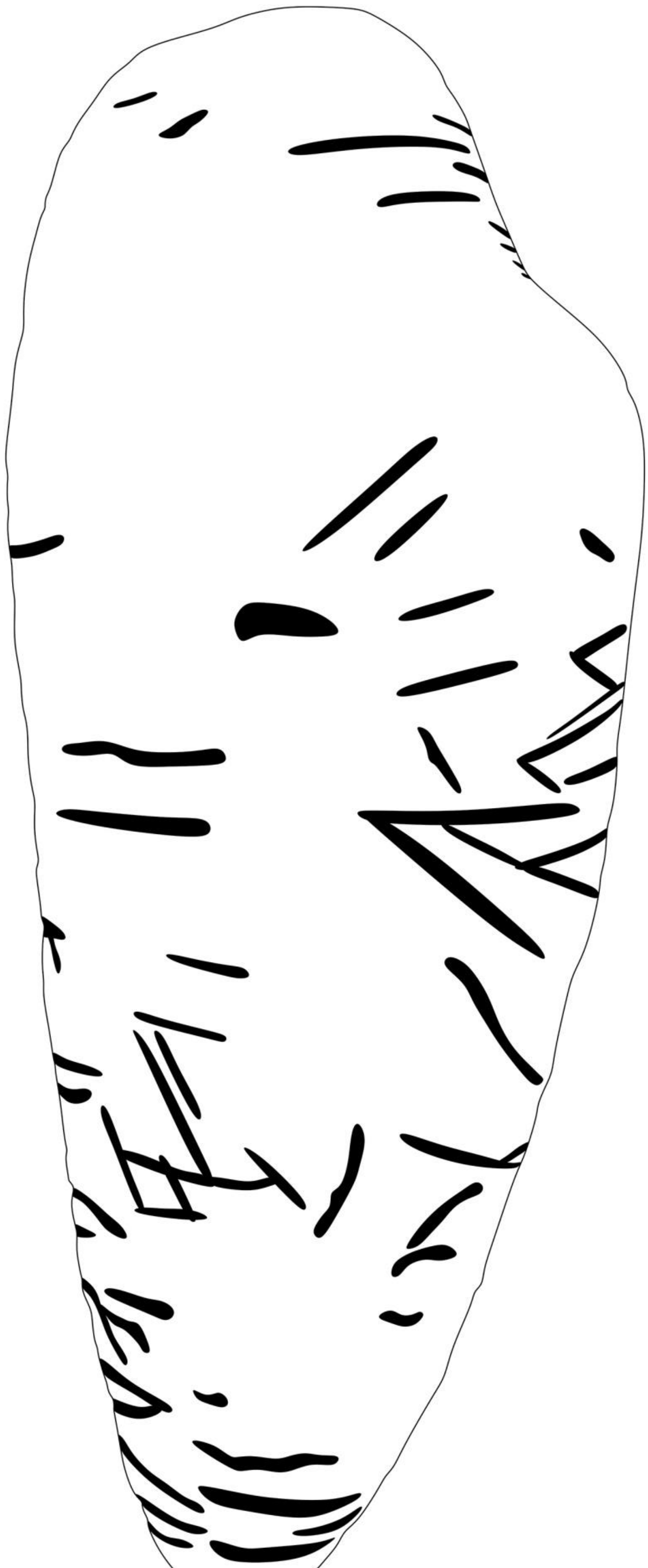
Specimen’s ID	264
Image front	
Image back	
Length, cm	11
Width, cm	5.5
Weight, g	236
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	Churinga covered with desert varnish from both sides, contains reticulated engraved ornamentation

Specimen’s ID	265
Image front	
Image top	
Image back	
Image bottom	
Length, cm	40
Width, cm	15
Weight, g	3525
Volume, m^3	0.001556
Density, kg / m^3	2265.42416
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	The block is in the shape of a fish similar to *rutilus* but with a head similar to a dolphin's head. Numerous linear and geometric engravings on the front (more protuberant) side. The back side (the flat one) contains three diagonal notches.

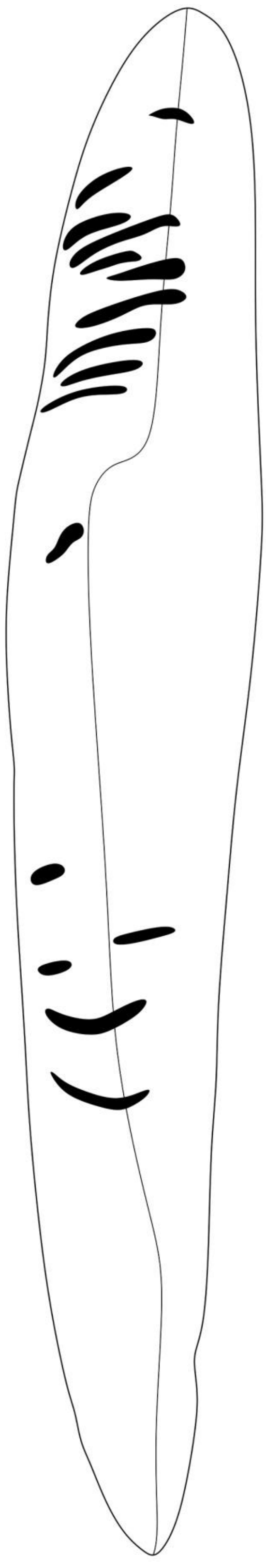
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Churinga is a flat concretion with a shape similar to a catfish. Its length — is 39.5 cm, and its width — is 14.7 cm. Images are concentrated on the protuberant side. The engraved composition covers the whole surface of the concretion’s front side. Notches introduce linear and sometimes angular engravings. They are primarily distant and do not belong to the clear art motifs. Only the central part of this site contains a few anthropomorphic figures. The image of an adult woman’s profile slightly turned right is evident. This includes the schematic image of a breath, head, eye, etc.
Descriptive image	
Description 2 source	Danilenko 1986: 123, 125
Note	The figure has been processed to its shape that used to be interpreted as a shape of a fish. It contains several linear engravings on its front side and a few parallel notches on the back. All the notches are shallow and almost invisible.

	Those that were interpreted as anthropomorphic figures are not evident. Most notches are parallel in their pairs and probably not anthropogenic.

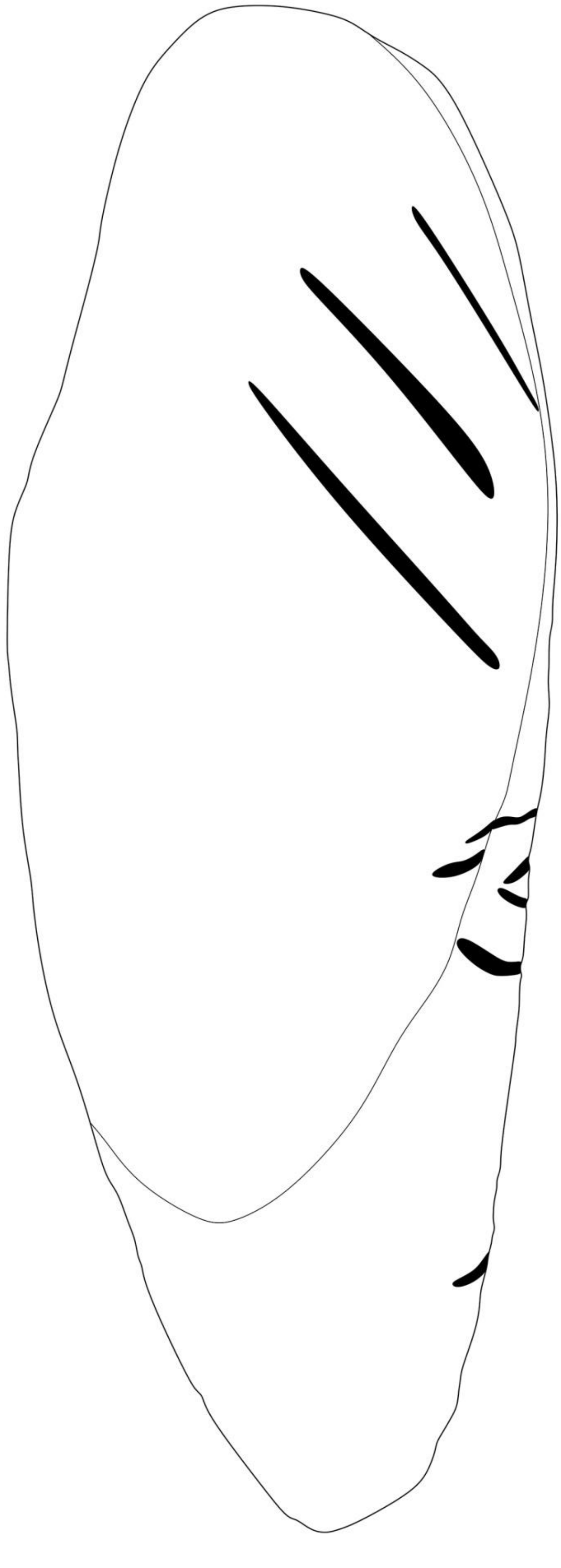
Technological drawing front



Technological drawing top

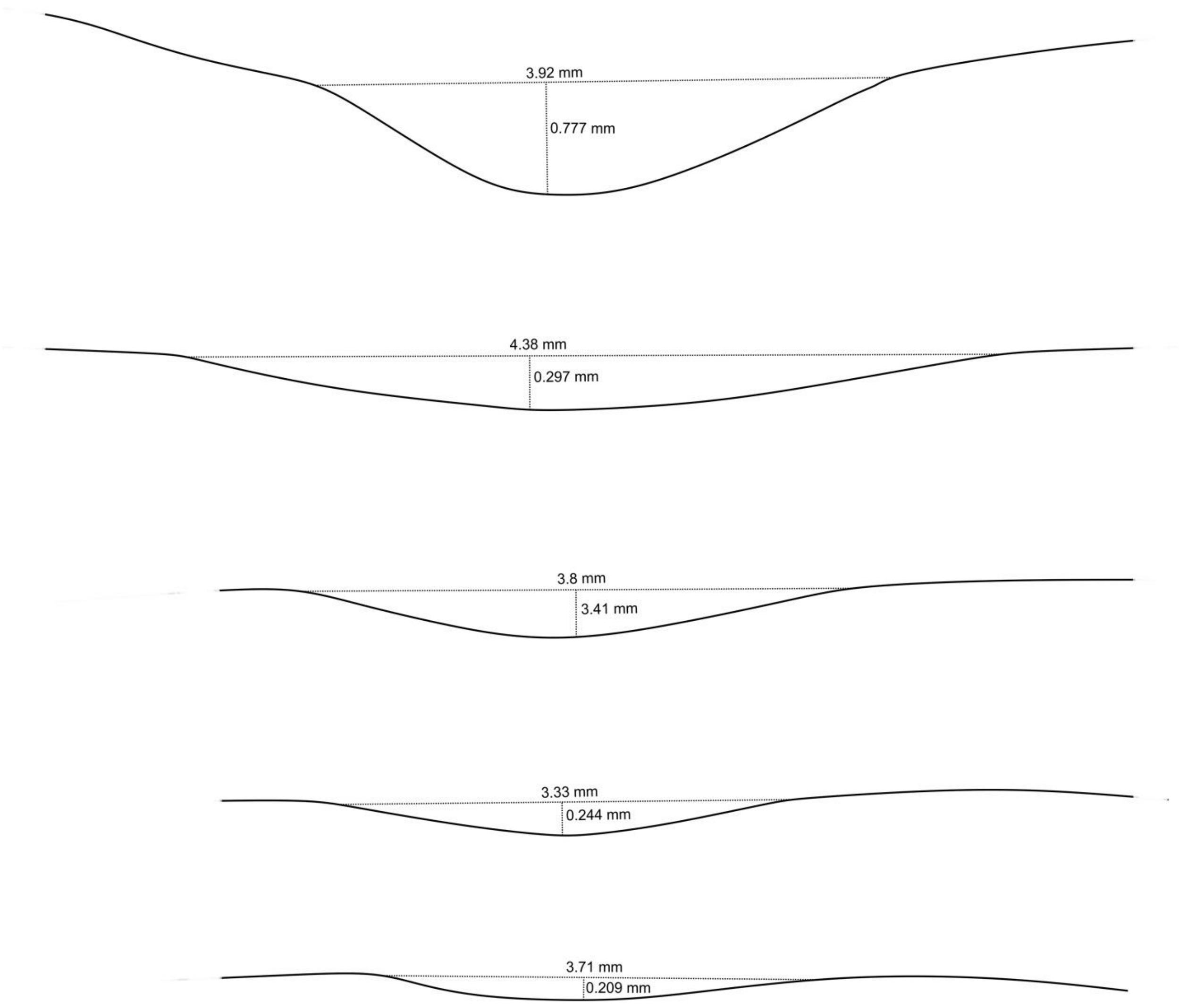


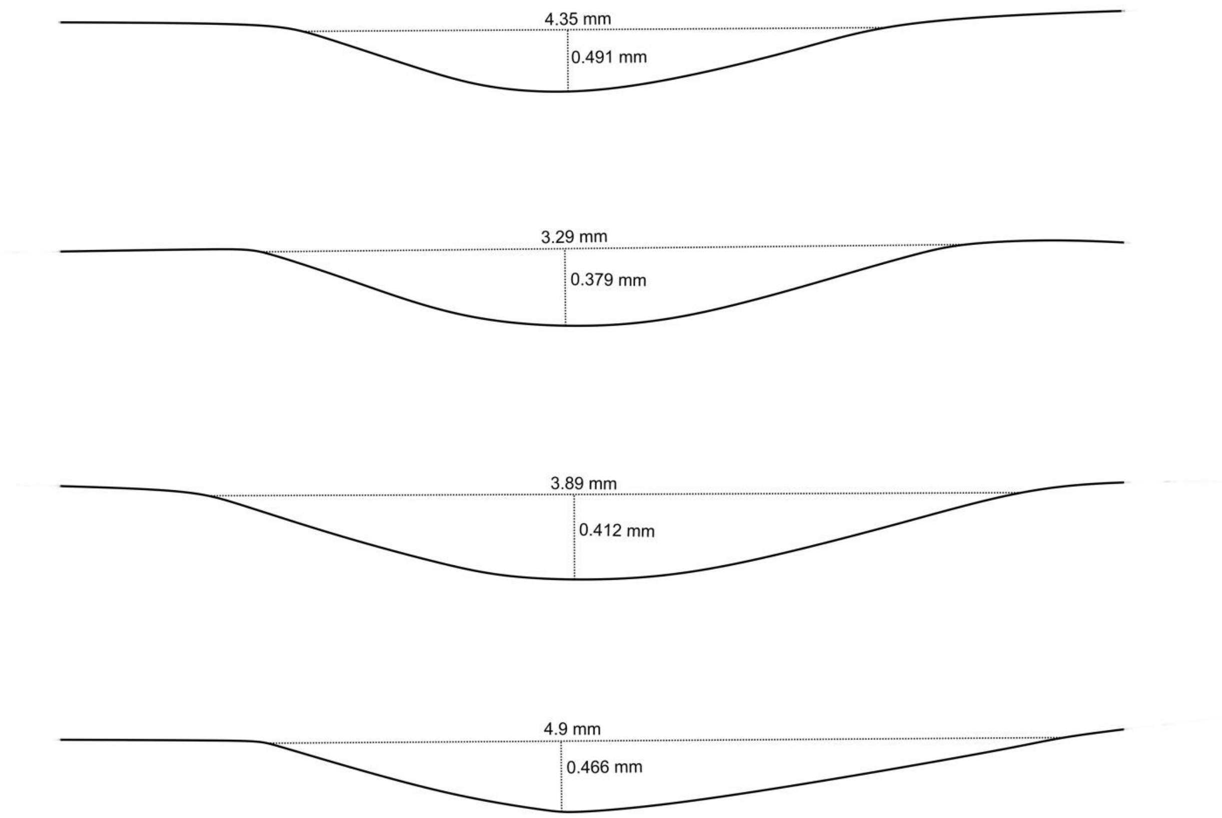
Technological drawing back

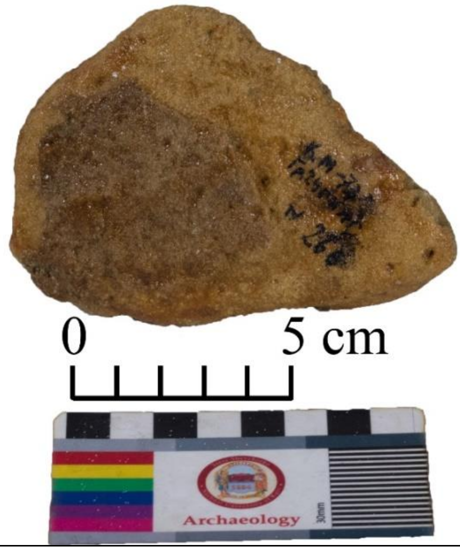


Technological drawing bottom

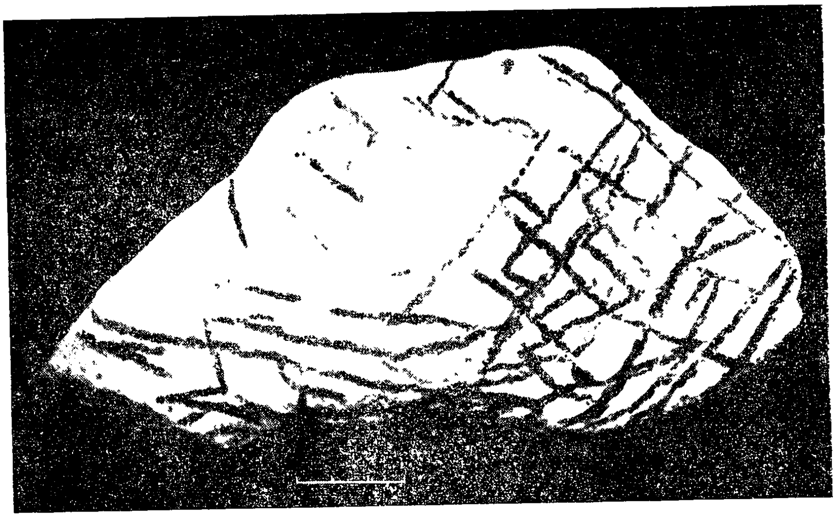
Profiles list




4.35 mm
0.491 mm
3.29 mm
0.379 mm
3.89 mm
0.412 mm
4.9 mm
0.466 mm

Specimen's ID	266
Image front	
Image back	
Length, cm	11.5
Width, cm	8.5
Weight, g	263
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga has a shape of a fish (or a segment). A reticulated ornamentation is located from the flat side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone is covered with desert varnish from both sides. Back side is partially destroyed and covered with glue to prevent crumbling.

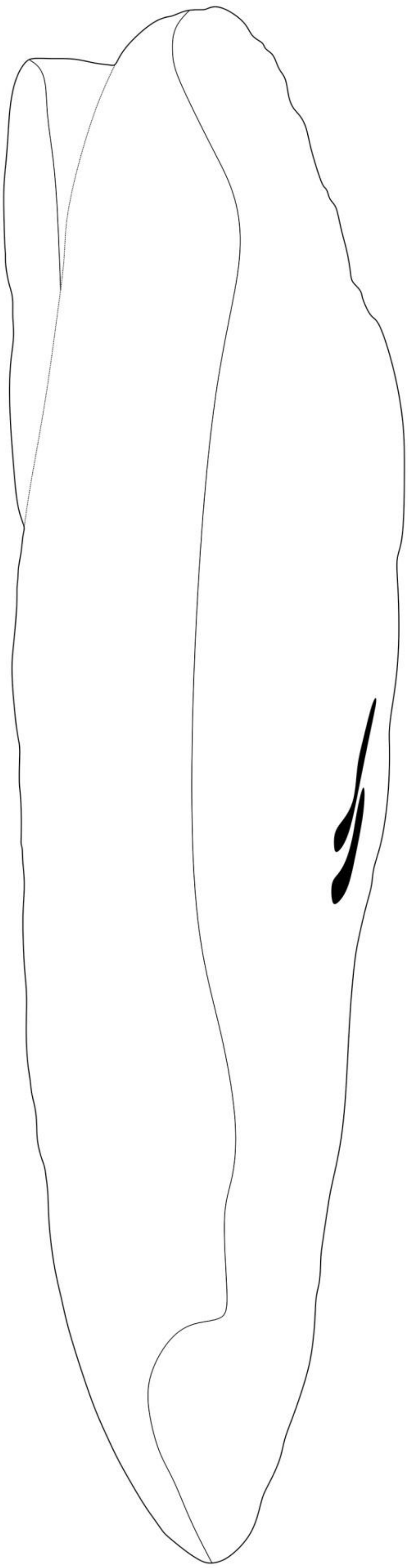
Specimen’s ID	268
Image front	
Image top	
Image back	
Image bottom	
Length, cm	24
Width, cm	12
Weight, g	1287
Volume, m^3	0.000614
Density, kg / m^3	2096.091205

Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	The fish-like churinga with the irregular segment-like shape. Is very similar to the churinga No. 267
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Churingas No. 267 and 268, with lengths of 18 and 24 cm, respectively, are close in shape to the flattened fishes, with their tails slightly shifted to the side. No. 267 is flatter, while No. 268 is protuberant.
Descriptive image	 
Description 2 source	Danilenko 1986: 122, 124
Note	Churinga contains the reticulated ornament from its front, top, and back sides. The surface is eroded. One piece of a block broke away; the place of the break is covered with desert varnish, as well as the front and back sides of the block. The surface has been partially damaged after the engravings were created from the

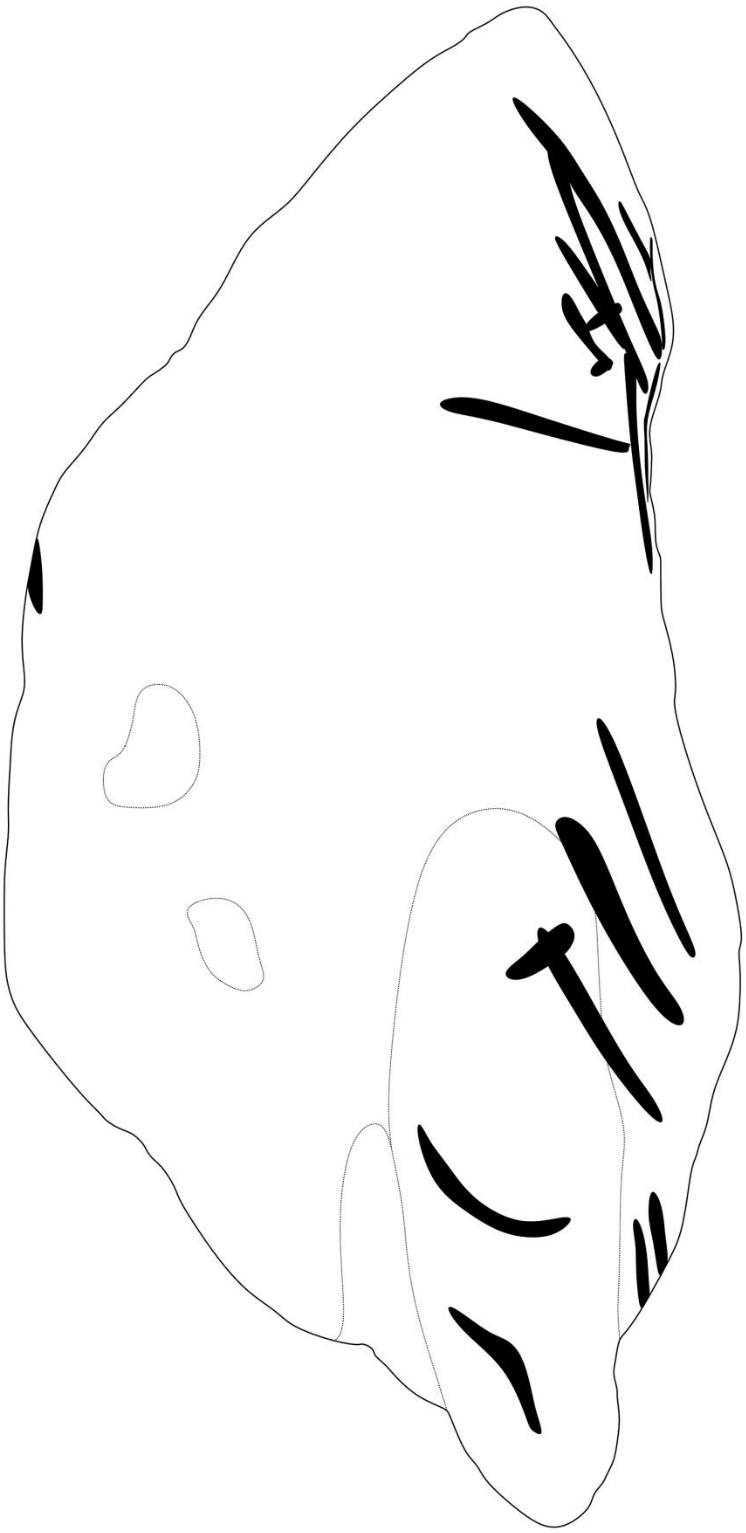
	front side. Determination of the relative chronology is not informative, as the reticulated ornament does not show any precise sequence. Engravings' profiles are primarily shallow and barely visible. The fish-like shape of this churinga is dubious, as well as the anthropomorphic origin of engraving most parts.

Technological drawing front

Technological drawing top

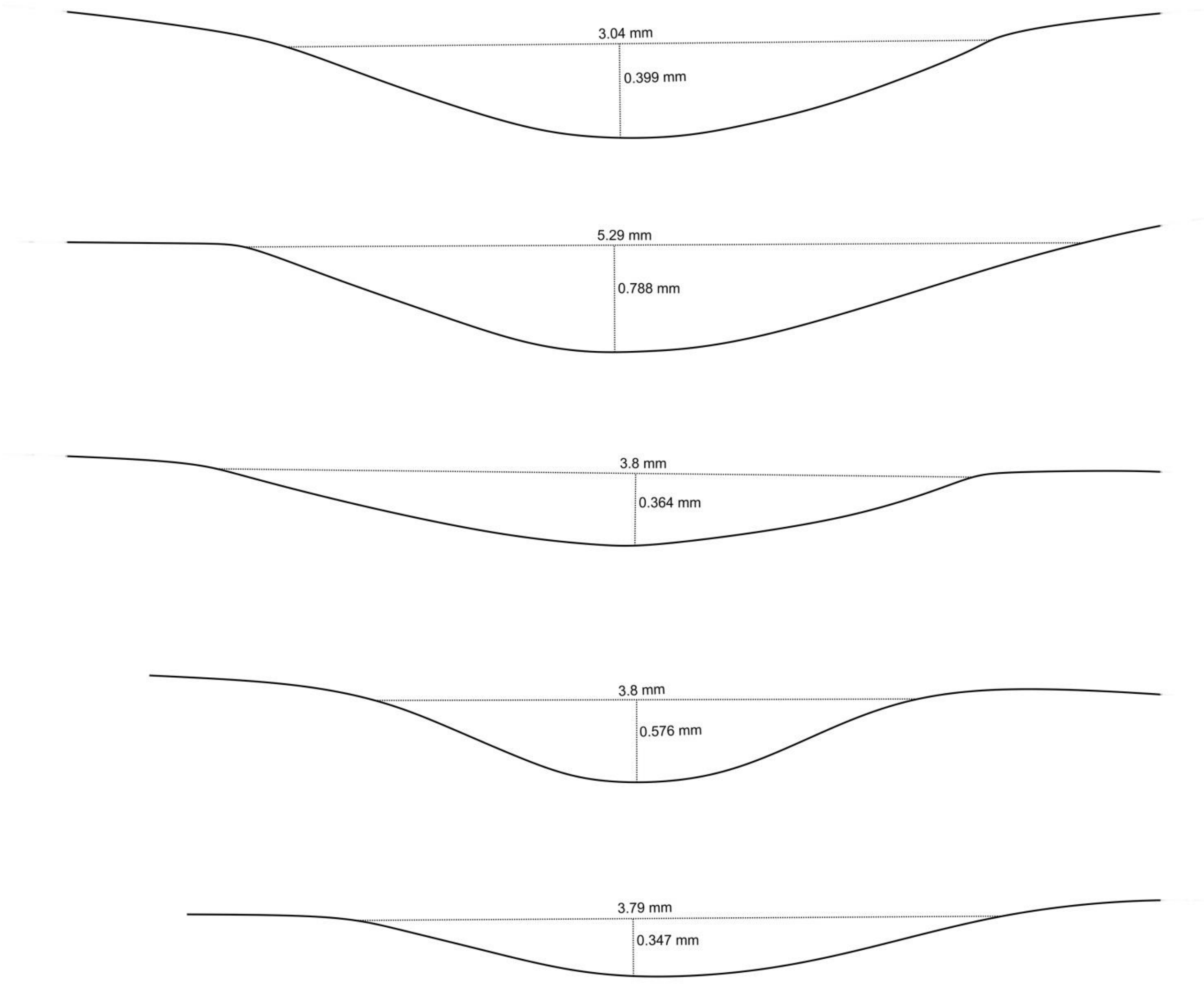


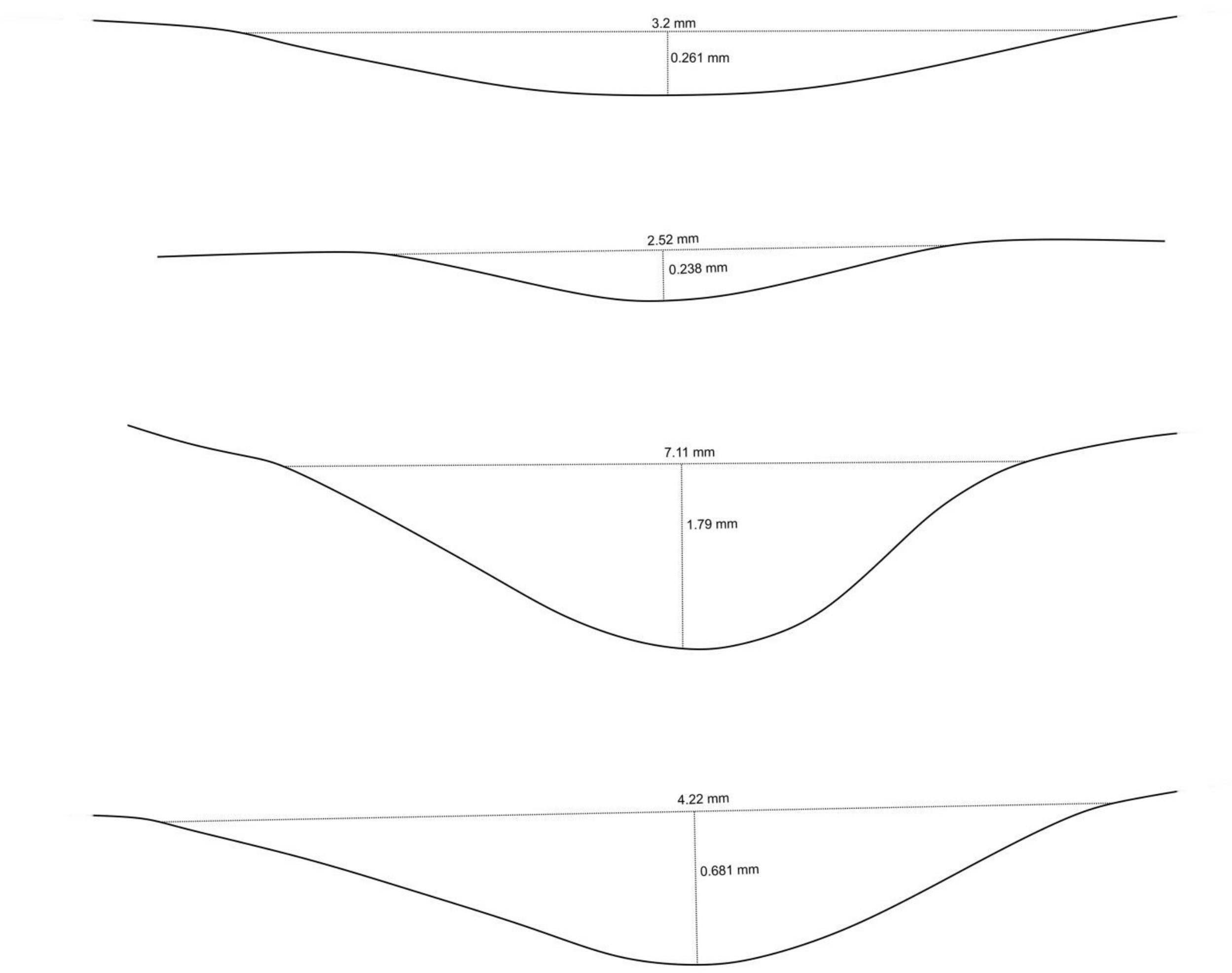
Technological drawing back

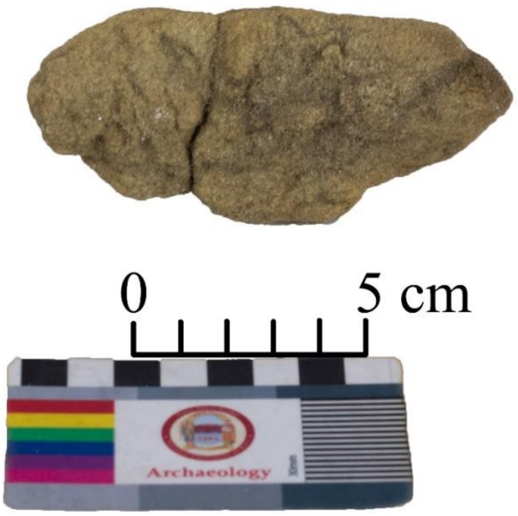


Technological drawing bottom

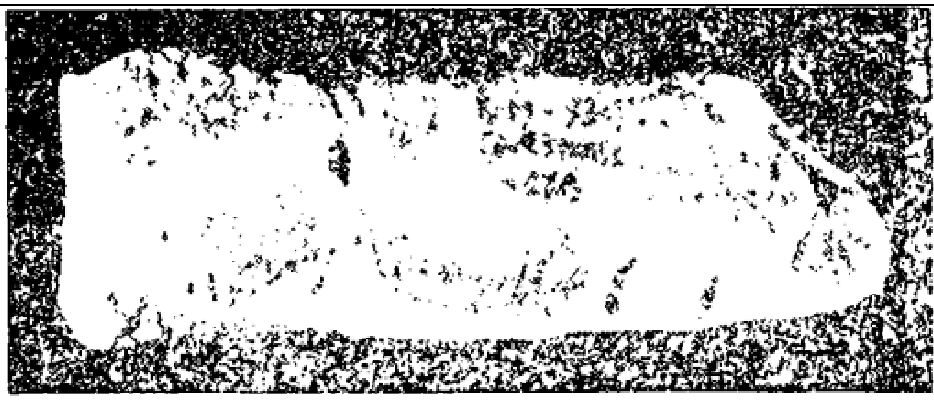
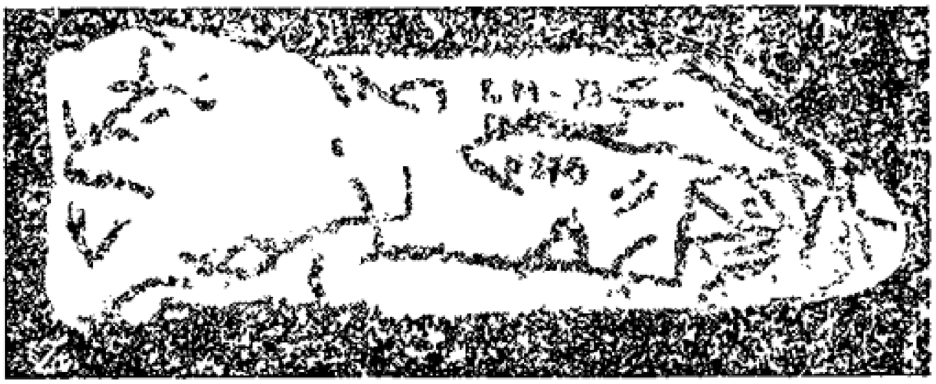
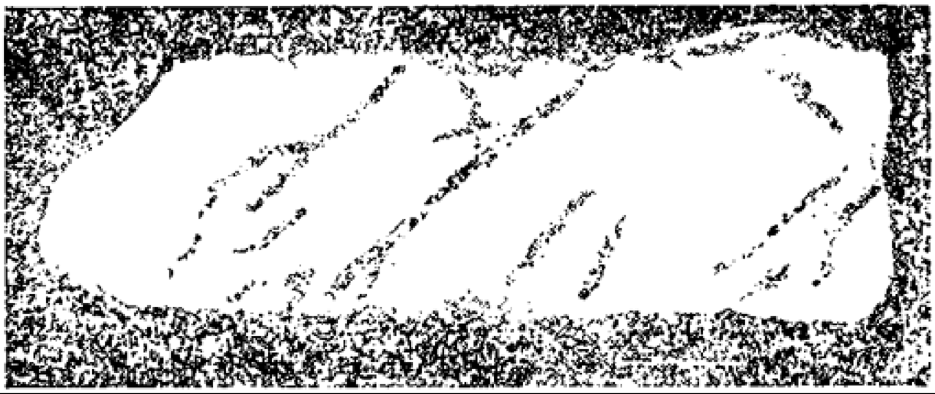
Profiles list




3.2 mm
0.261 mm
2.52 mm
0.238 mm
7.11 mm
1.79 mm
4.22 mm
0.681 mm

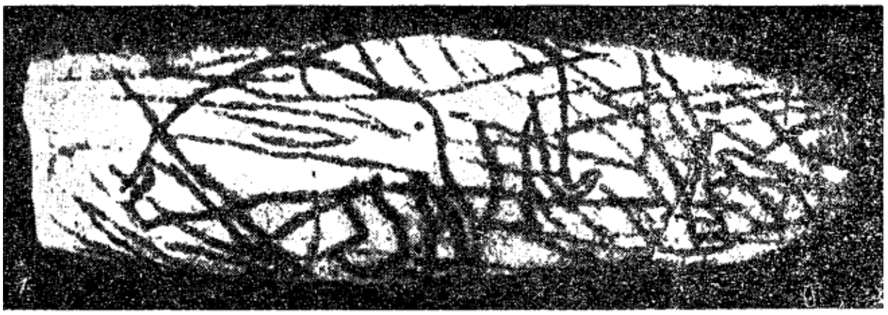
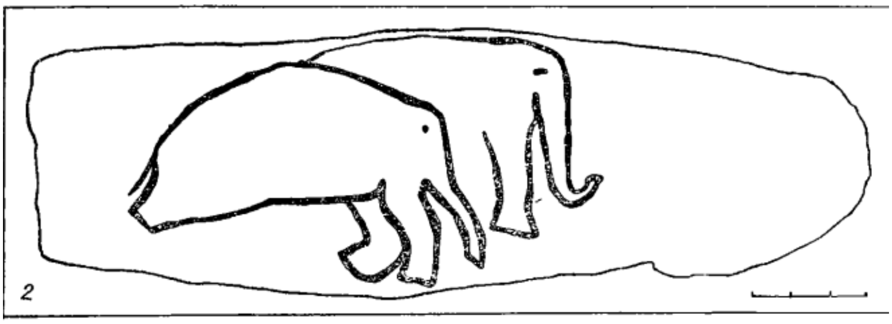
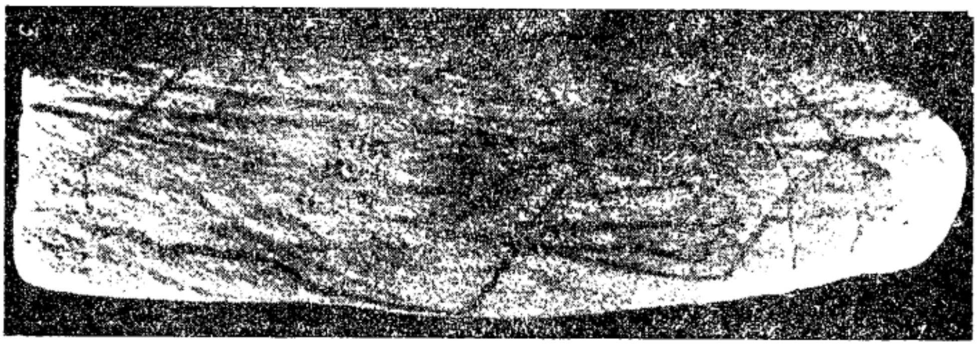
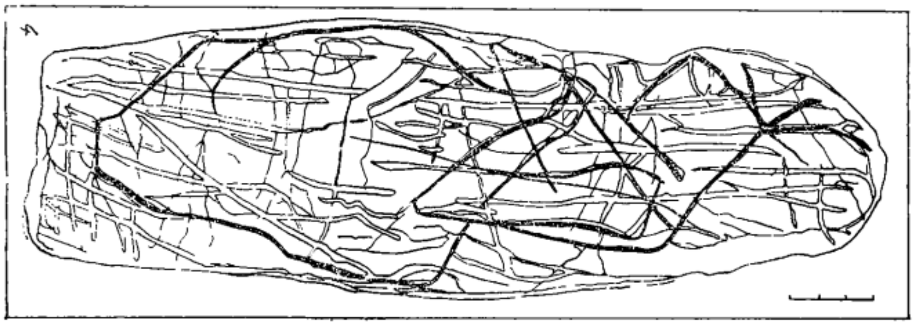
Specimen’s ID	269
Image front	
Image back	
Length, cm	10
Width, cm	5
Weight, g	174
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	An inexpressive churinga in a shape of a segment. Schematic linear engravings are located from the both sides
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	—

Specimen's ID	270
Image front	
Image back	
Bottom image	
Length, cm	17.5
Width, cm	6.5
Weight, g	—
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga has a shape of a fish, engraved from both sides
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Churinga has a shape of a fish, engraved from both sides
Description source 2	Danilenko 1986: 127 (fig. 86)

Descriptive image	  
Note	Churinga covered with desert varnish. Engraves are located both on the front and back side and on the bottom

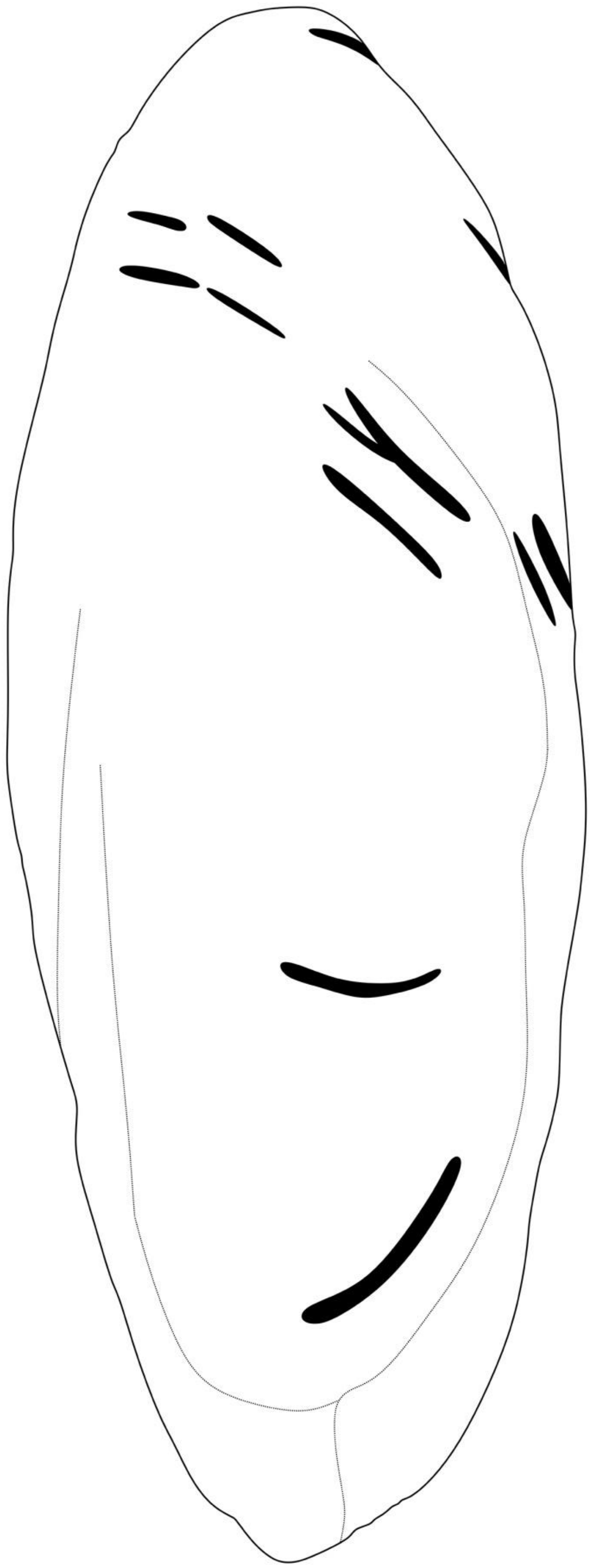
Specimen’s ID	271
Image front	
Image back	
Length, cm	16
Width, cm	10
Weight, g	721
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga has a shape of prolong ellipsoid made from a piece of a block. One side is fractured. It contains a reticulated ornament on the convex side
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	Churinga has covered with desert varnish from two sides. Linear engravings are on the front one

Specimen's ID	272
Image front	
Image back	
Length, cm	29
Width, cm	6.5
Weight, g	1025
Date of discovery	1973
Finder	V. Danilenko
Location	The Bull's cave, No. 9
Current location	Institute of Archaeology, Kyiv
Description	Churinga has a shape of a fish, similar to a pike. A simple reticulated ornament in located on the both sides and on the narrow and sharpened part
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	The image is two-sided. The front side contains a rare geometric composition with an unrecognizable meaning. The upper part contains two groups of curvilinear symbols that can be considered images of two mammoths. The other side contains the more clear composition. The background is filled with many profound and long vertical lines. Under this background image, there is a fat woman figure. Her face turned left. It has small horns, an angular face, breaths in her bent arms, and hypertrophied legs and hips.
Description source 2	Danilenko 1986: 129 (fig. 89)

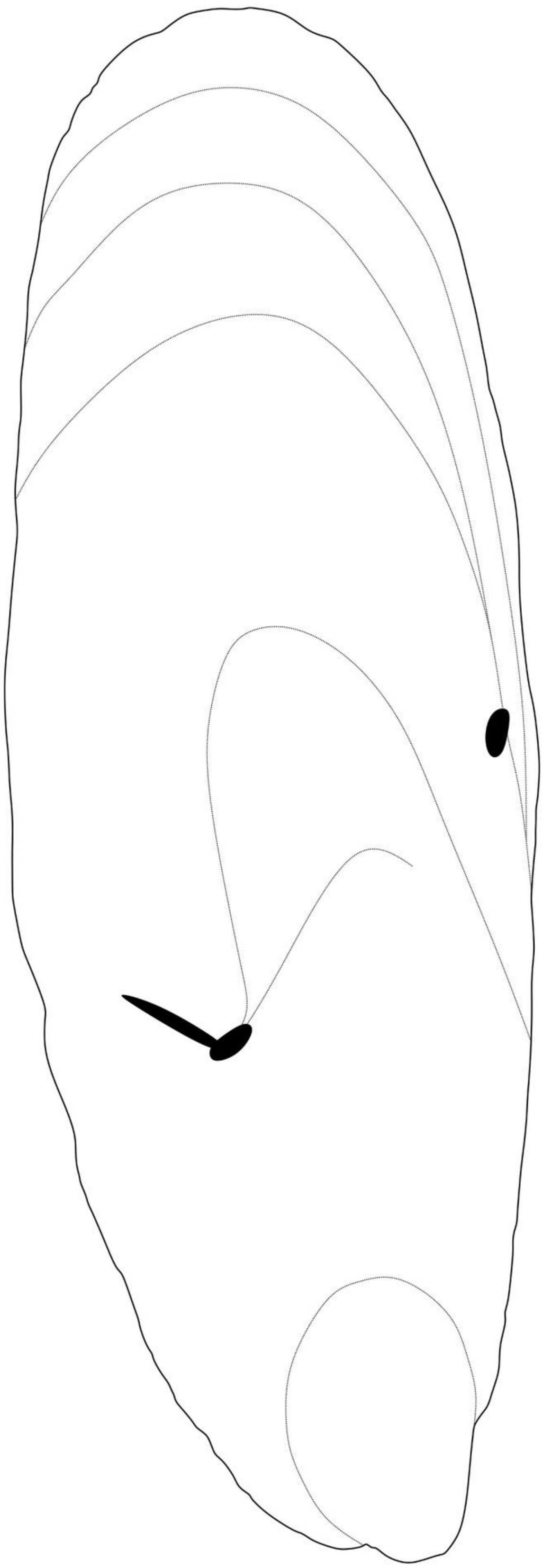
Descriptive image	 
Descriptive image 2	 
Note	Churinga is covered with engravings and desert varnish from both sides. A shape is processed. The only churinga found in the Bull's cave in its particular part is called "the cave of Churinga" (not the same as the "the Cave of Churinga's").

Specimen's ID	273
Image front	
Image back	
Length, cm	35.5
Width, cm	12
Weight, g	4190
Volume, m^3	0.001747
Density, kg / m^3	2398.39725
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	Churinga has a shape of a fish (similar to a catfish). It front side contains simple linear and geometric engravings.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block has been polished from the front side, where it does not contain any engravings except a few linear incisions. The front side is covered with desert varnish. Most notches are shallow and almost invisible, while the surface is highly damaged. The ellipsoid stone is polished and processed to a shape similar to a cigar (or a catfish, following V. Danilenko). The stone might be considered as one in a shape of a fish. However, this requires additional archaeological interpretation.

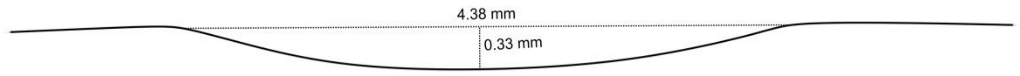
Technological drawing front

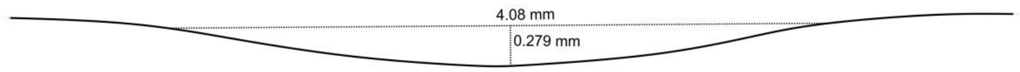


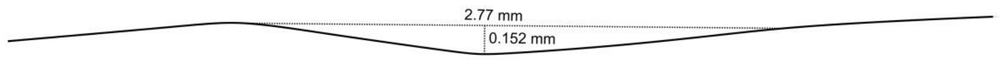
Technological drawing back

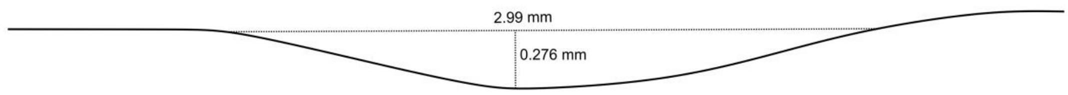


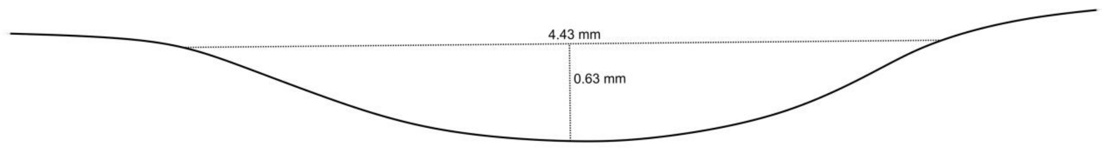
Profiles list

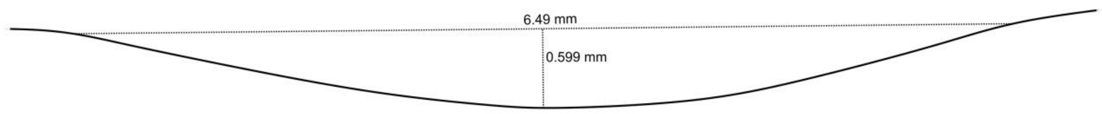










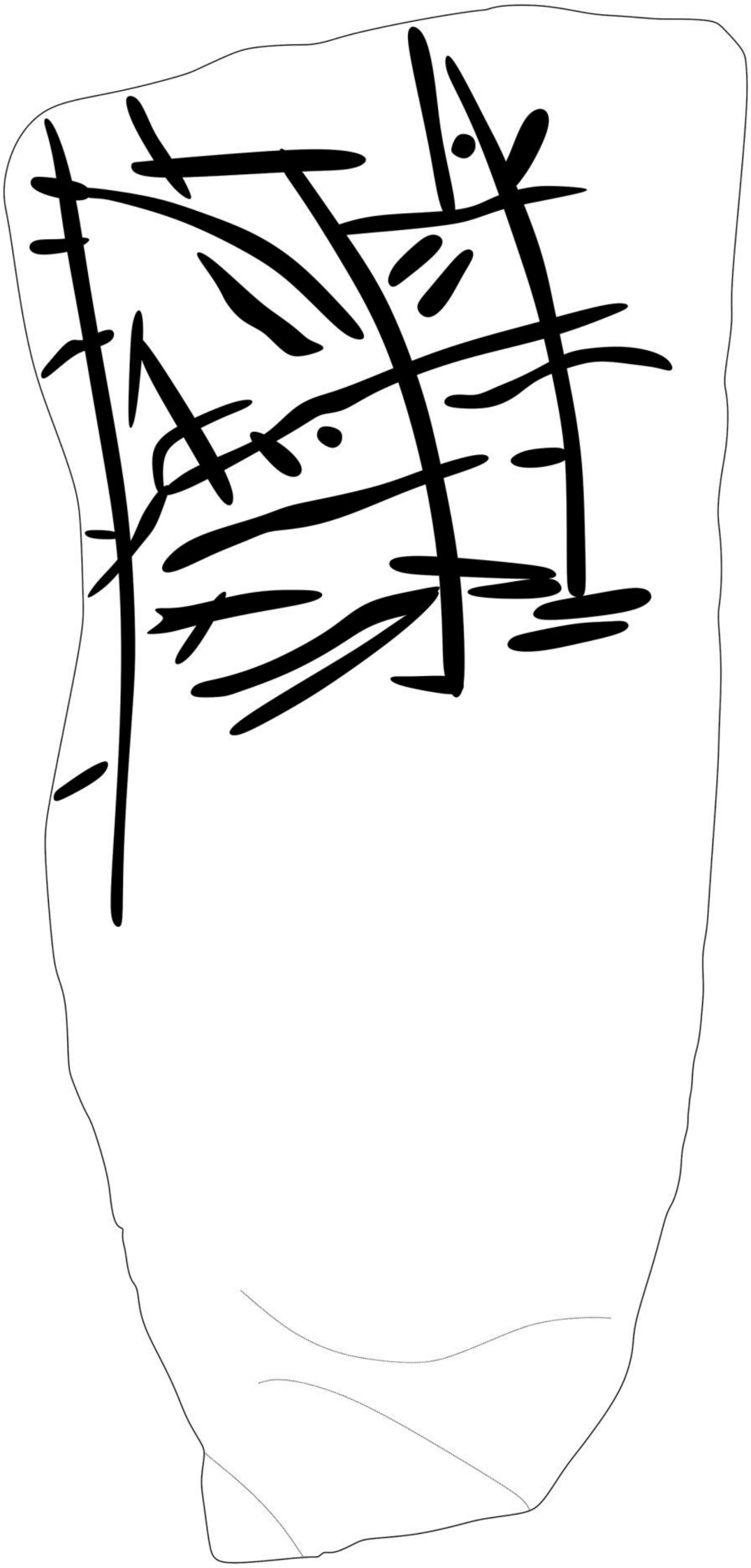


Specimen’s ID	275
Image front	
Image back	
Bottom image	
Length, cm	17
Width, cm	13
Weight, g	1056
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	A piece of subrectangular sandstone block, engraved from the both sides
Description source	V. Danilenko
Description 2	—
Descriptive image	—
Note	The shape of churinga is anthropogenic. The front side is darker and covered with desert varnish. Engravings are mainly on the front side, though a few of them are on the back one.

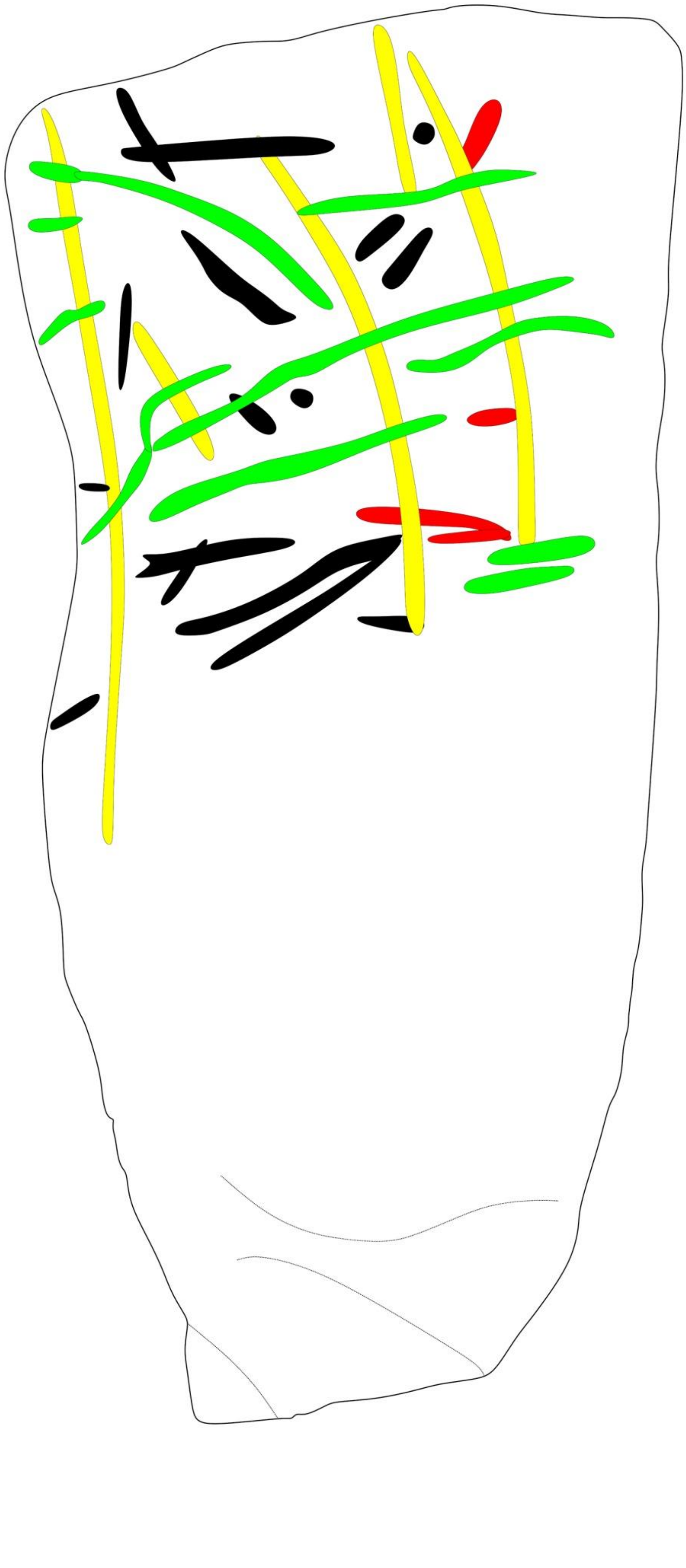
Specimen's ID	276
Image front	
Image top	
Image back	
Image right	
Length, cm	61
Width, cm	28
Weight, g	3857
Volume, m^3	0.001607
Density, kg / m^3	2397.14108
Date of discovery	1973

Finder	V. Danilenko
Location	“Mysteries” cave, No. 51a (near the “Churingas” cave)
Current location	Institute of Archaeology, Kyiv
Description	The block is connected to the bigger part. It contains one-sided linear and geometric engravings.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The subrectangular block contains a series of linear engravings that create a reticulated ornament on its front side. It probably is a part of a bigger structure. The layers of different sandstone types are visible on the stone except for the front side, which is covered with desert varnish. The relative chronology determines the precise sequence of engraving — horizontal lines before vertical ones. The block has been found in the cave that is located next to the Churingas cave. This is the only churinga from cave 51a found by V. Danilenko. Later one more was found by B. Mykhailov.

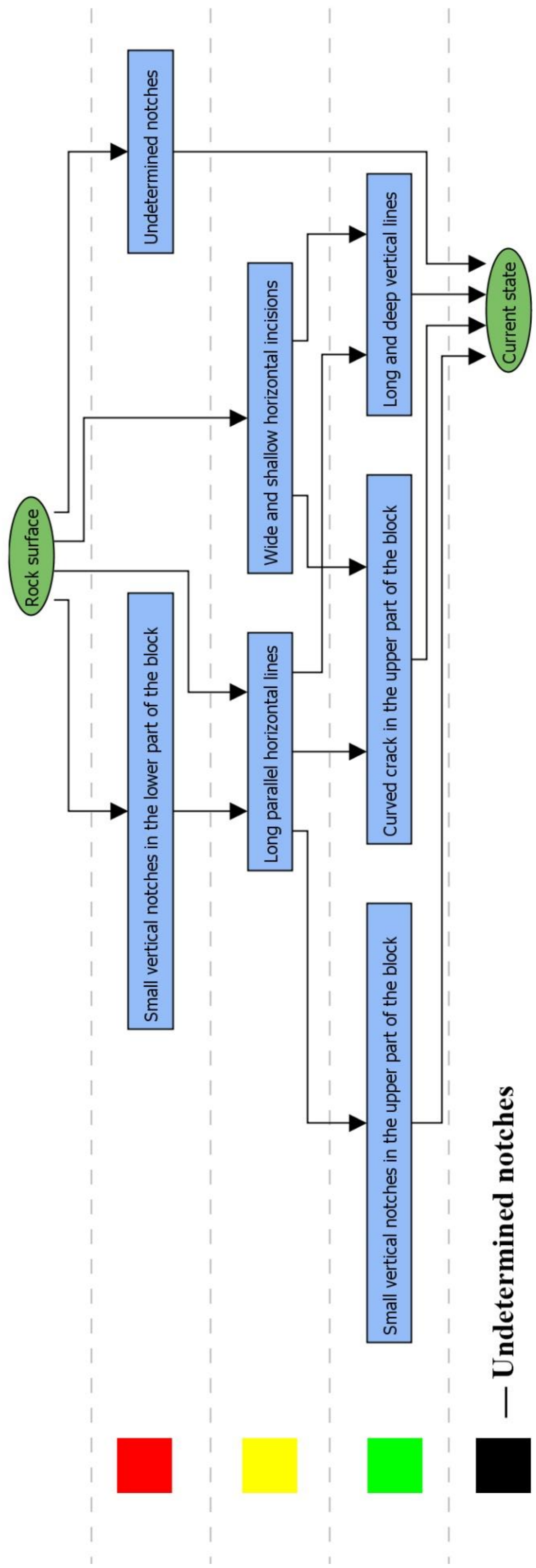
Technological drawing front



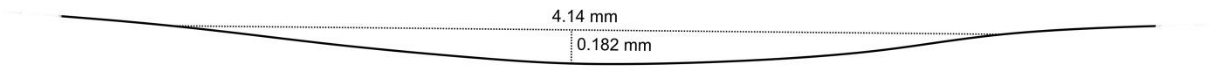
Relative chronology drawing front

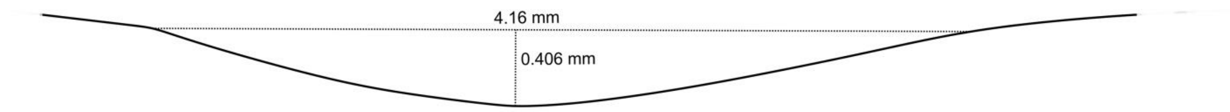


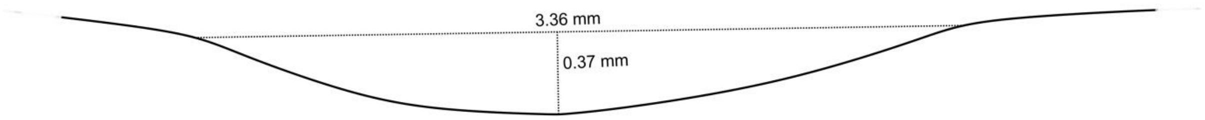
Harris matrix front

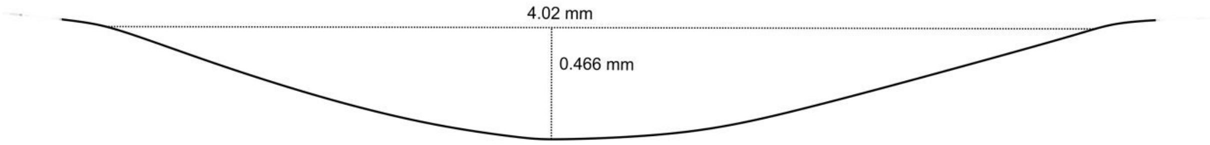


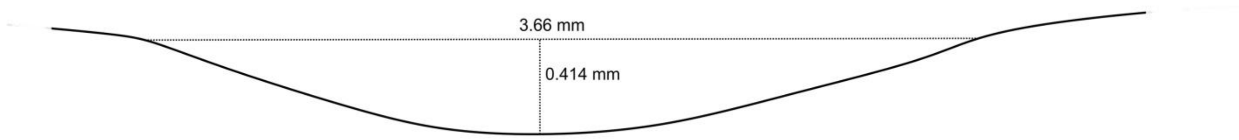
Profiles list

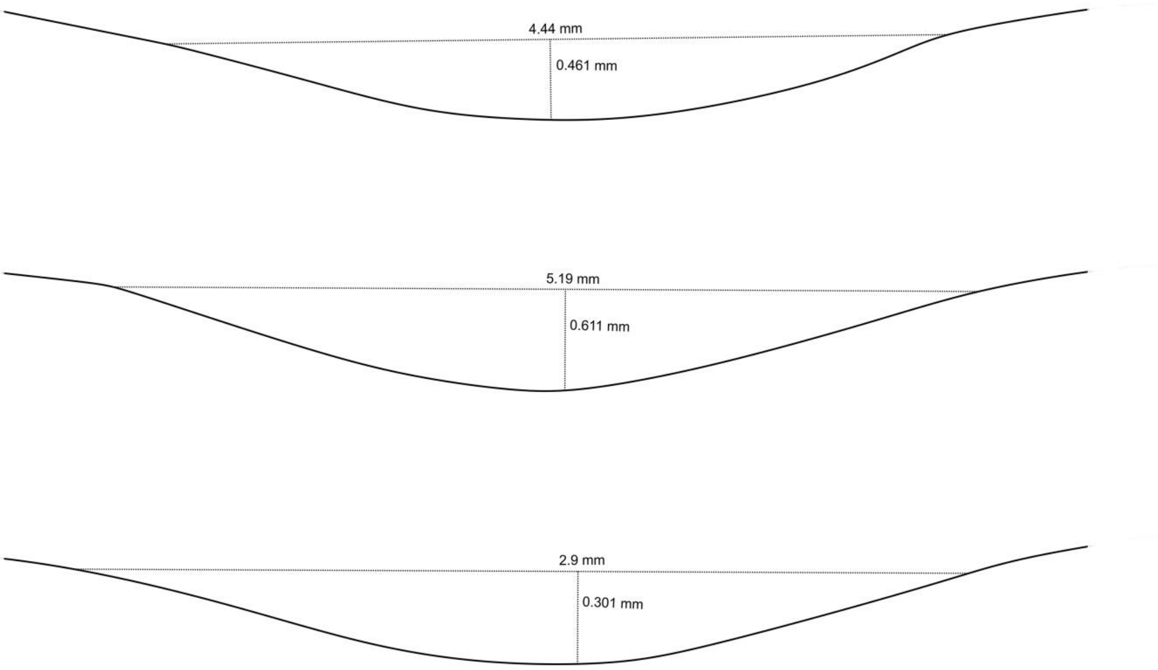











4.44 mm
0.461 mm
5.19 mm
0.611 mm
2.9 mm
0.301 mm

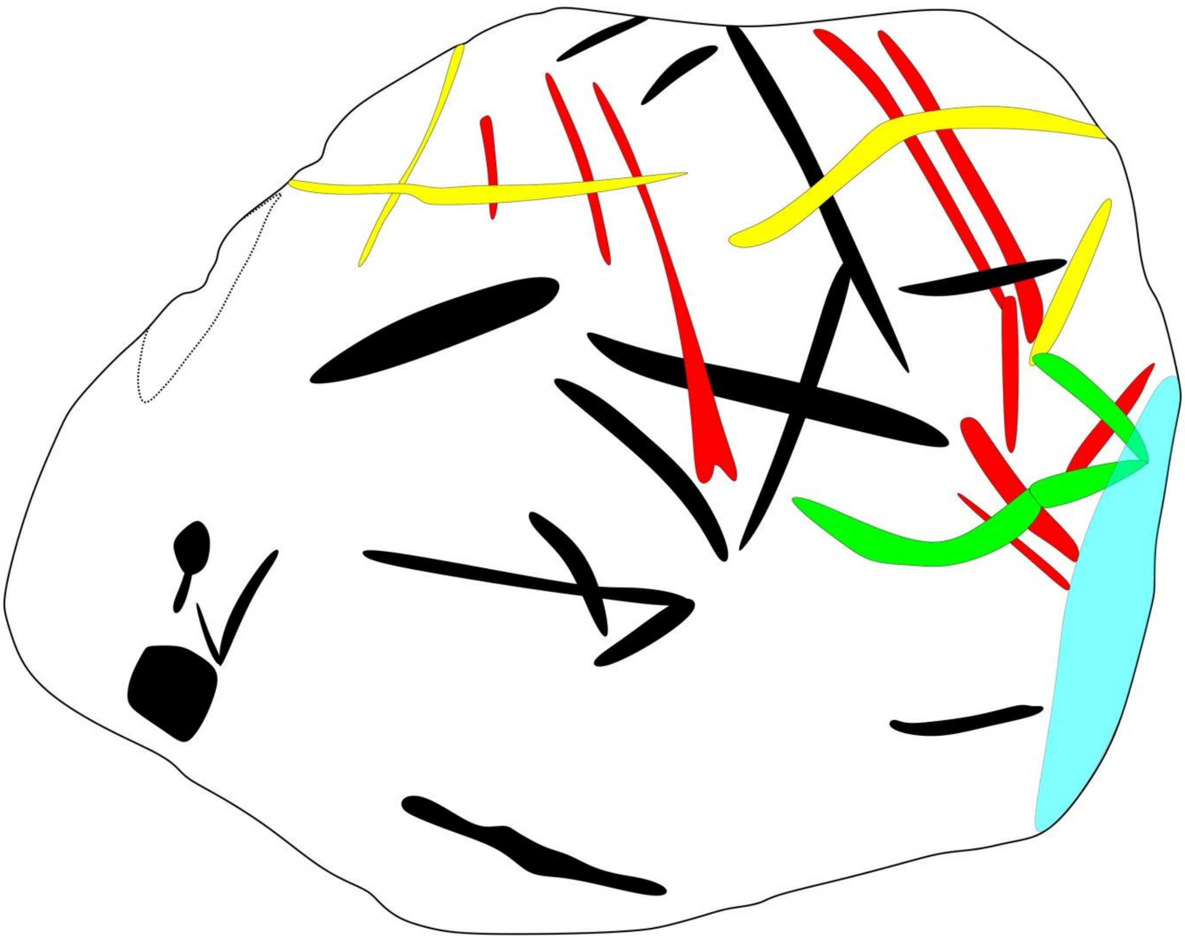
Specimen's ID	277
Image front	
Image back	
Length, cm	19
Width, cm	13
Weight, g	956
Volume, m^3	0.000472
Density, kg / m^3	2025.42373
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, "Eastern Entrance"
Current location	Institute of Archaeology, Kyiv
Description	Sandstone block with the one-sided reticulated ornament. It has covered an entrance to the vessels that accompanied the Hunnic burial in the Wizard's

	cave.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block contains linear and geometric engravings from both sides. The right part of the front side was polished after the engravings were created. The reticulated ornament contains several parallel lines. The back side of the block is also covered with shallow reticulated ornament. It also contains a semi-circle of two parallel notches made from several short incisions. The block is covered with desert varnish from both sides. Probably, it was decontextualized during the creation of the Hunnic burial in the Wizard's cave (V century CE).

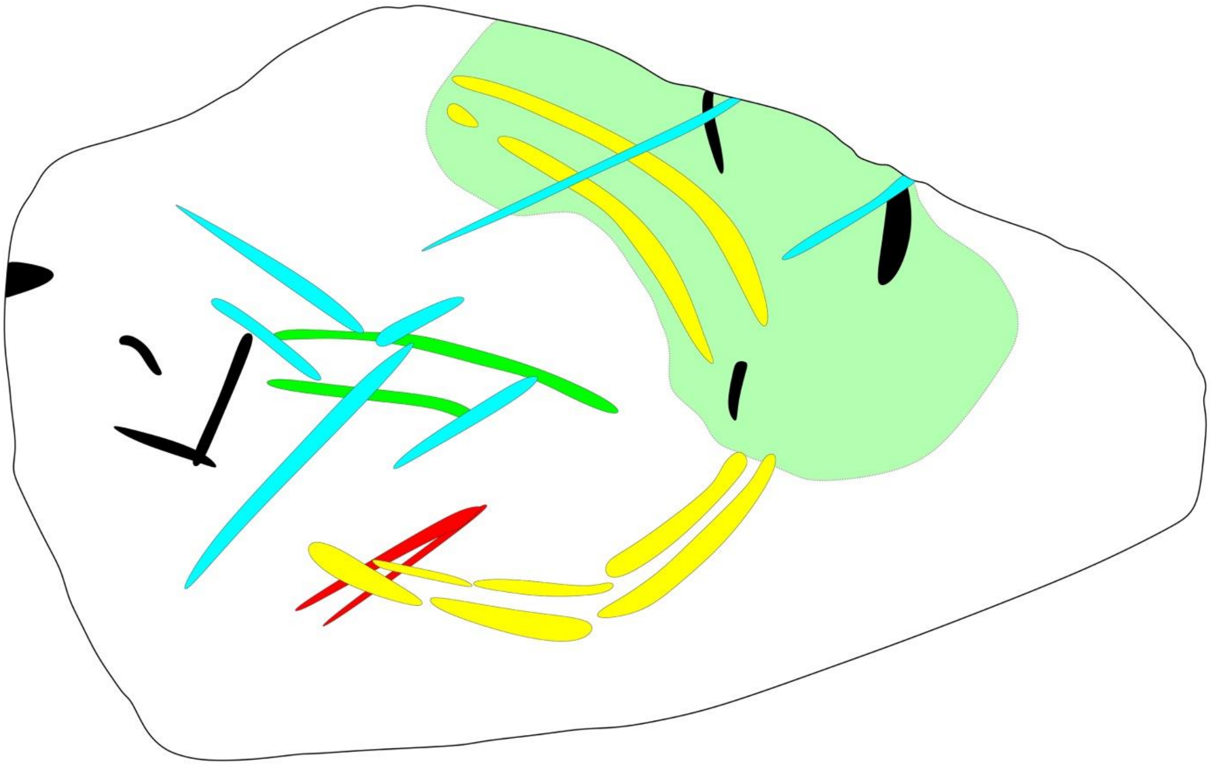
Technological drawing front

Technological drawing back

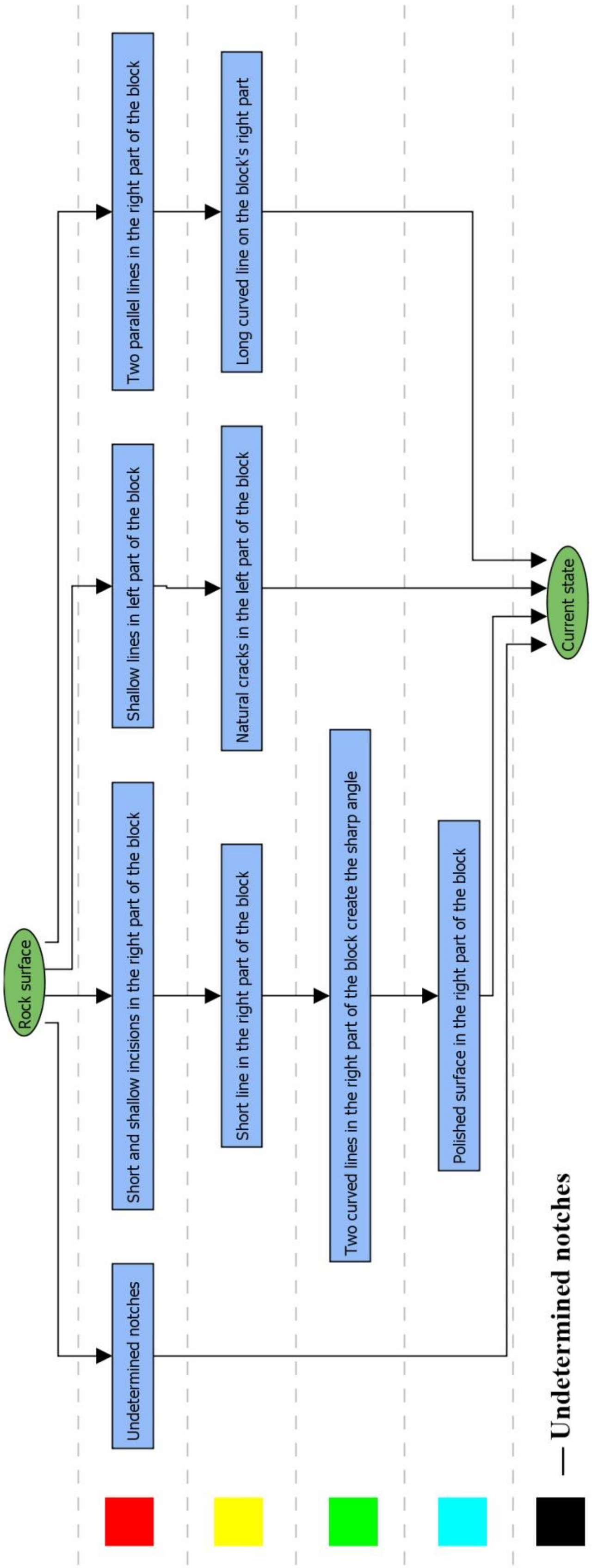
Relative chronology drawing front



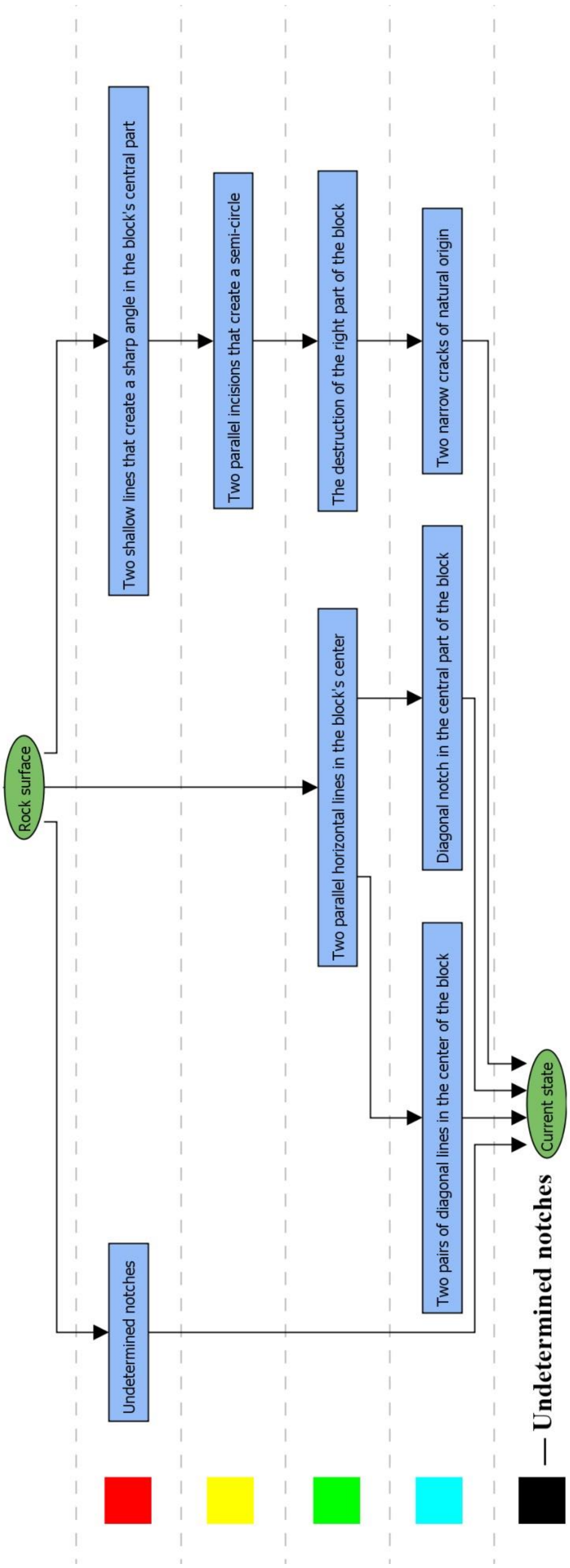
Relative chronology drawing back



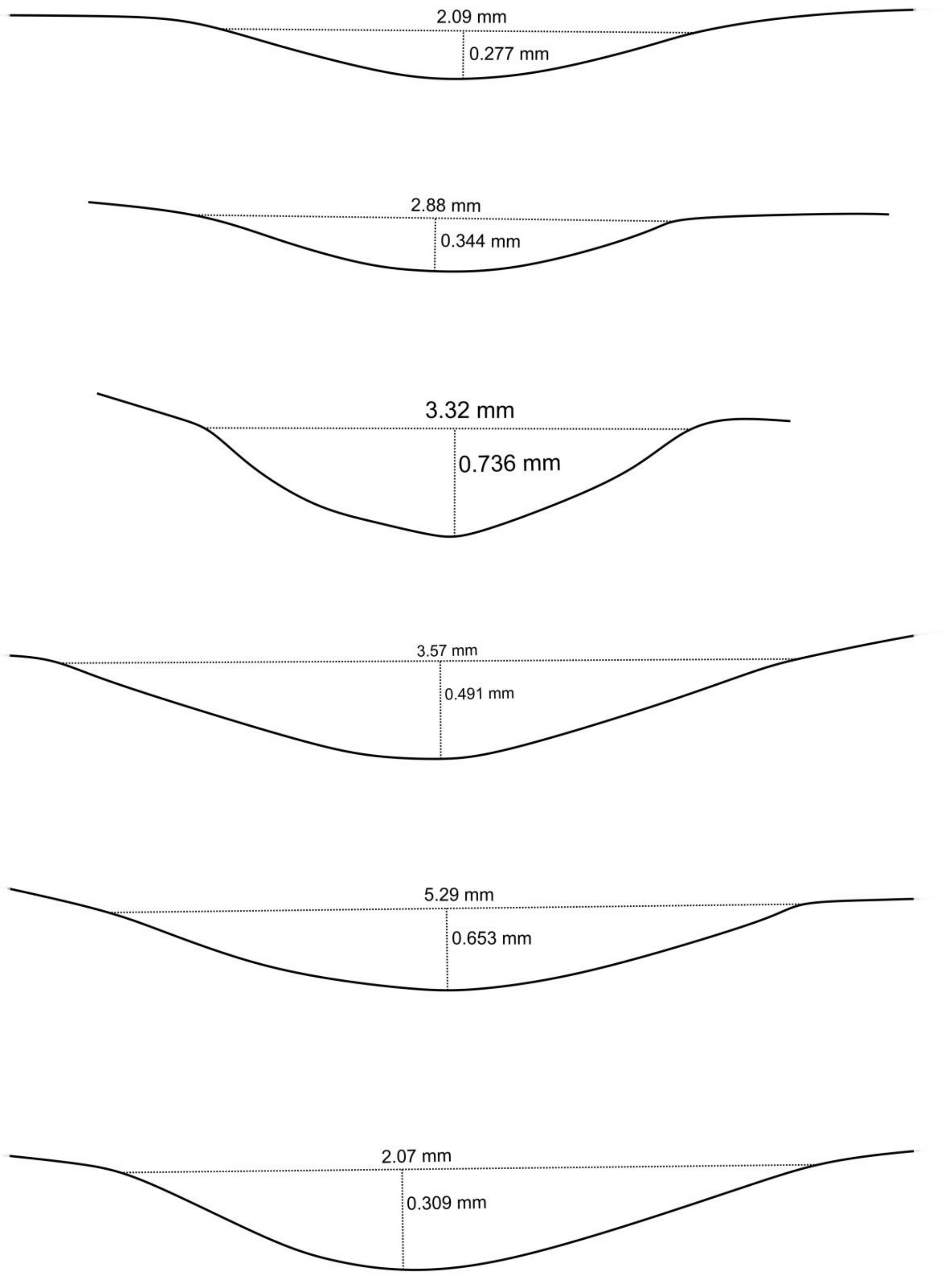
Harris matrix front

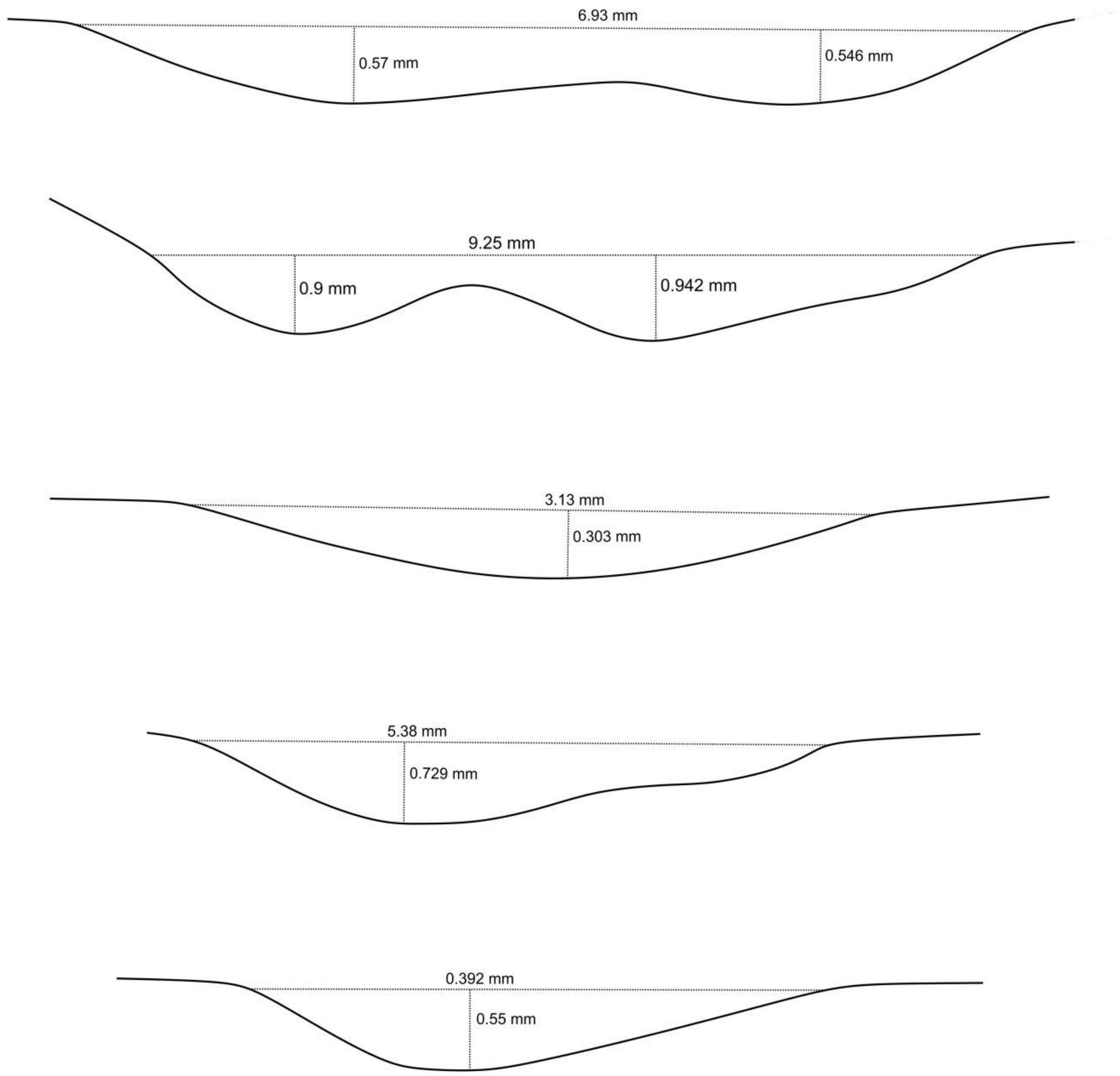


Harris matrix back

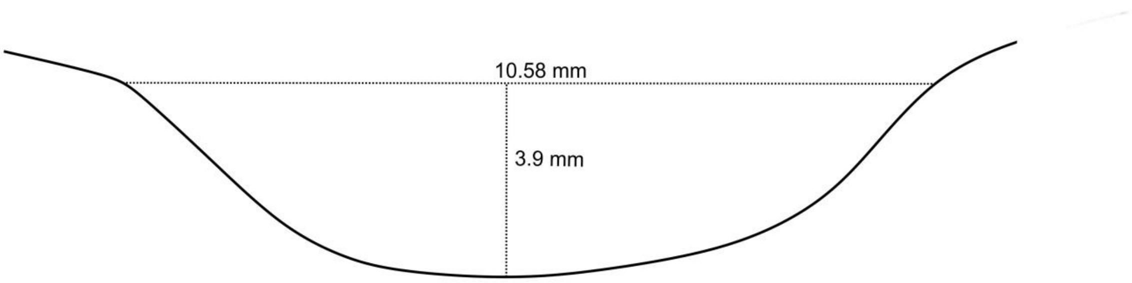


Profiles list





Cup mark on the front side

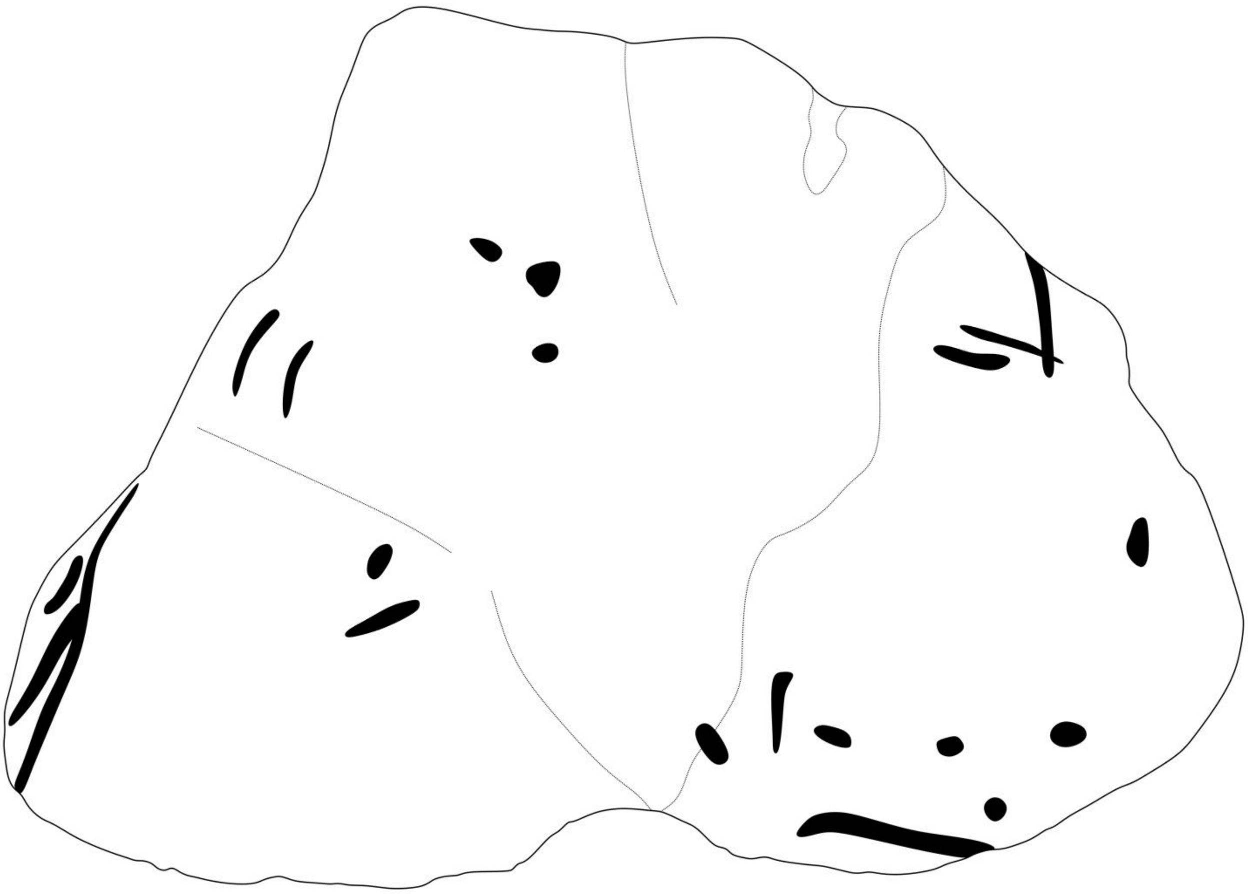


Specimen’s ID	278
Image front	
Image back	
Length, cm	29
Width, cm	19
Weight, g	2543
Volume, m^3	0.001302
Density, kg / m^3	1953.14901
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, “Eastern Entrance”
Current location	Institute of Archaeology, Kyiv
Description	Sandstone block with linear and geometric ornament from both sides. Used to cover the oinochoe that accompanied the Hunnic

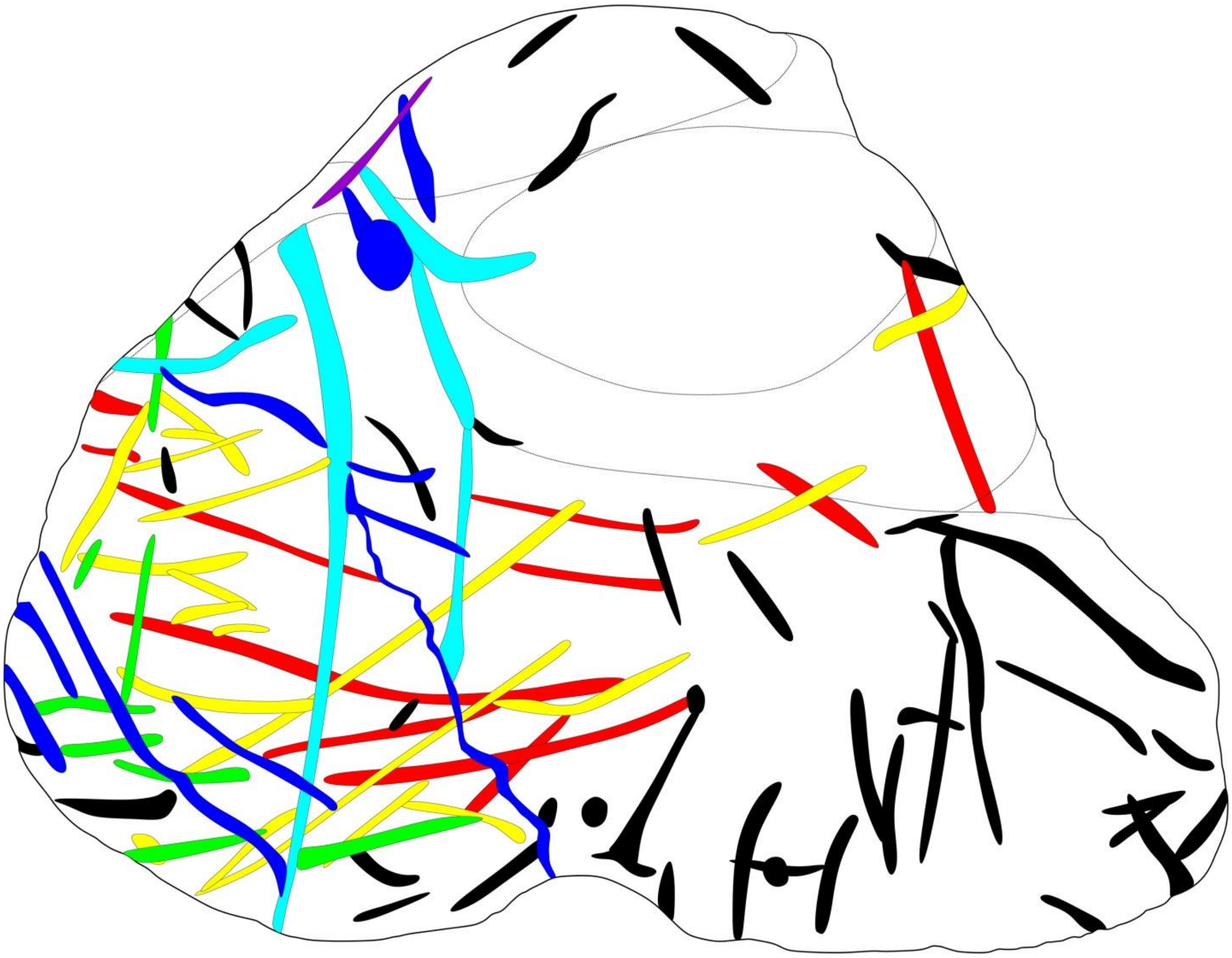
	burial in the Wizard's cave.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block contains linear and geometric engravings and desert varnish from both sides. Most of the lines create pairs of parallel ones. The sequence is complex and shows several stages. However, there are no recognizable motifs or images on the block. Probably, the stone was decontextualized during the creation of the Hunnic burial in the Wizard's cave (V century CE).

Technological drawing front

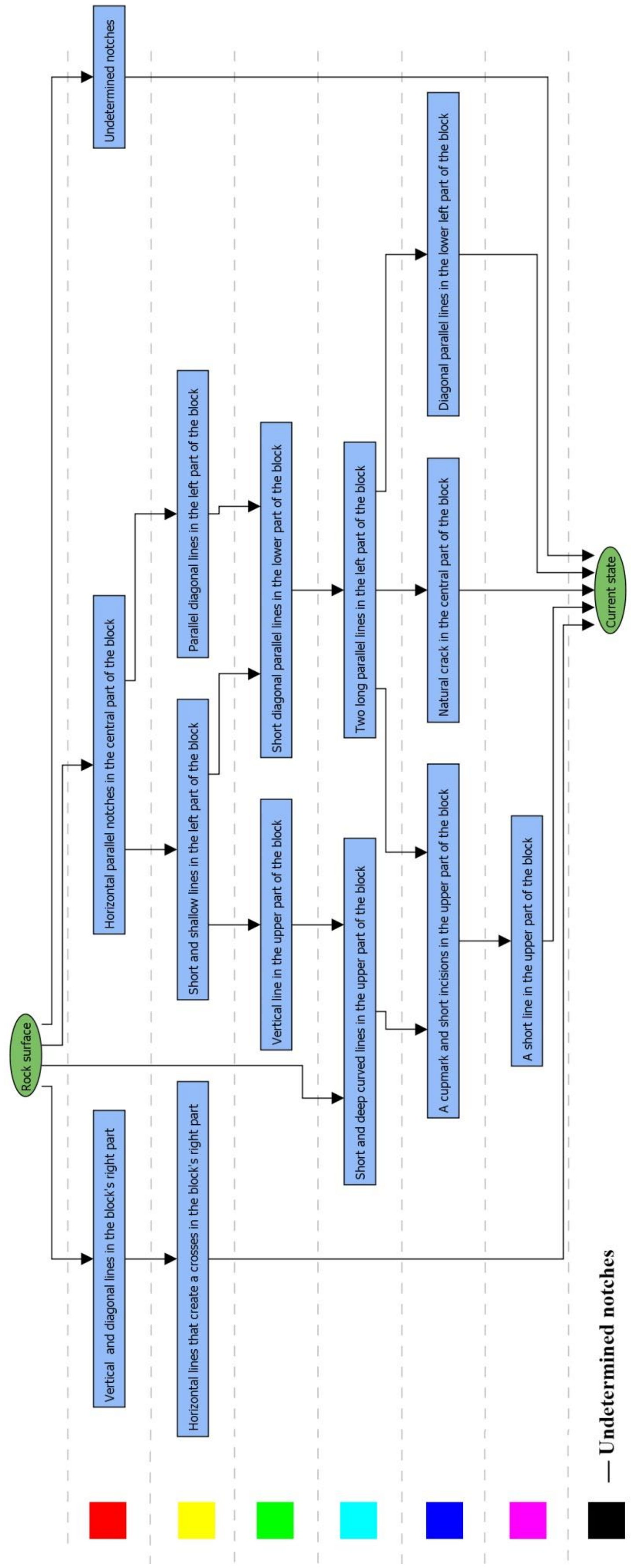
Technological drawing back



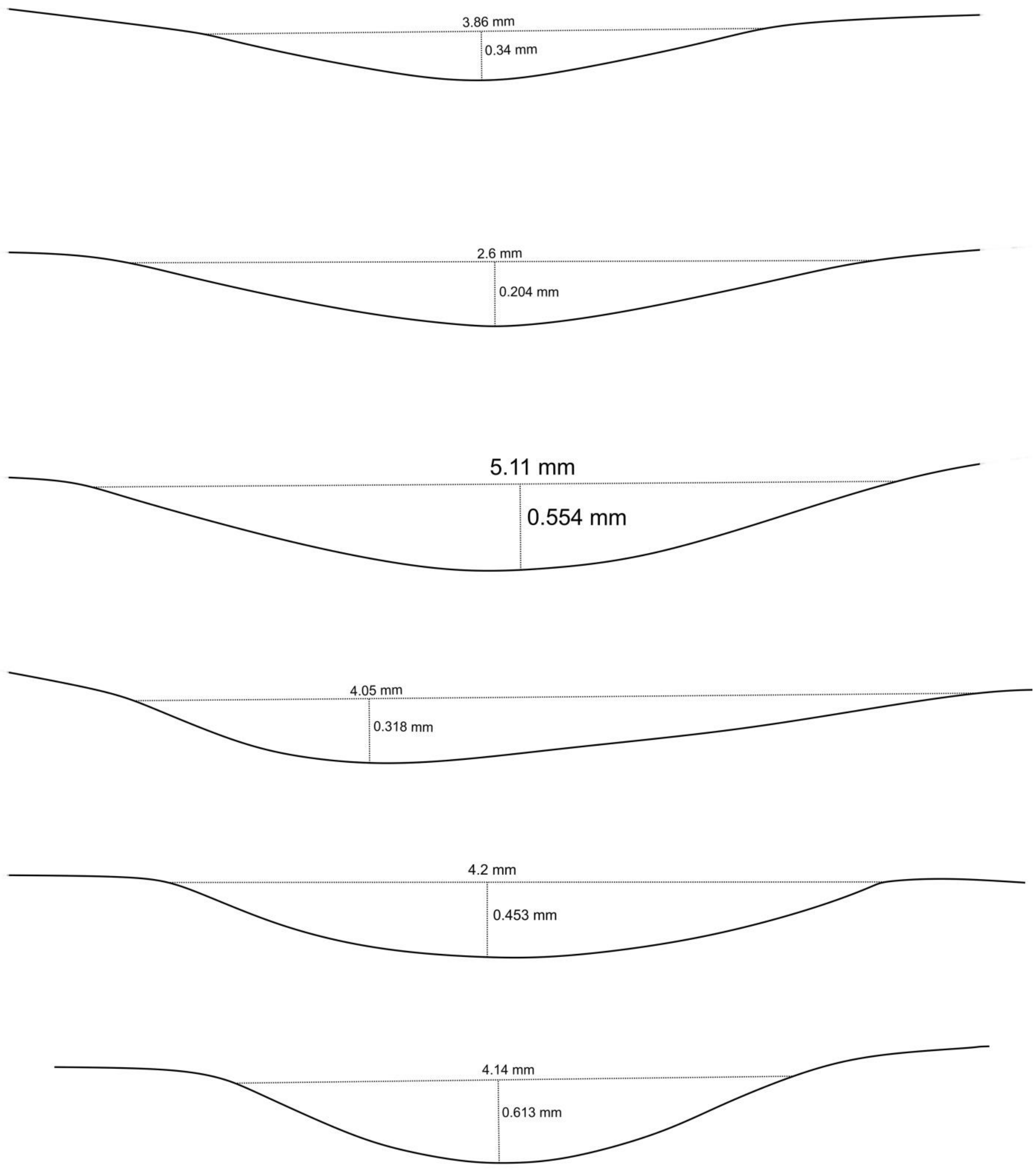
Relative chronology drawing front

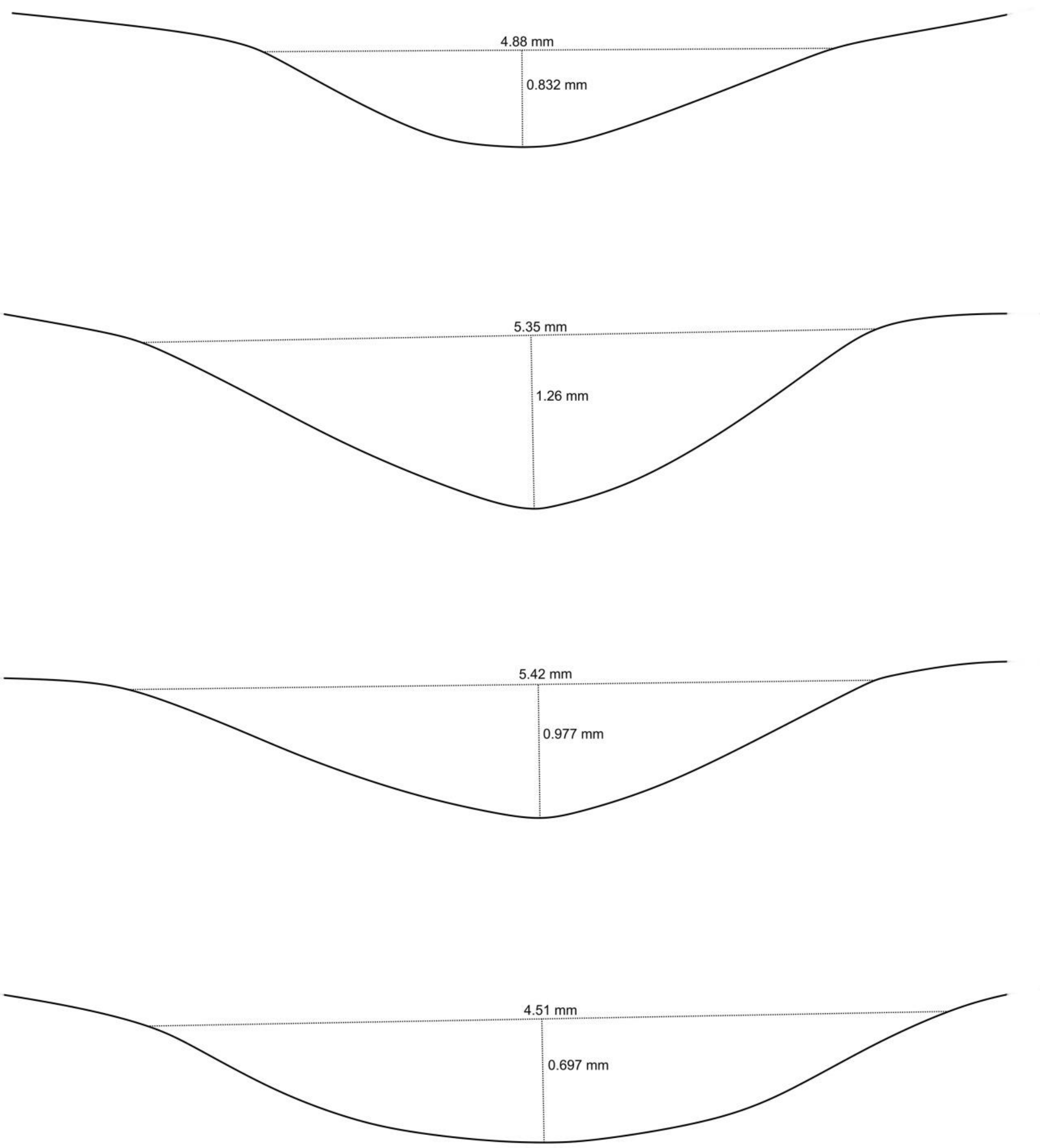


Harris matrix front



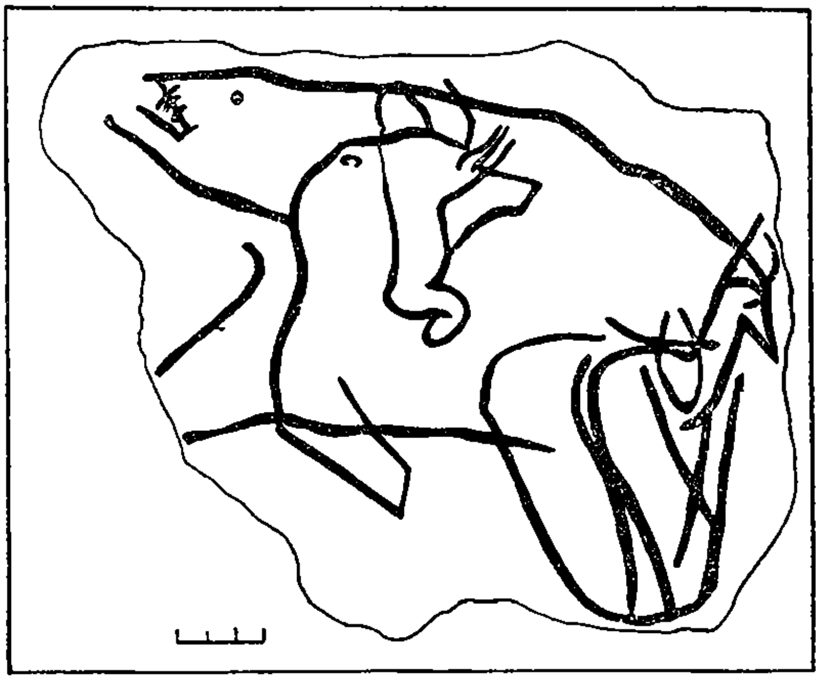
Profiles list




4.88 mm
0.832 mm
5.35 mm
1.26 mm
5.42 mm
0.977 mm
4.51 mm
0.697 mm

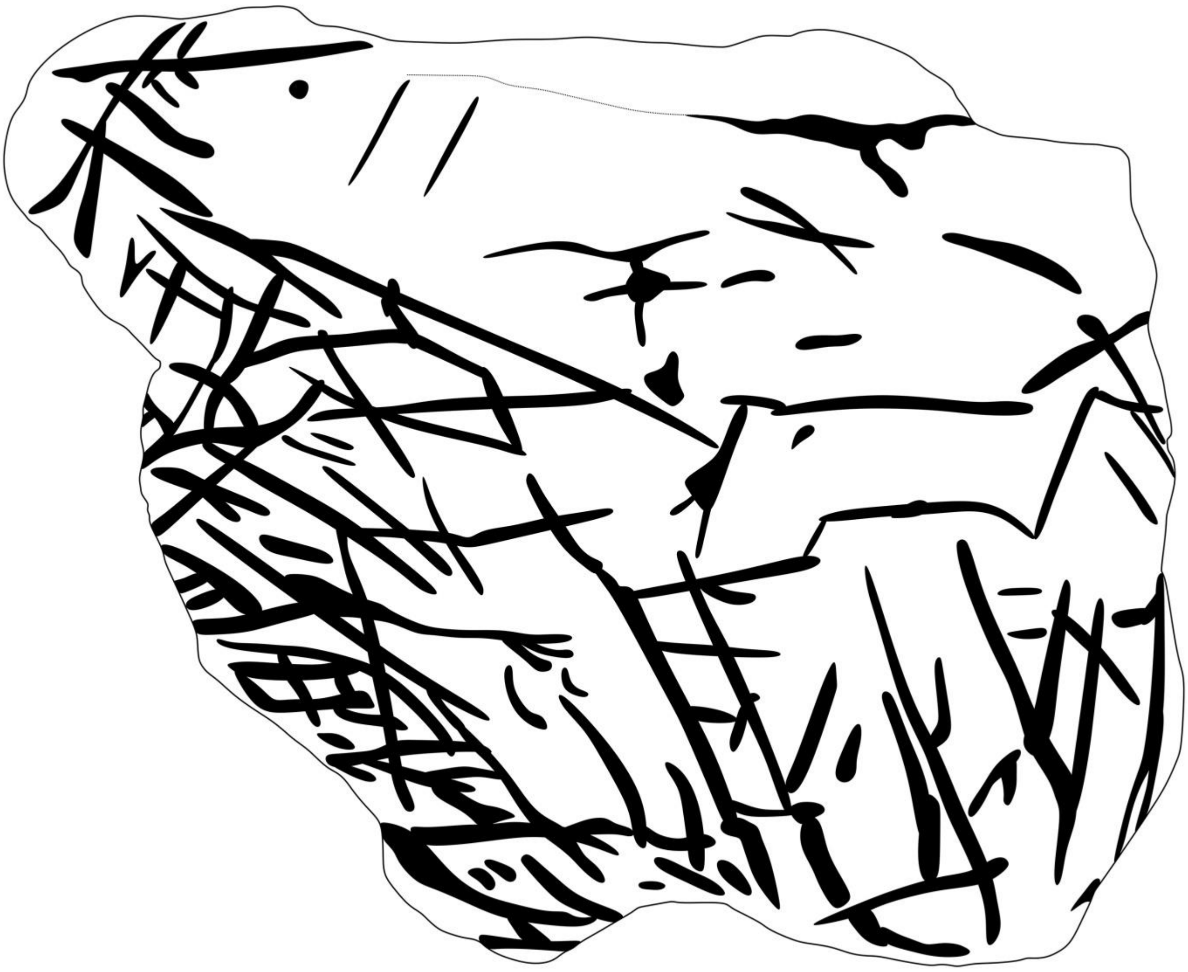
Specimen's ID	283
Image front	
Image back	
Length, cm	27
Width, cm	19
Weight, g	2897
Volume, m^3	0.001487
Density, kg / m^3	1948.21788
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The subrectangular sandstone block with one-sided linear and

	geometric engravings.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	The image also presents the figure of a mammoth. A feature of this block should be emphasized. The contour of block No. 283 is close to the shape of the mammoth with his hump and the lines of his head and back. A figure of an animal has been turned right. The head and trunk are featured with a bright line parallel to the correct angle and the whole right edge of a block. Using the natural proportion, the inner contour is marked with the second line. However, the outer one lasts to the very end of the block. This is because this line is a specific element of a second image (fig. 60). The mammoth snout contains an eyebrow protrusion and an eye. This makes the character depicted quite clear despite the absence of a stomach, legs, etc. Using the recently discovered oiconomia effect and rotating the block to 180 degrees, one can notice that the particular part of the mammoth turns to be a cave bear with a realistic snout (where an eye is also an eye of the mammoth). The lower part of this predator is also shown schematically. Looking carefully at the block, one can decipher several characters through several engravings. This includes an animal that is close to a rhinoceros, with her front side fused with a figure of a man (probably a woman that stays on her knees). The front part of the block contains an image of an animal with short horns and a humped back. The left lower quarter of the block contains engravings of a horned animal, probably a deer with the head, the neck, and a part of the breath mutual to those parts of a previous figure. These two, however, have two separate corpora. This image is similar to the Pair-non-pair (Gironda) image, where the stone goat (or the pair of them) has the same body and separate necks and heads.

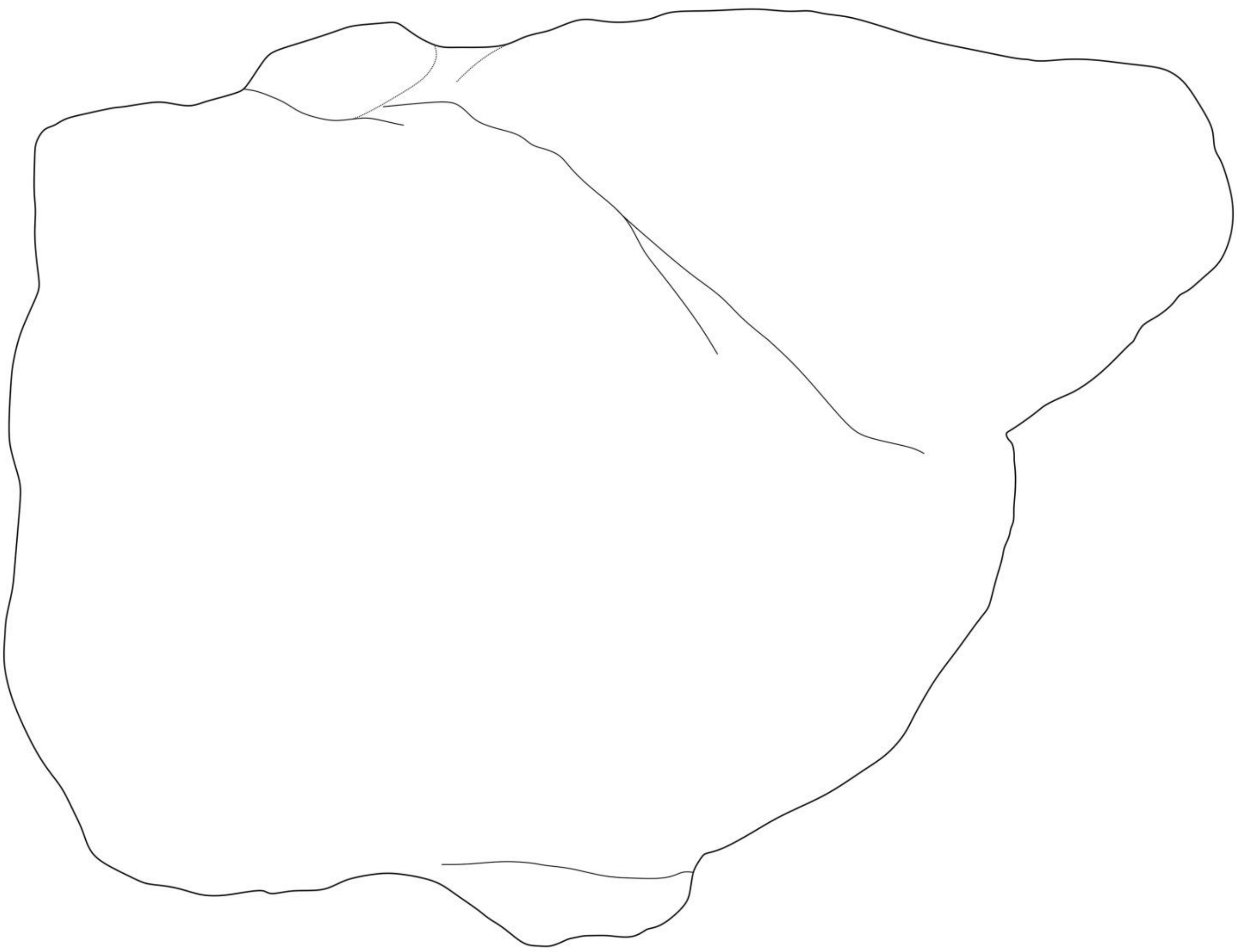
Descriptive image	 
Description source 2	Danilenko 1986: 107
Note	The block is covered with desert varnish from the front side. It contains numerous linear engravings that create an intense reticulated ornament. Some of them are pretty shallow or almost invisible, especially in the block's upper part. The motifs described by V. Danilenko are partially recognizable but remain dubious. This is due to the absence of a precise mammoth engraving, as described in his book. However, what he calls "a cave bear" is still visible. Some contour of the dear is also recognizable, though the nature of the dear is not evident. Some linear engravings create a kind of

	zoomorphic shape in the upper part of the block. These are pretty shallow, though recognizable on the 3D model's surface. Taking into account the absence of the zoomorphic or anthropomorphic engravings on the other blocks from the Wizard's cave, one should reconsider the origin of the engravings on block No. 283. This requires additional archaeological expertise. It is also noticeable that vertical ones always superimpose horizontal parallel lines. The latter was also created after the shallow engravings in the block's upper part, although the clear intersections' examples are minor. It is possible that the upper part of the block was polished after the engravings had been created there. This would explain the shallowness of particular notches. The reticulated ornamentation is probably anthropogenic, typically to other blocks from the Wizard's cave.

Technological drawing front



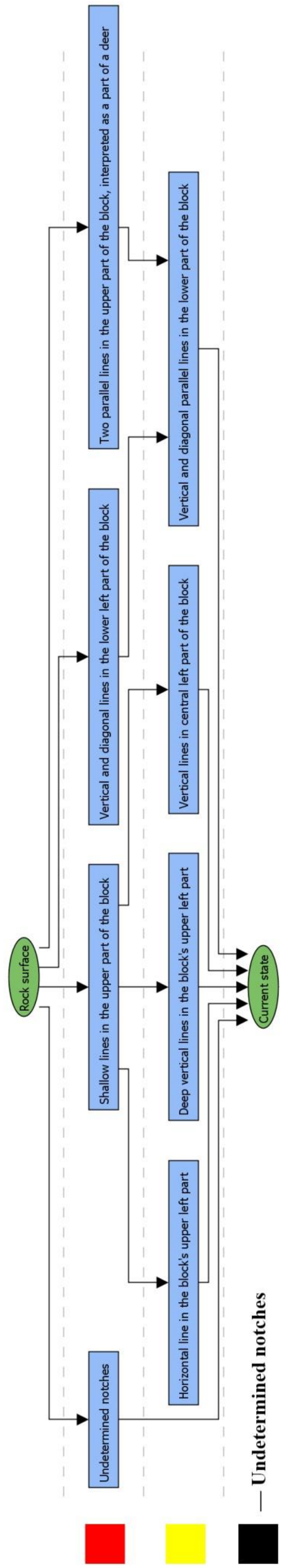
Technological drawing back



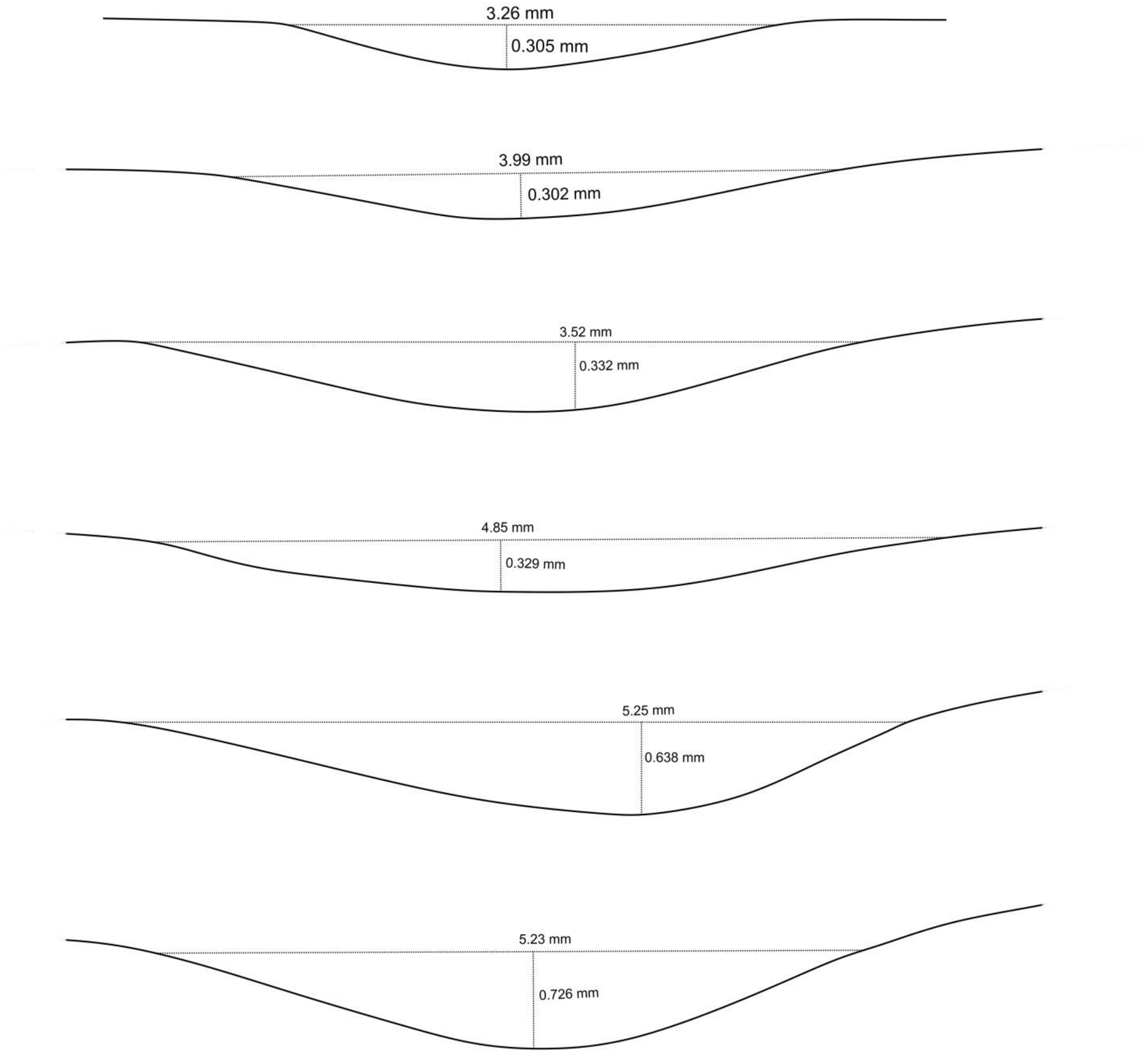
The incisions interpreted by V. Danilenko as parts of semantic composition

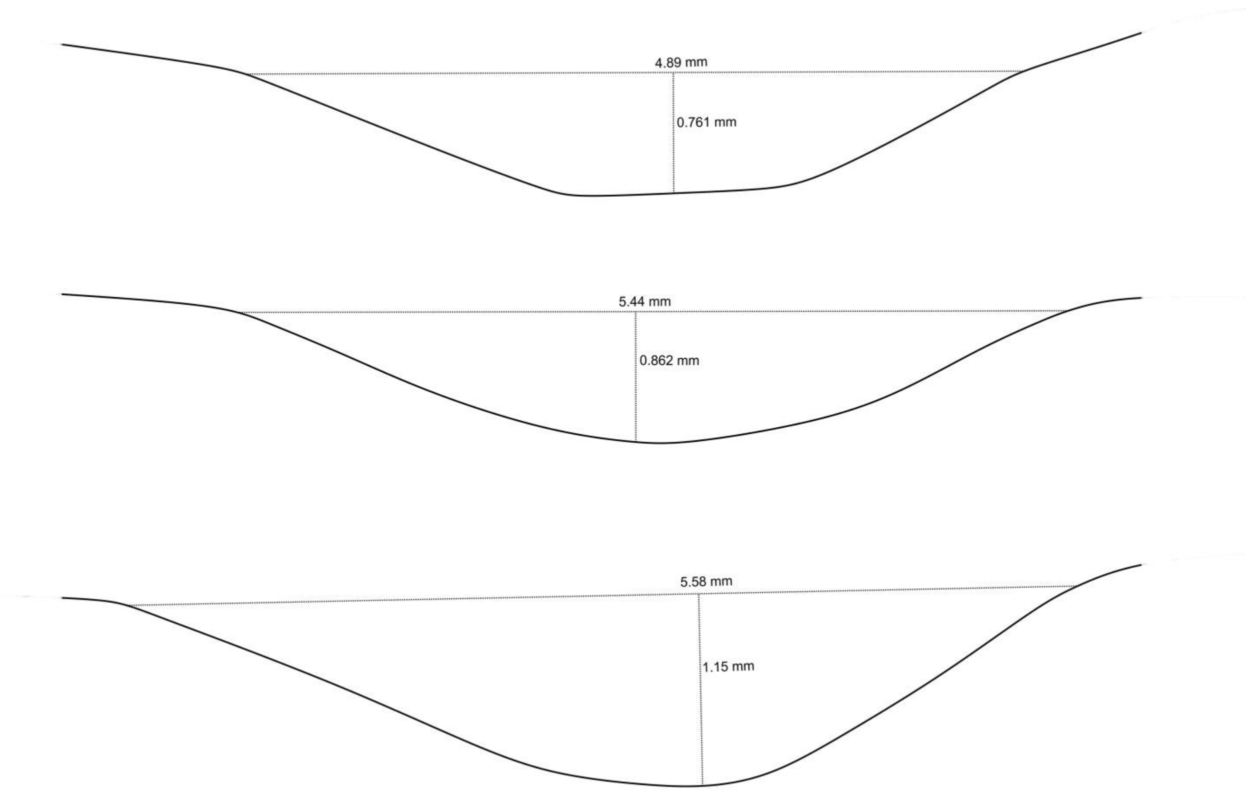
Relative chronology drawing front

Harris matrix front

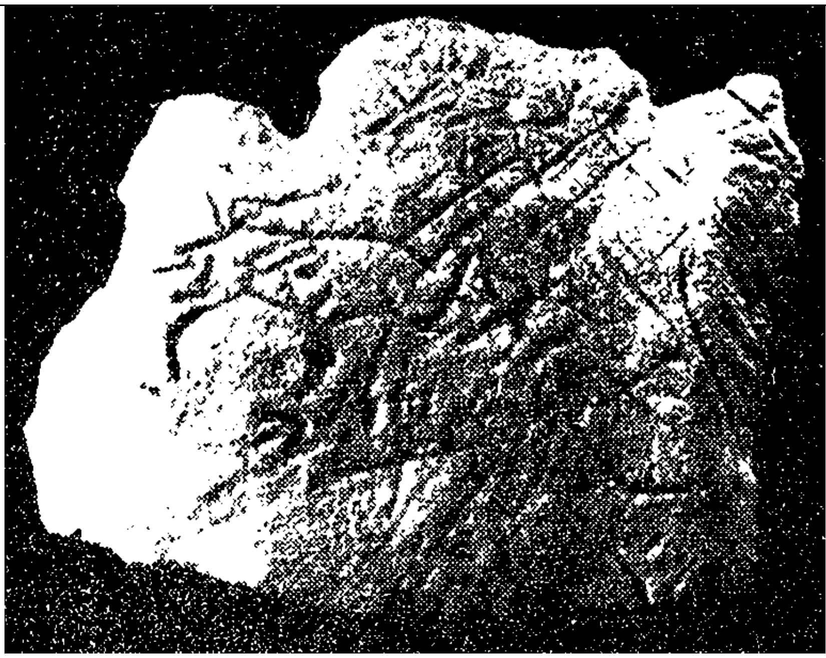


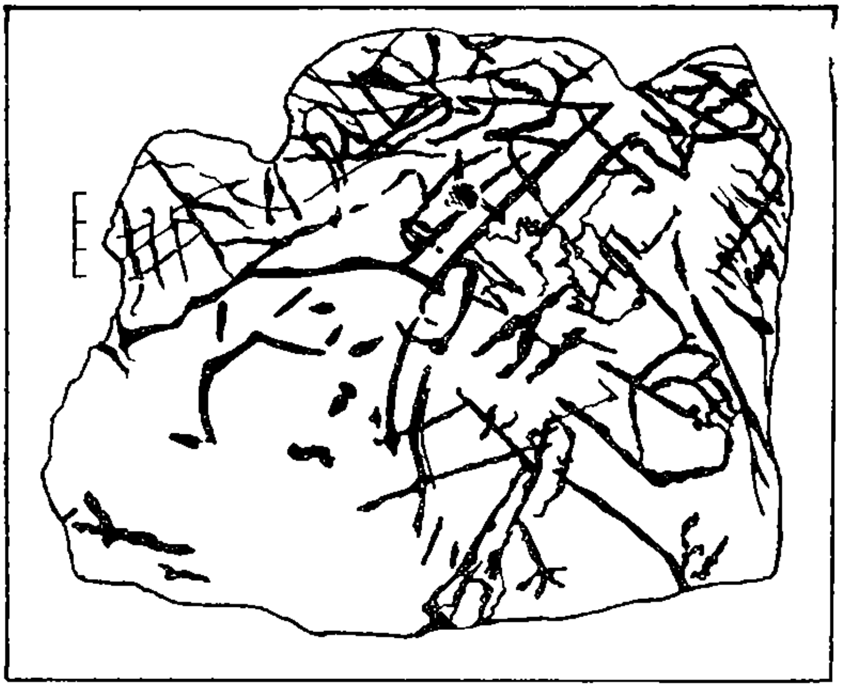
Profiles list



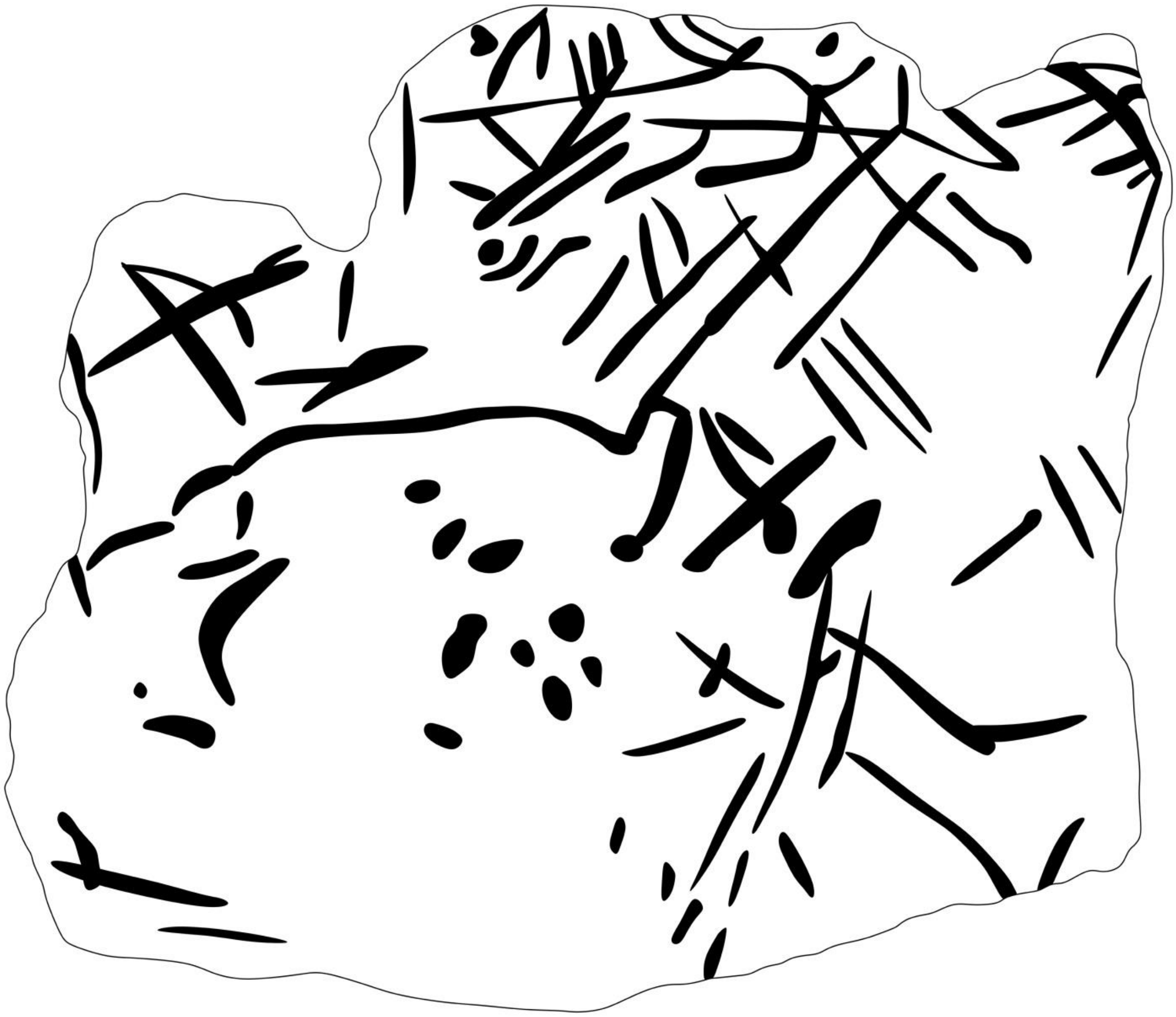

4.89 mm
0.761 mm
5.44 mm
0.862 mm
5.58 mm
1.15 mm

Specimen's ID	284
Image front	
Image back	
Length, cm	25
Width, cm	22
Weight, g	2252
Volume, m^3	0.001146
Density, kg / m^3	1965.09599
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The subrectangular sandstone block with one-sided linear and

	geometric engravings. The front side bears an image of an animal.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	A special churinga in terms of a combination of linear and geometric engravings with zoomorphic motifs. The block of average size (26.2x21.6 cm). The composition is located on its front side. Its meaning is defined with two components: linear and geometric elements with uncertain meanings and a schematic image of an animal in the left part of the block. The determination of the latter's specie is complicated. Straight but slightly curved in the front side body, convex stomach on a place of its connection with the breath, straight front legs, and curved hind legs testify that the imaged creature belongs to the ungulate. The rapid transition of the back line to the very convex head is also worth attention. This is an essential feature of a mammoth's look. Although the nature of a mammoth is dubious due to the size of the figure (especially its legs, which are presented as singular lines), we still consider this figure an image of a mammoth (fig. 46).
Descriptive image	

	
Description source 2	Danilenko 1986: 96
Note	The block is covered with desert varnish from the front side. It contains numerous linear engravings on the front side and a few natural cracks. Most of them present reticulated ornament without any clear semantic meaning. The central part of the block's front side has been polished and engraved. The lines in this part of churingas were interpreted as an animal by V. Danilenko. Though this interpretation is dubious, the incisions are anthropogenic without any doubt. Other parts of the surface are covered with parallel lines and irregular lattices. Most of the parallel lines superimposed the natural cracks. Those that are parallel to one another are usually simultaneous in terms of relative chronology.

Technological drawing front

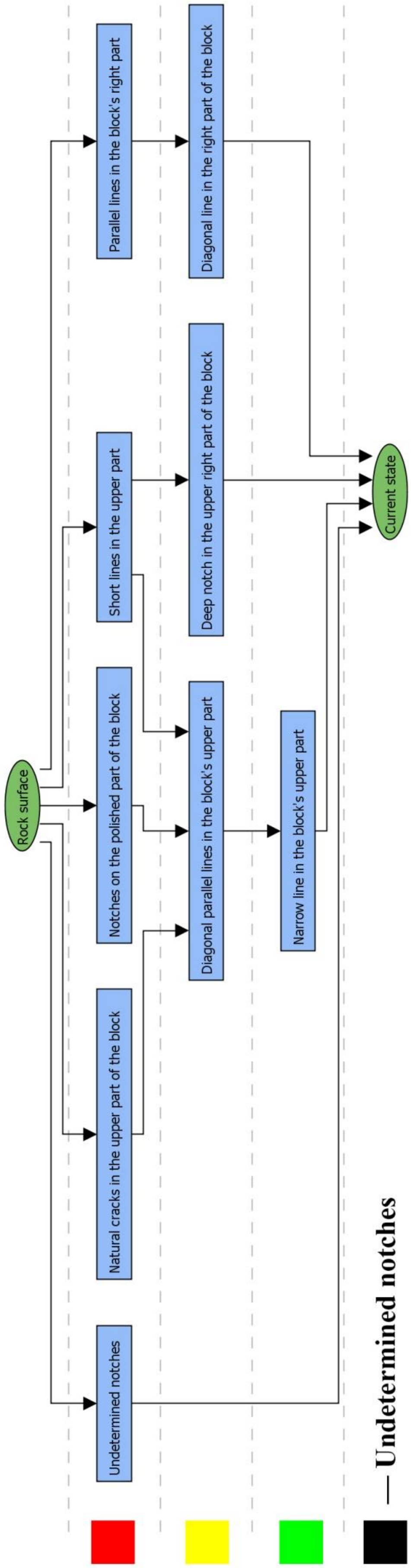


Technological drawing back

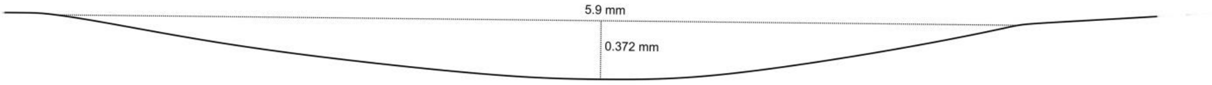
The incisions interpreted by V. Danilenko as parts of semantic composition

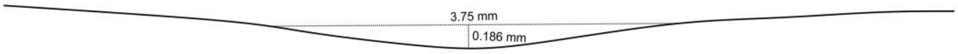
Relative chronology drawing front

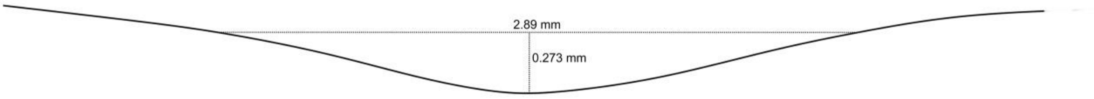
Harris matrix front

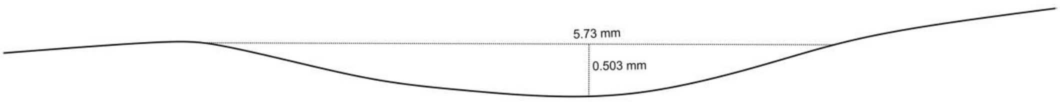


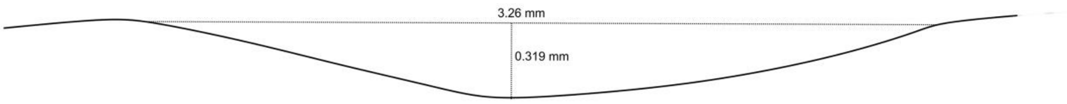
Profiles list

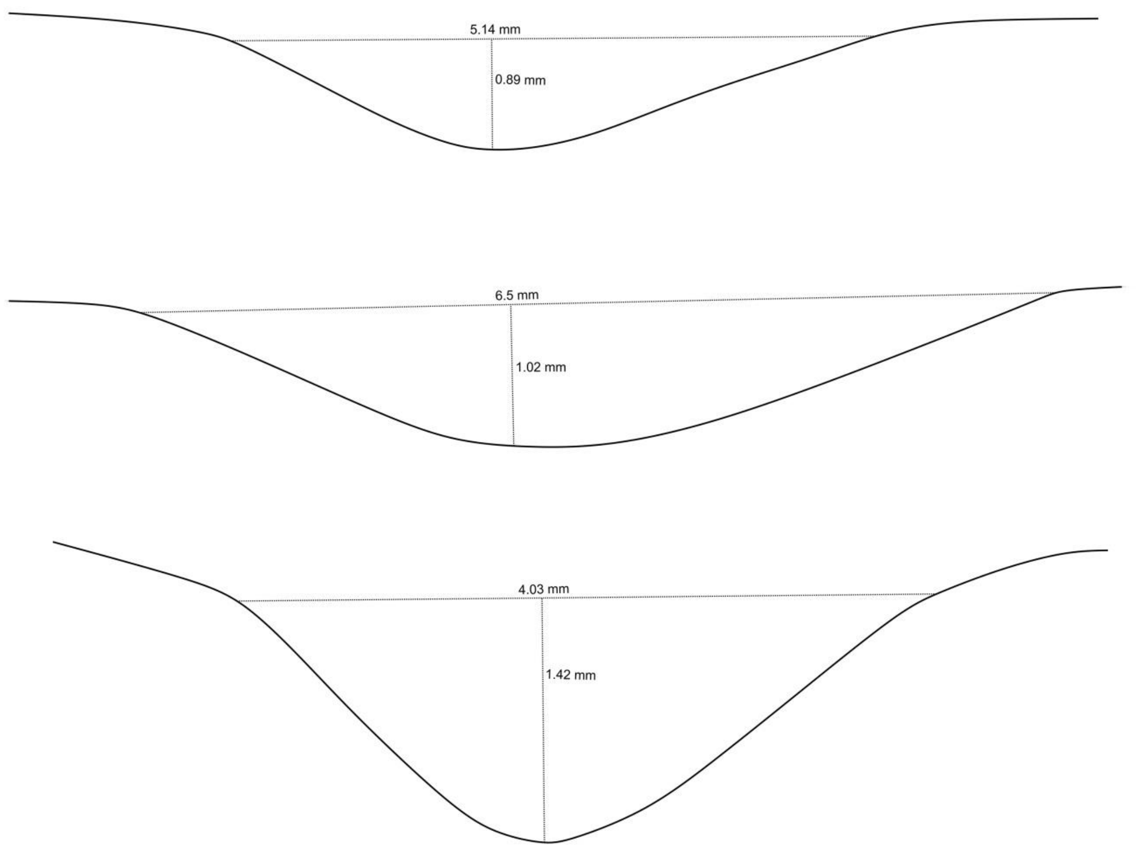


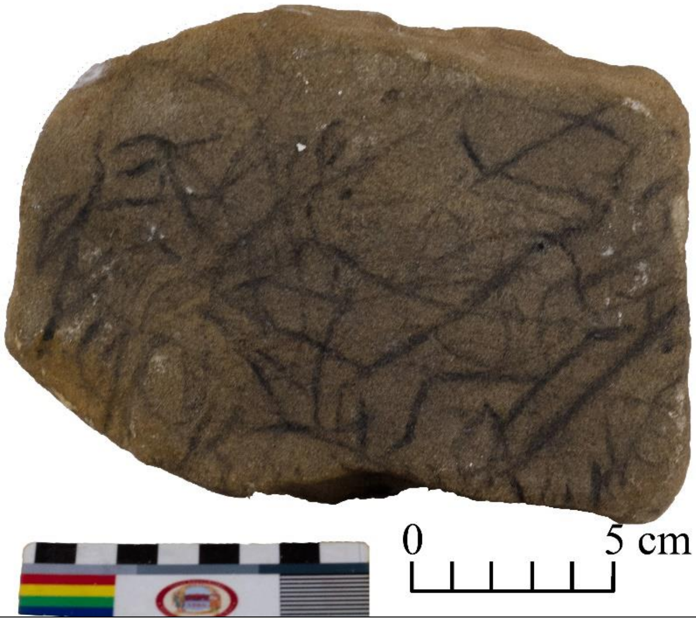








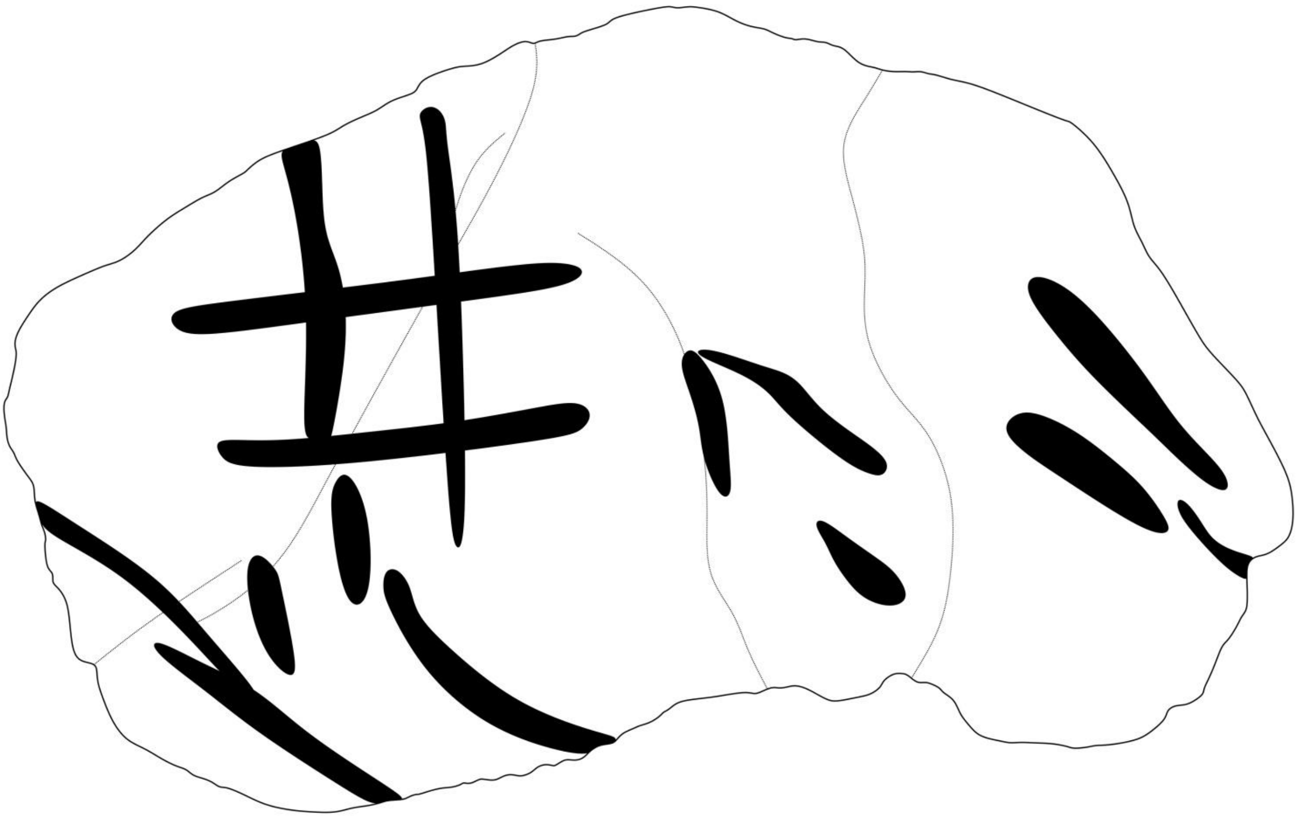

5.14 mm
0.89 mm
6.5 mm
1.02 mm
4.03 mm
1.42 mm

Specimen's ID	285
Image front	
Image back	
Length, cm	16.5
Width, cm	11
Weight, g	2195
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A subrectangular sandstone block covered with reticulated ornaments from the front side
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	Churinga has polished from both sides. The front side is darker, covered with desert varnish.

Specimen’s ID	287
Image front	
Image back	
Length, cm	8
Width, cm	4
Weight, g	298
Volume, m^3	0.000157
Density, kg / m^3	1898.08917
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A part of sandstone block with the linear and geometric engravings on the both sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block contains linear and geometric engravings from both sides. The reticulated ornament on the front side is highly damaged by the

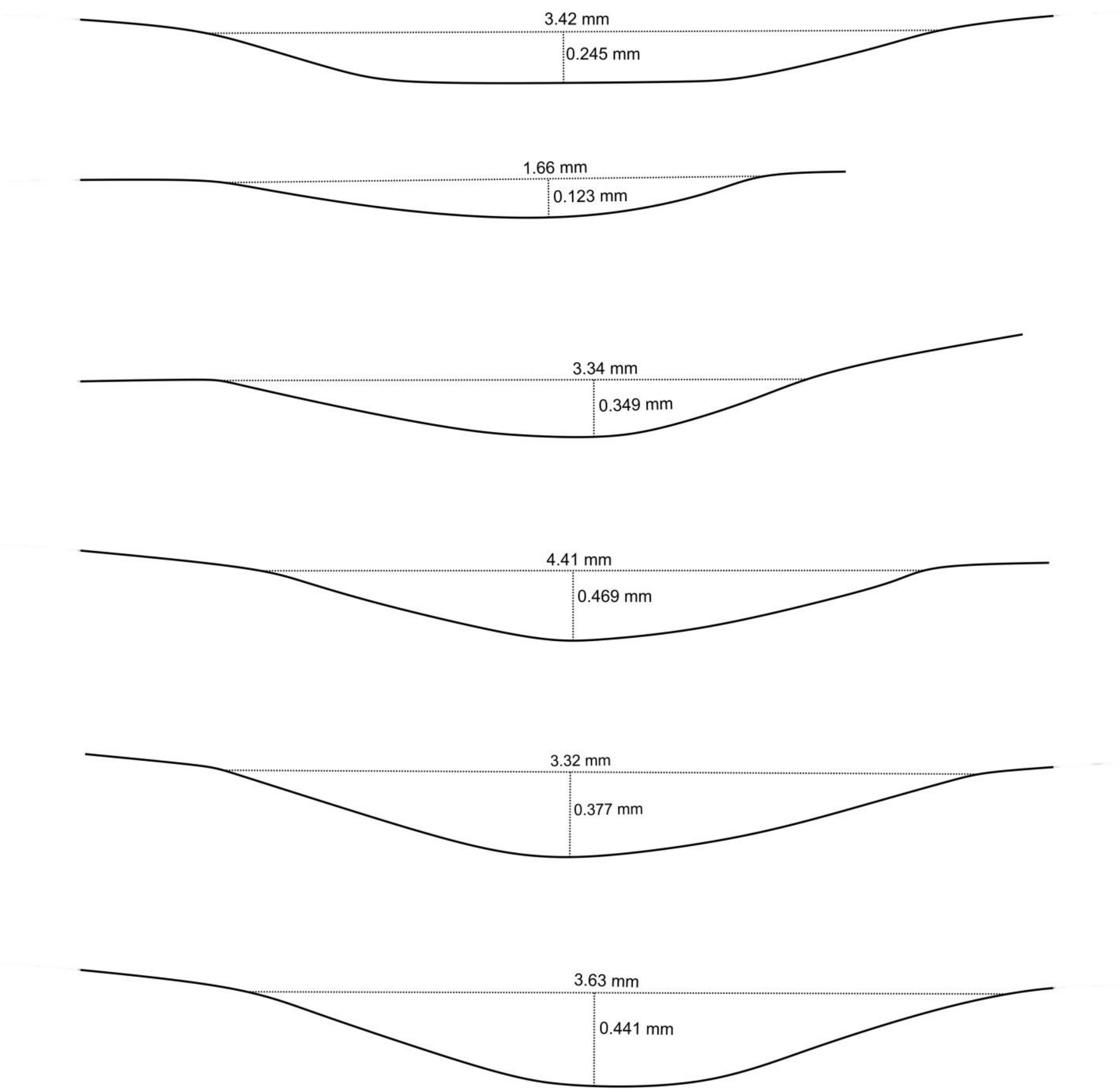
	destruction of the block's surface. The back side contains shallow vertical notches, mostly parallel. The block is covered with desert varnish. After the engravings were created, they broke into two parts and were glued by V. Danilenko. Due to the high level of destruction, the determination of relative chronology is impossible.

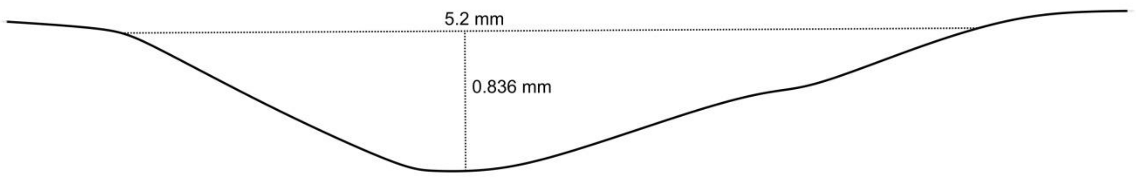
Technological drawing front

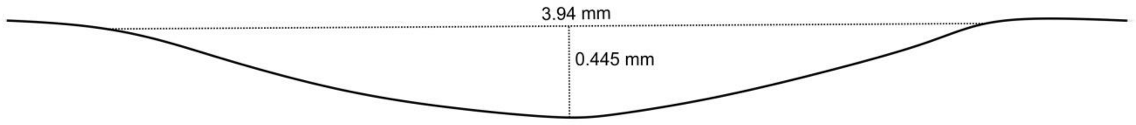


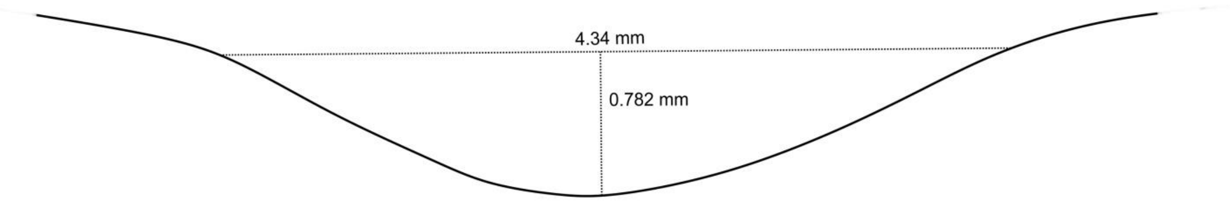
Technological drawing back

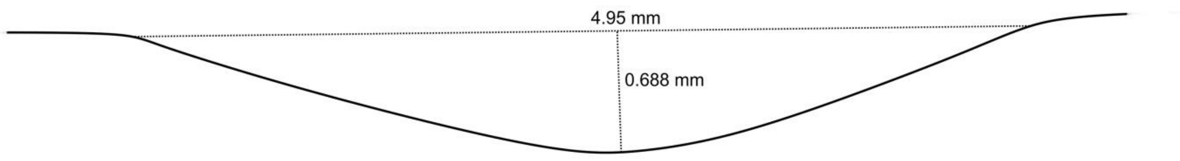
Profiles list



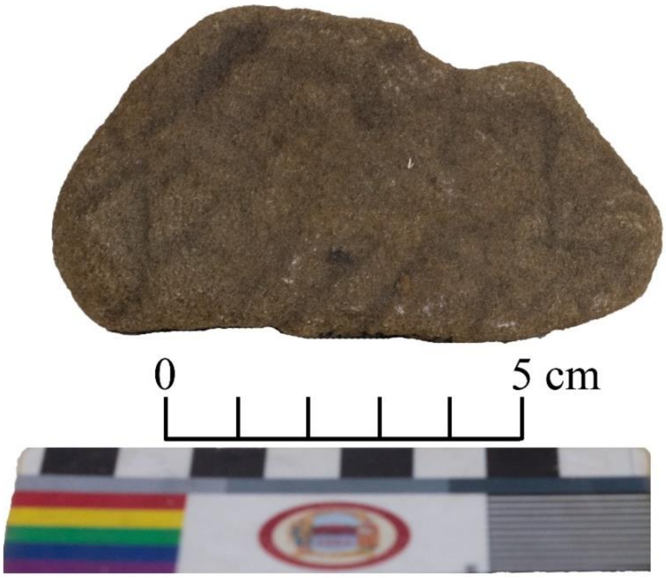

5.2 mm
0.836 mm


3.94 mm
0.445 mm

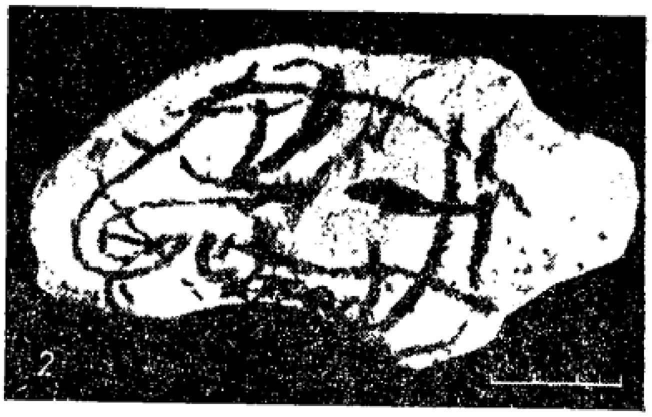
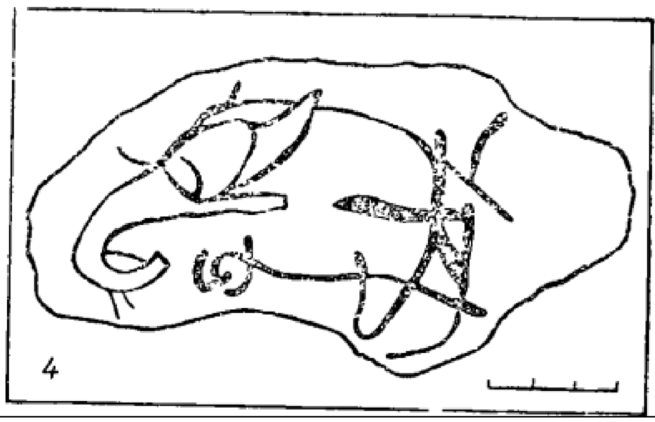

4.34 mm
0.782 mm


4.95 mm
0.688 mm

Specimen's ID	288
Image front	
Image back	
Length, cm	7.5
Width, cm	3.7
Weight, g	91
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A piece of sandstone concretion with reticulated ornamentation on the front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	Churinga is manufactured and covered with desert varnish from both sides.

Specimen's ID	291
Image front	
Image back	
Length, cm	8.5
Width, cm	4.5
Weight, g	107
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A sandstone block has a shape of a segment. Probably a churinga. Reticulated ornamentation is on the front and back side of the stone.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	A desert varnish and shallow engravings are from the both sides of the stone.

Specimen’s ID	292
Image front	
Image back	
Length, cm	13.5
Width, cm	7
Weight, g	212
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	Block has a shape of a segment. Probably a churinga. Reticulated ornamentation is on its both sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	A figure of a mammoth is turned left. It is noticeable due to the clear and visible trunk and two primitive tusks. Legs are short and fat. The head and the ear are considered in the complex. A tail has enlarged proportions and crosses with a vertical line, probably a spear. Generally, this image should be considered as one of the awkwardly pictured animals.
Description source 2	Danilenko 1986: 97 (fig. 48)

Descriptive image	 
Descriptive image 2	 
Note	A stone of irregular shape is covered with shallow engravings and desert varnish from both sides.

Specimen's ID	293
Image front	
Image back	
Length, cm	47
Width, cm	30
Weight, g	8700
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A sandstone block with an irregular shape that consists of five parts. The front side is covered with reticulated ornament.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	Stone broke in many parts that V. Danilenko glued after 1973. The desert varnish is on both sides.

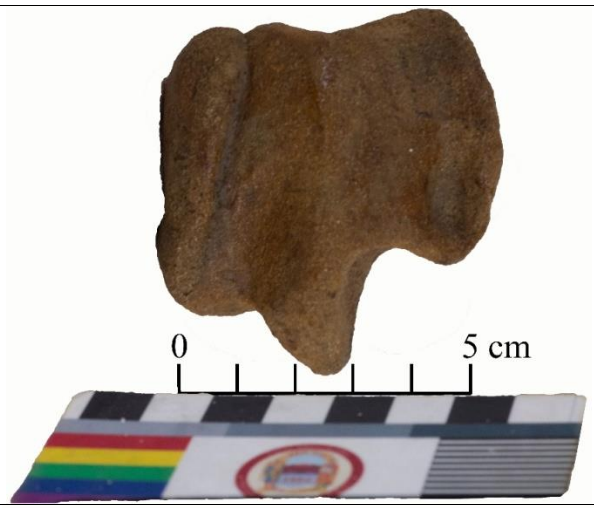
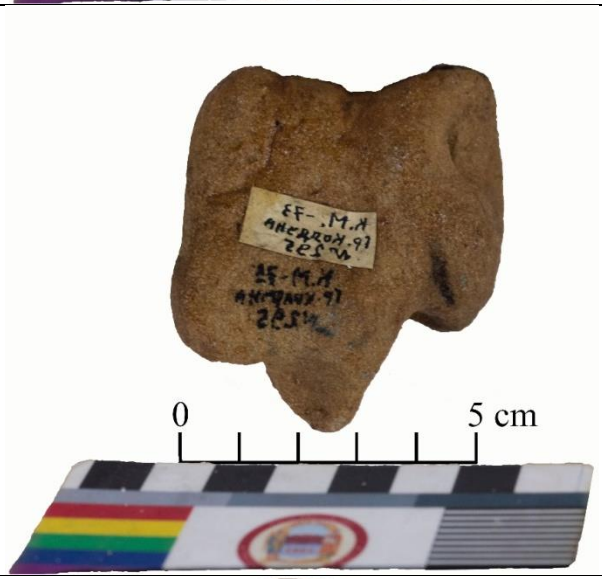
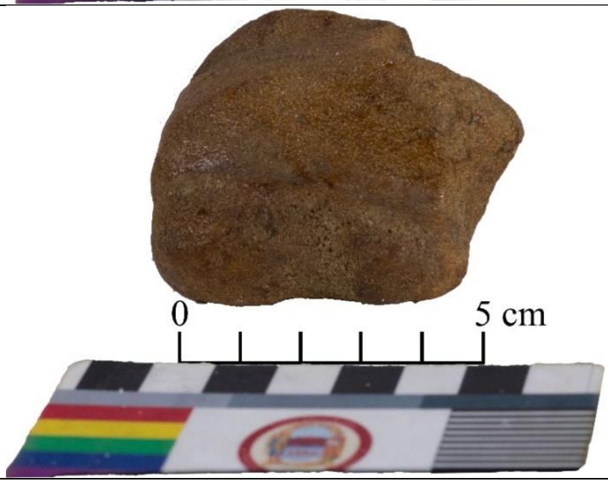
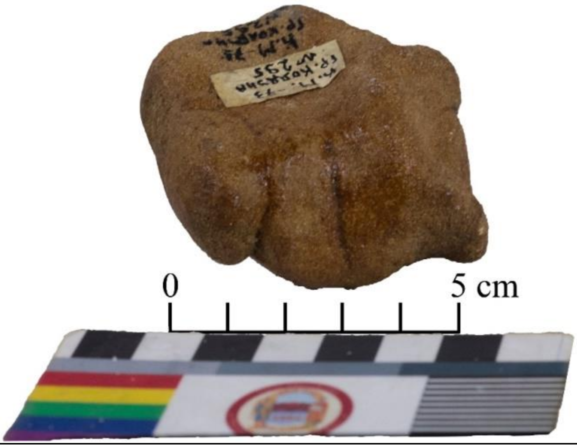
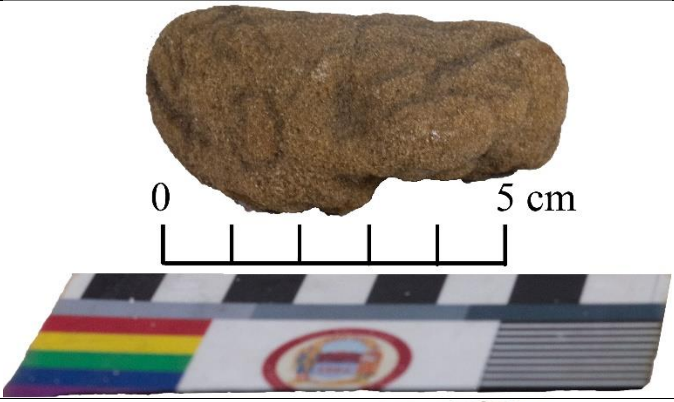
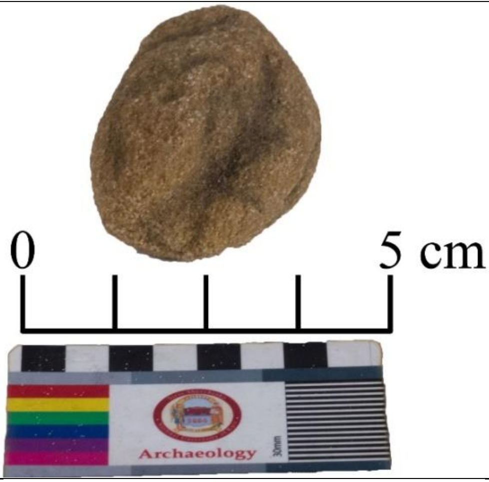
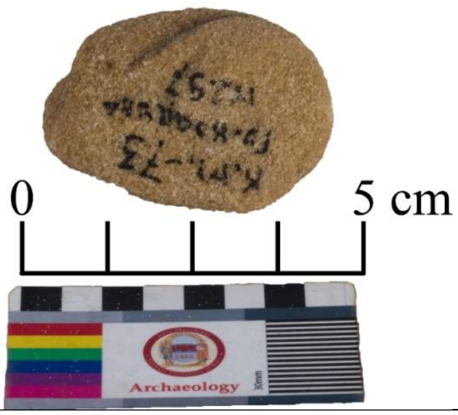
Specimen's ID	295
Image front	
Image back	
Image right	

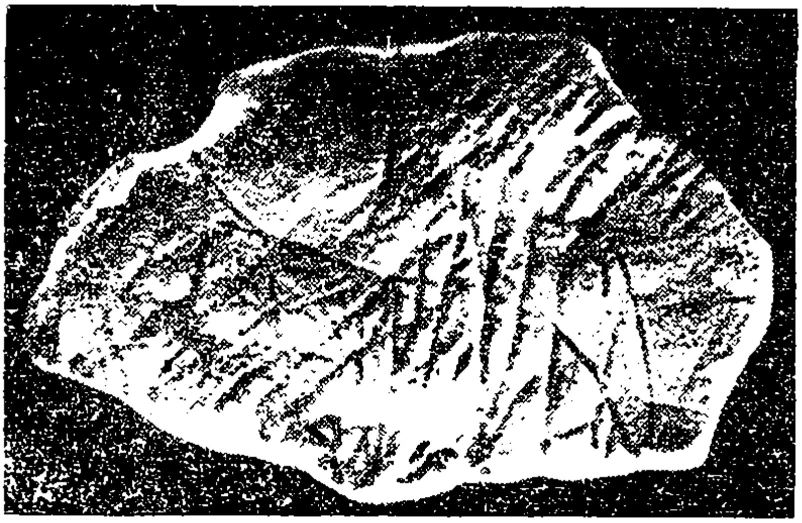
Image left	
Image bottom	
Image top	
Length, cm	7
Width, cm	5
Weight, g	154
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A sandstone sculpture shaped like a mammoth’s head. Its right ear is reconstructed because of the crumbling of a small fragment.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The shape of the stone is artificially processed. The stone is intensively covered with glue from all sides.

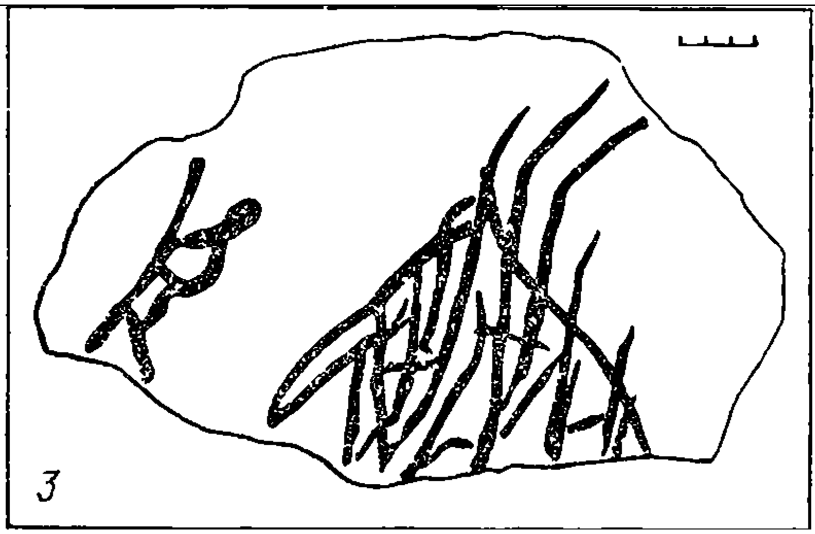
Specimen's ID	296
Image front	
Image back	
Image top	
Botoom image	

Length, cm	7
Width, cm	4
Weight, g	95
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A sandstone sculpture schematically represents a mammoth’s figure.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The stone is covered with desert varnish and shallow non-figurative engravings from all sides. Some of them are deep. The shape is artificially processed.

Specimen's ID	297
Image front	
Image back	
Length, cm	4
Width, cm	2.3
Weight, g	20
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A sandstone sculpture that represents a head of an animal (possibly a bear).
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The smallest stone from the collection. Its shape was artificially processed (polished) and covered with a few engravings. One of them is more profound than the others.

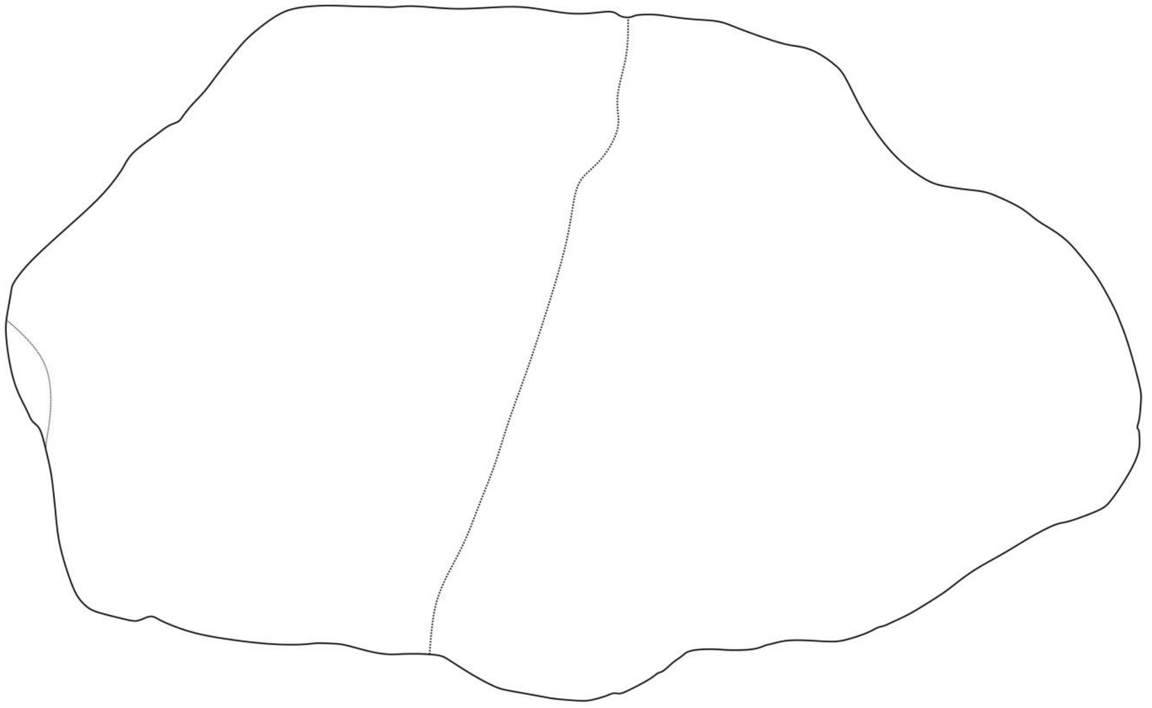
Specimen's ID	298
Image front	
Image back	
Length, cm	28
Width, cm	16.5
Weight, g	2947
Volume, m^3	0.001553
Density, kg / m^3	1897.61751
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard's” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The block has irregular segment-like shape with one-sided linear and geometric engravings.
Description source	The storage list of Institute of Archaeology in Kyiv

Description 2	The composition is one-sided; it covers the block of suboval shape (length 30 cm and width 18 cm). The central part of the composition presents the subtriangular figure that includes 15 lines (branches) connected on their top in a particular way. This also includes a small subtriangular figure in the lower central part of the big triangle. This may mark an entrance to the dwelling. Left from the latter is a woman figure with her head slightly lower than the roof of the dwelling. She has tiny convex breaths.
Descriptive image	 

	
Description source 2	Danilenko 1986: 116
Note	The block is covered with desert varnish from the front side. After the engravings were created, churinga broke into two parts and had been glued by V. Danilenko after 1973. The block is covered with reticulated ornament. It is noticeable that shallow engravings are oriented diagonally and located in the block’s upper part. At the same time, deep notches are vertical and primarily located in the lower part of the block. The engravings that were interpreted as a dwelling and a human being are presented on the block. However, the interpretation remains dubious — details differ from what Danilenko depicts. Therefore, this interpretation requires additional archaeological expertise.

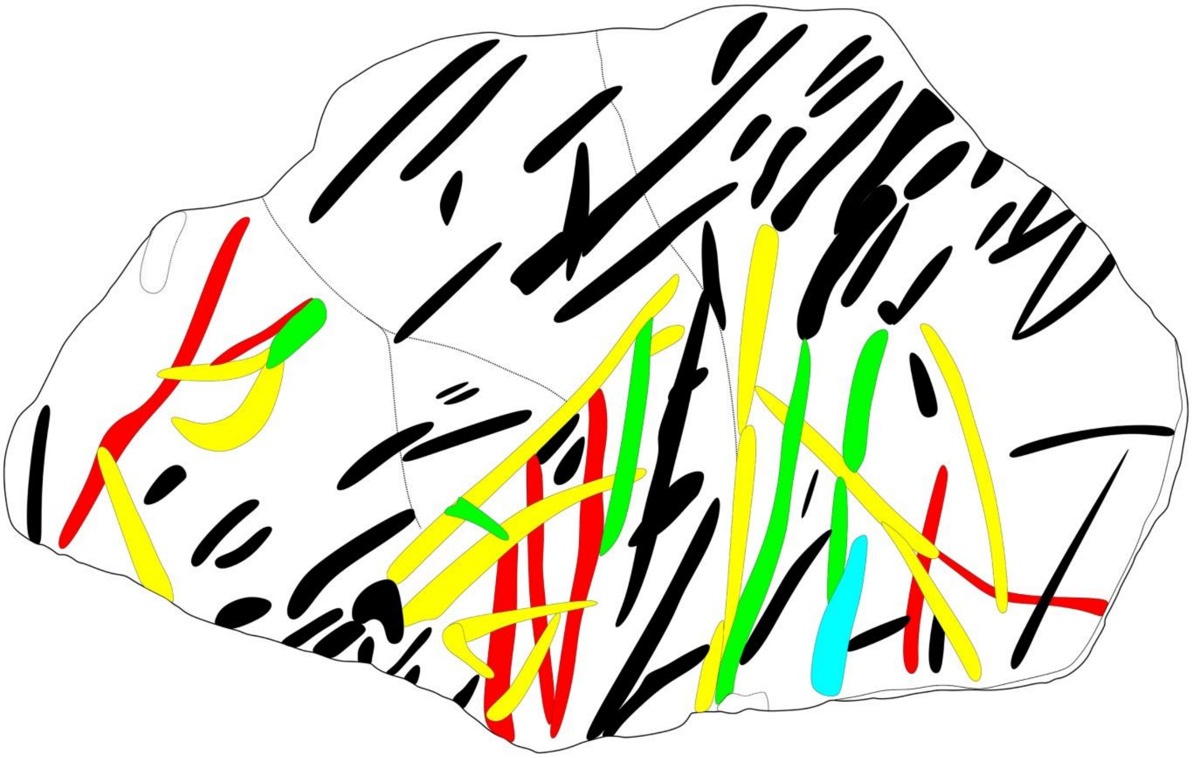
Technological drawing front

Technological drawing back

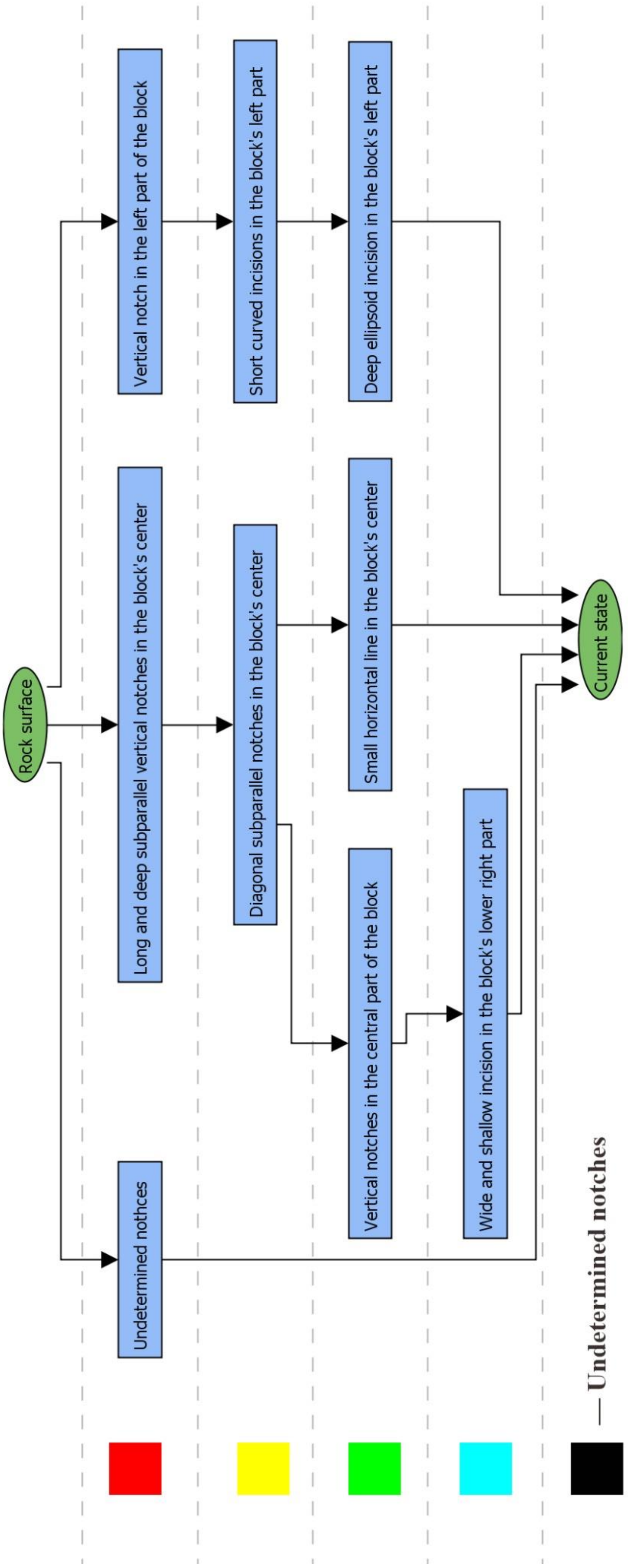


The incisions interpreted by V. Danilenko as parts of semantic composition

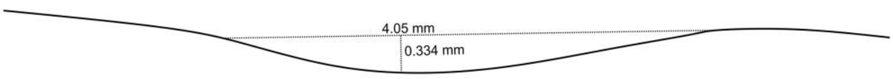
Relative chronology drawing front

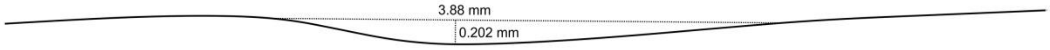


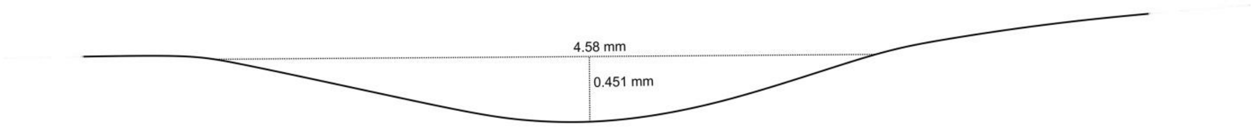
Harris matrix front

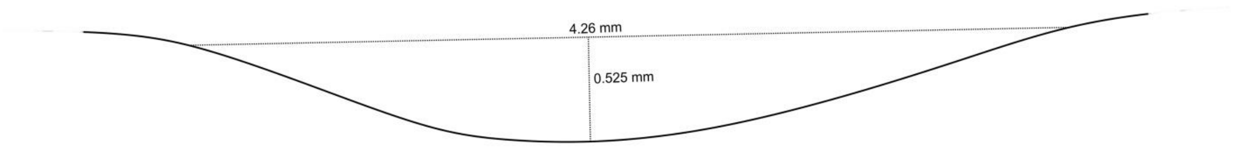


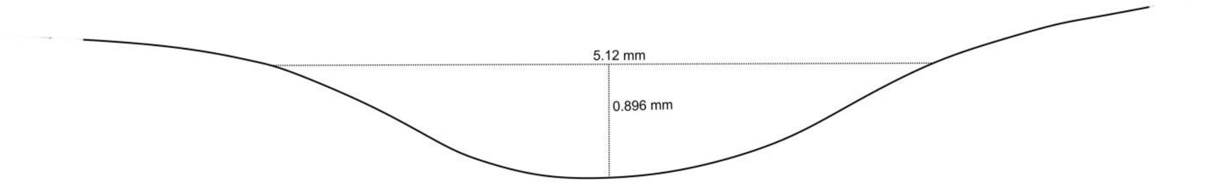
Profiles list

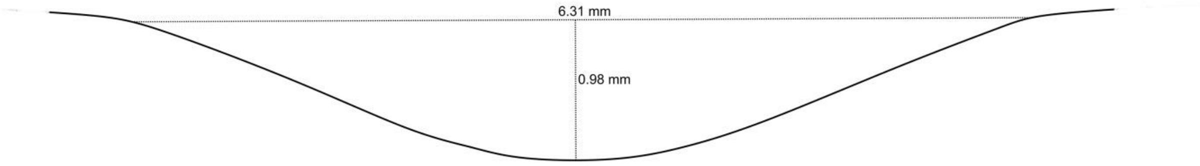


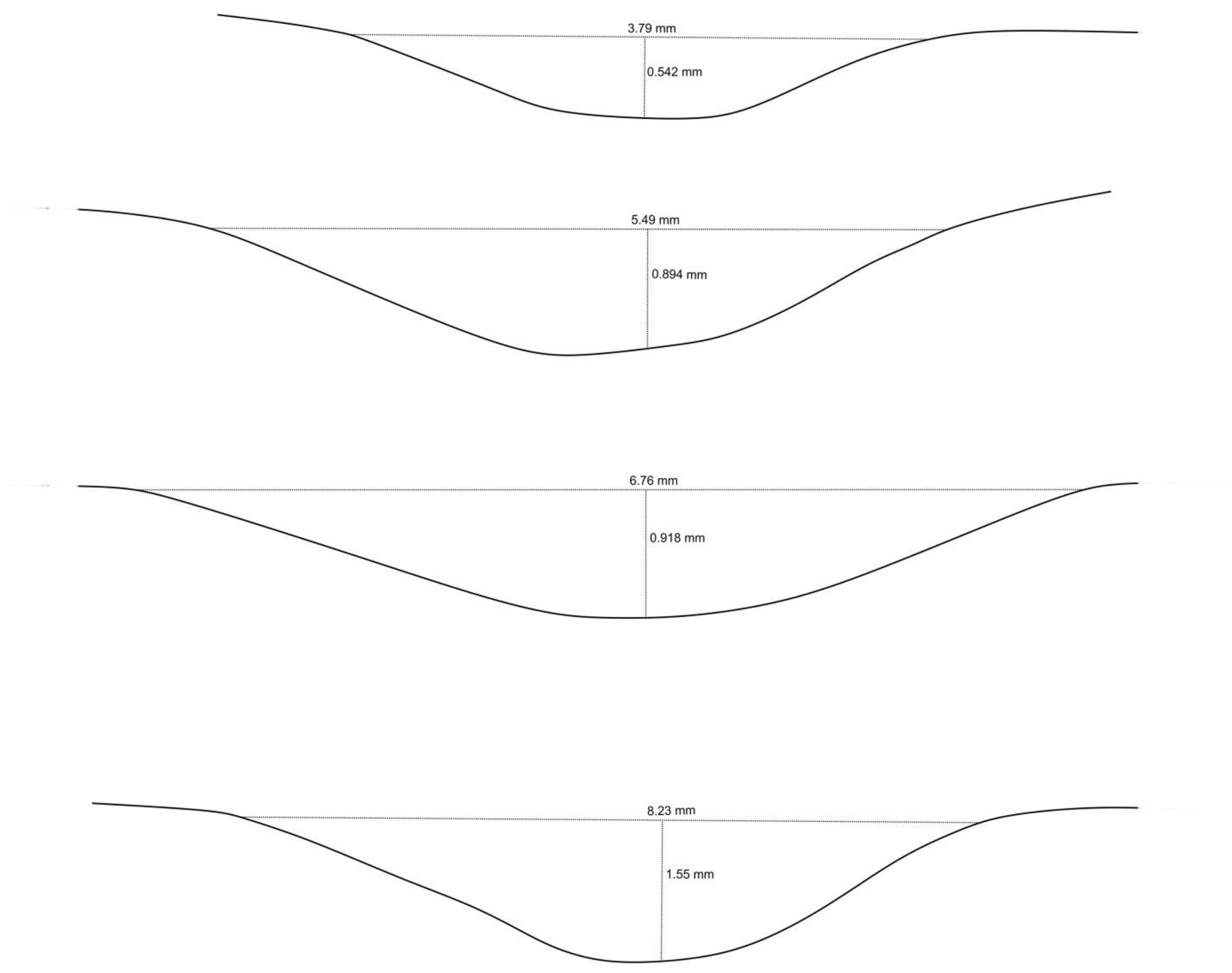




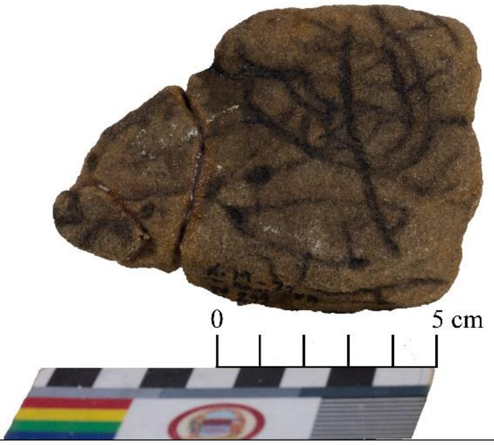








3.79 mm
0.542 mm
5.49 mm
0.894 mm
6.76 mm
0.918 mm
8.23 mm
1.55 mm

Specimen’s ID	299
Image front	
Image back	
Length, cm	11
Width, cm	8
Weight, g	240
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A piece of sandstone block in a shape of a segment. Possibly a churinga with linear and geometric (reticulated) ornamentation from both sides of a block.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	A stone broke up in two parts and was glued by V. Danilenko after 1973. Both sides of the churinga are covered with desert varnish and non-figurative engraved ornament.

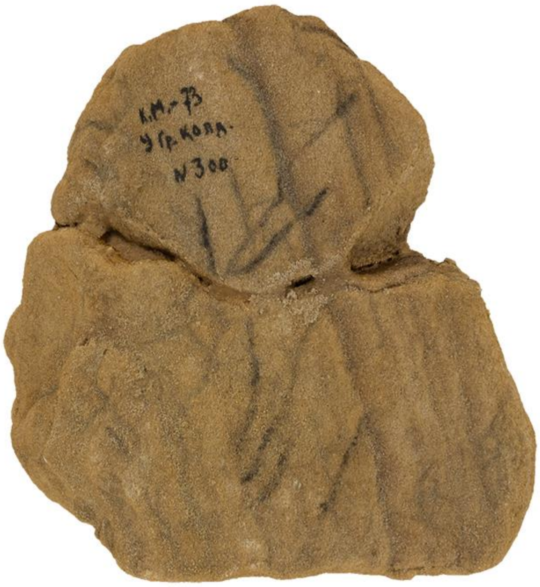
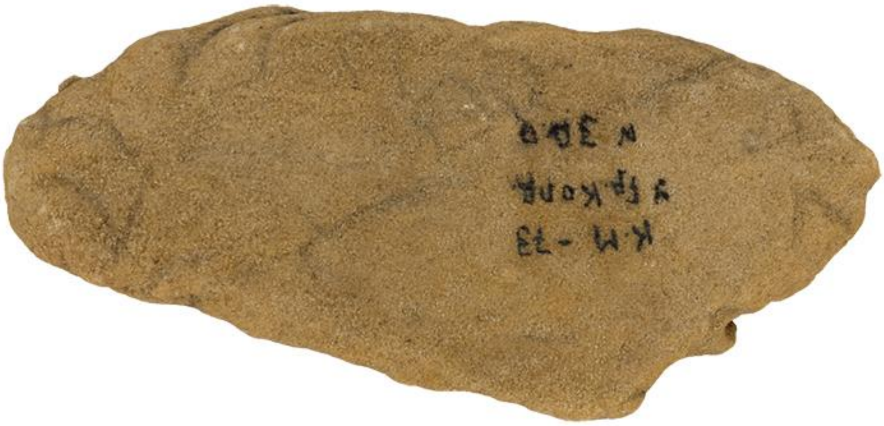
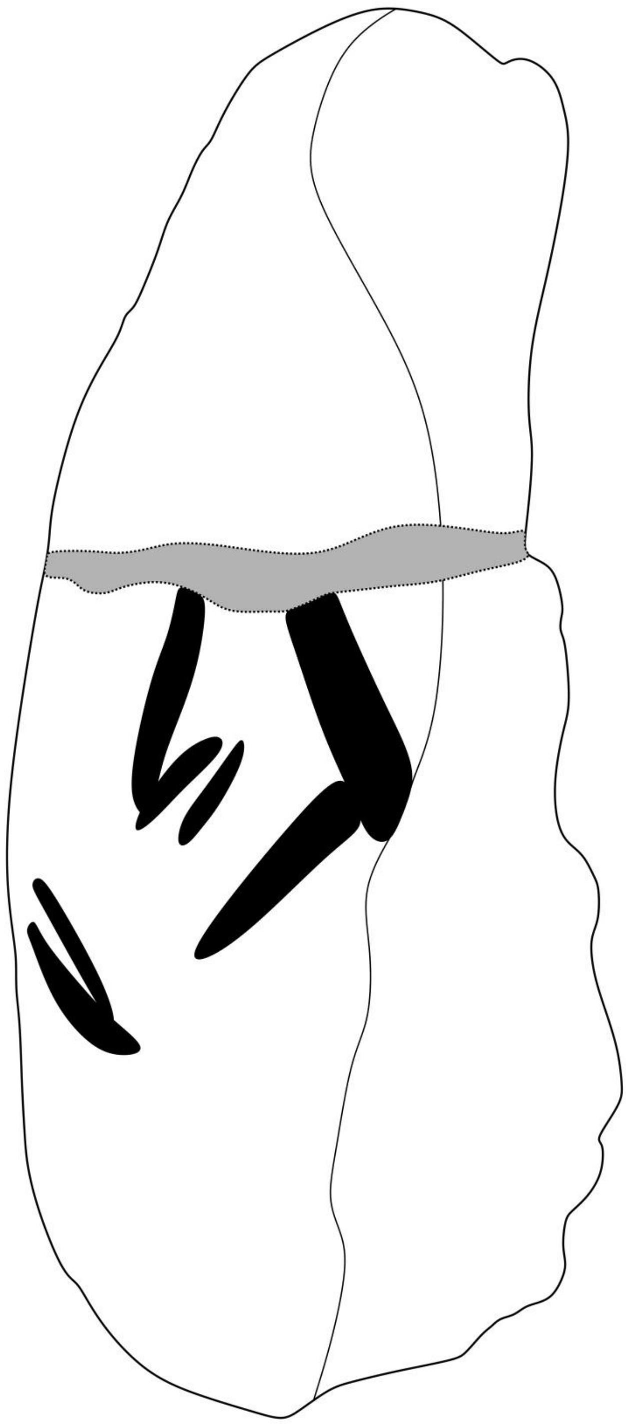
Specimen's ID	300
Image front	
Image right	
Image back	

Image left	
Image top	
Image bottom	
Length, cm	16
Width, cm	10

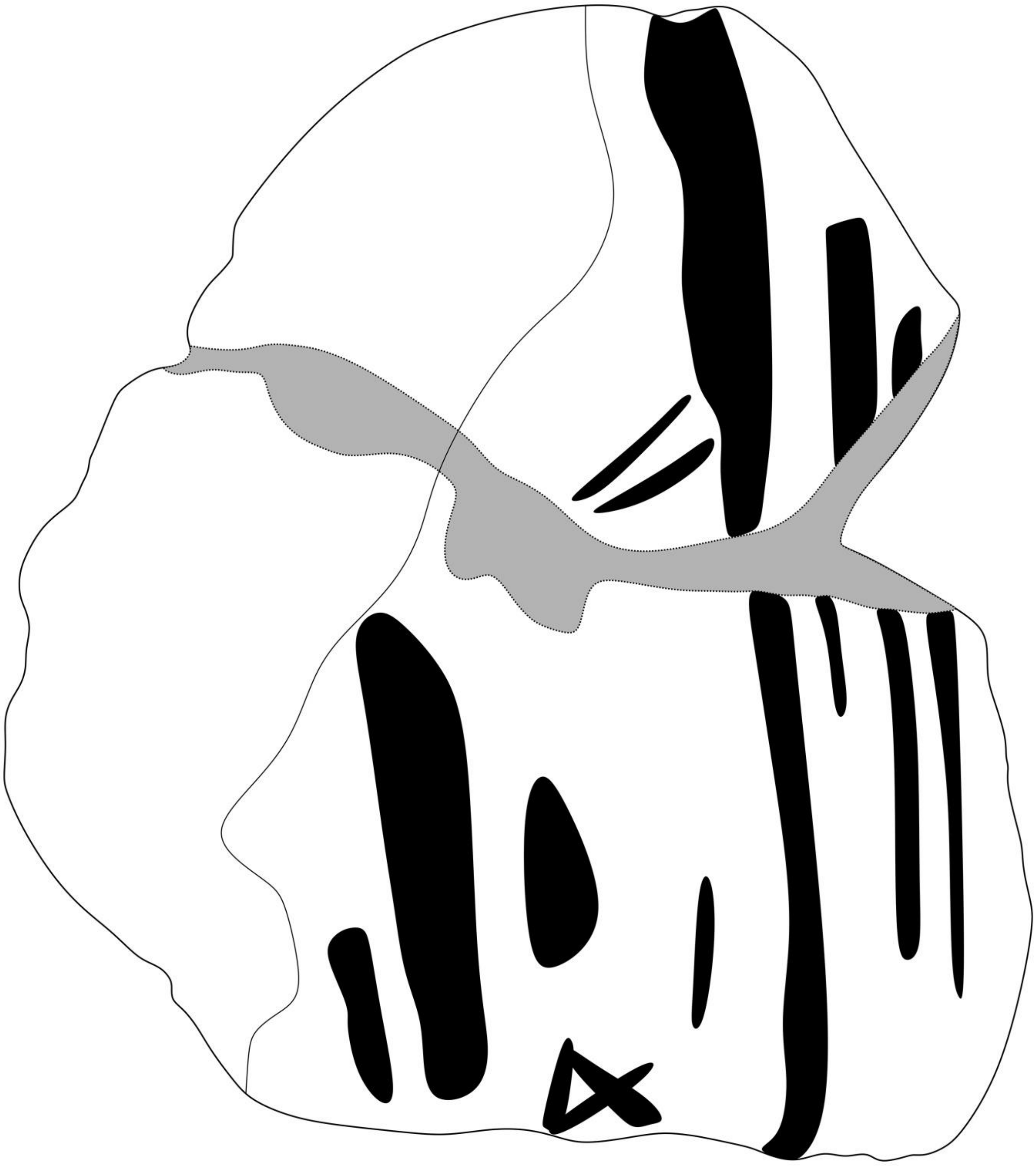
Weight, g	2429
Volume, m^3	0.001247
Density, kg / m^3	1947.8749
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A sandstone block (fallen in two parts) contains incisions from one side. The incisions depict a high relief in a finger-like shape.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block has been broken into a few pieces. Two of them were found and glued by V. Danilenko. It contains a series of linear subparallel engravings from both sides. Their profiles are complex but primarily similar. The engravings were created before the block broke. The stone might be considered a part of the wall. The surfaces were not polished from any side and were not covered with recognizable traces of desert varnish. The nature of subparallel engravings is unclear — they might be either zoogenic or anthropogenic.

Technological drawing front

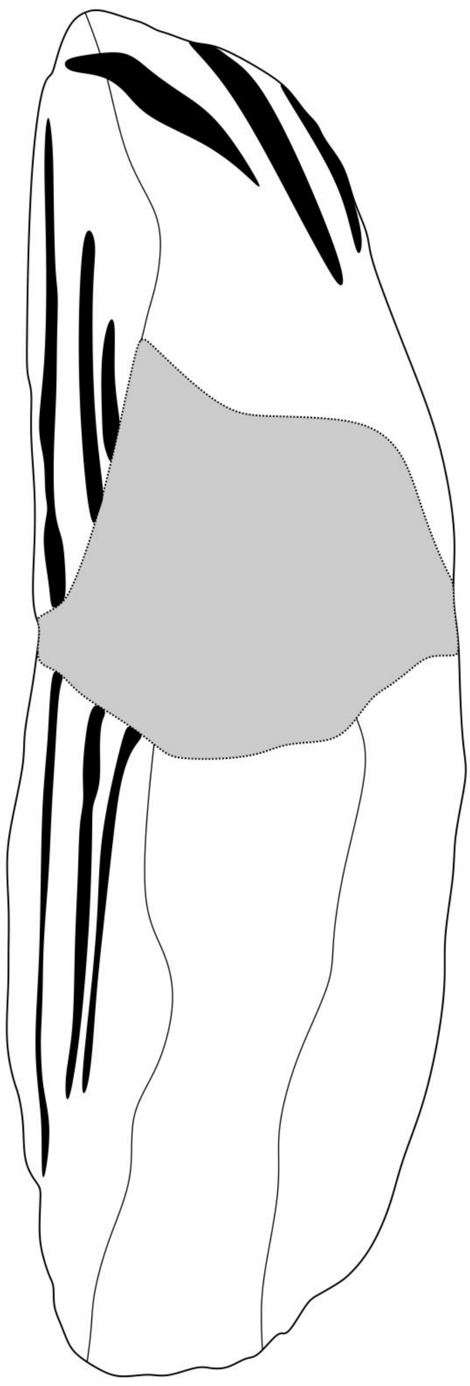
Technological drawing right



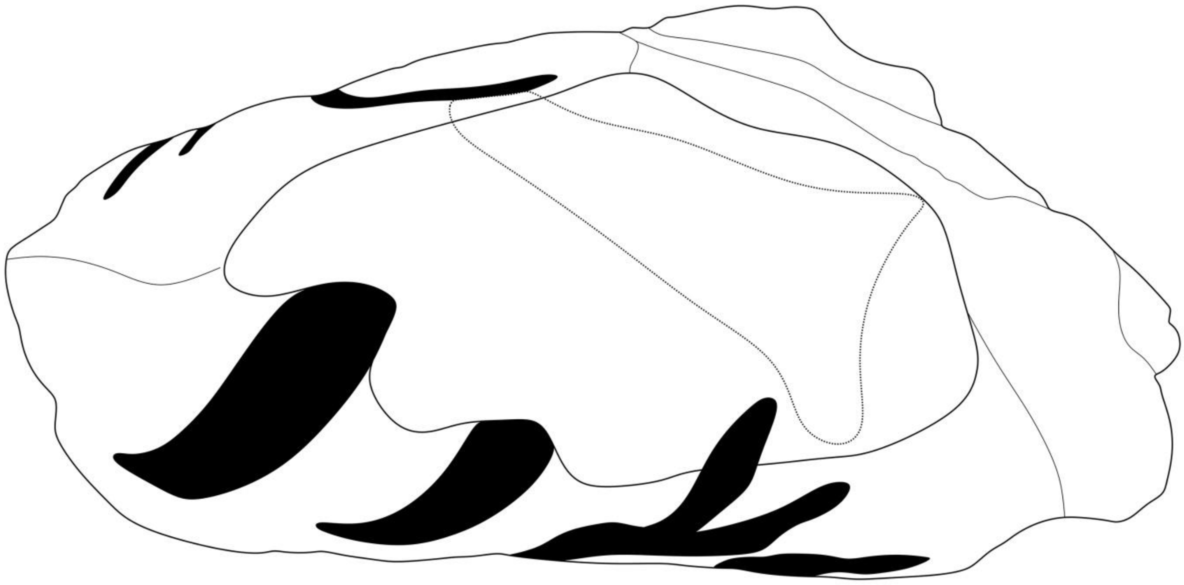
Technological drawing back



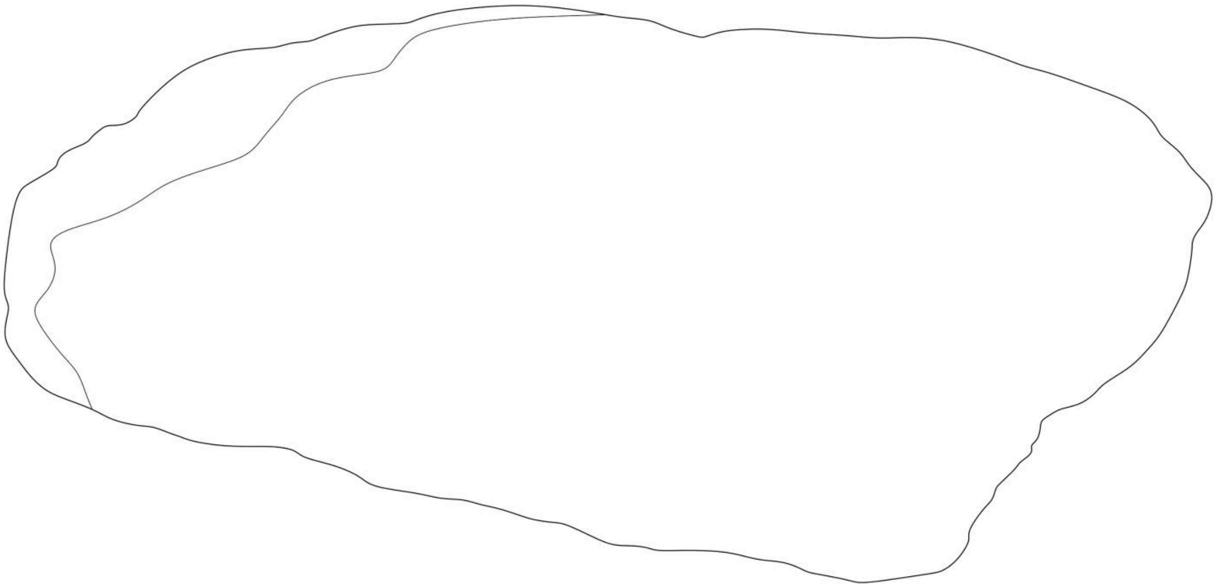
Technological drawing left



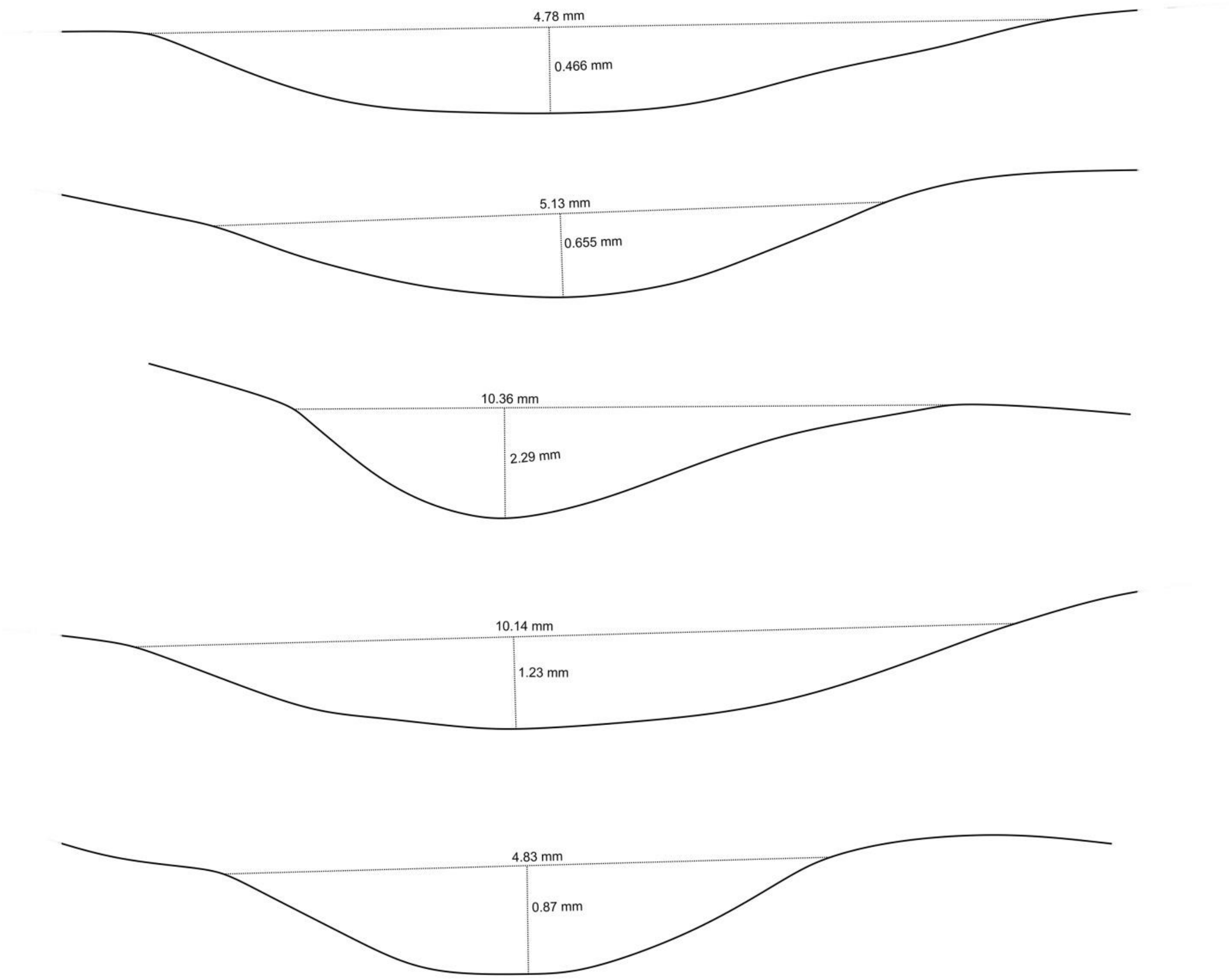
Technological drawing top

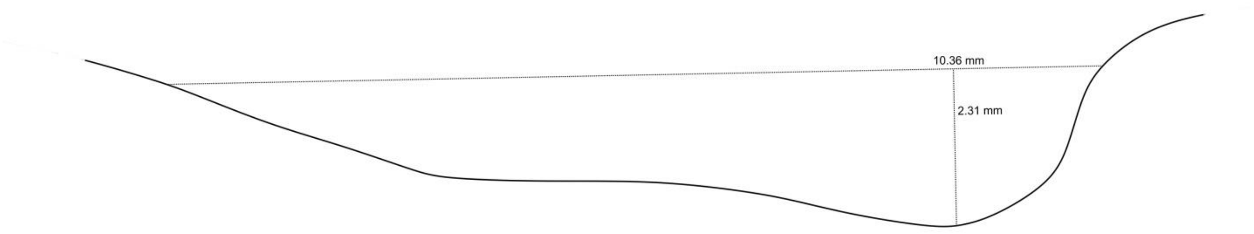


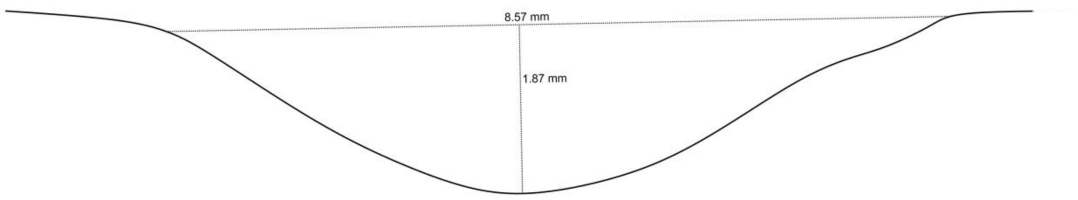
Technological drawing bottom

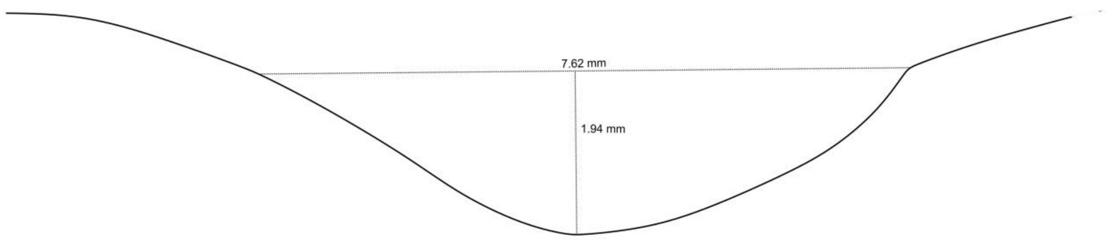


Profiles list



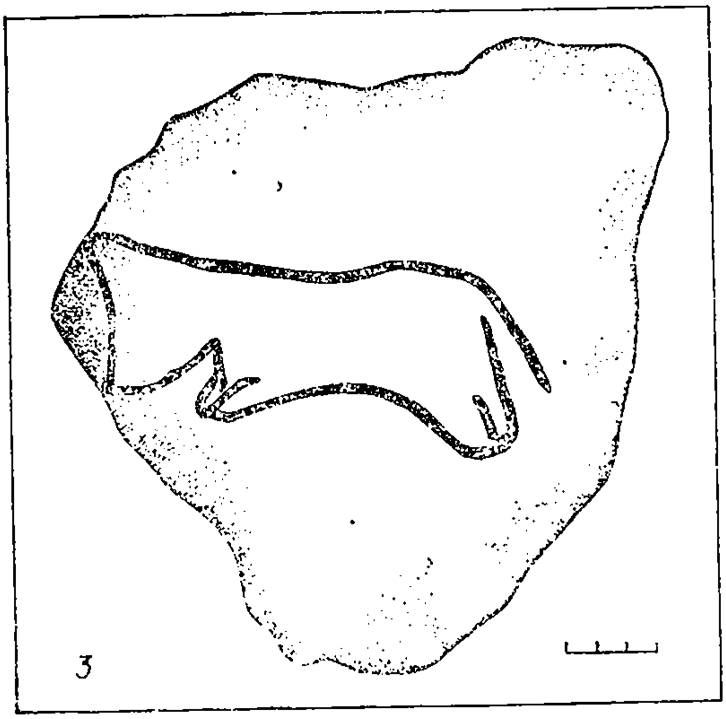

10.36 mm
2.31 mm

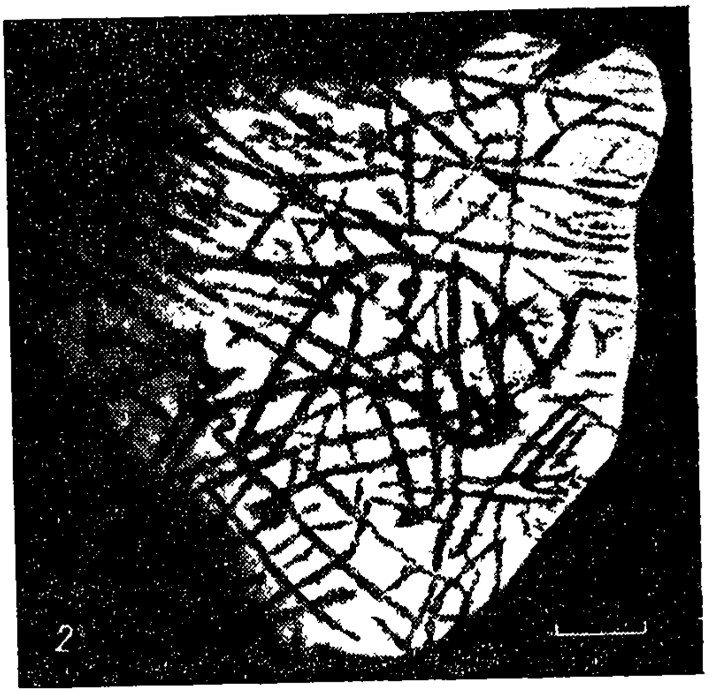

8.57 mm
1.87 mm

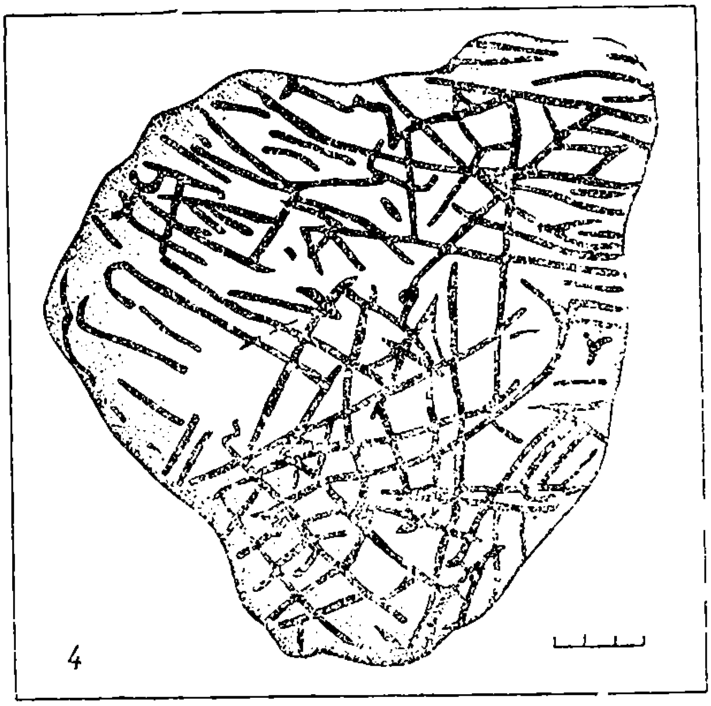

7.62 mm
1.94 mm

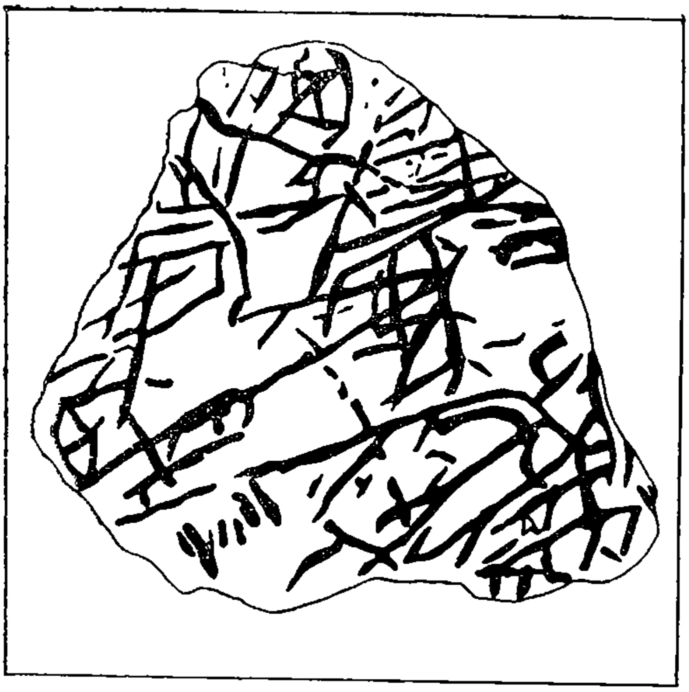
Specimen's ID	302
Image front	
Image back	
Length, cm	22.5
Width, cm	19.3
Weight, g	1270
Volume, m^3	0.000658
Density, kg / m^3	1930.09119
Date of discovery	1973
Finder	V. Danilenko

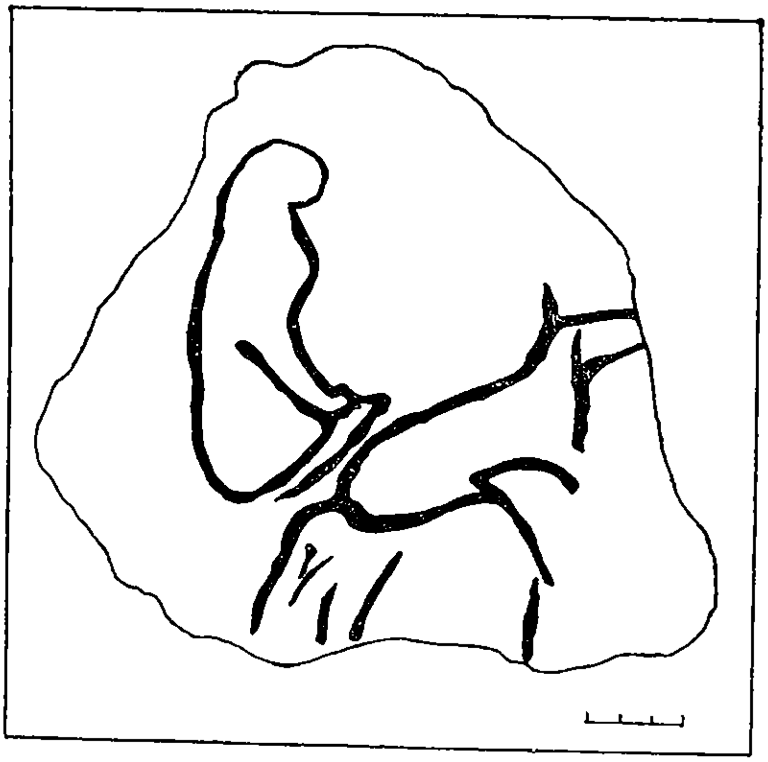
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	Subtriangular block with linear and geometric engravings on the both sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	A block contains a complex composition from both sides of the subtriangular block. The front side of the block shows a reticulated diagonal ornament. Its left part contains a predator’s profile image. The predator belongs to the wolf’s breed and has a massive head and legs. The combination of reticulated ornament and the wolf’s images allows assuming that the latter is in the trap (fig. 54). The back side of the block also contains a reticulated ornament as a background. Two different animals superimpose it. On the left of the block’s center, a predator similar to a cat is located. This might be considered as a female of a cave lion depicted from the right. She is sitting on her hind legs and rests on the front ones. The letters are in touch with the formers. Her shoulders are massive and well-depicted; her head has a circular shape. On the right part of the block, linear elements create a zoomorphic motif of a deer or a goat that lies on the ground. The composition, in general, probably shows the cave lion watching its prey (fig. 55).

Descriptive image	 


2


4



	 
Description 2 source	Danilenko 1986: 101—103
Note	The block is covered with numerous linear engravings from the front and back sides. The back side is also slightly darker than the front side due to the more intense desert varnish. The semantic compositions interpreted by V. Danilenko are not evident. The number of linear engravings assumed to present the wolf, the lion, and the deer is noticeable, but the engravings, as V. Danilenko depicts them,

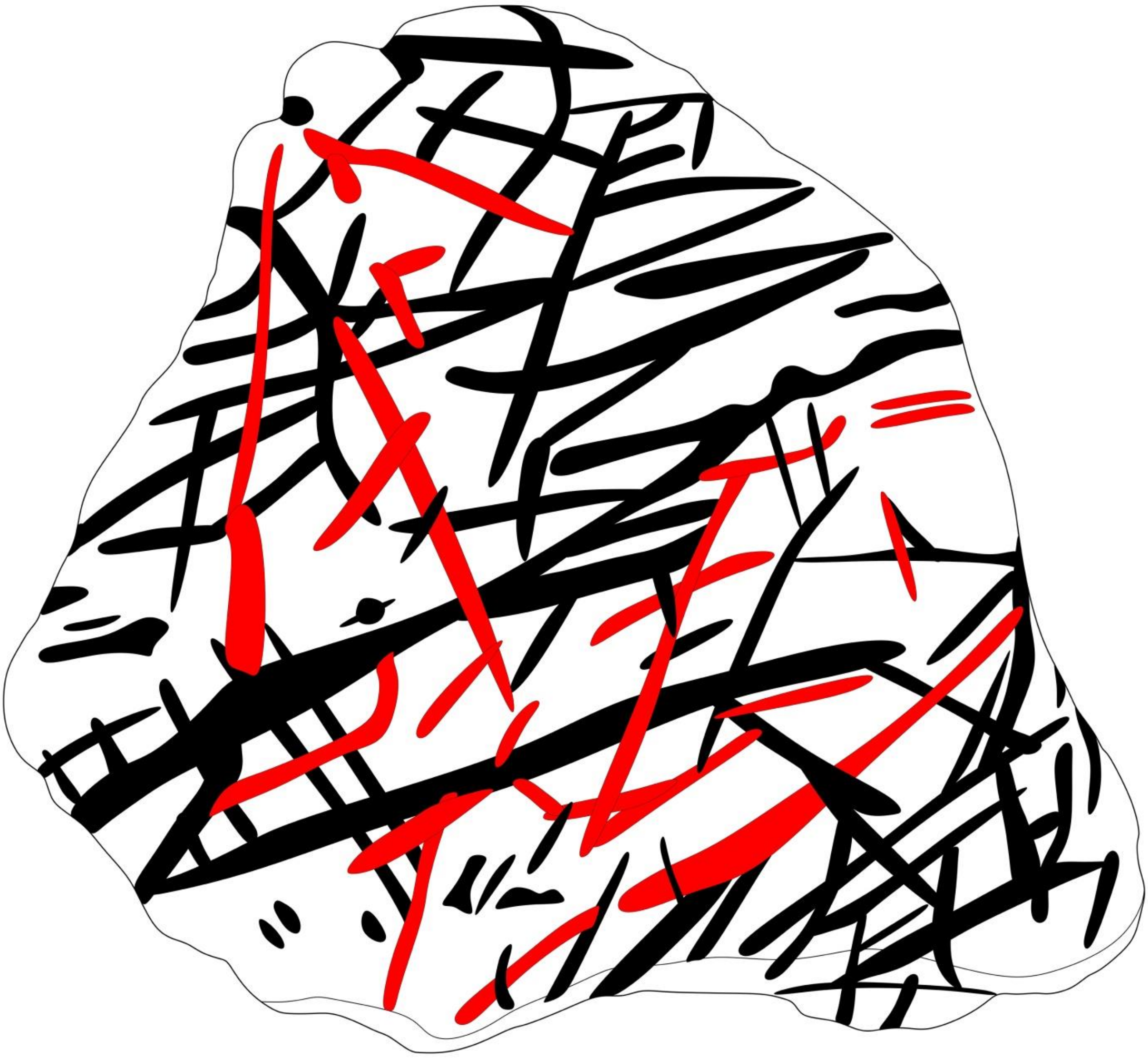
	are absent. The engravings are very numerous, and the relative chronology is complex, though the general patterns are evident and mutual to those from the rest of Kamyana Mohyla churingas: parallel lines mostly belong to the same phase; shallow engravings are usually superimposed by pairs of parallel and deeper ones with the non-symmetric profile. The semantic interpretation made by V. Danilenko would require additional archaeological expertise. However, these motifs are proved to be absent on the block surface.

Technological drawing front

Technological drawing back

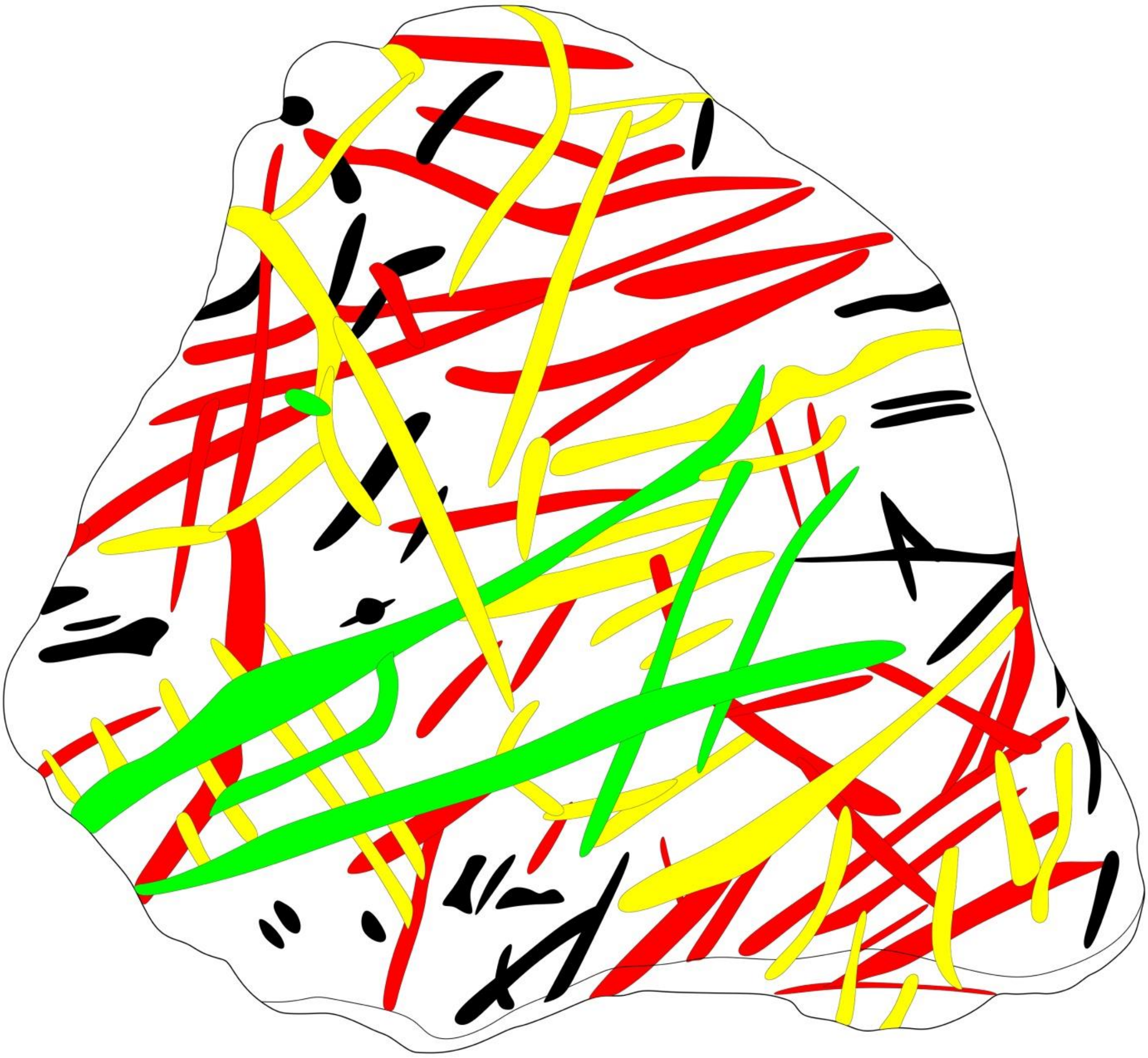
The incisions interpreted by V. Danilenko as parts of semantic composition (front)

The incisions interpreted by V. Danilenko as parts of semantic composition (back)

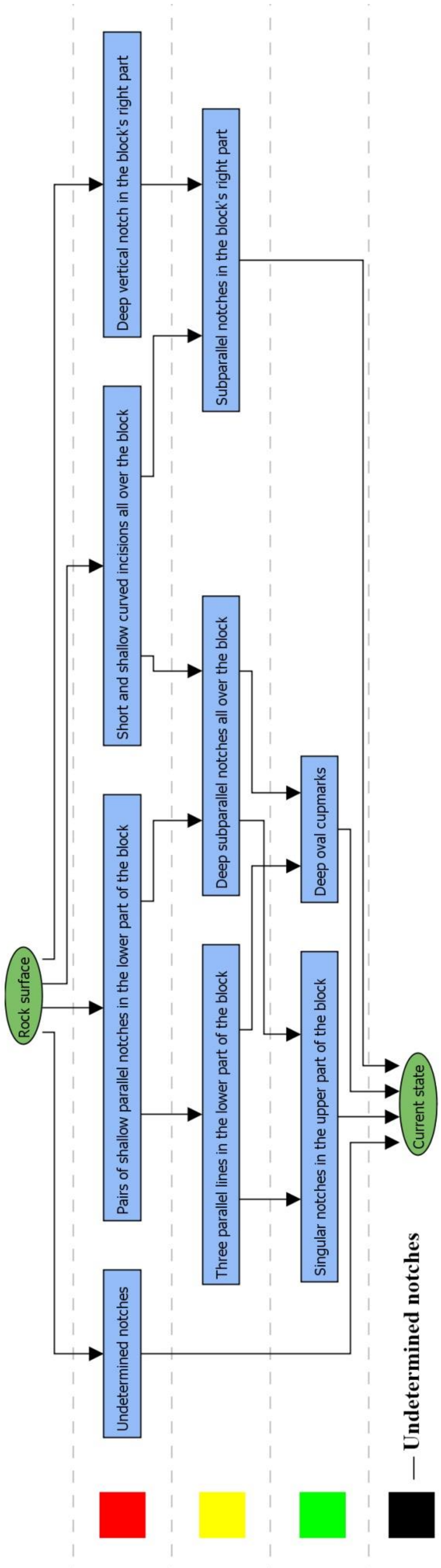


Relative chronology drawing (front)

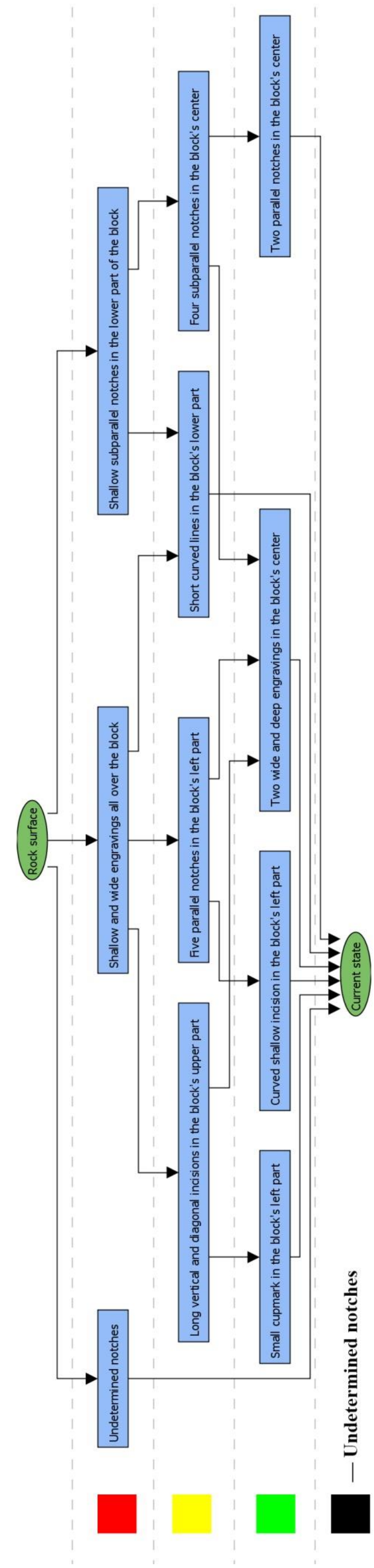
Relative chronology drawing (back):



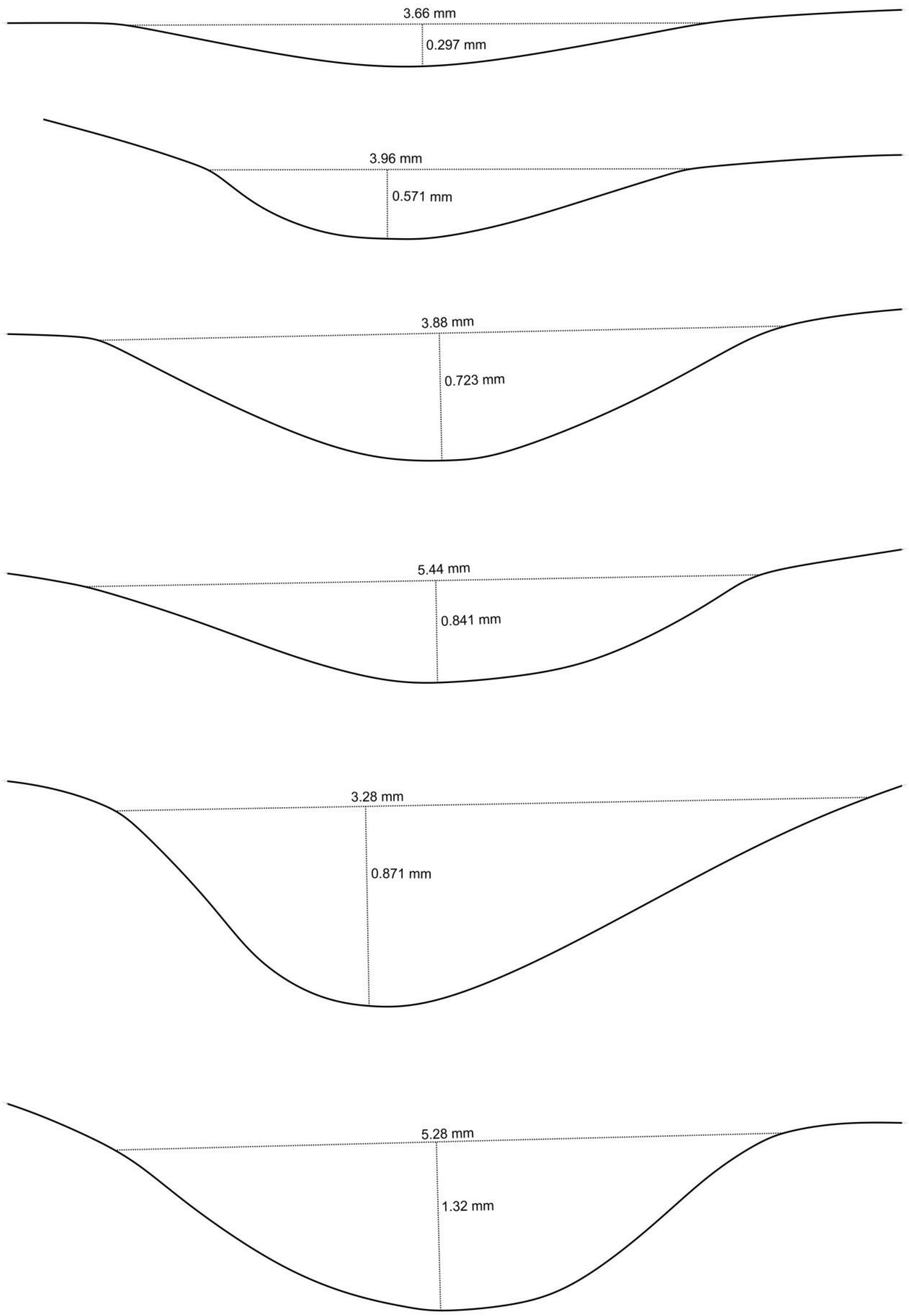
Harris matrix front

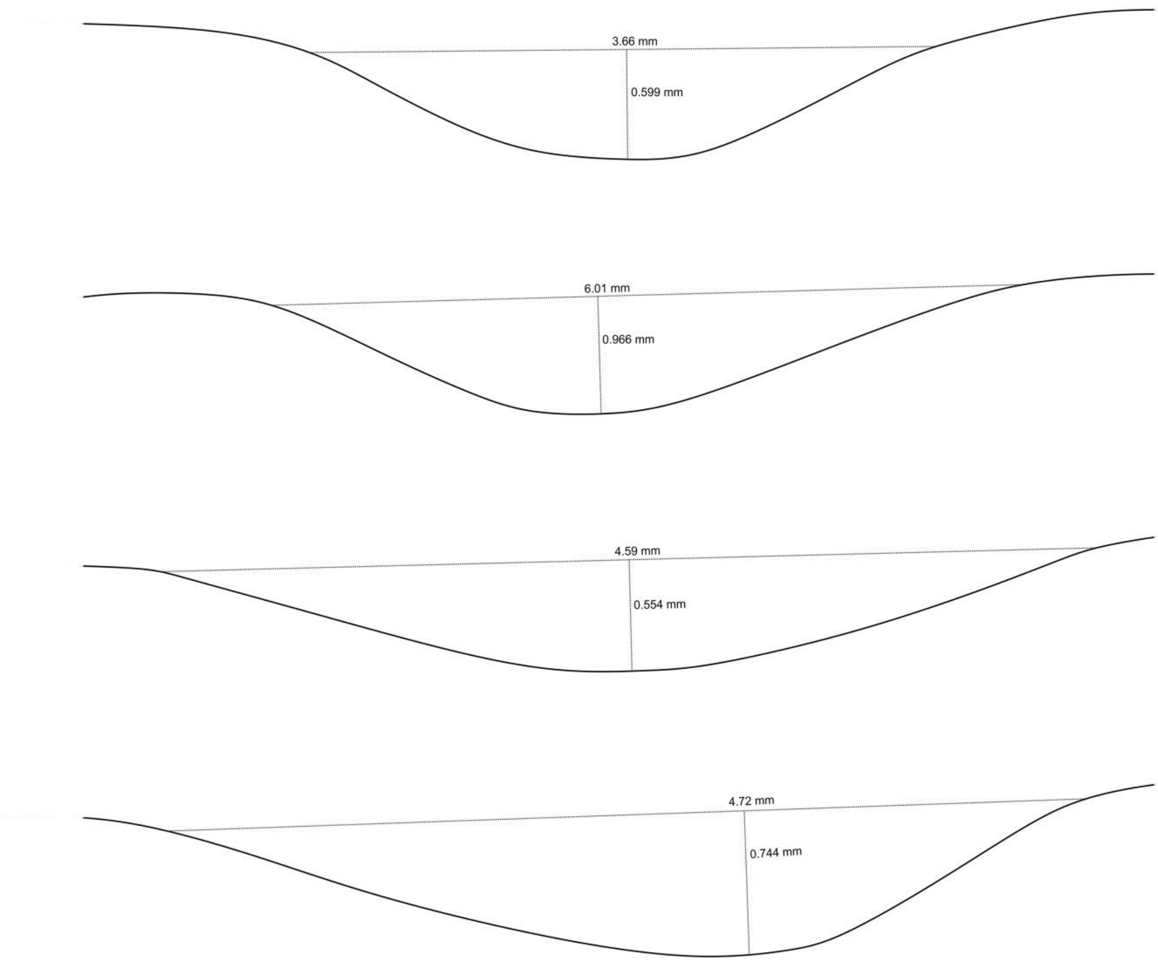


Harris matrix back

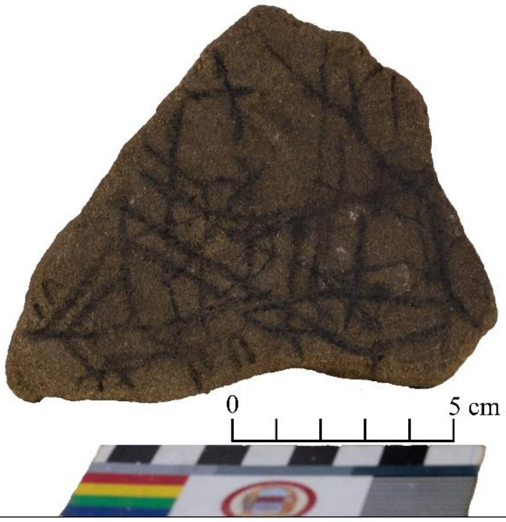
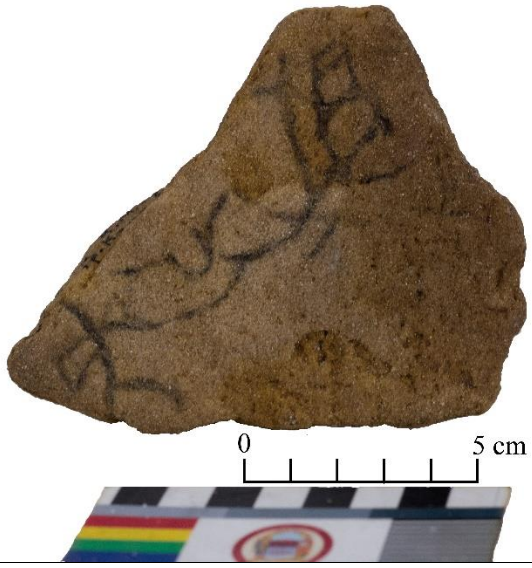


Profiles list




3.66 mm
0.599 mm
6.01 mm
0.966 mm
4.59 mm
0.554 mm
4.72 mm
0.744 mm

Specimen's ID	304
Image front	
Image back	
Length, cm	8
Width, cm	6
Weight, g	78
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A piece of oval-shape sandstone block with the engravings from its both sides. Might be considered as an upper part of anthropomorphic figure.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	A stone is covered with desert varnish. The front side contains non-figurative engravings, while the back one is polished.

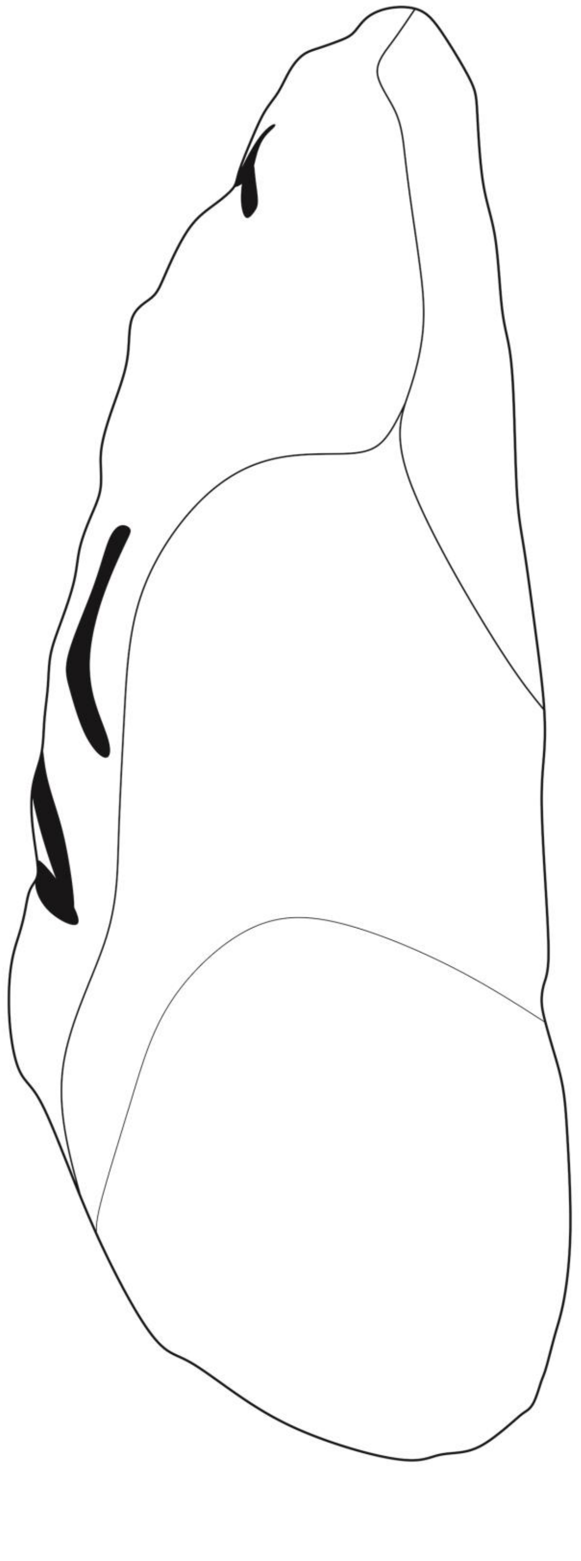
Specimen’s ID	305
Image front	
Image back	
Length, cm	11.5
Width, cm	10.5
Weight, g	240
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A subtriangular sandstone block is engraved both from the front and back sides. One side contains a single engraving. The other one reveals a complex system.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	A block is covered with desert varnish from both sides. The sides are polished and covered with shallow engravings. The back side of the stone appears to be in a poor position.

Specimen's ID	306
Image front	
Image right	
Image back	

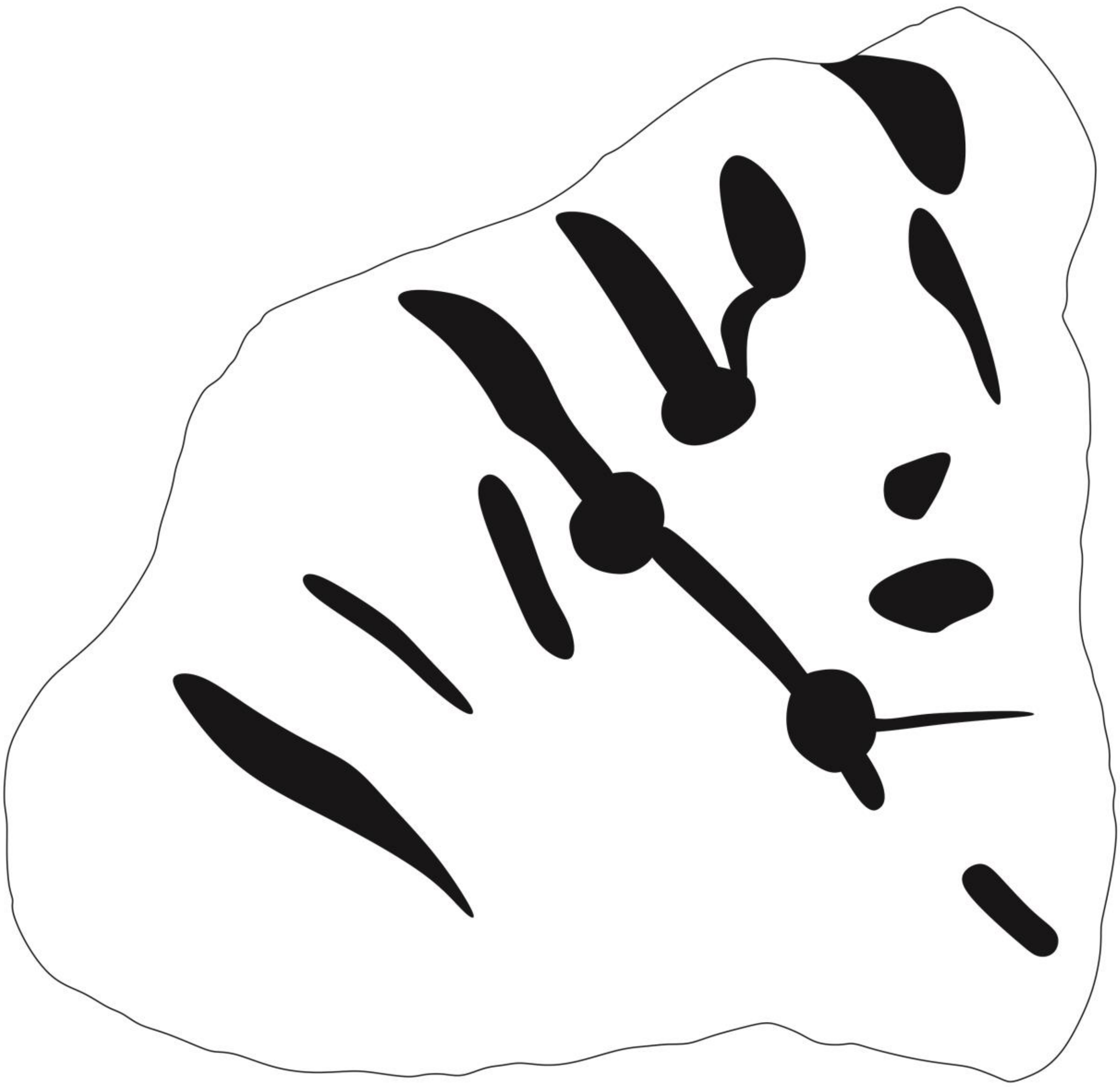
Image left	
Length, cm	11.5
Width, cm	10.5
Weight, g	192
Volume, m^3	0.000100
Density, kg / m^3	1920.0000
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	Subtriangular block with engravings from both sides. The back side includes one incision, and the front one — a complex system.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. It contains a series of linear engravings. Most of them are shallow and subparallel incisions. After their engraving, a part of the block crashed. The back side of the block also contains several parallel wide notches and a few cupules. The cupules are deep and have irregular profiles. The block contains a line with the V-shape profile of probably anthropogenic origin that is quite rare on the other specimens.

Technological drawing front

Technological drawing right

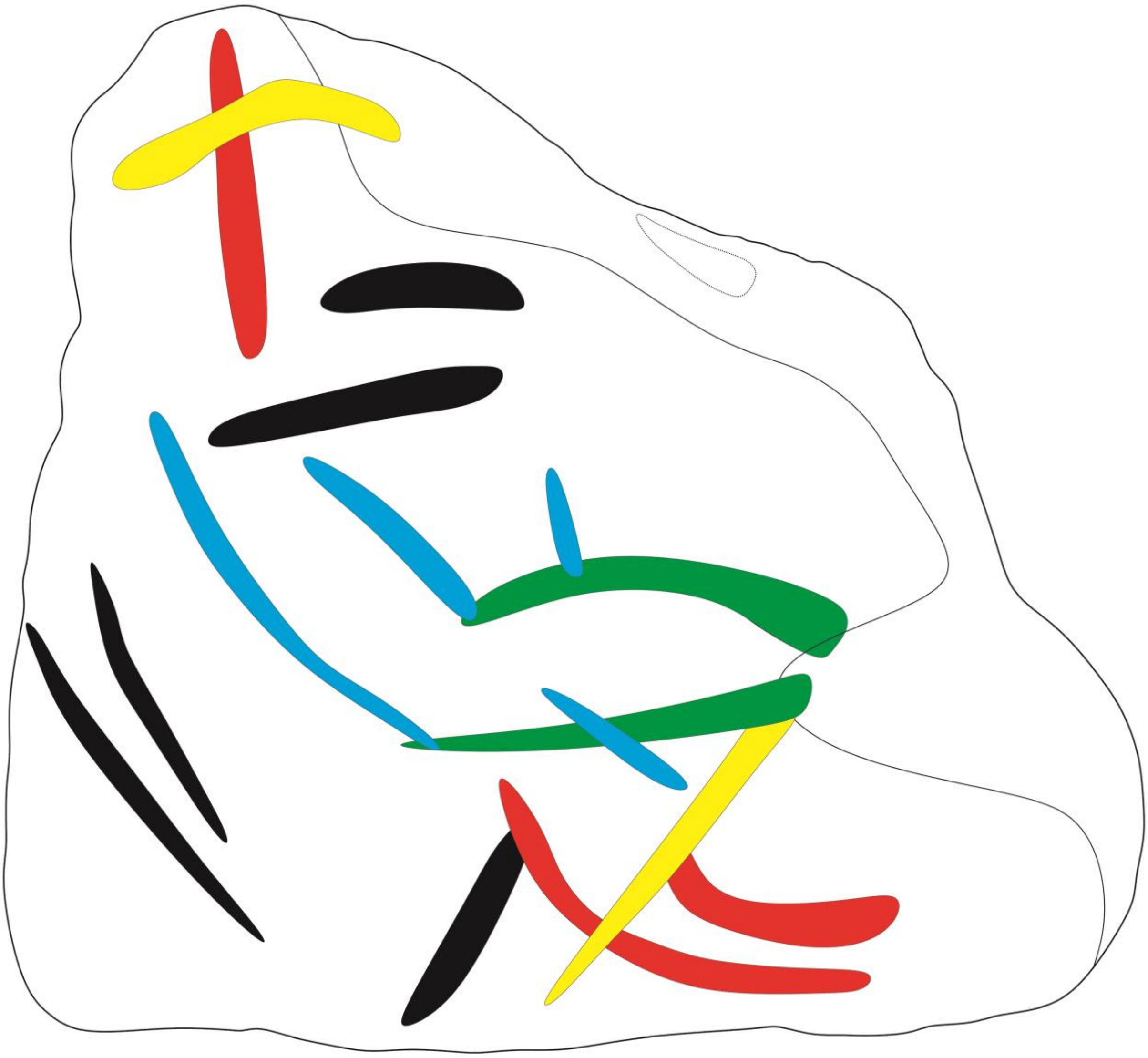


Technological drawing back

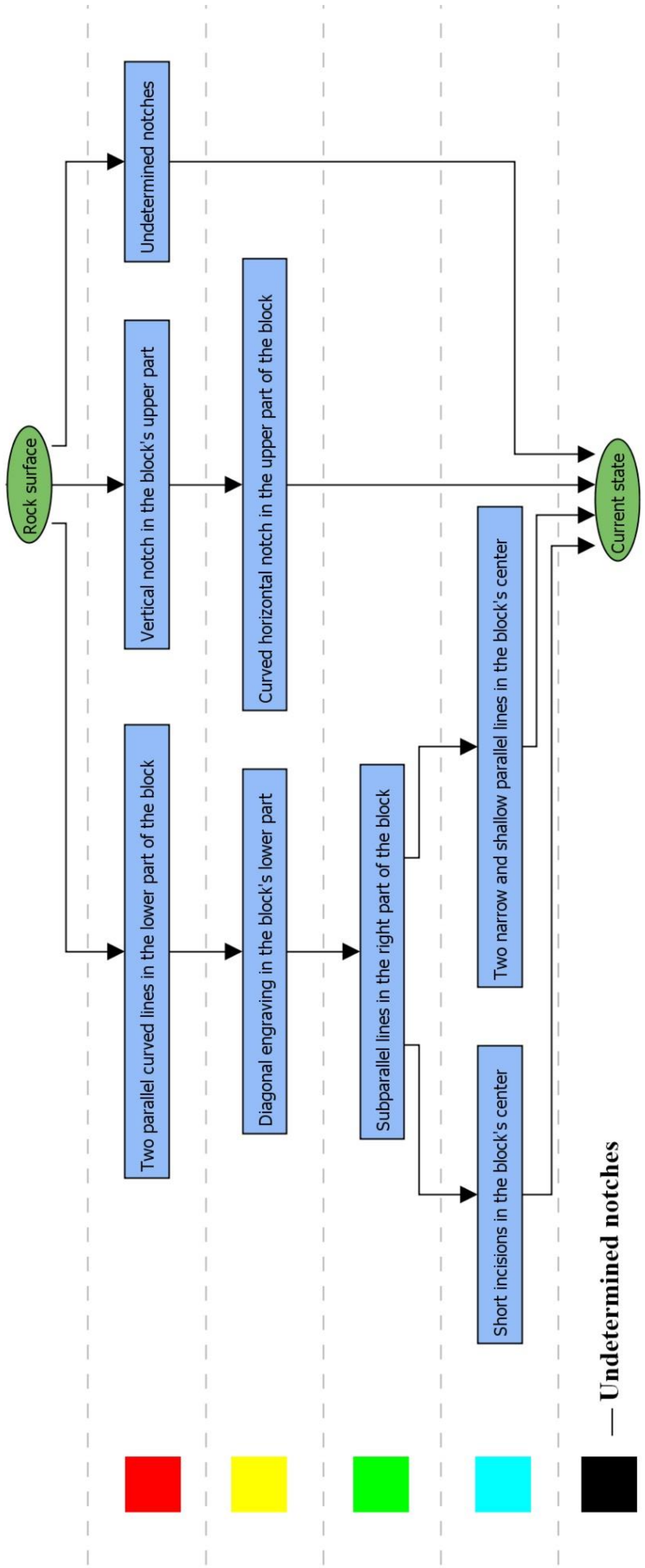


Technological drawing left

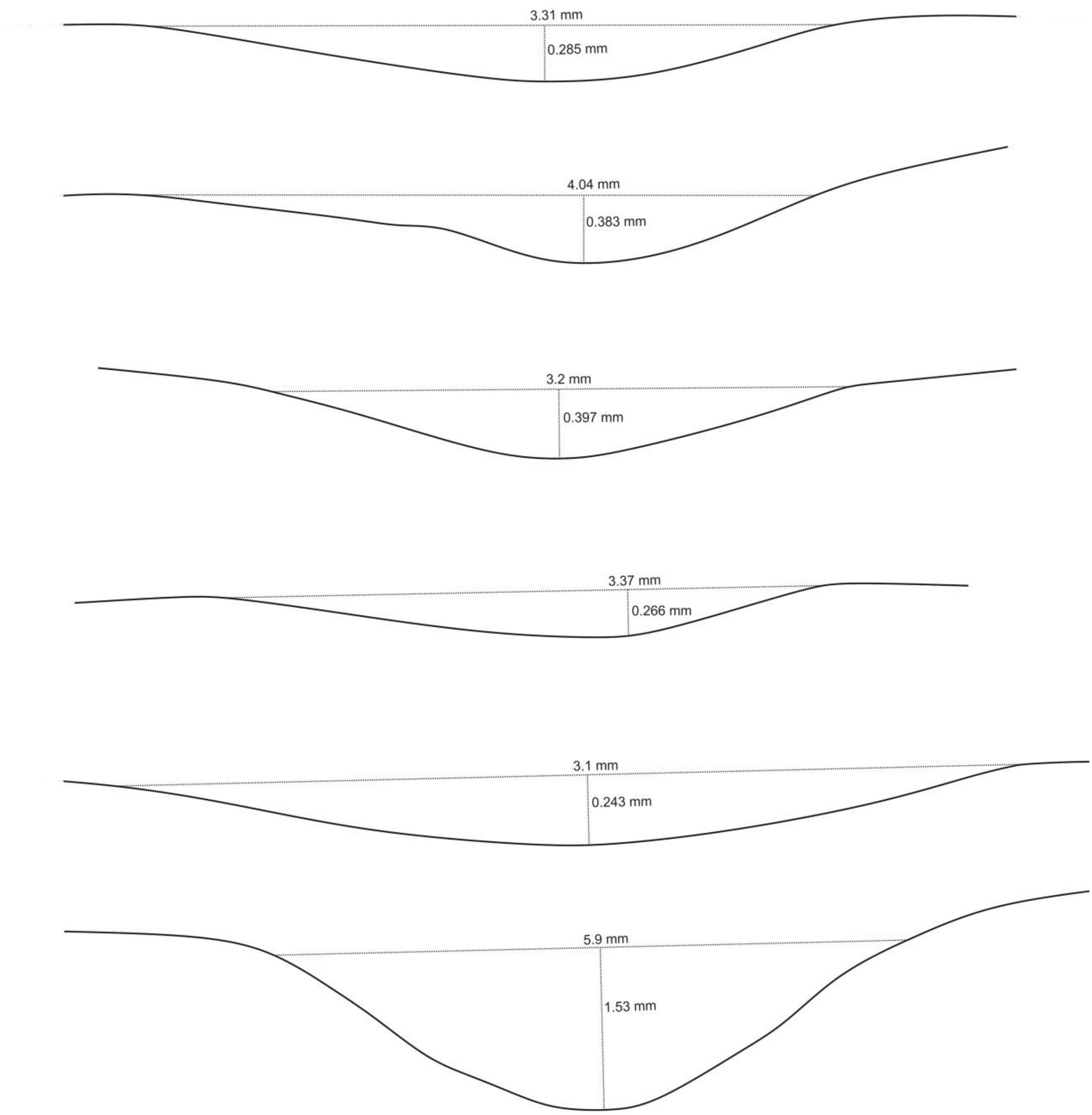
Relative chronology drawing (front)

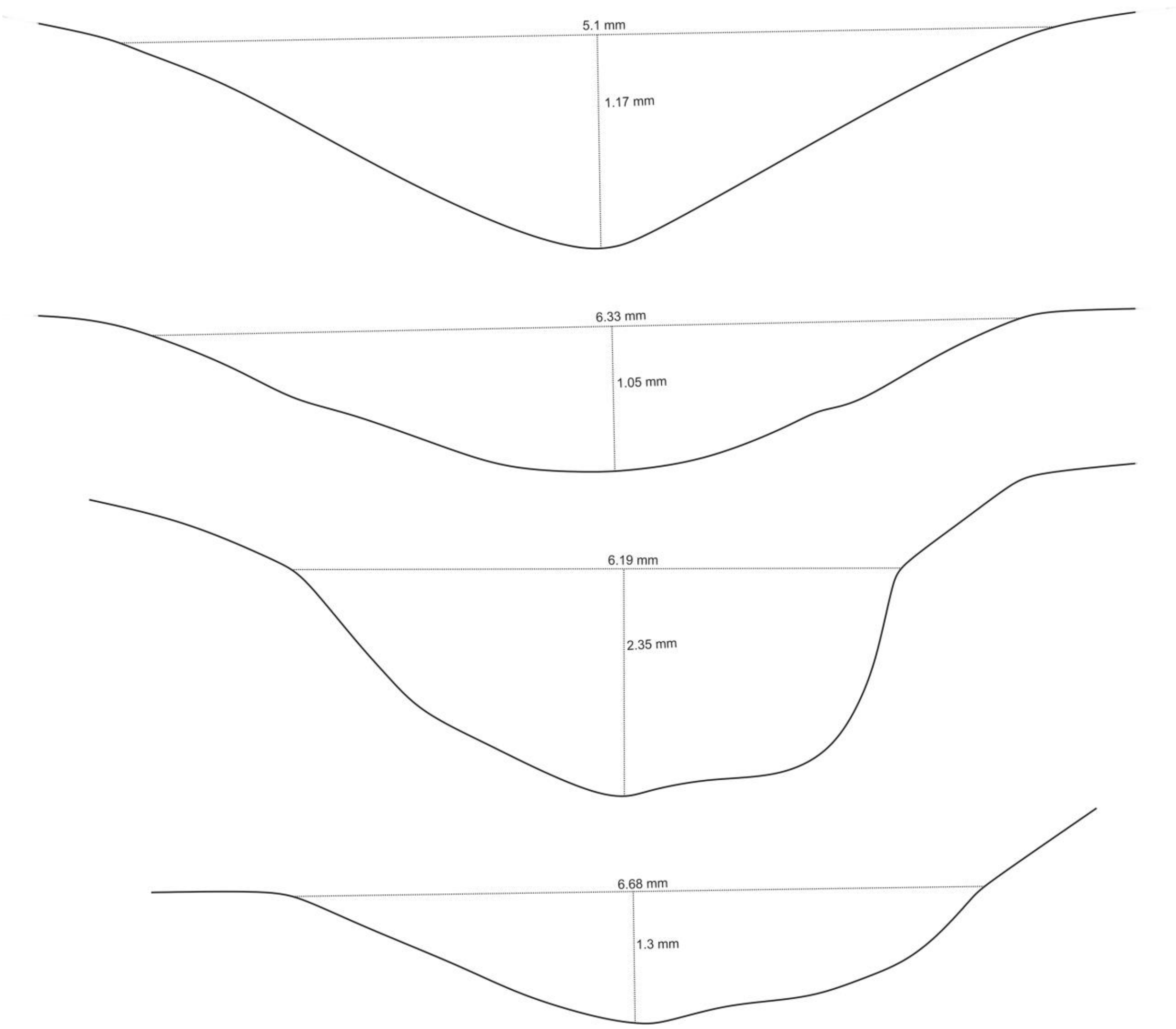


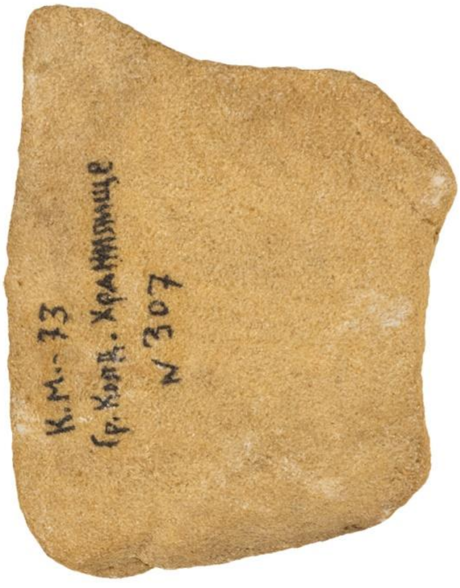
Harris matrix front



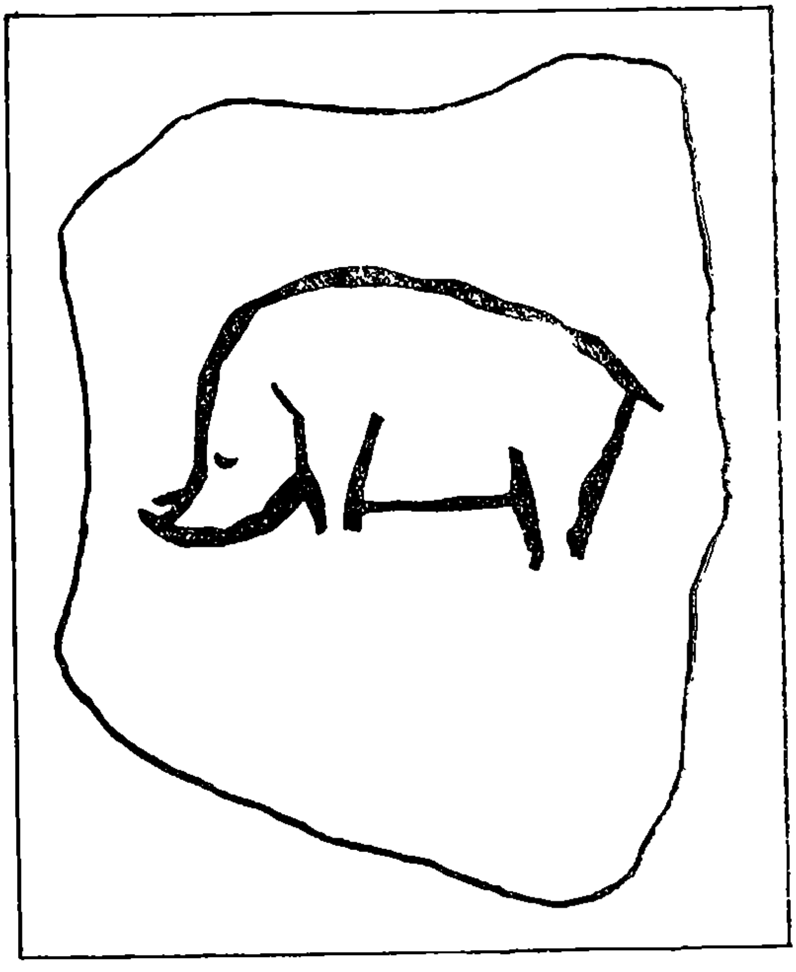
Profiles list




5.1 mm
1.17 mm
6.33 mm
1.05 mm
6.19 mm
2.35 mm
6.68 mm
1.3 mm

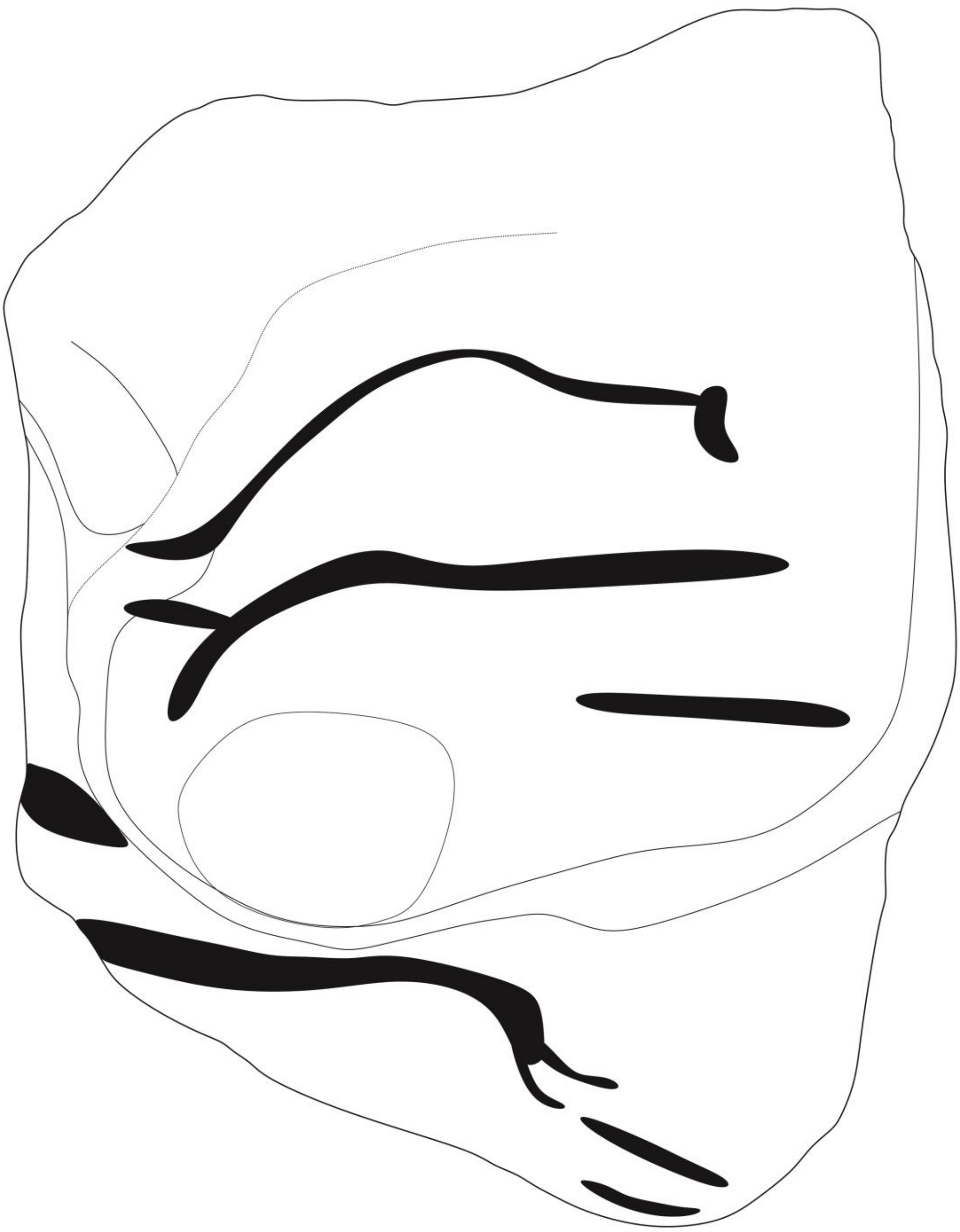
Specimen's ID	307
Image front	
Image right	
Image back	

Length, cm	12
Width, cm	8.5
Weight, g	368
Volume, m^3	0.000189
Density, kg / m^3	1947.0899
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	Subtriangular block with the linear incisions from the front side
Description source	The storage list of Institute of Archaeology in Kyiv
Description	To define the comparatively early Upper Paleolithic age of the engravings on the walls and blocks from the Scynia in Wizard’s cave, one should consider those compositions that include the images of rhinoceroses. There are a few of them. To begin with, the minor block No. 307. It contains a one-sided image. The background of this block includes the curvilinear incisions that might be related to the rudimental depiction of some zoomorphic motifs. The central part of the block includes an image of an animal with short legs, a massive body, a small tail, and a long snout that ends with a small horn. The features mentioned above allow assuming that the animal is rhinoceros, probably a young one (fig. 50).

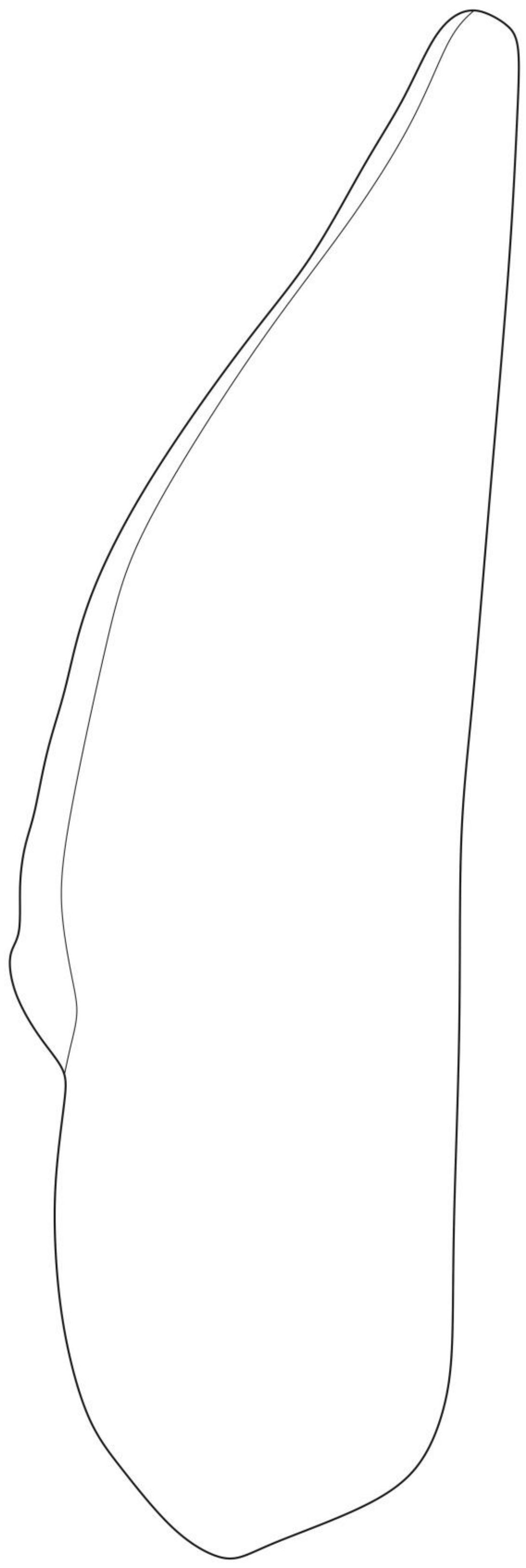
Descriptive image	 
Description 2 source	Danilenko 1986: 98—99

Note	The front side of the block is covered with desert varnish, while the back is slightly polished to be flat. The latter contains one notch of probably natural origin. The former contains several incisions. However, the surface of the front side is quite irregular. The notches that V. Danilenko considered as the image of the rhinoceros are pretty shallow and almost not evident. Some might be considered artificial, others are natural, but most are generally absent. The block's front side's convex shape also impacts the composition interpretation. This makes the interpretation of the block quite dubious. V. Danilenko uses the motifs that he considered as the image of the rhinoceros as the primary indicator of the Upper Paleolithic age of Wizard's cave. However, this concept needs to be reconsidered due to the new data.

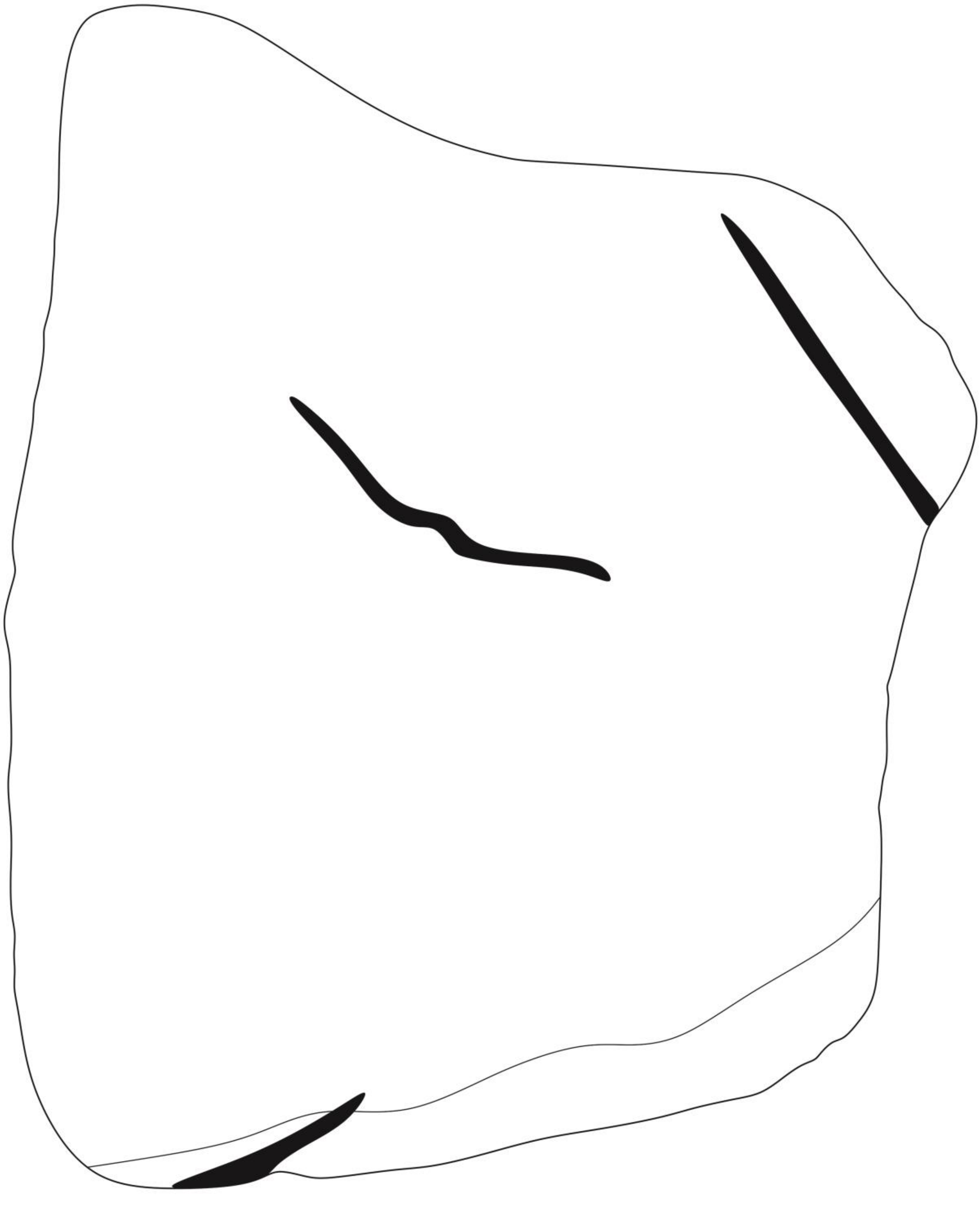
Technological drawing front



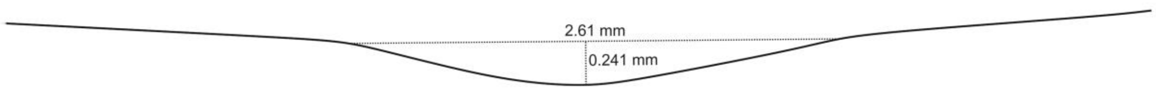
Technological drawing right

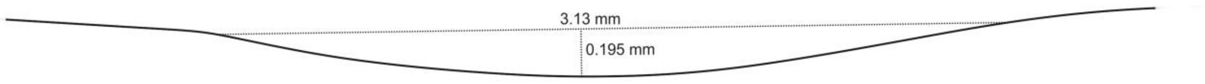


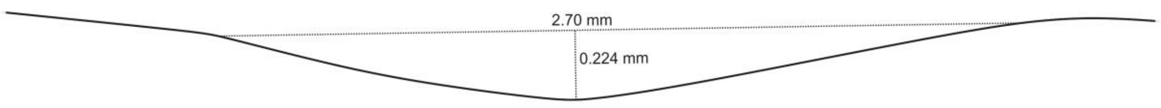
Technological drawing back

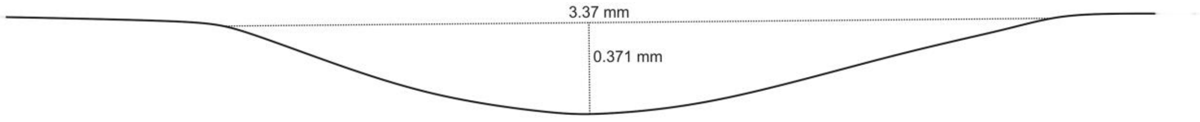


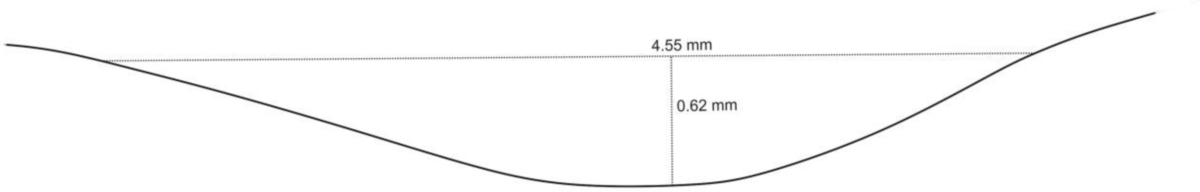
Profiles list



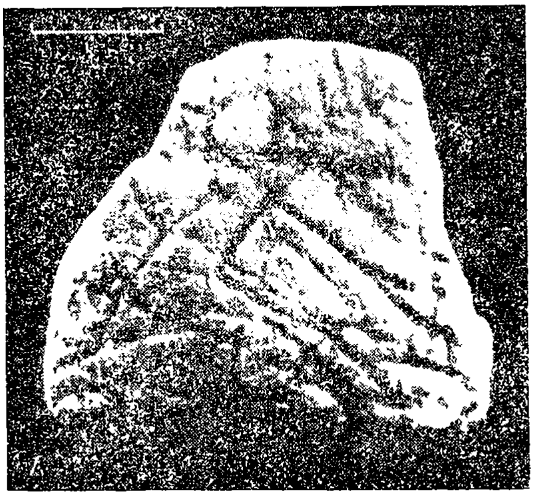
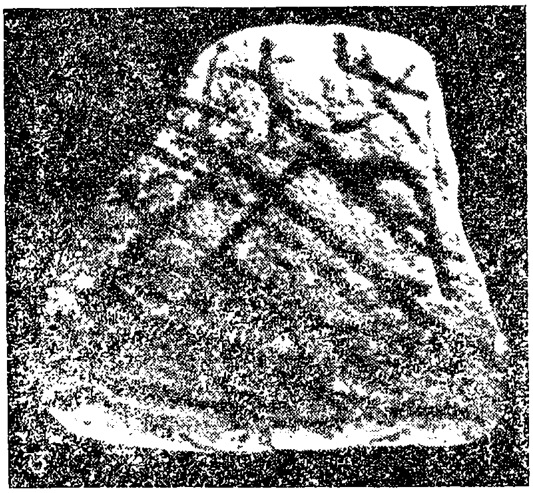


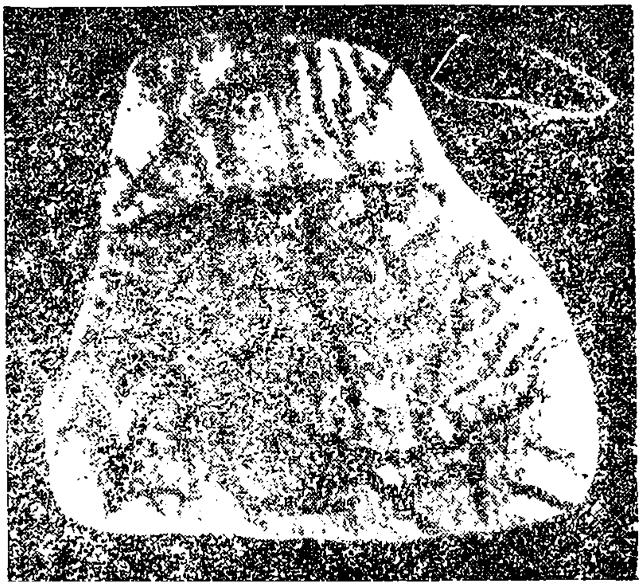






Specimen's ID	308
Image front	
Image back	
Length, cm	12
Width, cm	11
Weight, g	342
Volume, m^3	0.000175
Density, kg / m^3	1954.28571
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia

Current location	Institute of Archaeology, Kyiv
Description	A tile has a shape of trapeze with linear and geometric engravings on front and back sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	The deciphering of this stone is very complicated. It is a concretion in a shape of a trapeze. During the engraving of the block, its shape has sometimes been considered and caused a composition of a triangular shape. Its base is a subtriangular figure created by two parallel lines that cross in one of the sharp angles and intrude into a short and wide line. The whole surface of the block is covered with parallel lines that create a kind of tent-like construction. The upper and the lower parts of the subtriangle also contain two curvilinear elements that can be interpreted as a figure of a sitting man. Therefore, if such an interpretation is correct, this is one more image of a human being together with its dwelling.
Descriptive image	 

	 
Description 2 source	Danilenko 1986: 115—116
Note	The block is covered with desert varnish from both sides. It contains a series of linear engravings. Most are deep and form parallel or subparallel structures and reticulated ornamentation. The interpretation provided by V. Danilenko does not correspond with the relevant drawing and is not evident according to the surface analysis (the anthropogenic figure is not visible, and the tent-like engraving appears to be several parallel notches). This might be considered one more case of overinterpretation. Incisions on the back side also create reticulated ornamentation. The latter was not interpreted from a semantic point of view and probably did not contain any meaningful engravings.

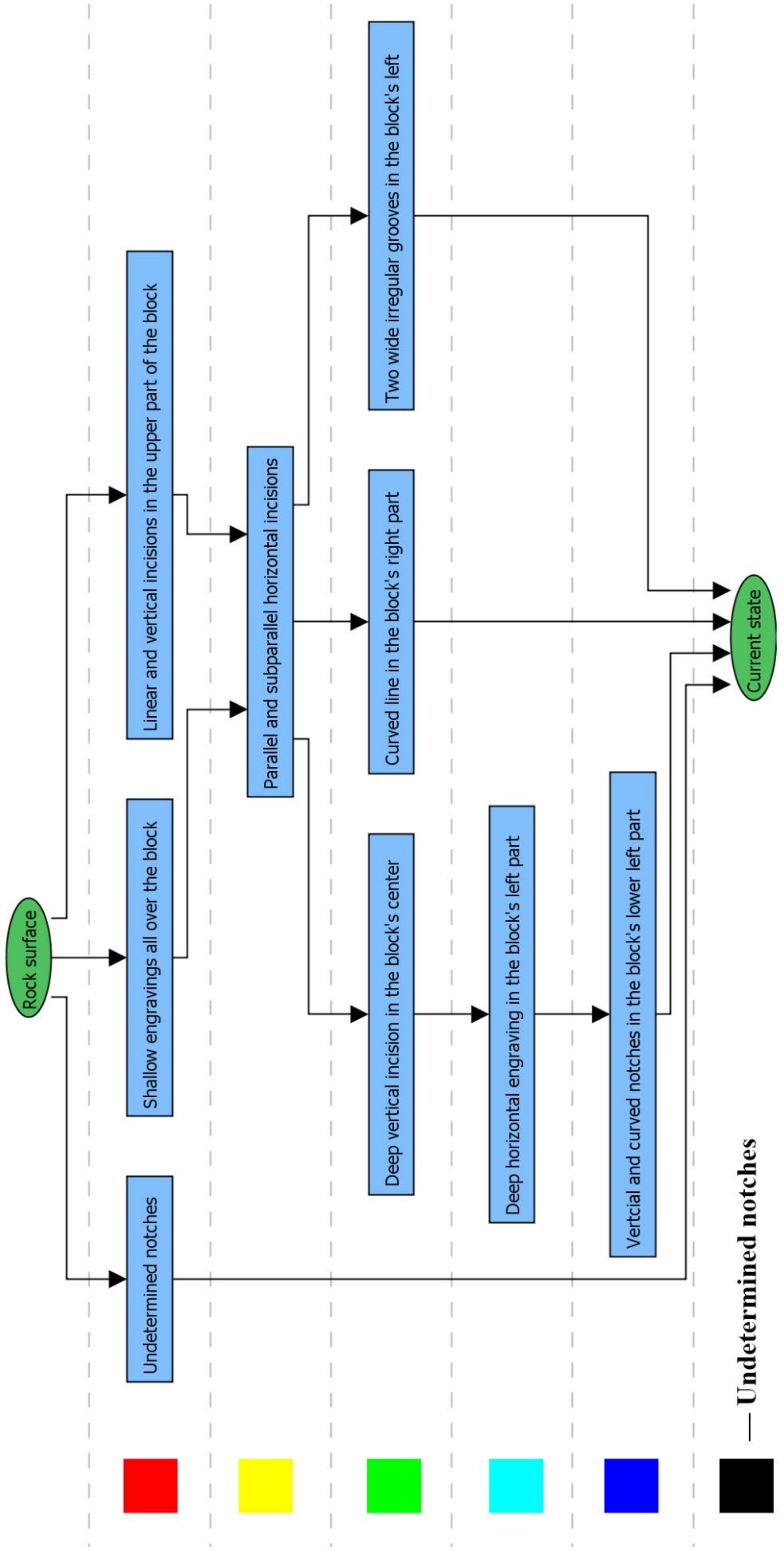
Technological drawing front

Technological drawing back

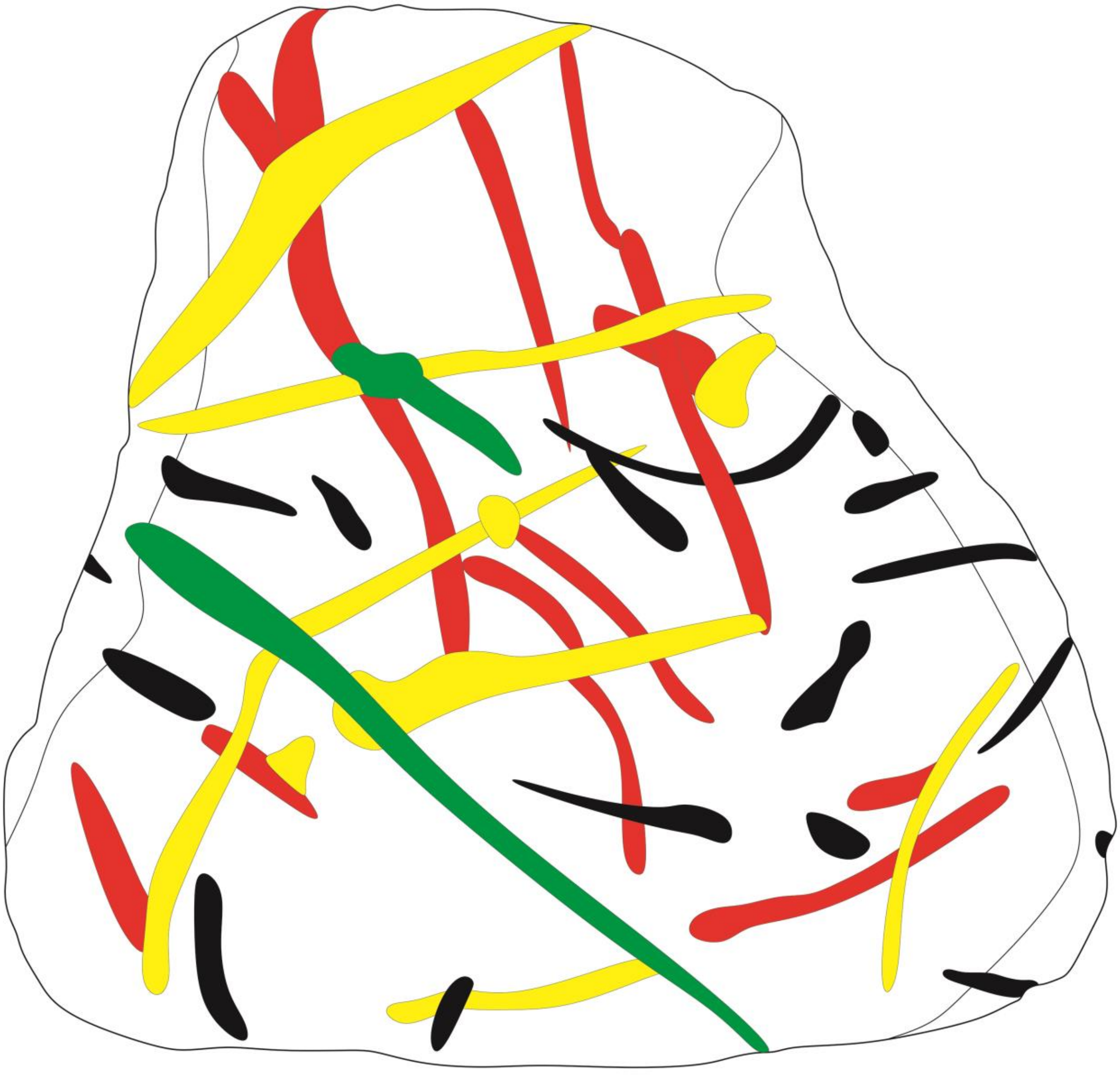
Drawing according to the V. Danilenko interpretation (front)

Relative chronology drawing (front)

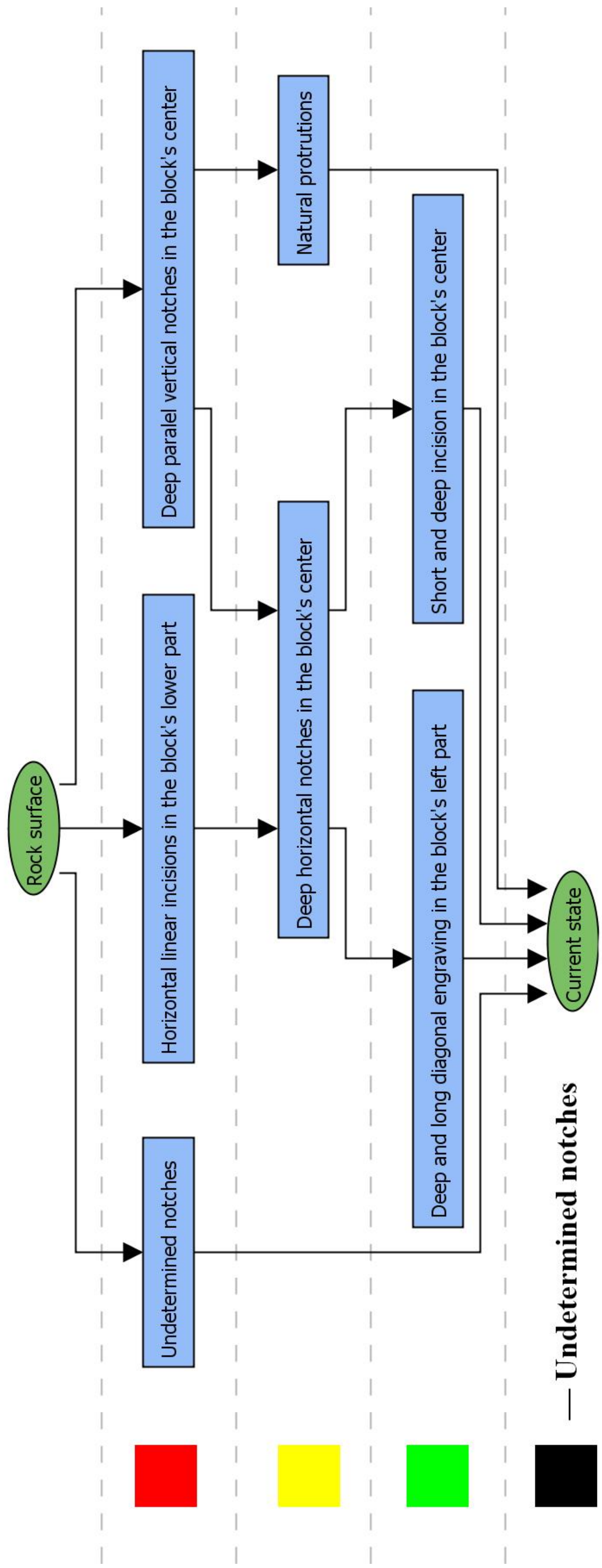
Harris matrix front



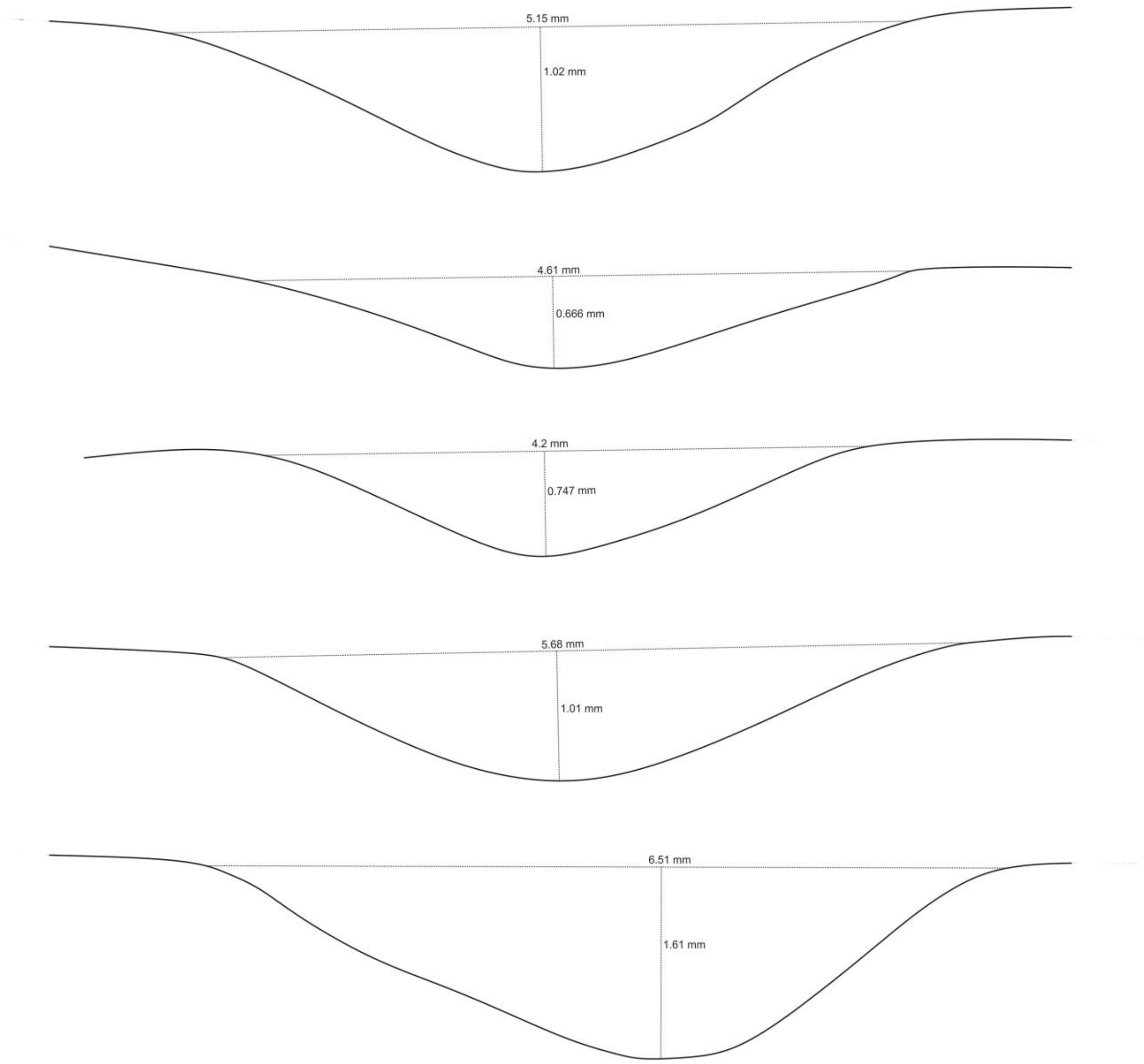
Relative chronology drawing (back)

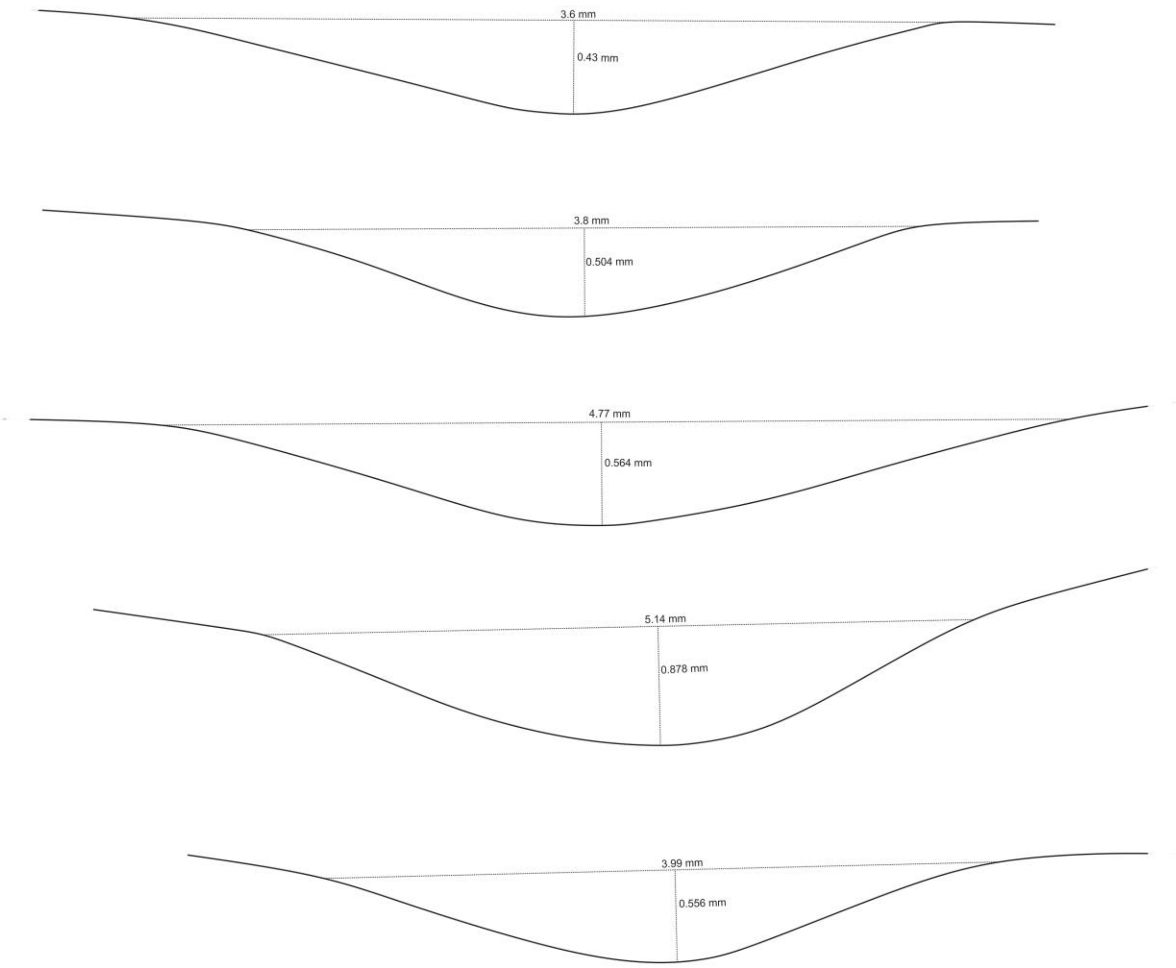


Harris matrix back



Profiles list

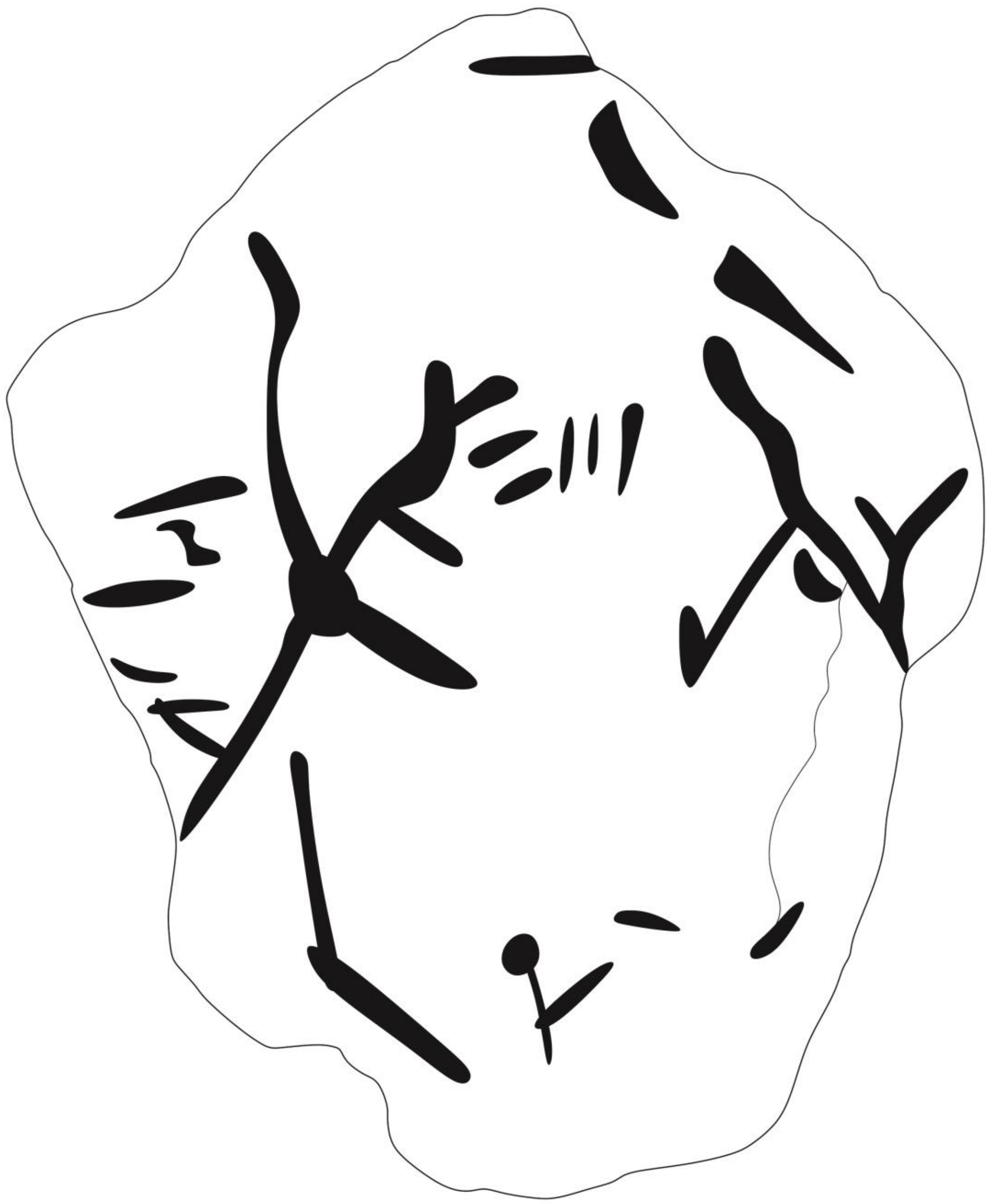



3.6 mm
0.43 mm
3.8 mm
0.504 mm
4.77 mm
0.564 mm
5.14 mm
0.878 mm
3.99 mm
0.556 mm

Specimen’s ID	309
Image front	
Image back	
Length, cm	16.5
Width, cm	13
Weight, g	1025
Volume, m^3	0.000526
Density, kg / m^3	1948.6692
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv

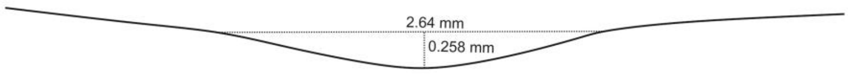
Description	A block with five angles with the linear and geometric engravings on the one side
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. The surface is eroded and covered with numerous natural cracks. The block's surface was partially destroyed after the engravings were created. Therefore, most of them are damaged or almost invisible. In all cases, natural cracks superimpose the incisions. Some notches have extensive irregular profiles. Others are shallow and narrow. No semantic or geometric compositions were recorded.

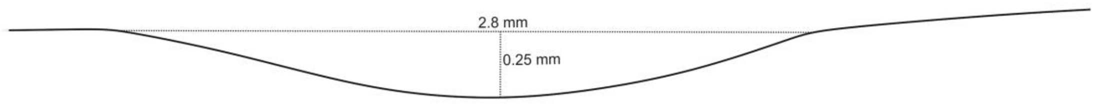
Technological drawing front

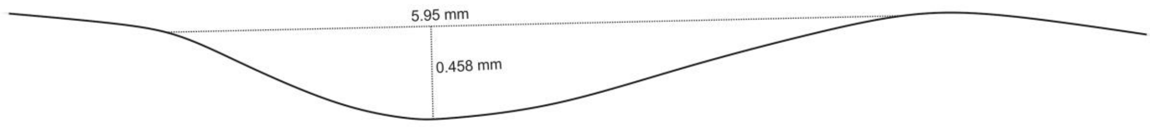


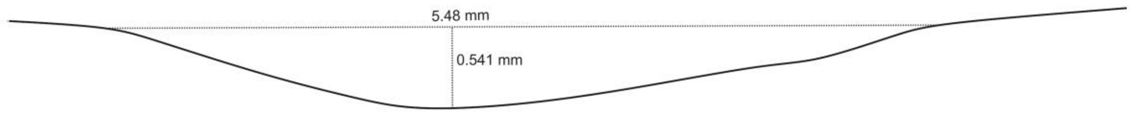
Technological drawing back

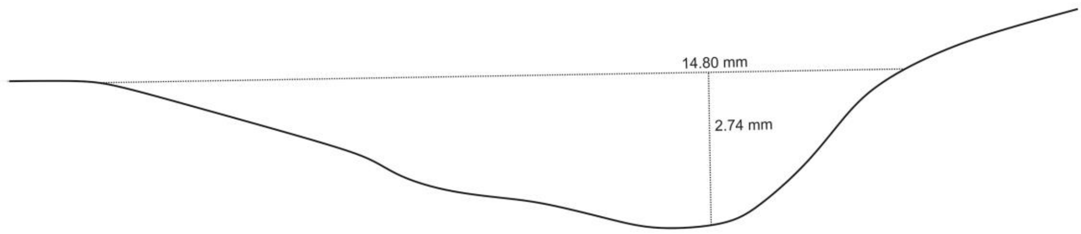
Profiles list

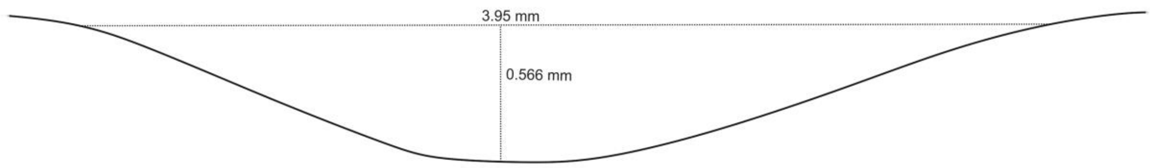


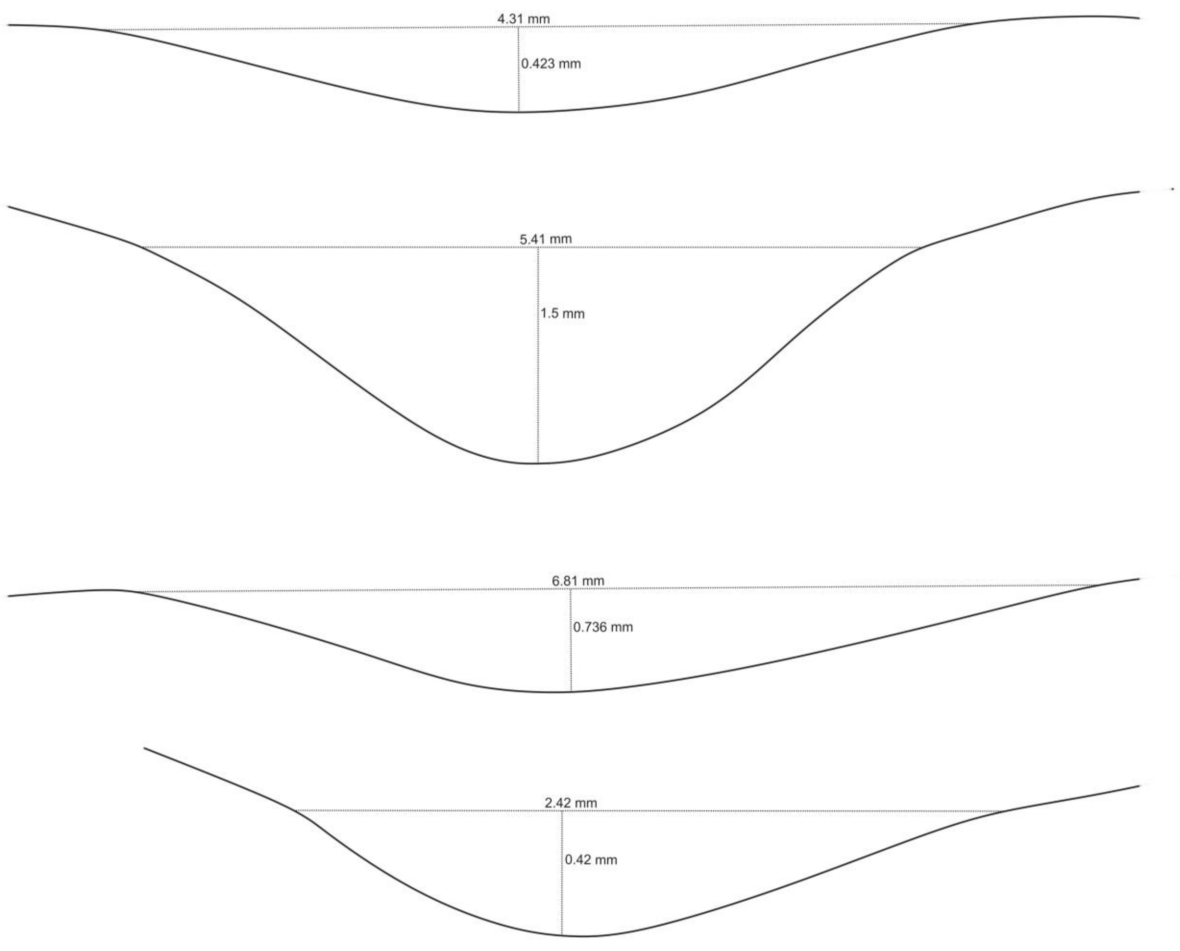






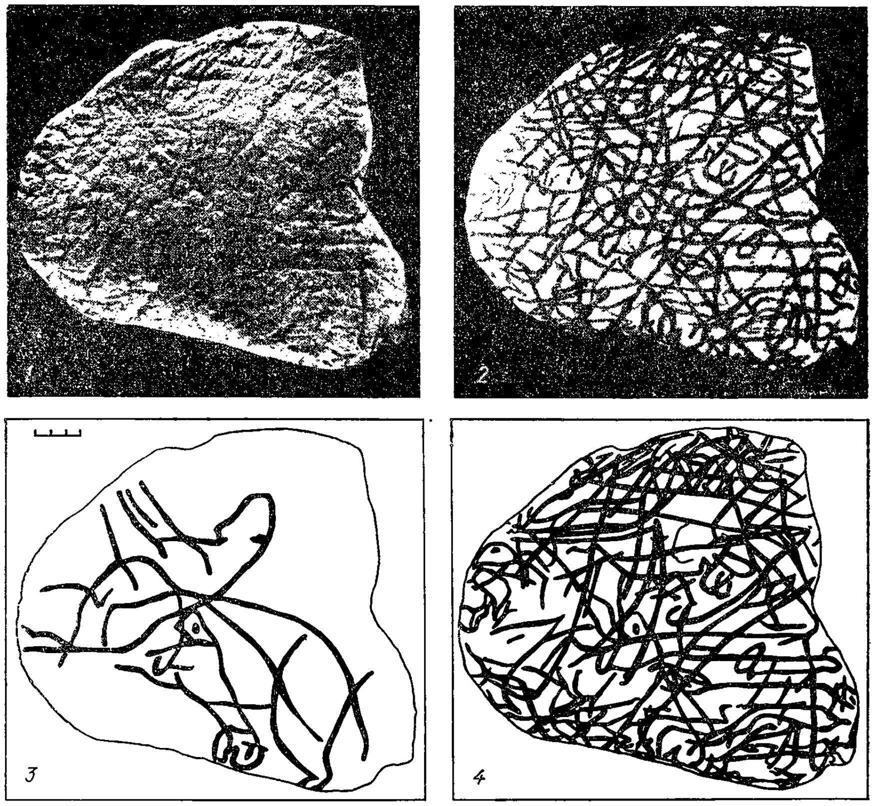





4.31 mm
0.423 mm
5.41 mm
1.5 mm
6.81 mm
0.736 mm
2.42 mm
0.42 mm

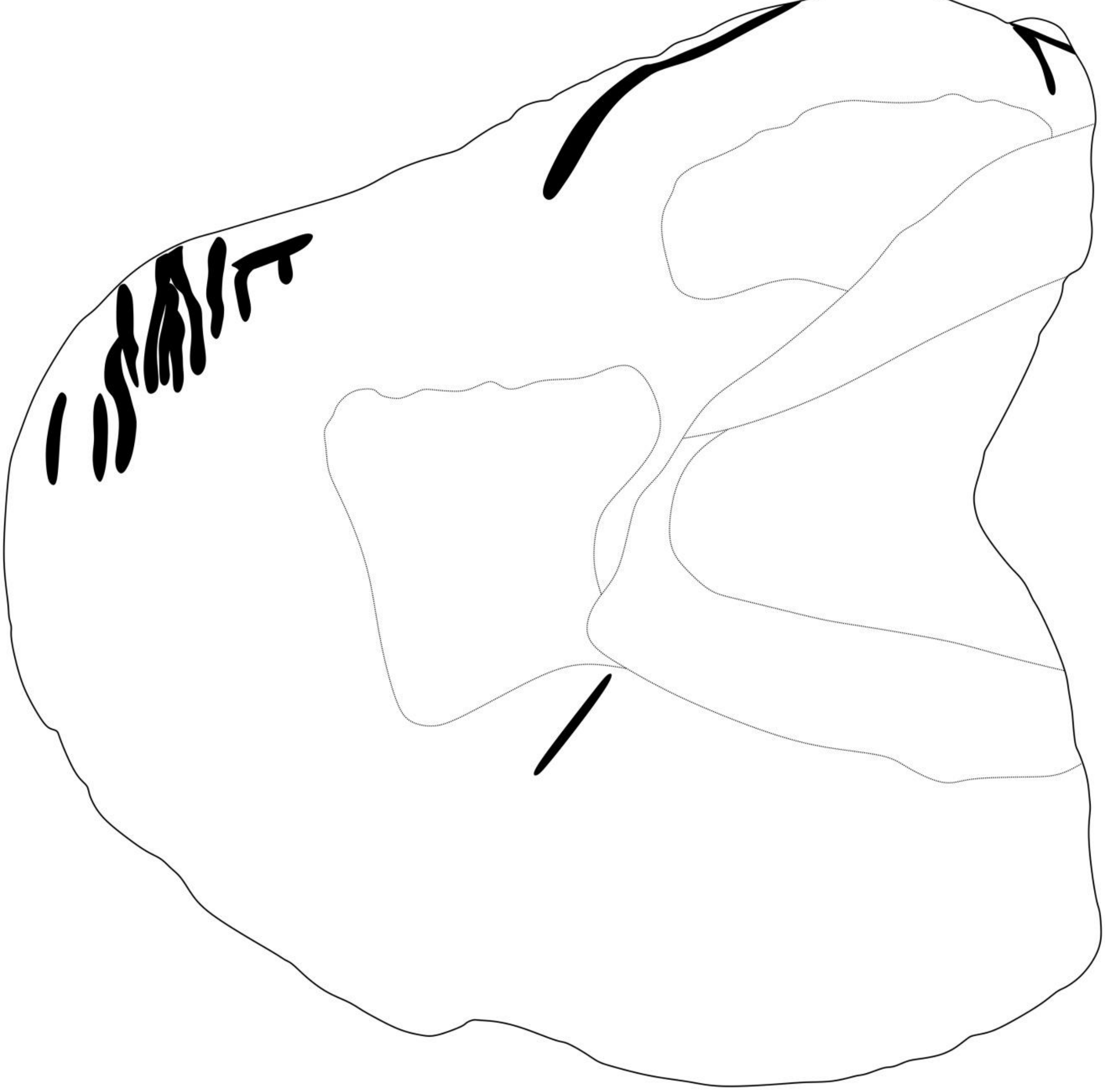
Specimen’s ID	310
Image front	
Image back	
Length, cm	28
Width, cm	25
Weight, g	3600
Volume, m^3	0.001846
Density, kg / m^3	1950.16251
Date of discovery	1973
Finder	V. Danilenko

Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The block has a high segment-like shape with intense linear and geometric engravings on the front and single incisions on the back.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Small (29 x 27 cm) but a comparatively massive block from the location of Skynia in Wizard’s cave) contains a complex scene on the front side. The scene consists of a few figures. Separate elements of the scene are not readable. The block is subtriangular. The composition should be considered from the block’s position when the base of the triangle forms the right side of the block. The central part of the block contains the contour of the mammoth’s upper part — trunk, tusks, head, back, bottom, tail, and a part of a leg. Nearby is a small figure of a baby mammoth close to its “mother.” A schematically depicted predator attacks them. His body is elongated diagonally to the body of a baby mammoth. The lion has schematically depicted legs located in the image’s left part. The image of an adult mammoth is covered with one more image of a mammoth. Its head and trunk are connected with the head and trunk of the first one. The last mammoth is the biggest, with a clear head, trunk, and tusks. The back of this mammoth merges with the figure of the first one near their backs. The line that contours his bottom is close to the upper edge of the block’s right lower part. The biggest mammoth is connected with another awkward figure. It is located near the edge of the block that is limited with an angle in its upper and lower part. It has elongated proportions with a head without horns, long legs, and a body. Possibly it is one more cave lion. The size of an animal allows assuming the lion against the doe (fig. 56).

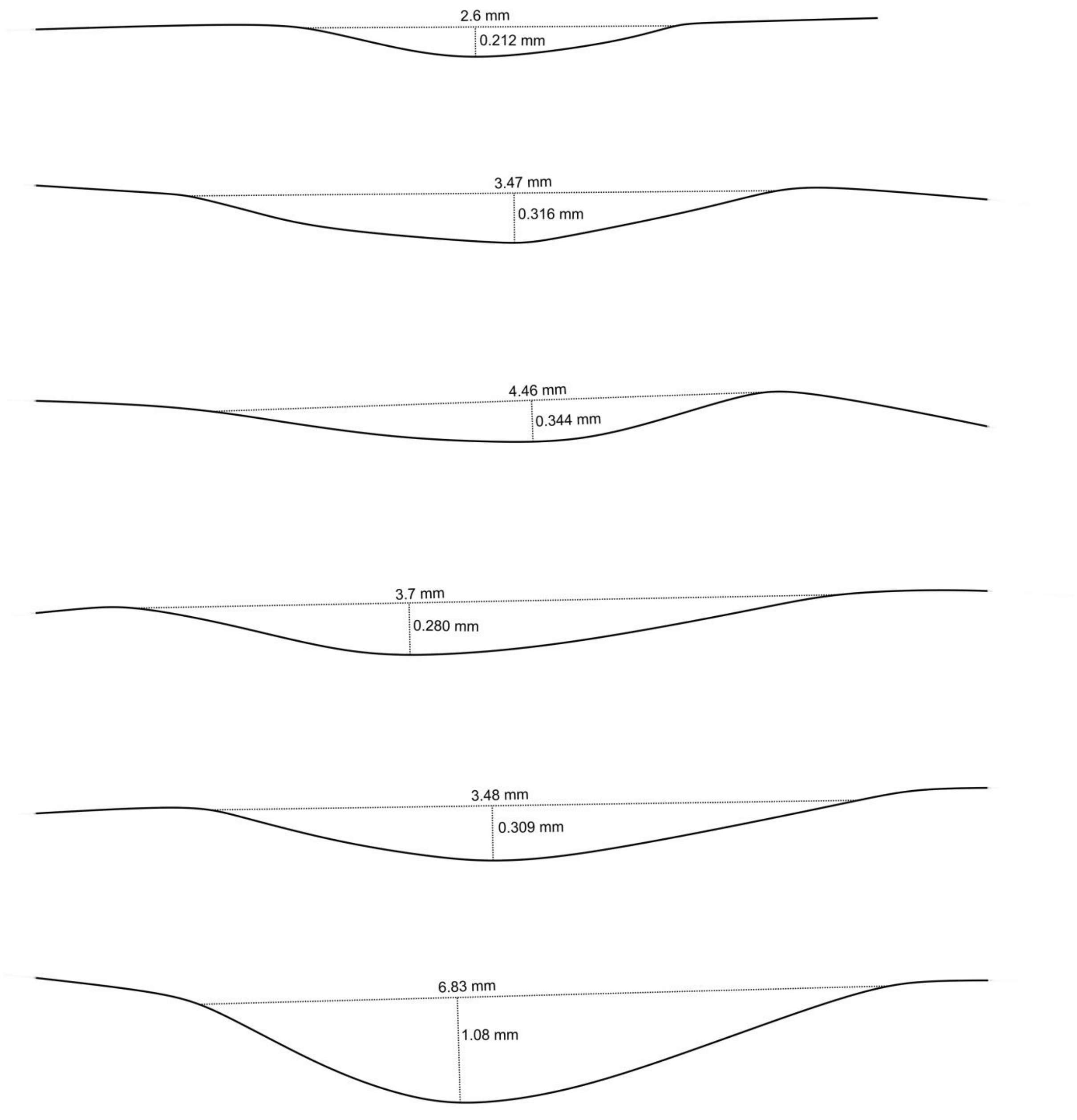
Descriptive image	
Description 2 source	Danilenko 1986: 103—104
Note	The block contains linear and geometric engravings from both sides. The back side has a few parallel notches, while the front is covered with reticulated ornament. The desert varnish is presented only on the front side. The surface of the block is very eroded and damaged. This makes any assessment of relative chronology impossible. The engravings interpreted and described by V. Danilenko are not evident except for a few linear incisions. They are also not evident in his painting on the stone itself. Therefore, the interpretation of the block ends up on a drawing with numerous engraved lines.

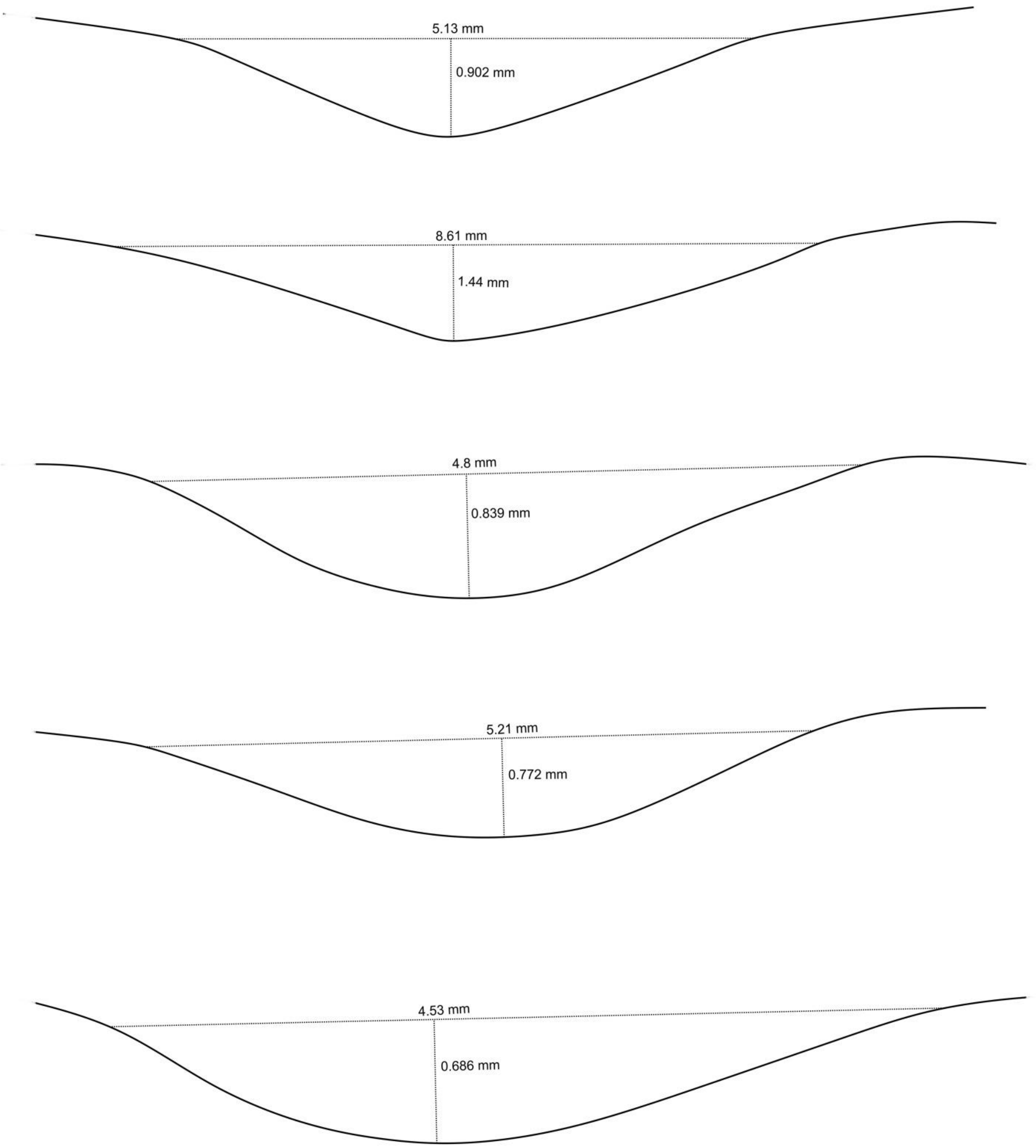
Technological drawing front

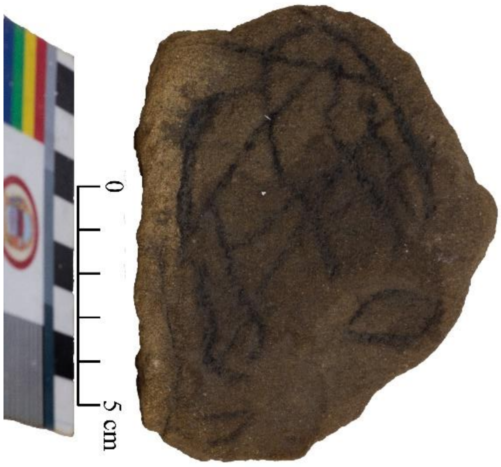
Technological drawing back

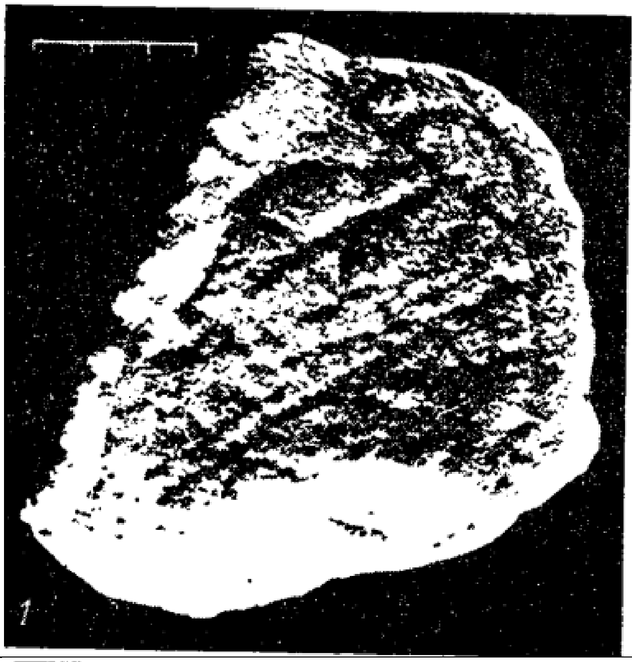
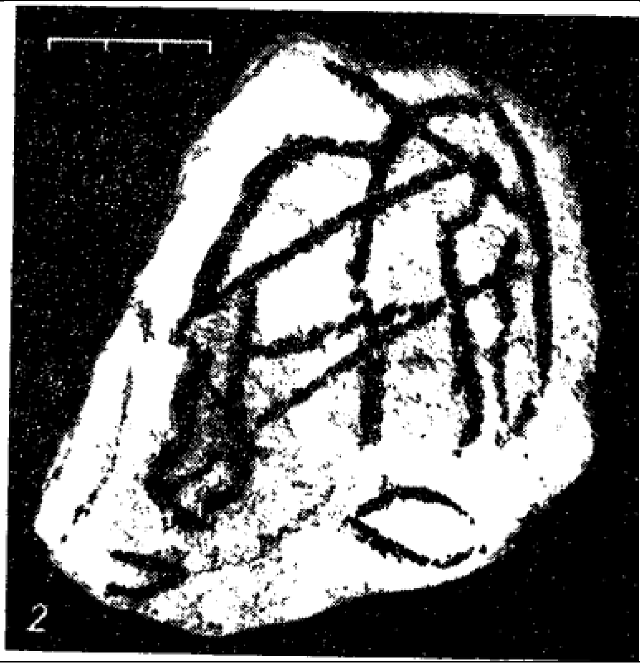


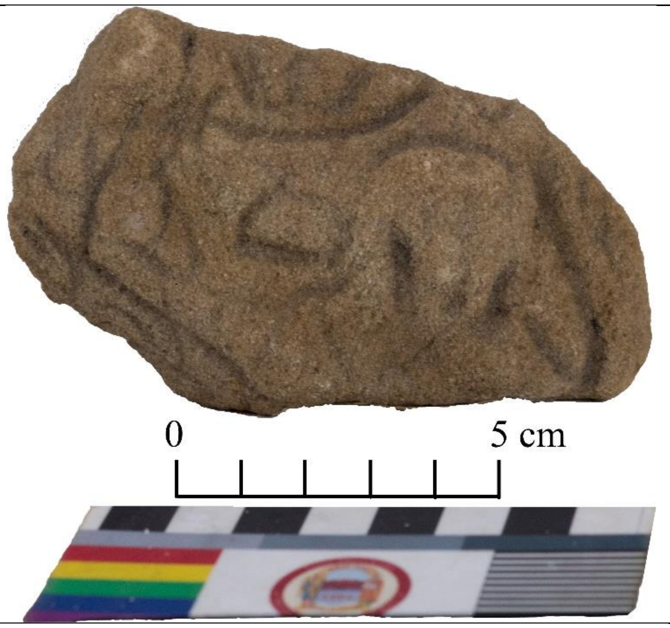
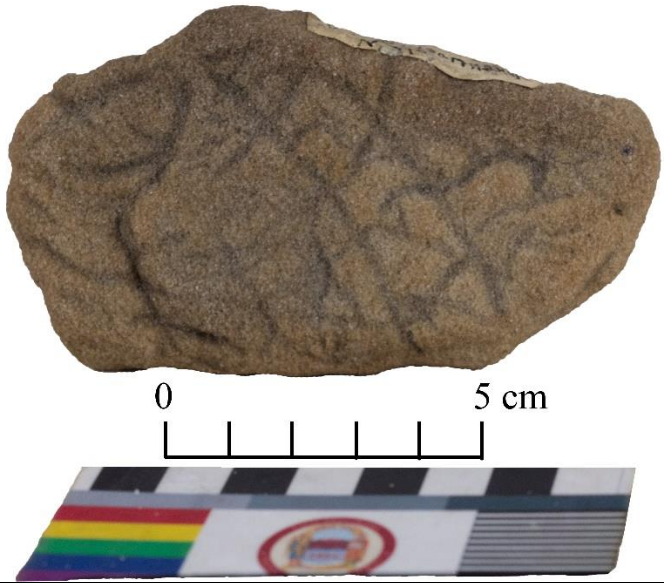
Profiles list

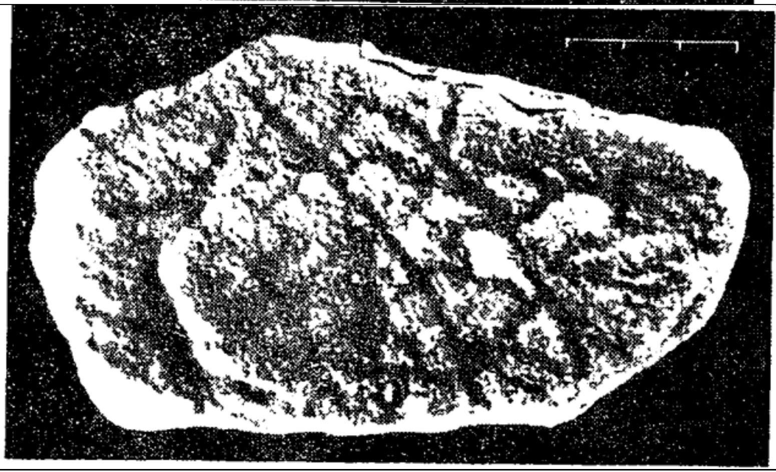


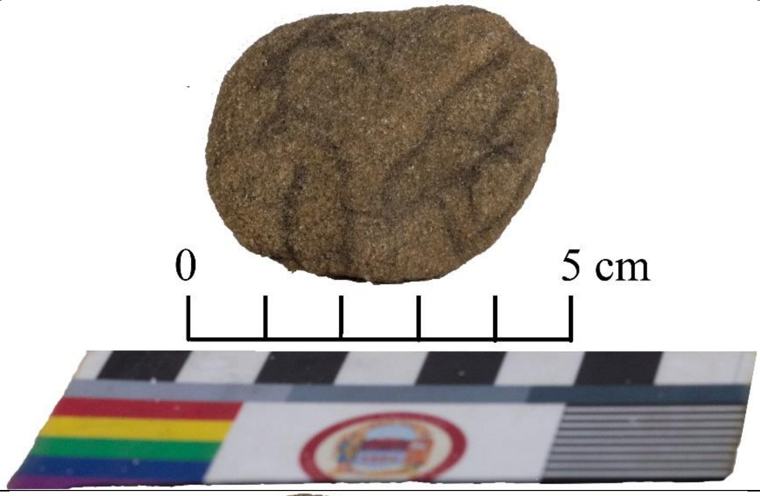
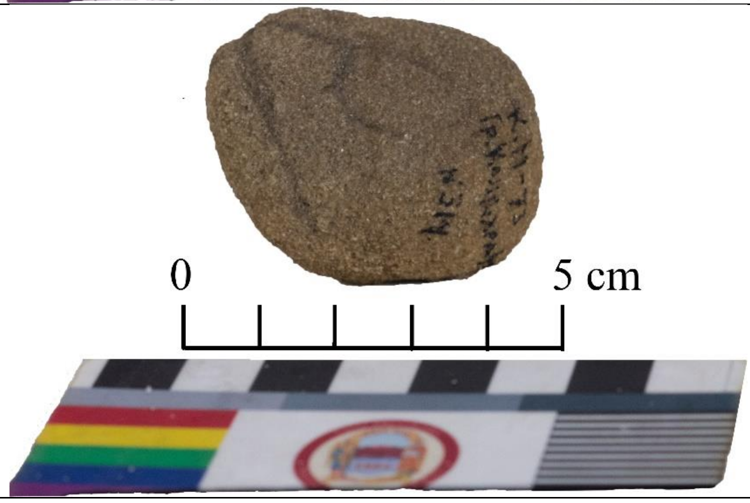

5.13 mm
0.902 mm
8.61 mm
1.44 mm
4.8 mm
0.839 mm
5.21 mm
0.772 mm
4.53 mm
0.686 mm

Specimen's ID	311
Image front	
Image back	
Length, cm	12
Width, cm	9
Weight, g	324
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A stone has the shape of an irregular symbol with linear engravings from the front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	A depicted mammoth is turning to the right (in profile). A trunk and an eye are articulated. At least three big spears are stuck out in its body. Below there is an oval object, possibly a throwing stone.
Description source 2	Danilenko 1986: 97 (fig. 47)

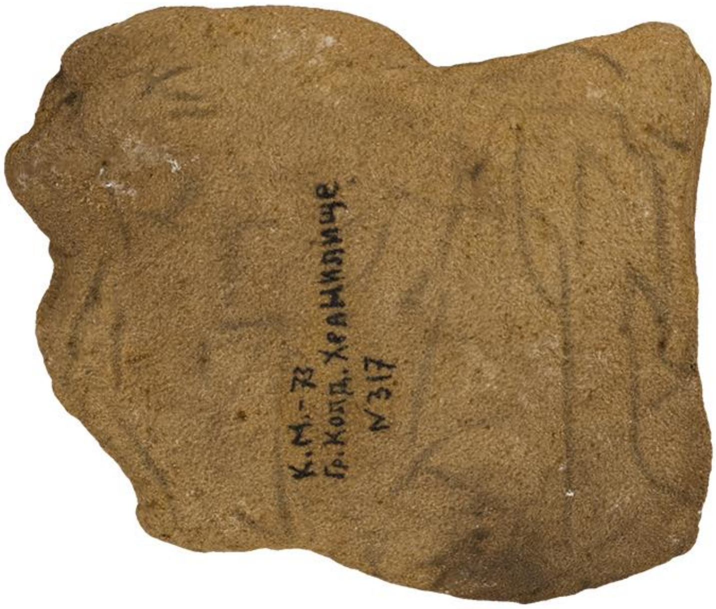
Descriptive image	
Descriptive image 2	
Note	The small sandstone block is covered with desert varnish and polished from the front and back sides. The front one contains a series of engravings.

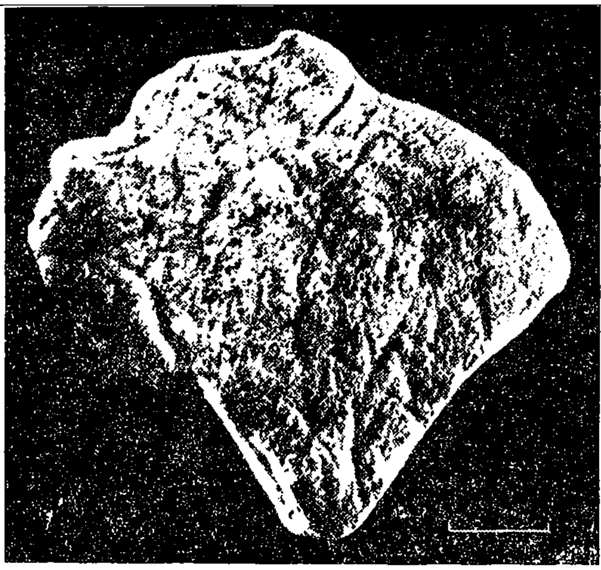
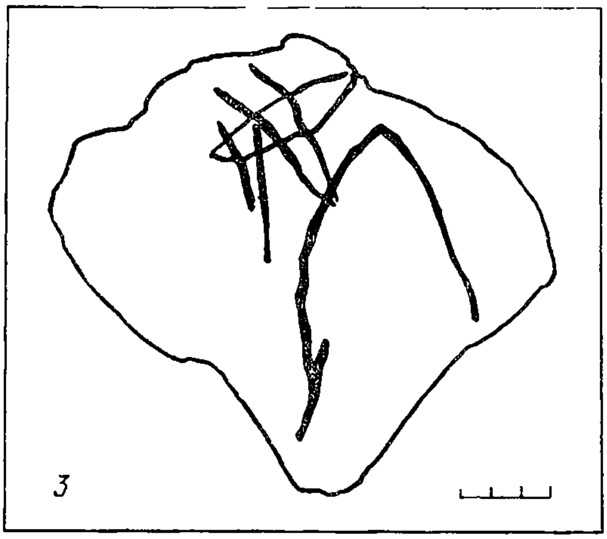
Specimen's ID	312
Image front	
Image back	
Length, cm	12
Width, cm	6.5
Weight, g	172
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	The sandstone block is in the shape of an irregular segment. It contains a bas-relief from one side and linear engravings from both sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	The image from both sides is created in a shape of a flat relief. The front side reproduces an image of bison or a moose with the head turned right. It has a hump on its back, a head without horns, and probably bent legs. The back side contains an image of a woman (a mother) turned three-quarters left along the vertical axis. A child figure is pictured nearby, as high as the woman's breath. The relief of this image is not high, so the shapes are

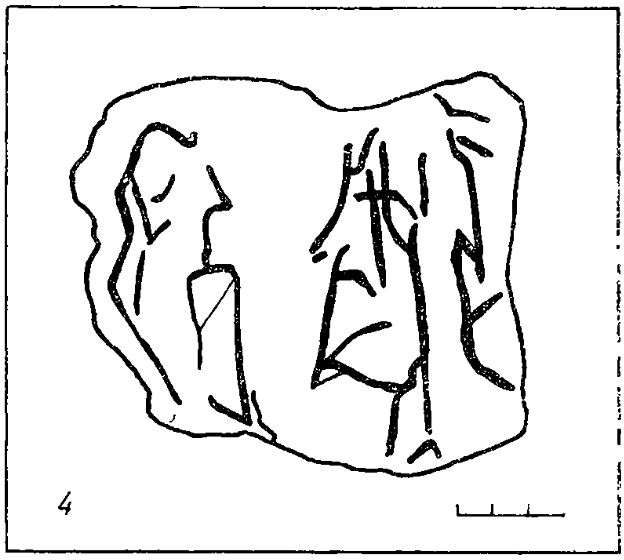
	pictured softly and gently. Three parallel diagonal lines superimpose both figures for an unknown reason.
Description source 2	Danilenko 1986: 111—112 (fig. 65)
Descriptive image	
Descriptive image 2	
Note	The stone is covered with desert varnish and linear engravings from the both sides.

Specimen's ID	314
Image front	
Image back	
Length, cm	5.5
Width, cm	4
Weight, g	46
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A sub-oval pebble with the engravings from two sides is similar to the bear's head.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	Small stone is polished and covered with desert varnish from all its sides. Engravings are also both on the front and back.

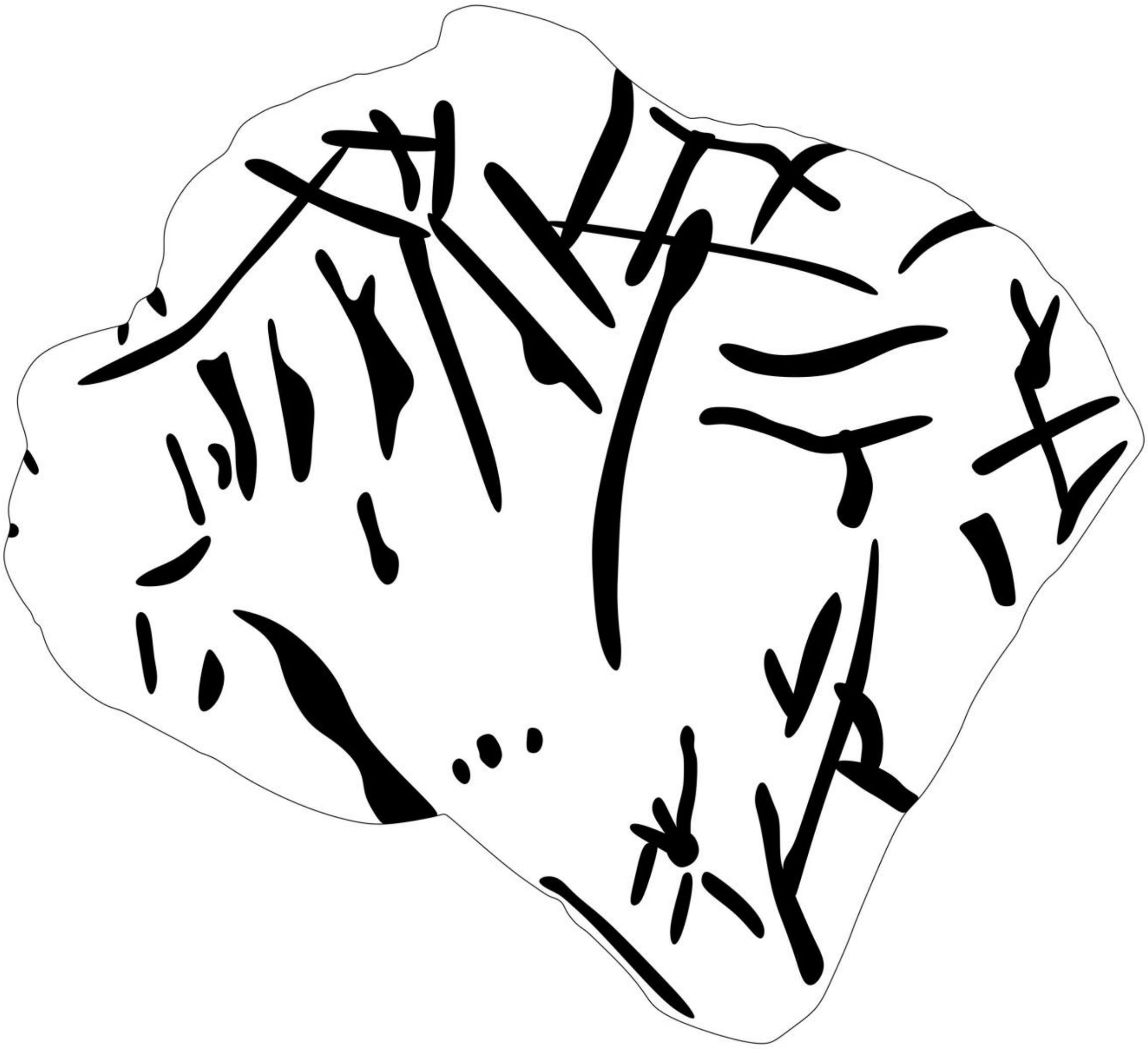
Specimen's ID	315
Image front	
Image back	
Length, cm	3
Width, cm	3
Weight, g	19
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A piece of a subrectangular block with engravings from one side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	A small stone is polished and covered with desert varnish from all sides. The front side contain non-figurative engravings.

Specimen's ID	317
Image front	
Image back	
Length, cm	45
Width, cm	11
Weight, g	553
Volume, m^3	0.000283
Density, kg / m^3	1954.06360
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia (Storage)
Current location	Institute of Archaeology, Kyiv

Description	Takes a special place among the churingas of Kamyana Mohyla. This one is special primarily due to the engravings on both sides and their anthropomorphic character. The front side of the block shows two busts of a man and a woman. To the left is a woman's bust depicted from the right side. It shows a long-haired adult woman with subrectangular shoulders; her face has a straight nose, an eye, and an eyebrow but does not have a mouth and a clear chin (fig. 64). In front of this figure, there is a bust of an adult man that turns his face to the woman (to the left). His hair falls on the shoulders; an eye, mouth, slightly concave nose, and comparatively small beard are depicted schematically. This data allows assuming that the block contains a scene of a married couple of a man and woman — the principal members of the family pair. The back side of this block contains a tent-like figure. Above the latter is the lower part of a human figure with the big simple bow turned down.
Descriptive image	 

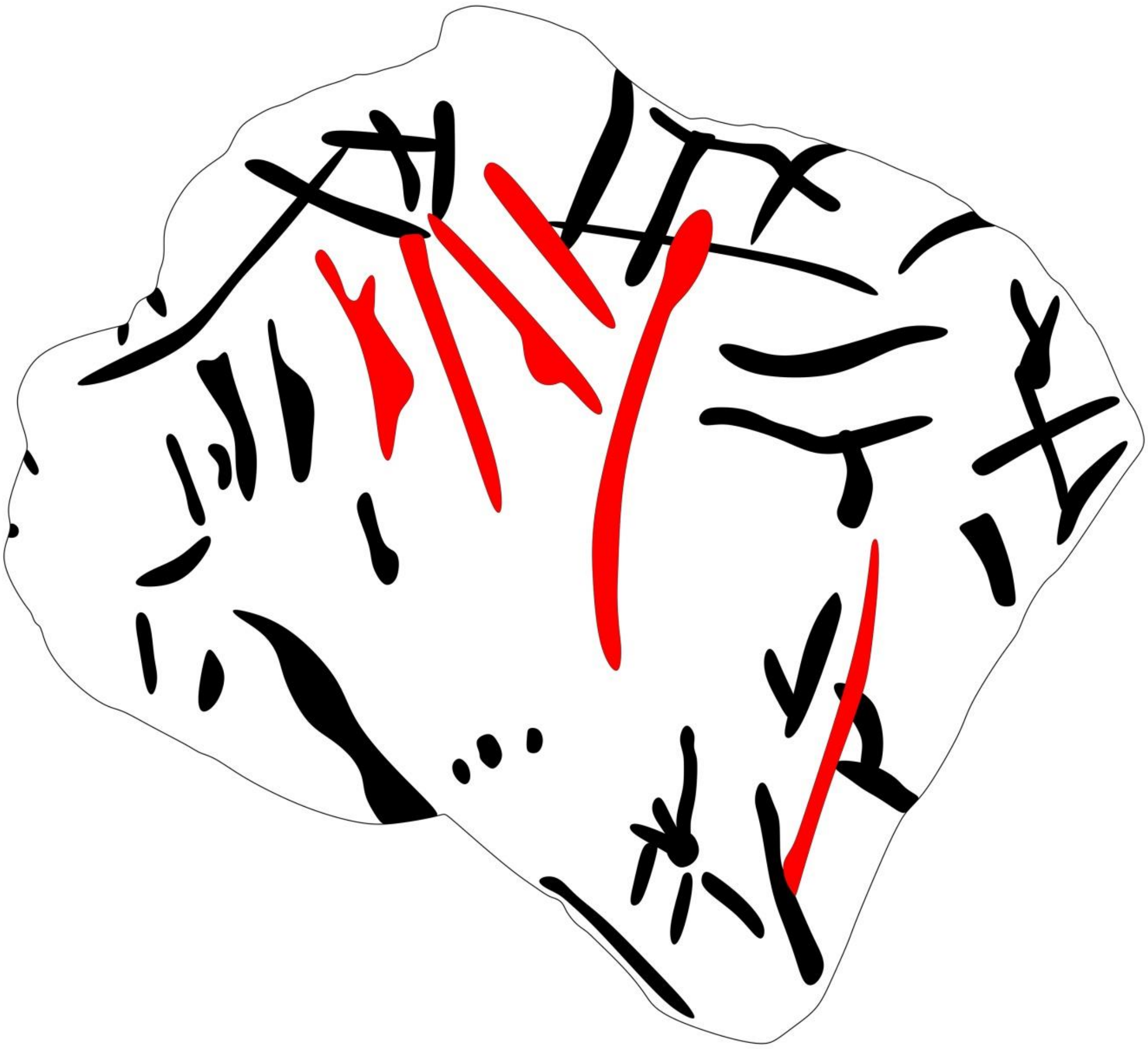
	 
Description source	Danilenko 1986: 110—111
Note	The block contains several notches on both sides. Both the front and back sides are covered with desert varnish and eroded. The engravings are small and shallow. The interpretations of V. Danilenko are not evident on the block’s surface, as most of the engravings were drawn by him in a simplified and dubious manner and are not visible through mesh analysis. Instead of anthropomorphic images, the reticulated ornaments and several natural cracks are noticed both on the front and back sides.

Technological drawing front



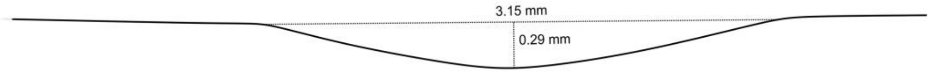
Technological drawing back

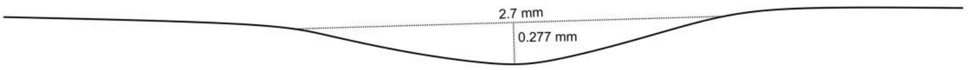
Engravings, interpreted by V. Danilenko, front:

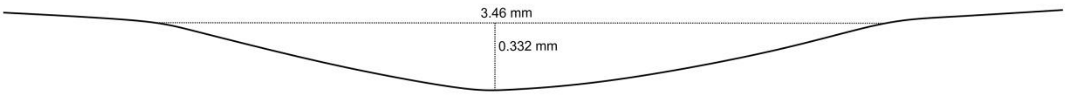


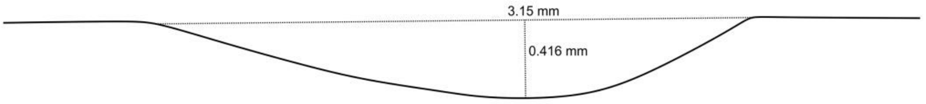
Engravings interpreted by V. Danilenko, back

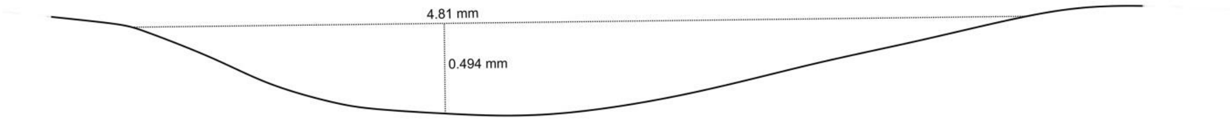
Profiles list

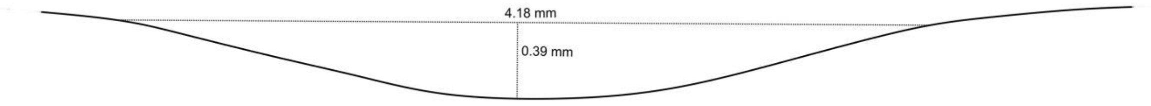


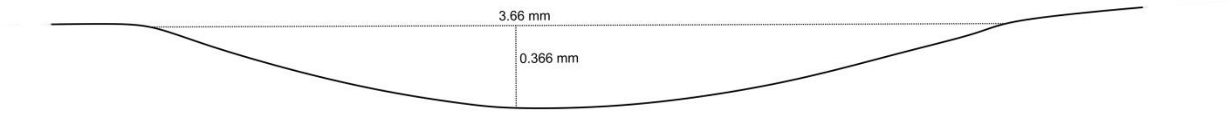


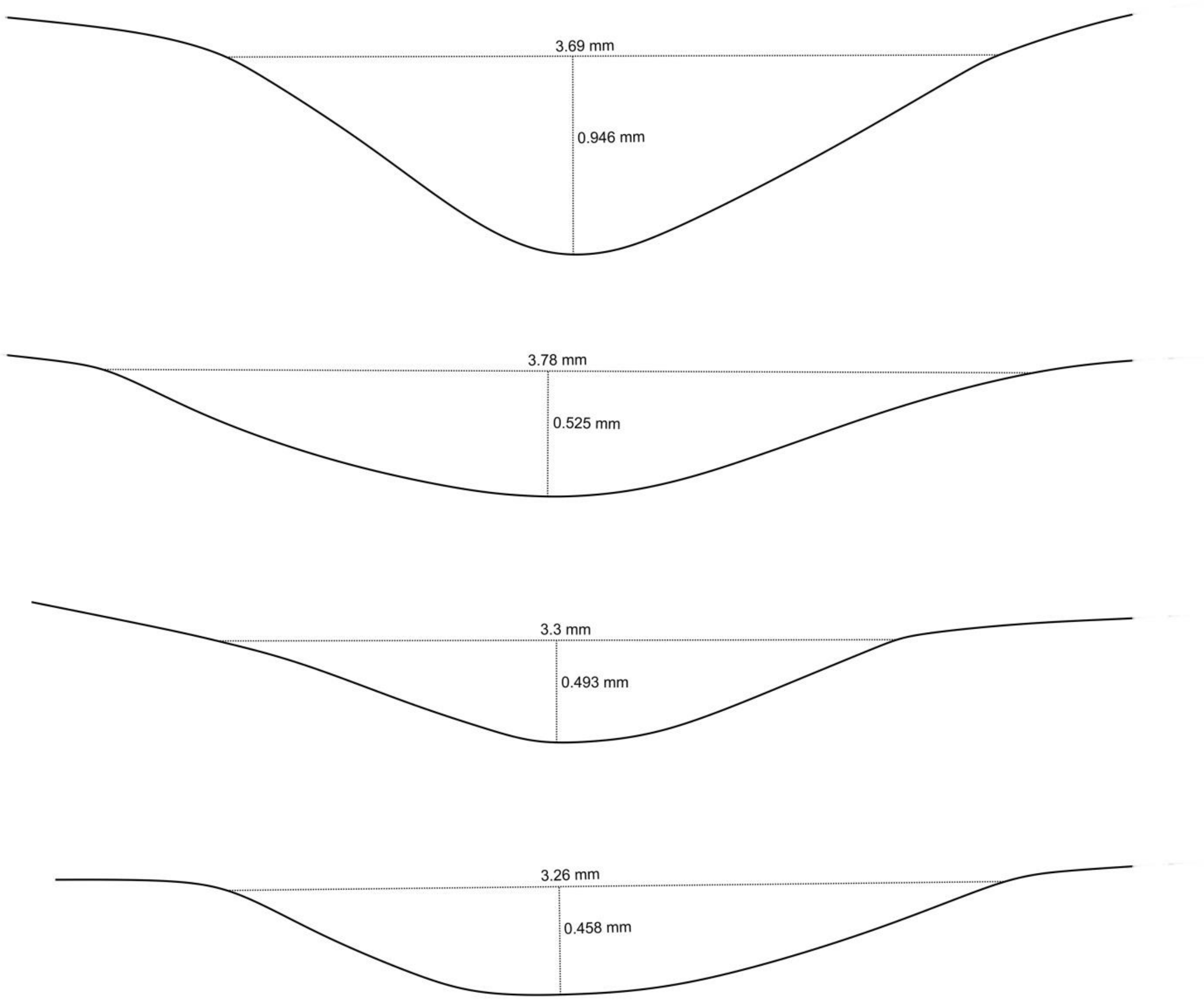








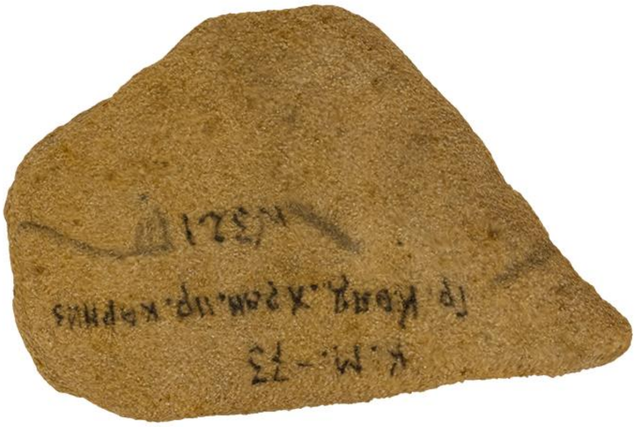



3.69 mm
0.946 mm
3.78 mm
0.525 mm
3.3 mm
0.493 mm
3.26 mm
0.458 mm

Specimen's ID	318
Image front	

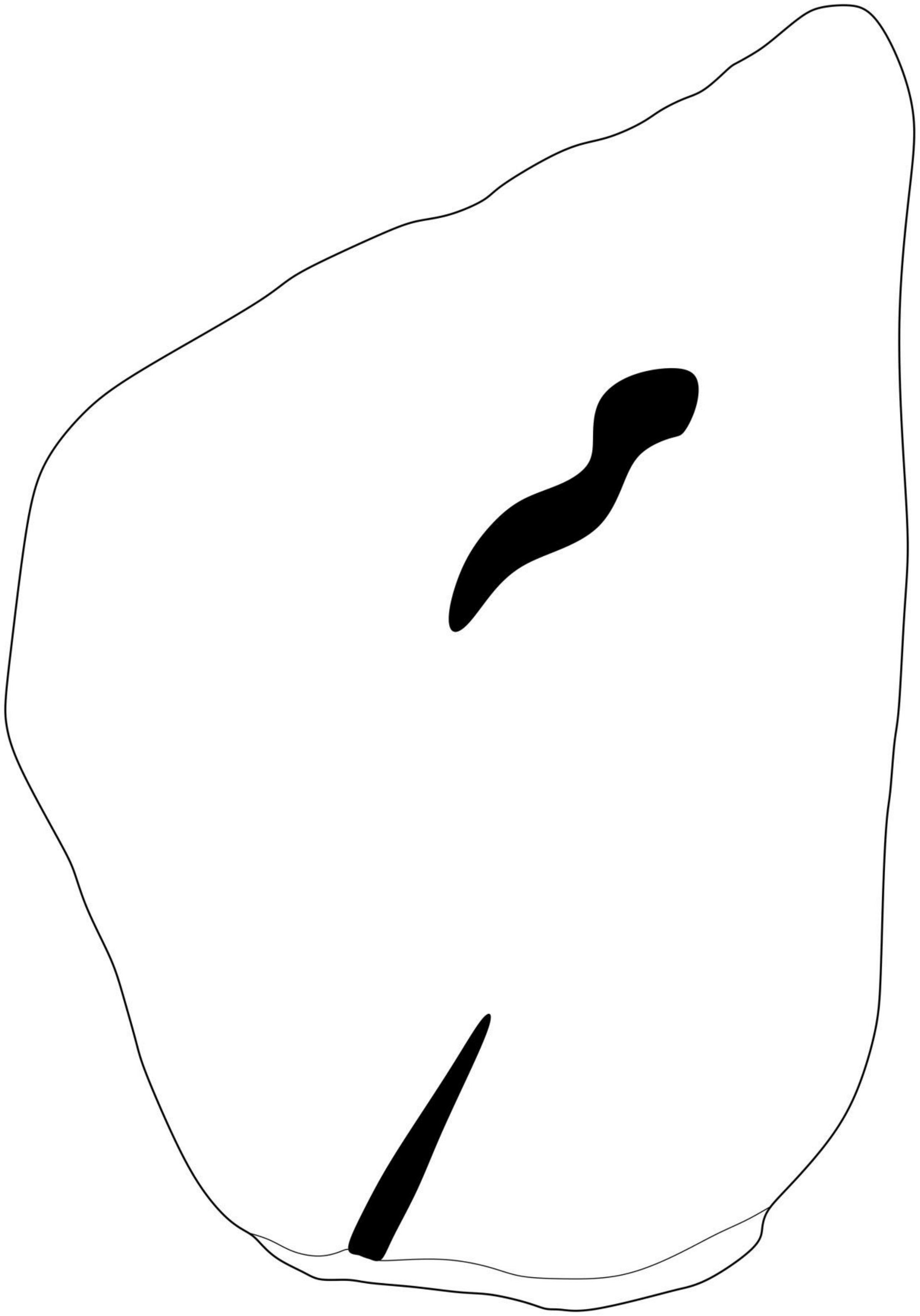
Image back	
Length, cm	58
Width, cm	33
Weight, g	12900
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A concretion of an almost oval shape with an almost vertically cut right side. The convex side contains an intense system of linear and geometric engravings. The flat one — a few separate engravings.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The stone consists of three big pieces. It is covered with desert varnish from the front side. This side is also covered with reticulated ornamentation and linear, geometric, and curved lines of different lengths and widths. The varnish is unusually red, though the back side of the stone is typical.

Specimen’s ID	319
Image front	
Image back	
Length, cm	12
Width, cm	12.5
Weight, g	734
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia, Right Cornice
Current location	Institute of Archaeology, Kyiv
Description	A piece of a subtriangular block with linear engravings on the front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	A stone is intensively polished and covered with desert varnish. The front side contains engraved non-figurative ornamentation and a small perforated cup mark.

Specimen's ID	321
Image front	
Image back	
Length, cm	9.5
Width, cm	6
Weight, g	140
Volume, m^3	0.000074
Density, kg / m^3	1891.89189
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia (Storage)
Current location	Institute of Archaeology, Kyiv
Description	A subrectangular fragment of the block with one-sided linear and geometric engravings.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from the front side. It contains a series of linear parallel or sub-parallel engravings on the front. Most of them are shallow and wide and have a very irregular shape. The relative chronology is not informative.

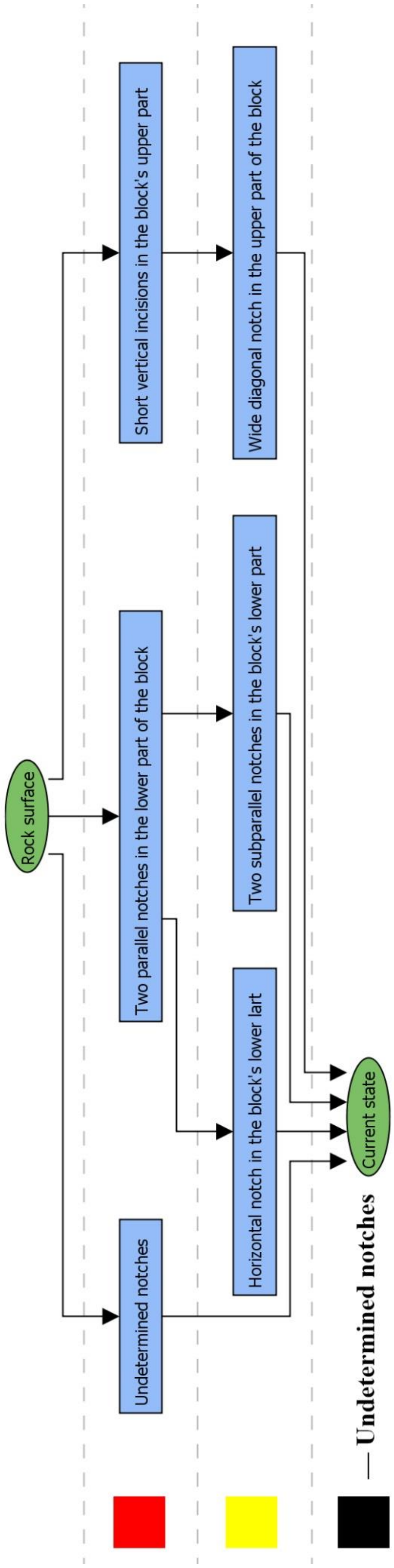
Technological drawing front

Technological drawing back

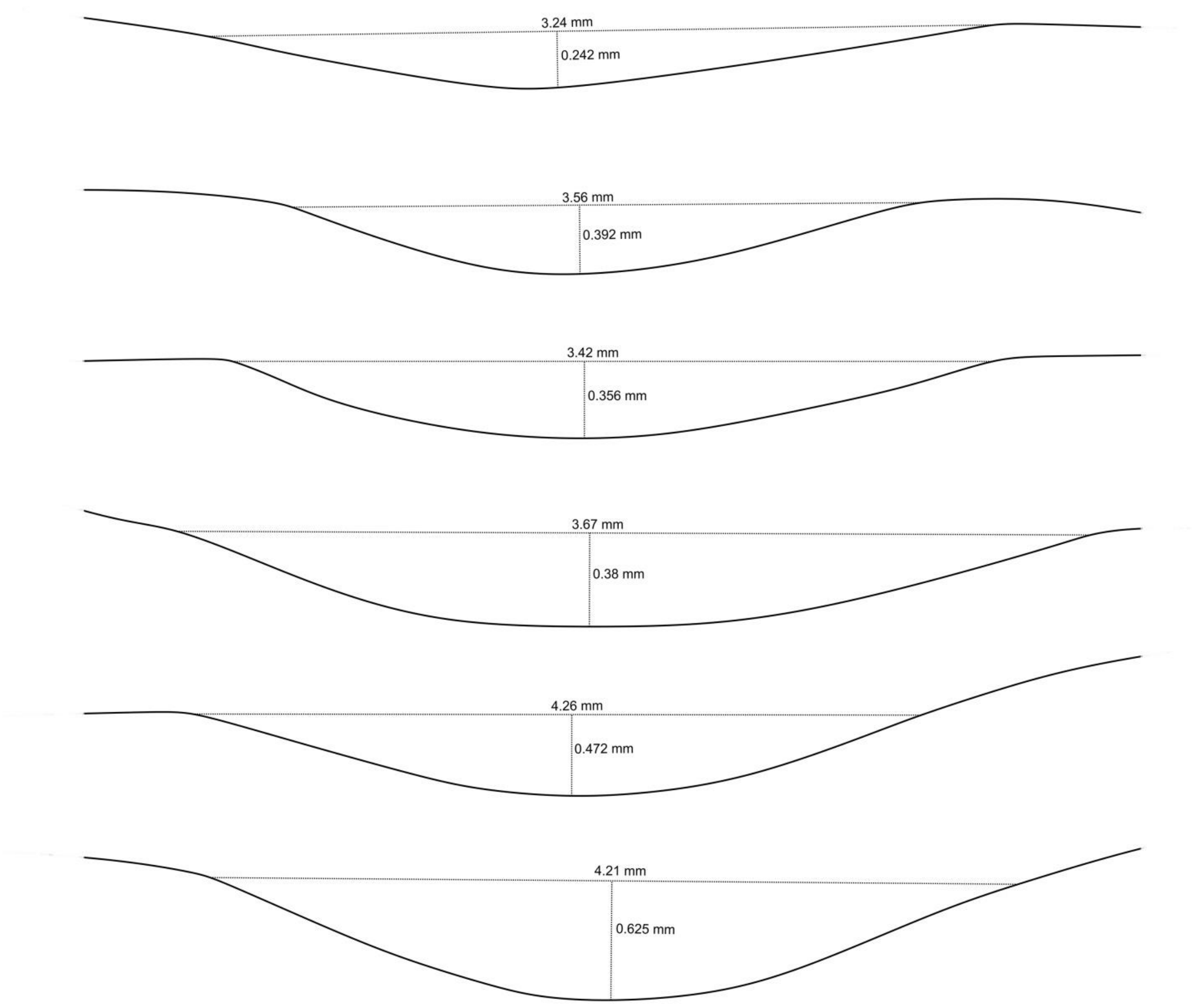


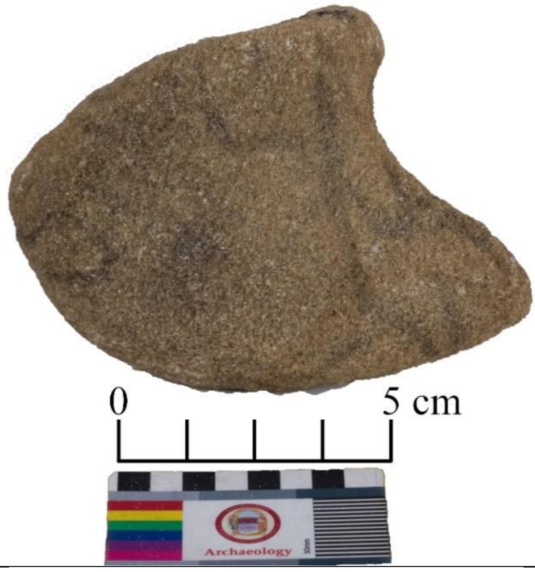
Relative chronology drawing front

Harris matrix front



Profiles list



Specimen’s ID	322
Image front	
Image back	
Length, cm	5.5
Width, cm	6
Weight, g	132
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia, right cornice
Current location	Institute of Archaeology, Kyiv
Description	A piece of concretion is similar to a profile of a bear. It is featured linear engravings from both sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The stone is covered with linear engravings and desert varnish both from the front and back sides. The shape is artificially processed.

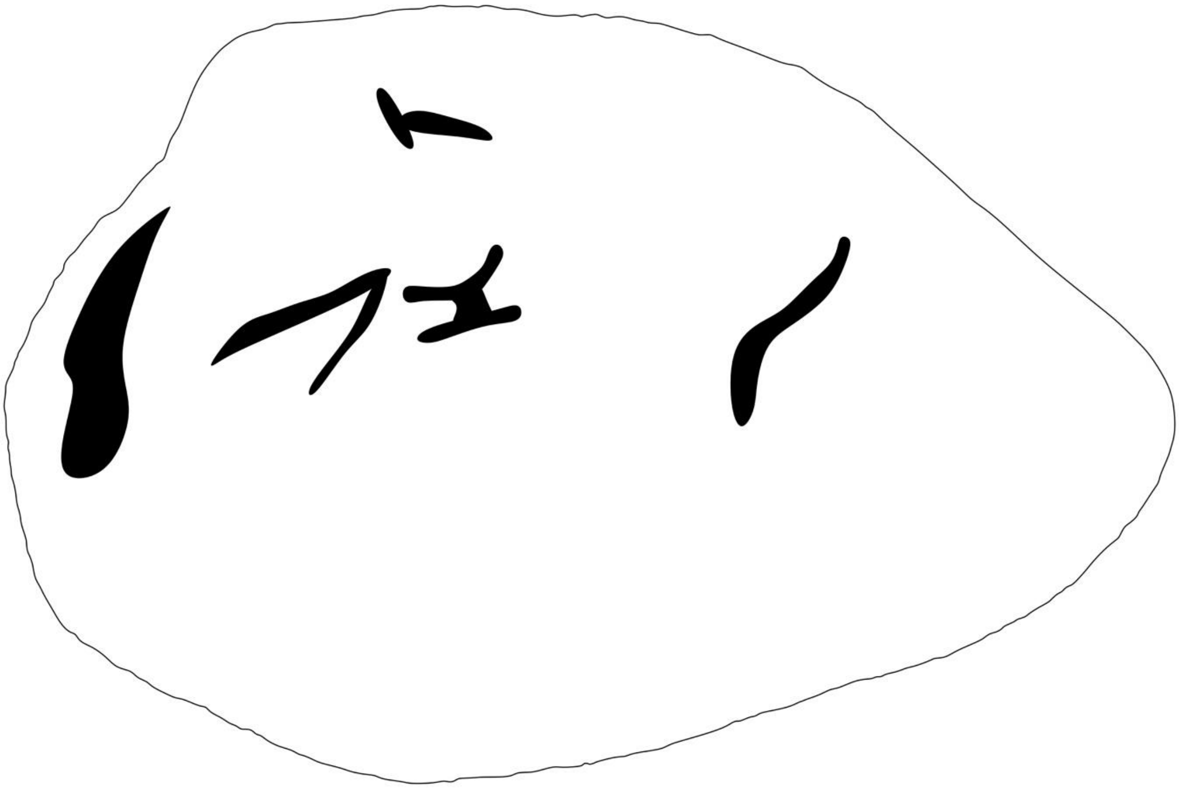
Specimen's ID	323
Image front	
Image back	
Length, cm	6.5
Width, cm	6
Weight, g	70
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A pebble of an irregular oval shape featured engravings from the front and back sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	An artificially processed (probably polished) stone covered with desert varnish and linear engravings from both sides. Few cupmarks are located on the front side.

Specimen’s ID	324
Image front	
Image back	
Length, cm	12
Width, cm	8.5
Weight, g	199
Volume, m^3	0.000104
Density, kg / m^3	1913.46154
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia (Storage)
Current location	Institute of Archaeology, Kyiv
Description	The pebble is of an irregular oval shape with linear engravings on the front. Its shape is similar to the shape of a bear’s head.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is slightly covered with desert varnish from both sides. V.

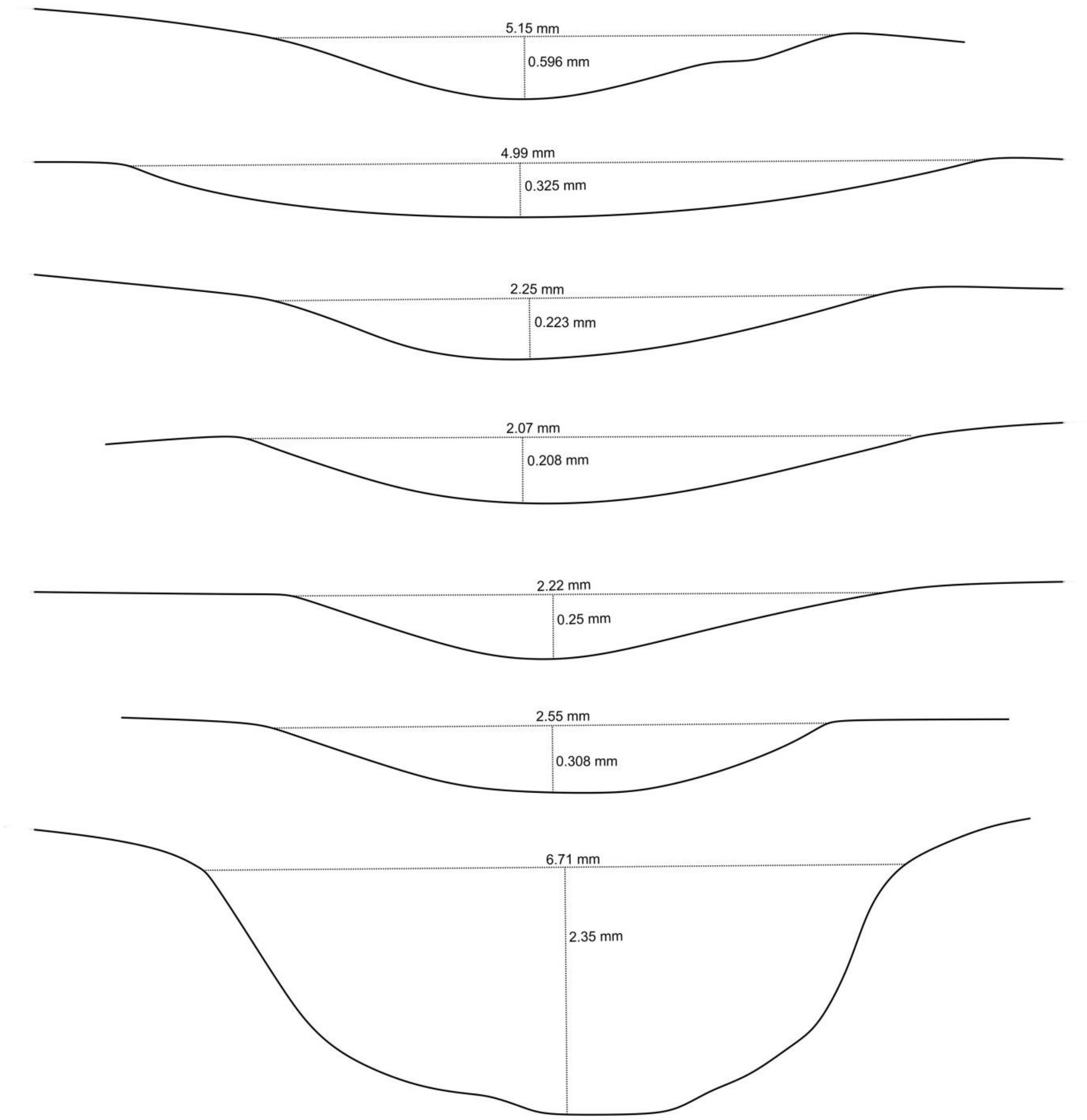
	Danilenko draws several small engravings on both sides. However, he writes that the engravings are located only from the front side. The vast majority of these incisions are invisible on the block's surface and probably not exists. The front side also contains a deep cupule of irregular oval shape. V. Danilenko did not report any semantic interpretation of the block. This seems to be relevant. Considering the block's shape as similar to the bear's head requires additional archaeological interpretation.

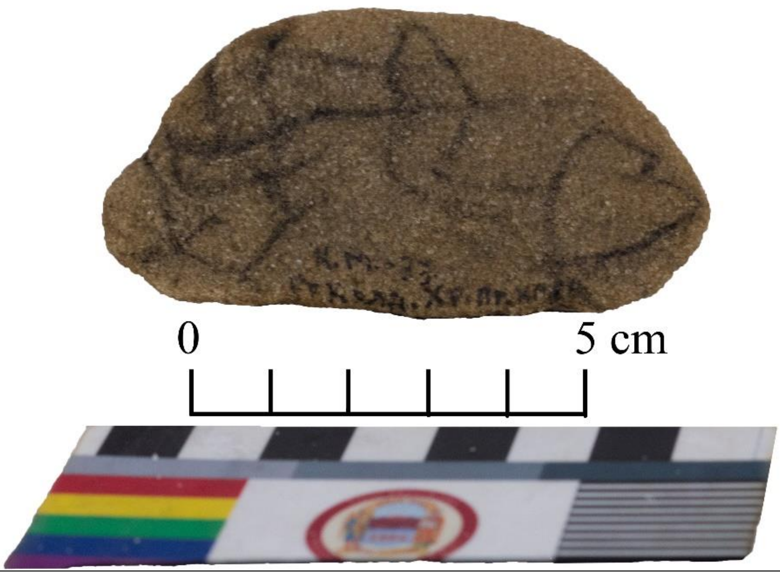
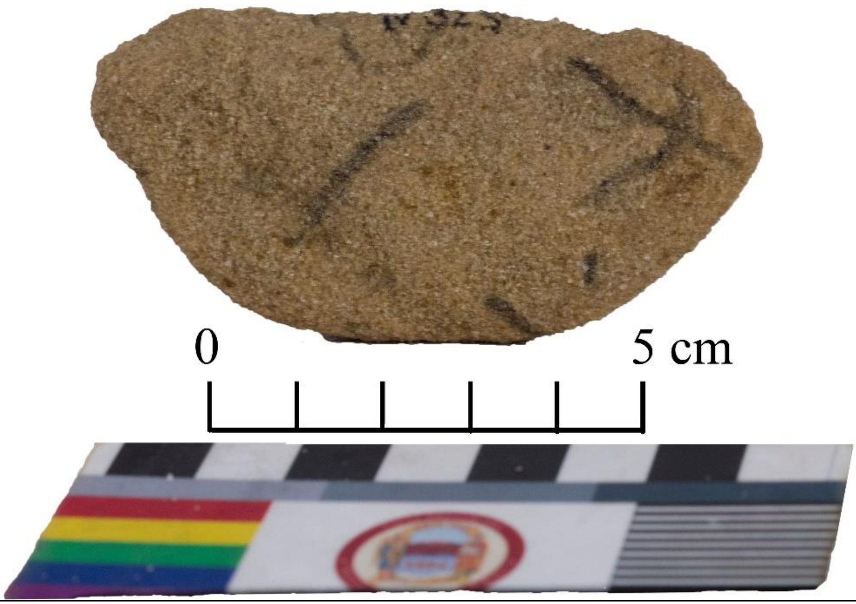
Technological drawing front

Technological drawing back

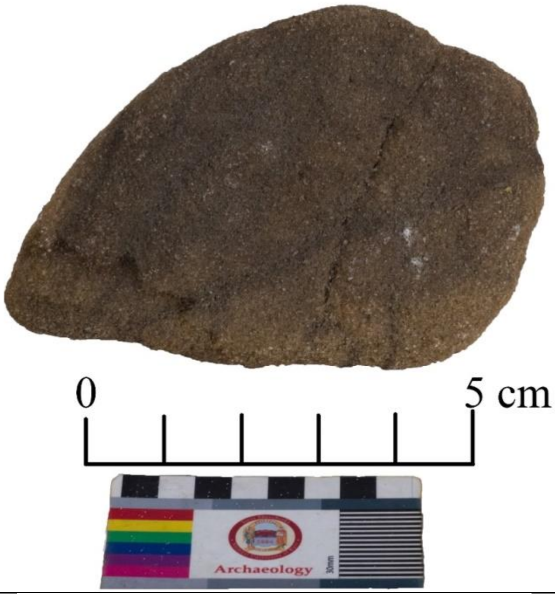


Profiles list



Specimen's ID	325
Image front	
Image back	
Length, cm	9
Width, cm	4.5
Weight, g	71
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A piece of a pebble has a shape of a segment with linear engravings from the front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	A stone covered with desert varnish and linear engravings from the front and back sides. A shape is probably polished.

Specimen’s ID	326
Image front	
Image back	
Length, cm	11.5
Width, cm	5.5
Weight, g	204
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A piece of a block similar to the upper part of an anthropomorphic figure pictured in a profile and featured with linear engravings.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The stone is covered with desert varnish. Linear engravings are on the stone's front, back, and top sides. The block broke up in two parts and was glued by V. Danilenko after 1973. A shape is featured by polishing.

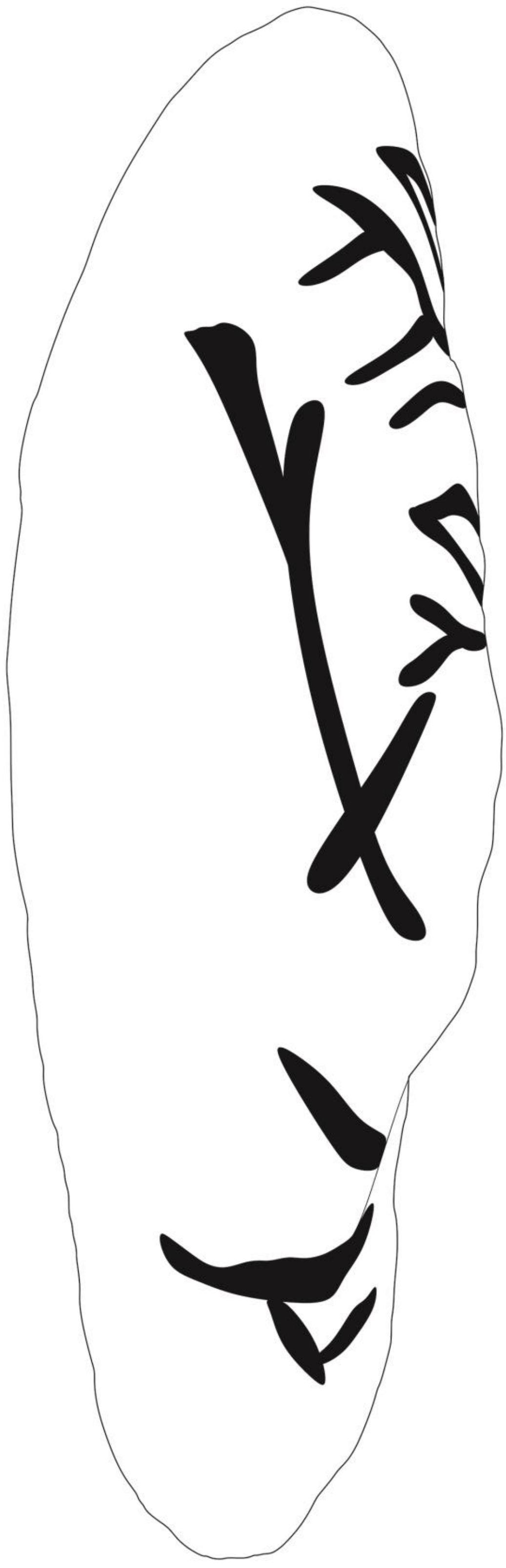
Specimen’s ID	327
Image front	
Image back	
Length, cm	8.5
Width, cm	4
Weight, g	76
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A subrectangular pebble with linear engravings from the front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The stone is covered with desert varnish. The front and back sides are slightly polished. The front one is covered with shallow linear engravings (reticulated ornamentation). A natural crack crosses the stone by its horizontal axis.

Specimen’s ID	328
Image front	
Image top	
Image back	
Image bottom	
Length, cm	19
Width, cm	10.5

Weight, g	1035
Volume, m^3	0.000529
Density, kg / m^3	1956.52174
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A piece of a concretion that is similar to a shape of an animal. It contains linear engravings on both sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. The whole surface is eroded; the back contains signs of destruction. The block is covered with irregular reticulated ornamentation. It contains noticeable incisions with symmetric profiles that are anthropogenic. The chronological sequence shows that a small engraving also superimposed these incisions. They do not present the last phase of the block’s life cycle. The stone also contains natural cracks superimposed by engravings with different profiles.

Technological drawing front

Technological drawing top

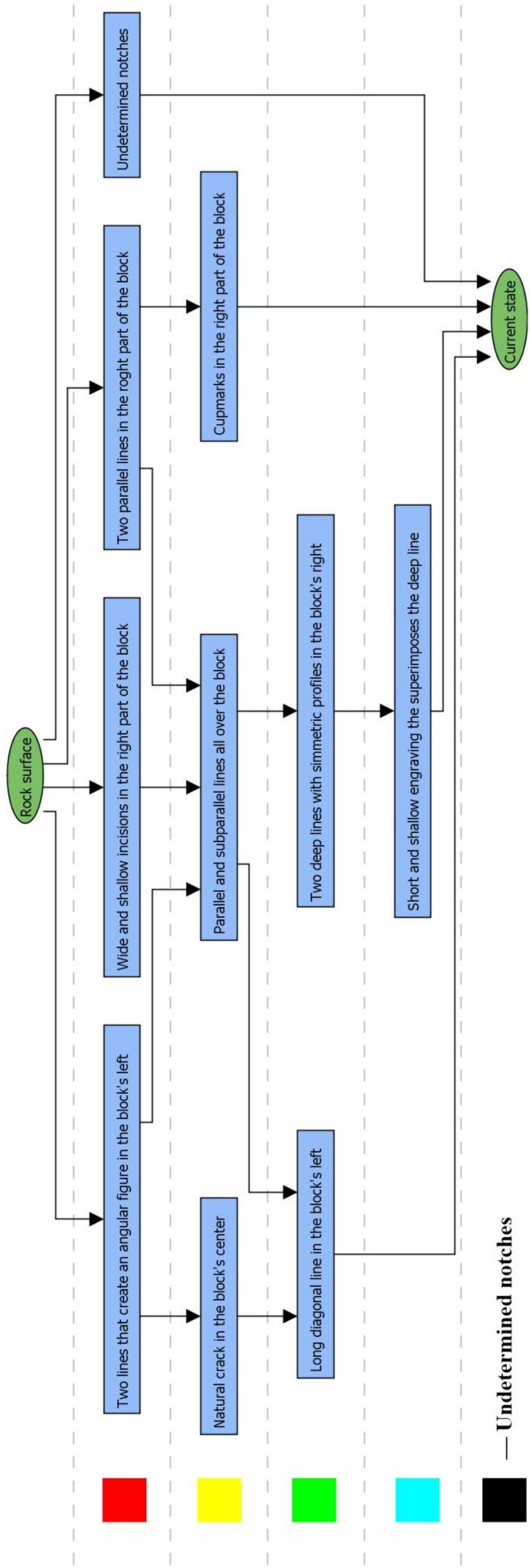


Technological drawing back

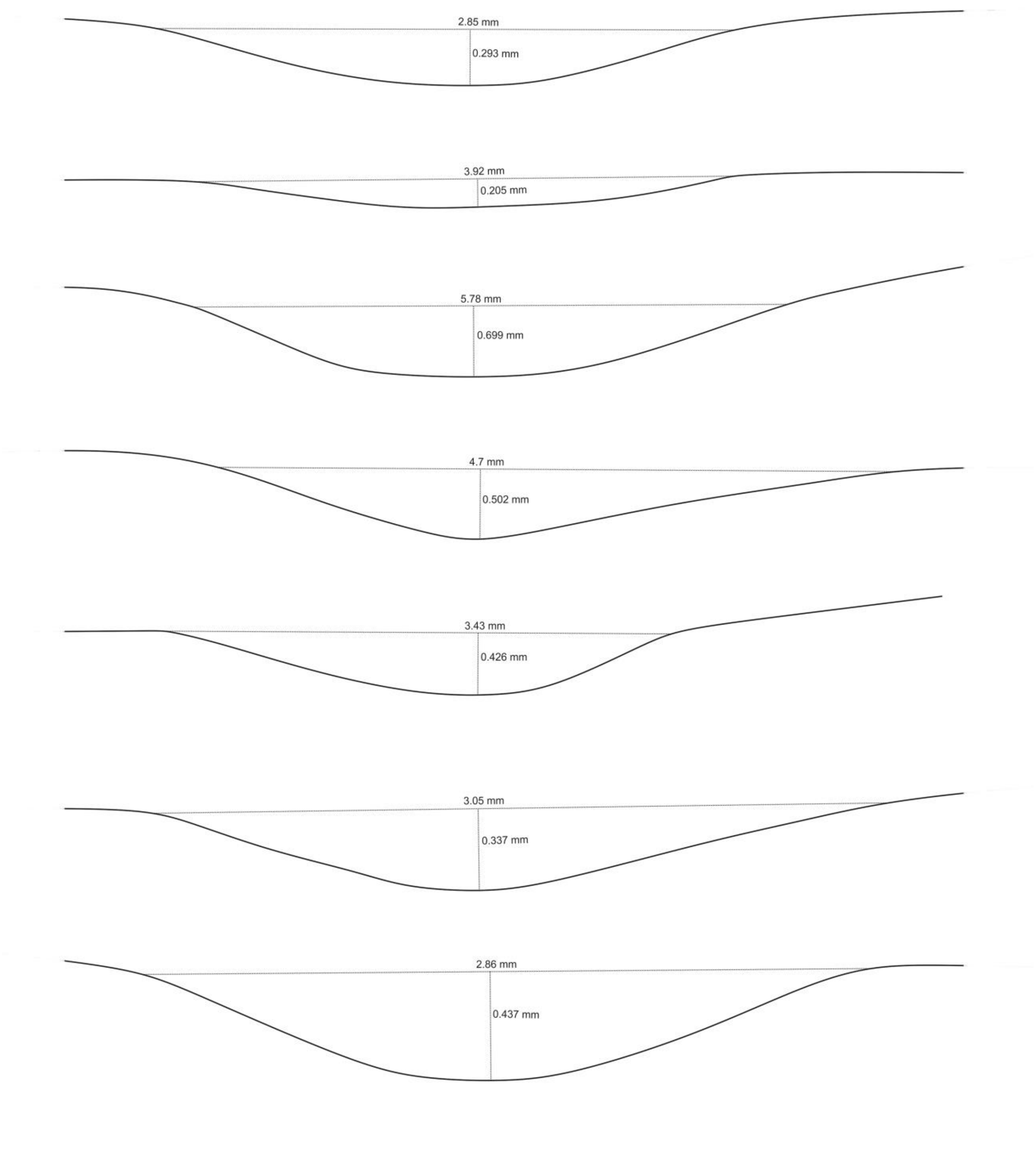
Technological drawing bottom

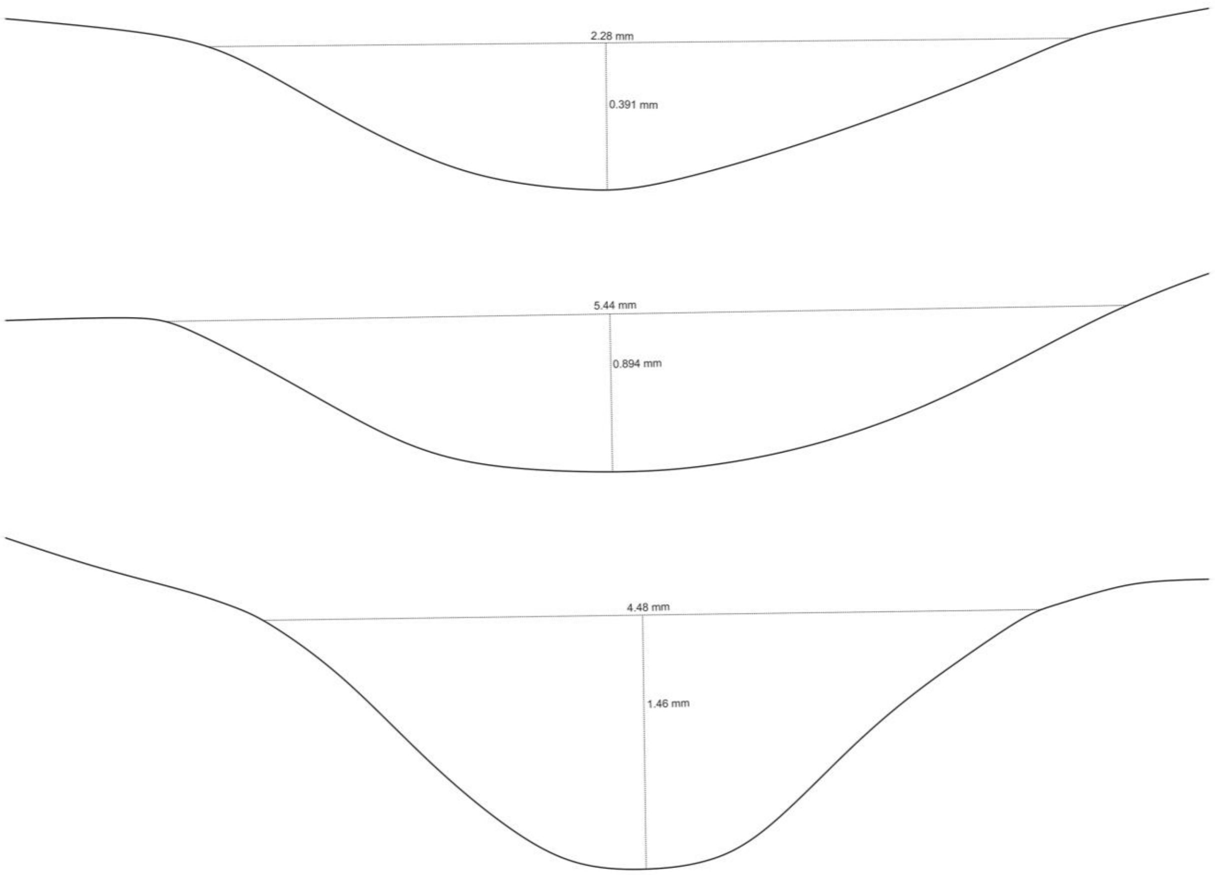
Relative chronology drawing (front)

Harris matrix front

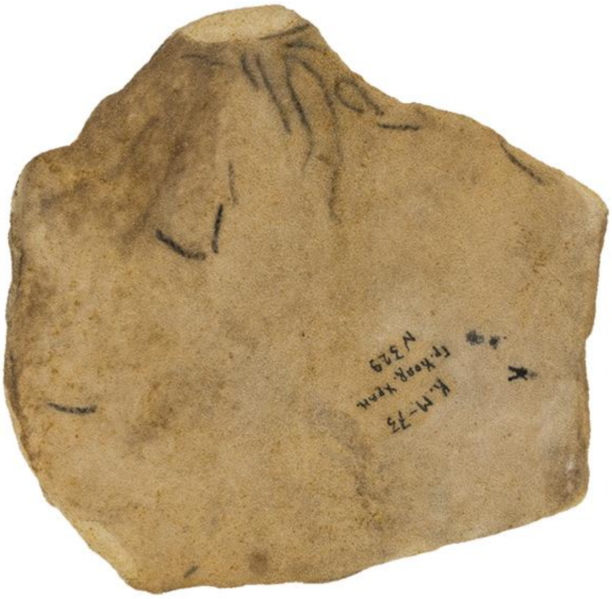


Profiles list



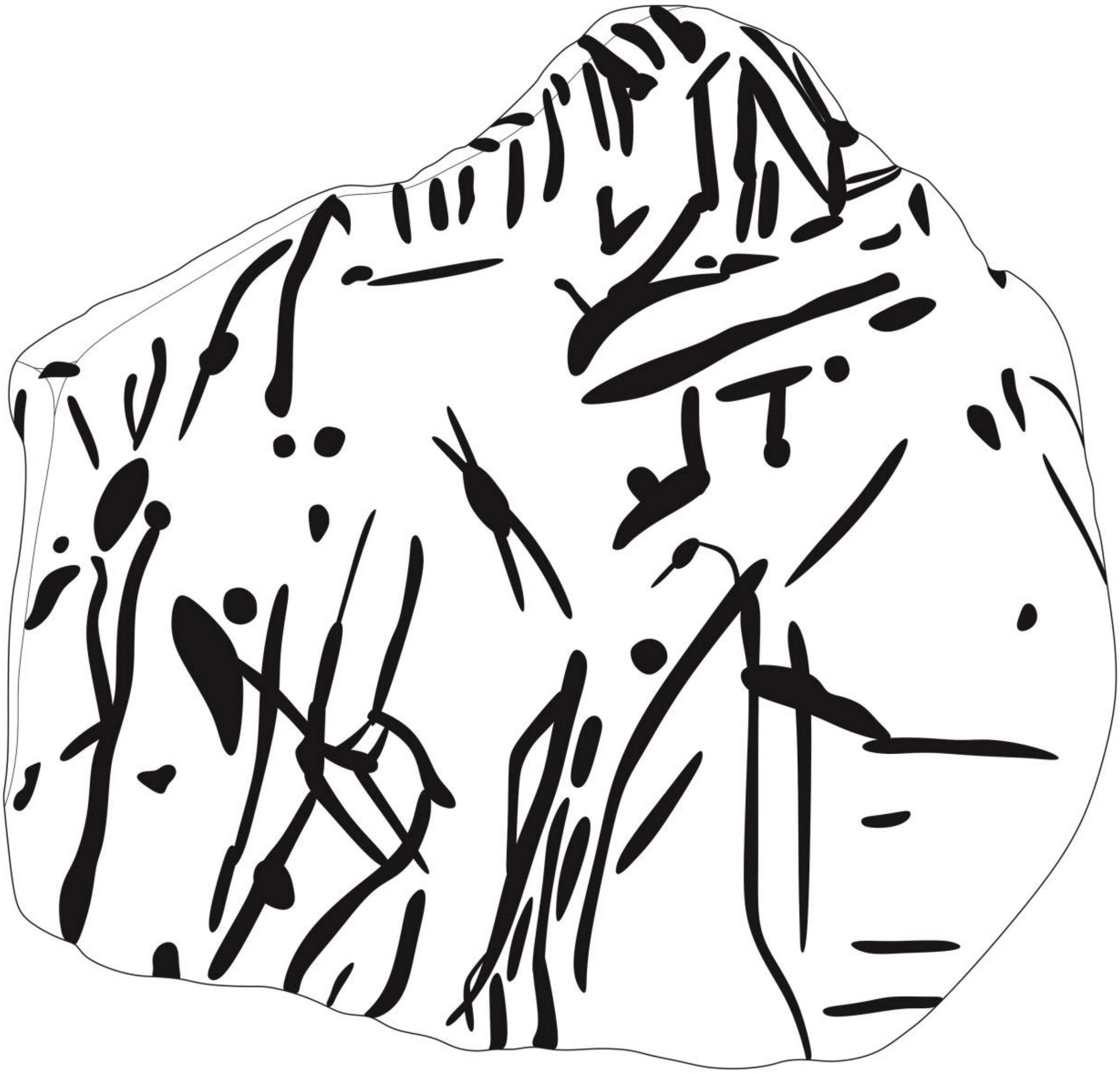


2.28 mm
0.391 mm
5.44 mm
0.894 mm
4.48 mm
1.46 mm

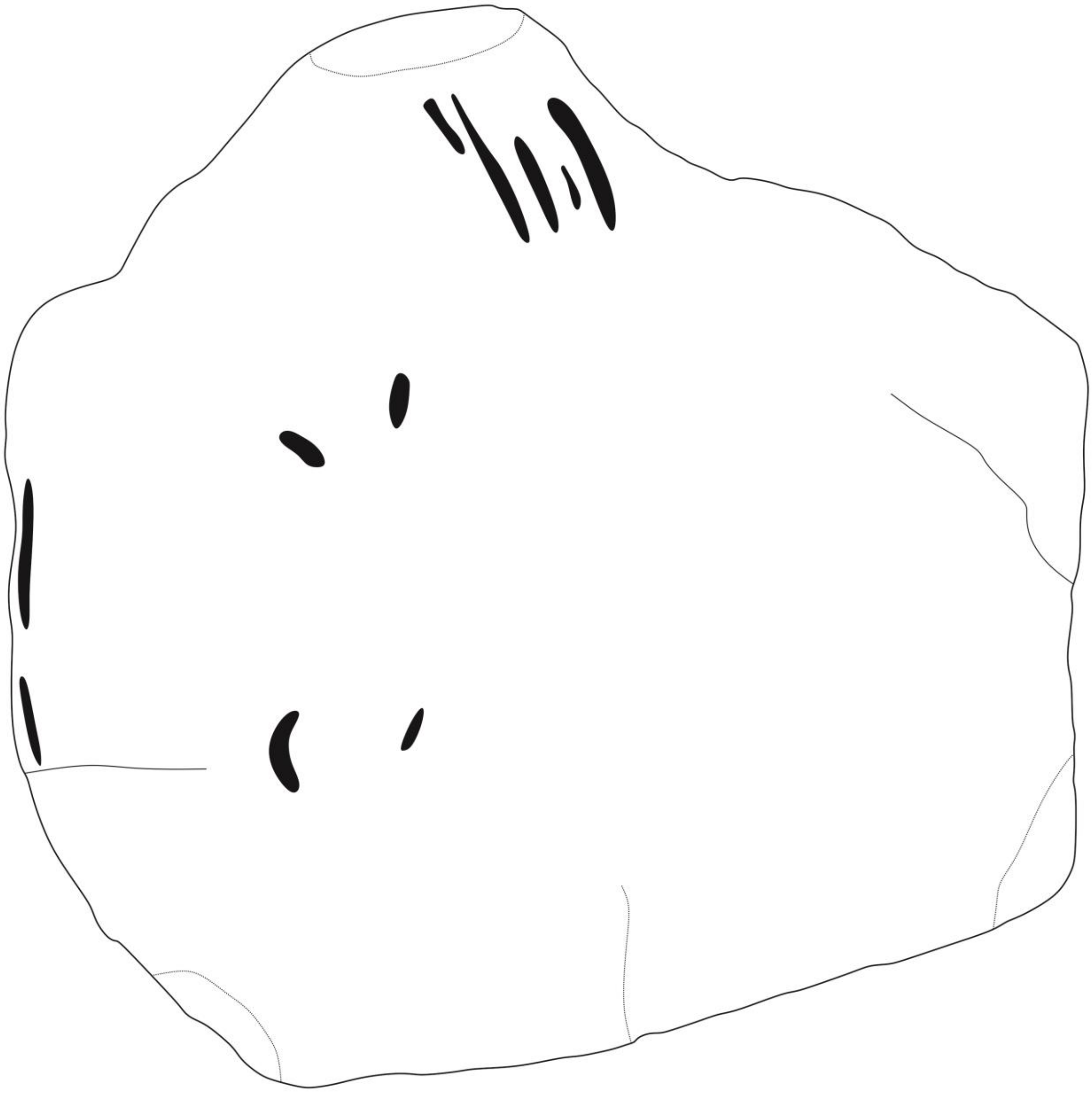
Specimen’s ID	329
Image front	
Image back	
Length, cm	25.5
Width, cm	27
Weight, g	3498
Volume, m^3	0.001823
Density, kg / m^3	1918.81514
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52

Current location	Institute of Archaeology, Kyiv
Description	A block of irregular shape with five angles. Contains linear engravings on the more protuberant side and a small number of incisions on the flat one.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. The back side and the right part of the front one seem to be slightly polished to their shape (possibly by natural processes or by an anthropomorphic impact). This happened after engraving the vertical groves in the block's center. Notches are always superimposed by natural cracks and cupmarks that are numerous on the block. Though V. Danilenko draws an anthropomorphic figure in the lower part of the block, it is not evident on the block's surface. He also did not describe or publish it in the book. The notches are primarily deep and narrow, both symmetric and asymmetric. The relative chronology is not informative. The engravings on the stone might be considered reticulated ornamentation. The back side of the block is brighter than the front one; it contains several subparallel lines. The block has been damaged during the transportation to Kyiv — the crust, created by desert varnish, is destroyed in some parts of the block.

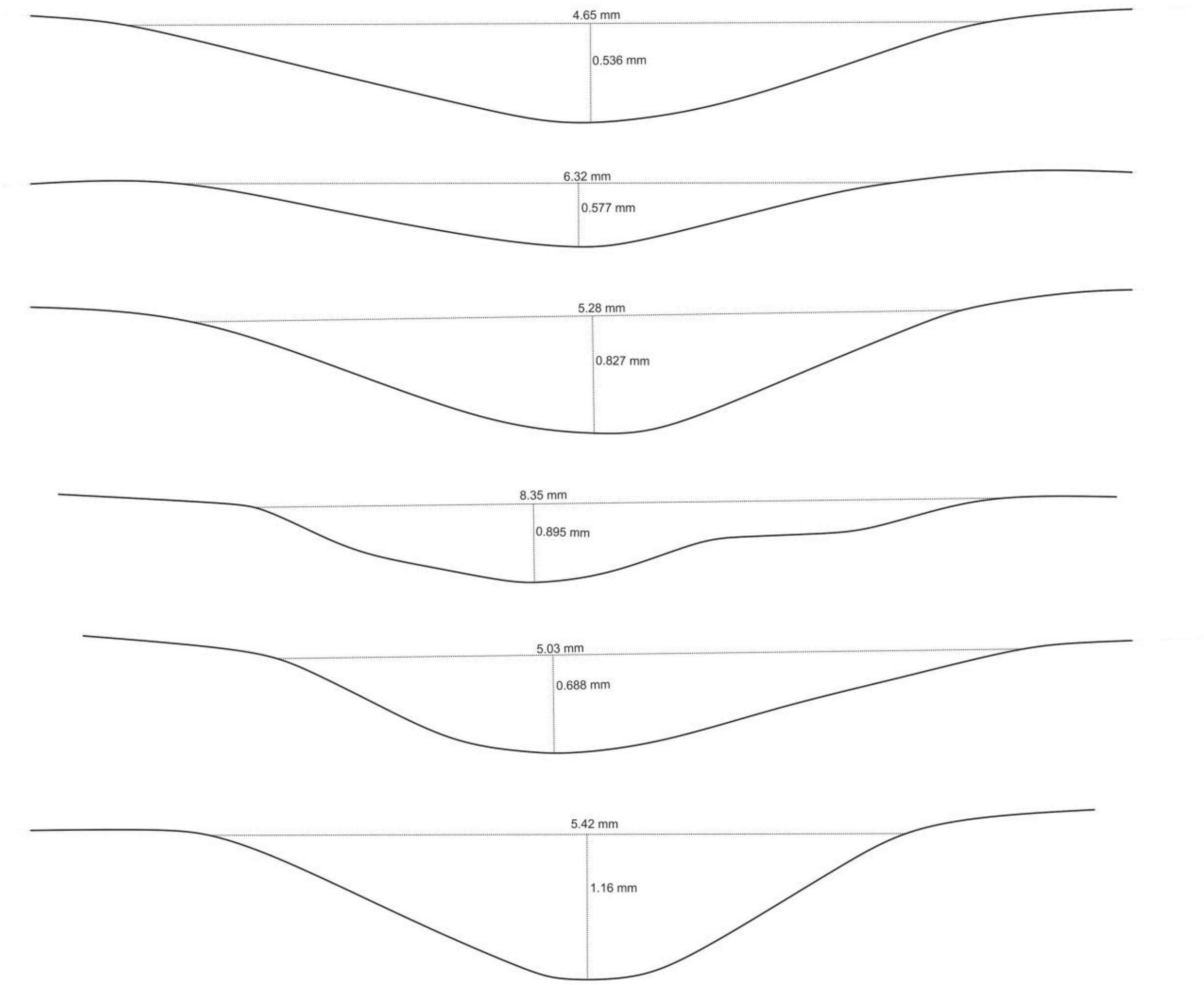
Technological drawing front

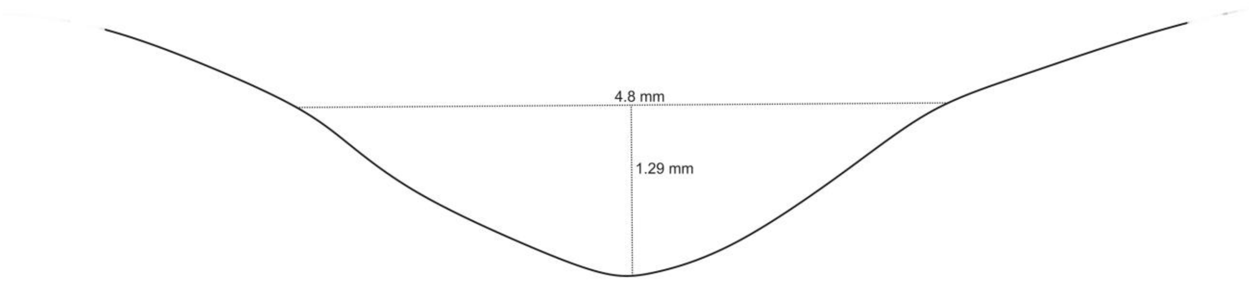


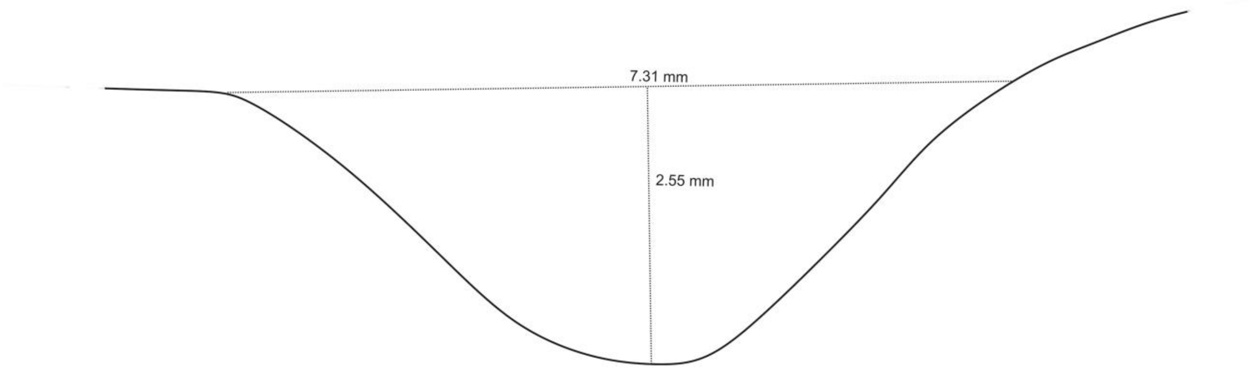
Technological drawing back

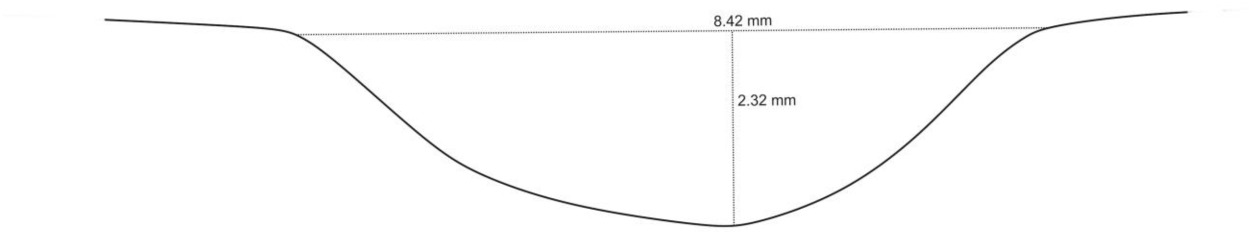


Profiles list




4.8 mm
1.29 mm

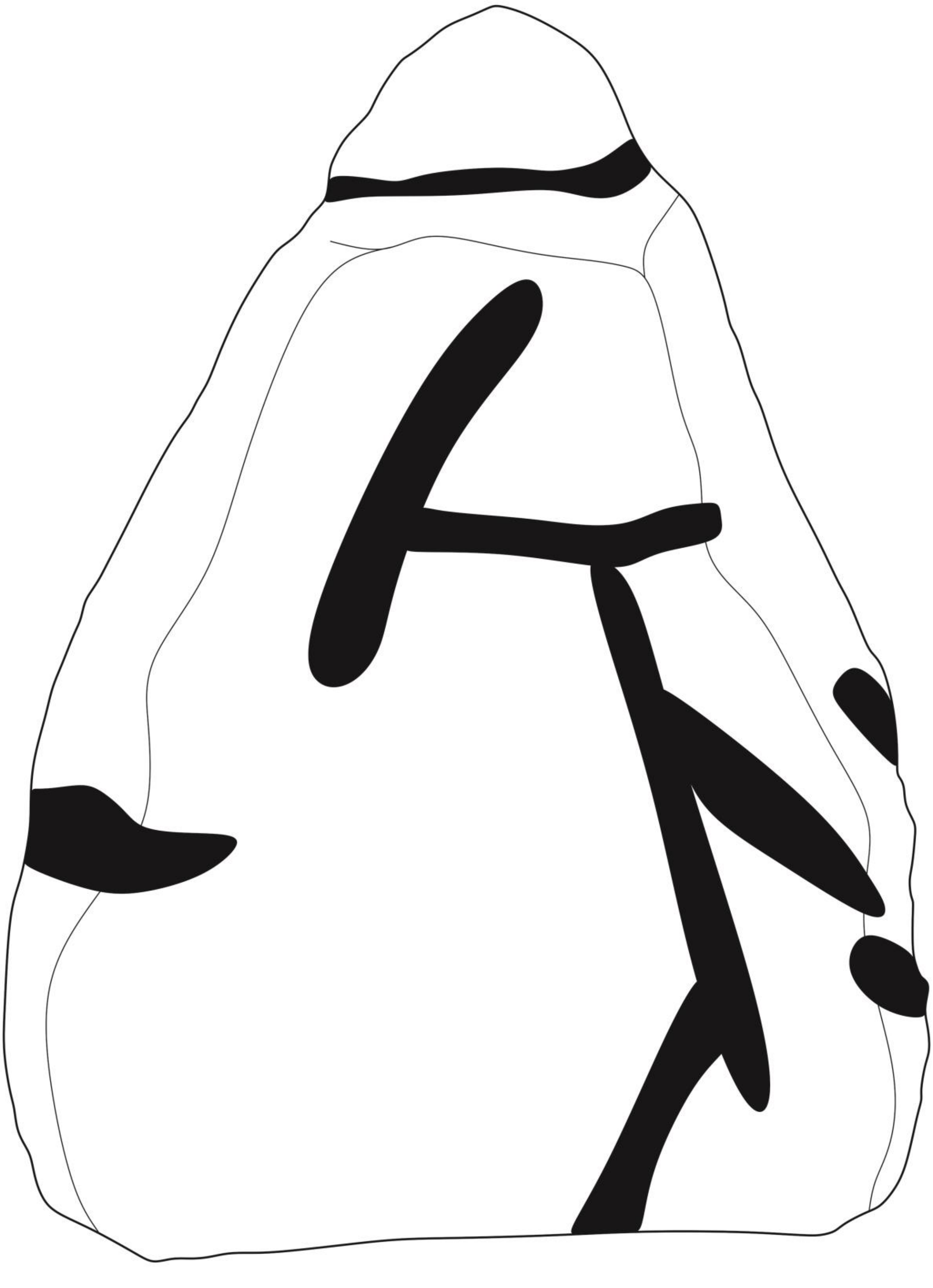

7.31 mm
2.55 mm


8.42 mm
2.32 mm

<table>
<tr><td>Specimen's ID</td><td>331</td></tr>
<tr><td>Image front</td><td></td></tr>
<tr><td>Image back</td><td></td></tr>
</table>

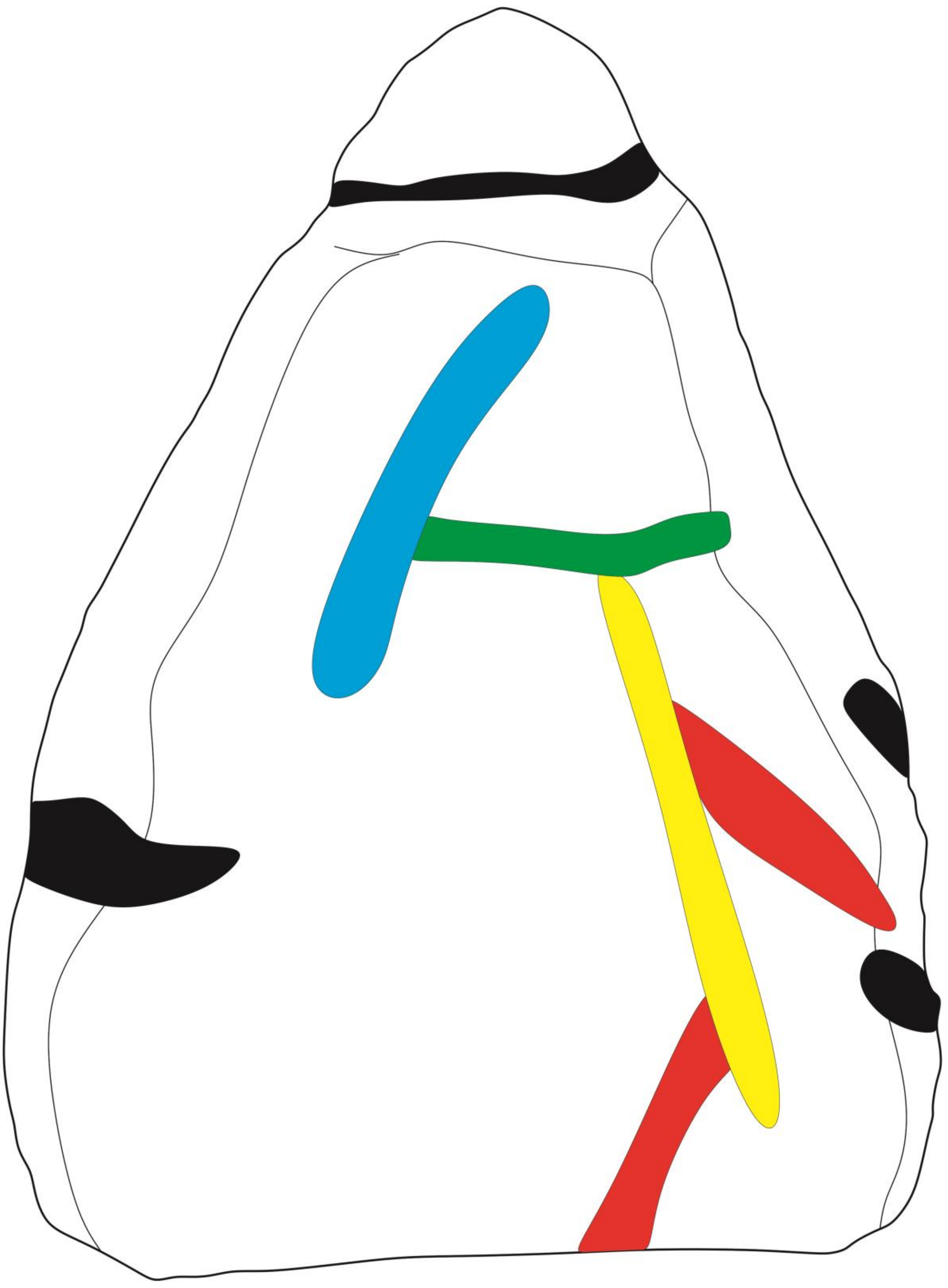
Length, cm	8
Width, cm	6
Weight, g	80
Volume, m^3	0.000044
Density, kg / m^3	1818.18182
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A piece of an oval block with engravings on both sides. It is similar to the upper part of the anthropomorphic figure.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. It contains linear engravings on both sides. They do not create any kind of composition and are almost invisible due to their shallowness. The block's upper part broke away and was glued by V. Danilenko after 1973. The interpretation of the block as the upper part of the anthropomorphic figure is dubious and not supported by technological analysis. This requires additional archaeological interpretation.

Technological drawing front

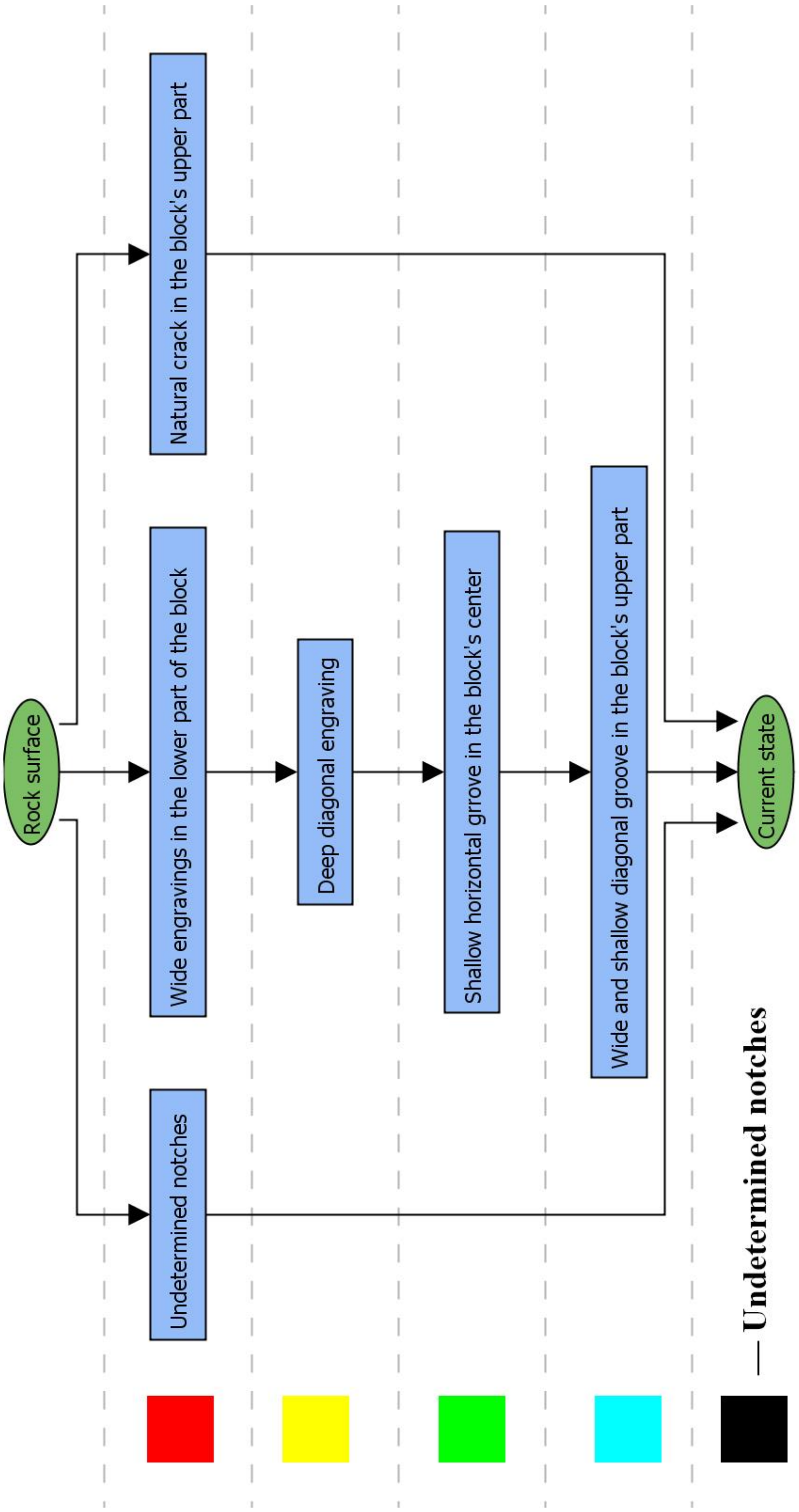


Technological drawing back

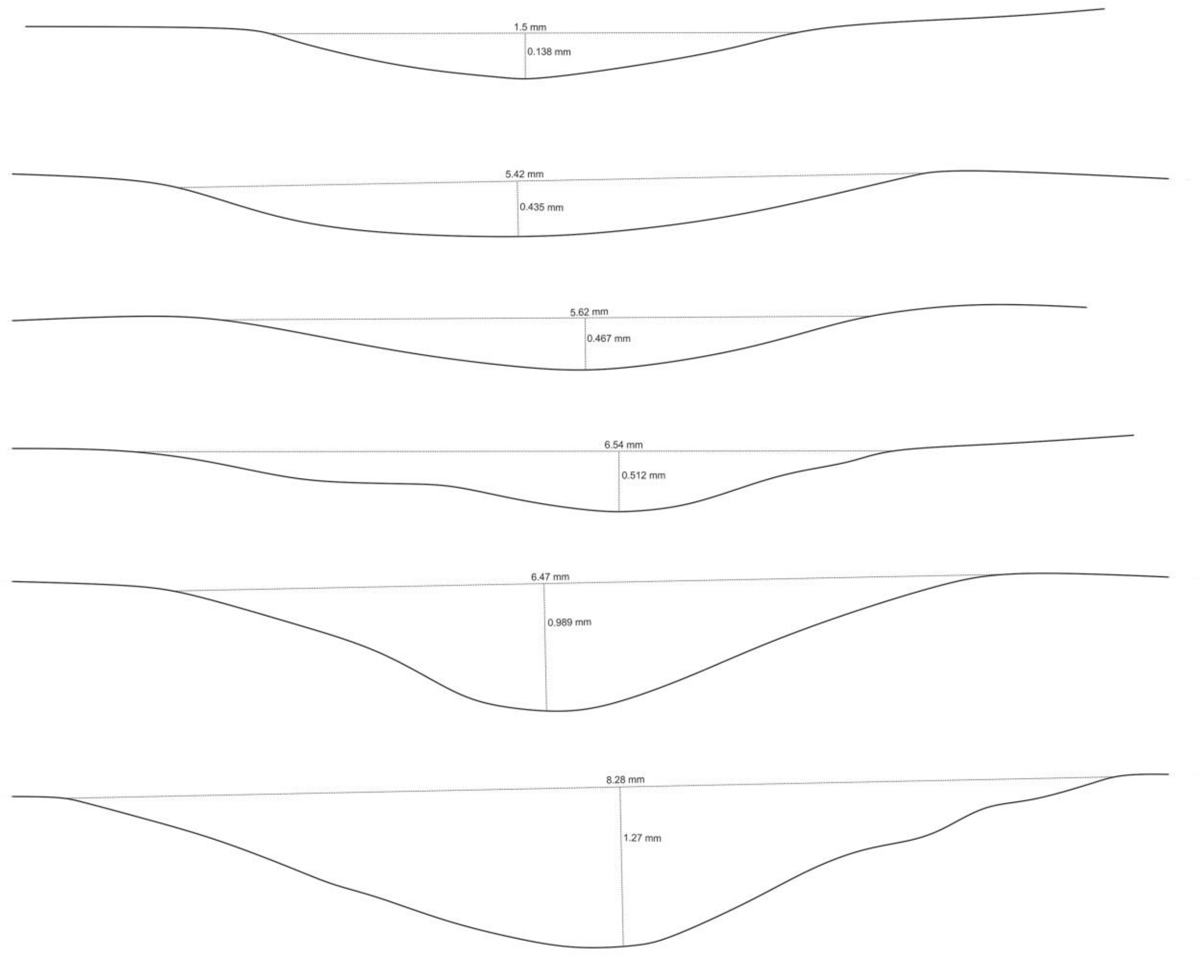
Relative chronology drawing (front)



Harris matrix front



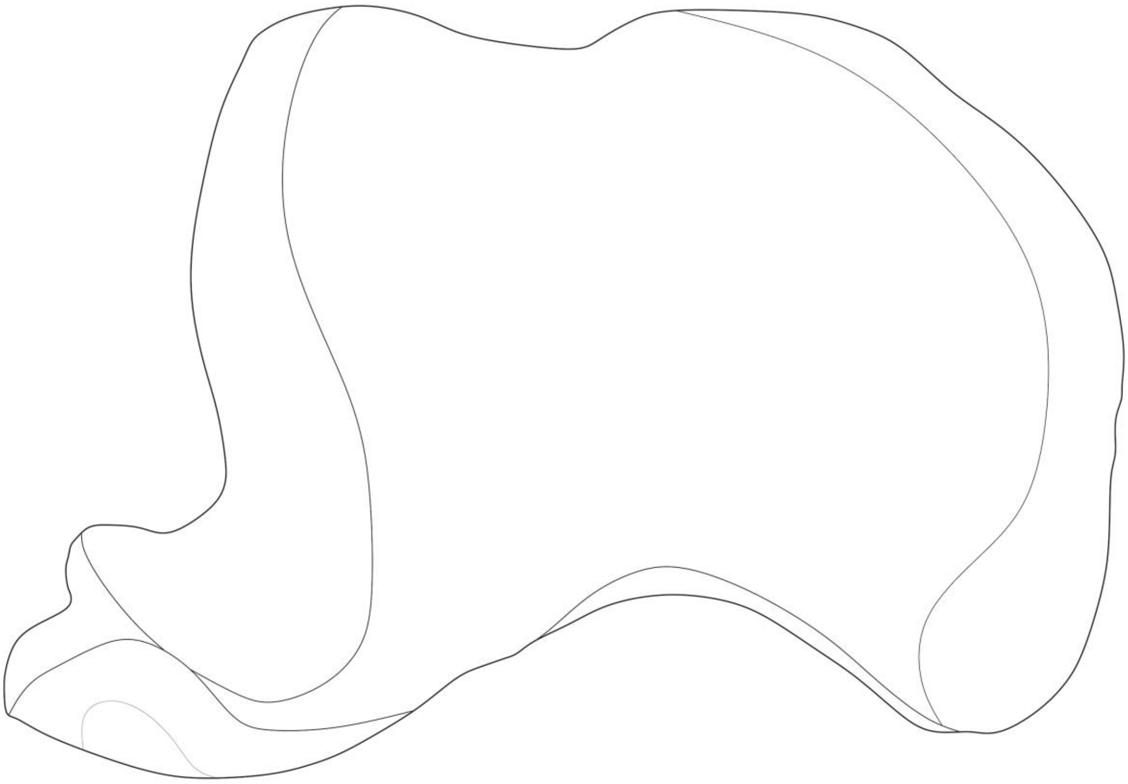
Profiles list



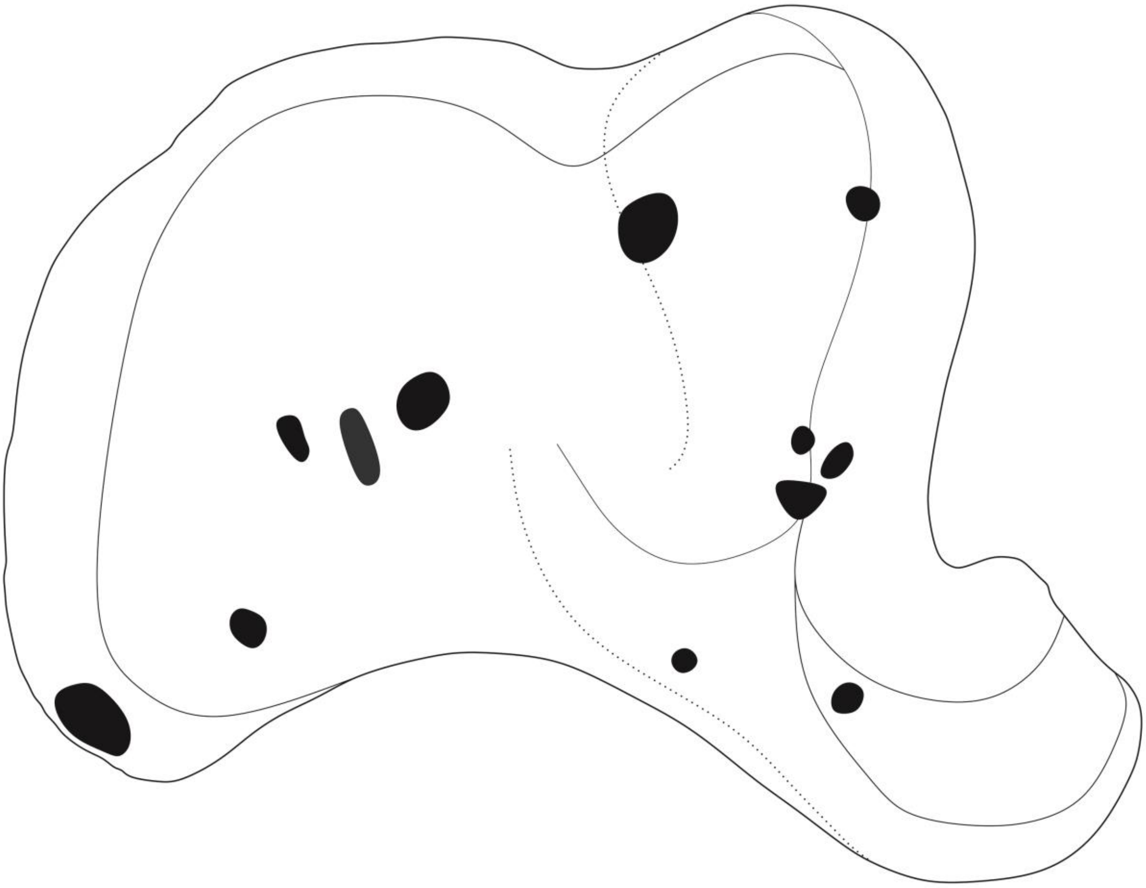
Specimen's ID	332
Image front	
Image back	
Length, cm	9
Width, cm	6
Weight, g	110
Volume, m^3	0.000053
Density, kg / m^3	2075.4717
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Eastern Entrance
Current location	Institute of Archaeology, Kyiv
Description	A concretion, probably picked up or produced figure that is really similar by its shape to the mammoth profile (is considered like that by the wide group of different-aged people).
Description source	The storage list of Institute of Archaeology in Kyiv

Note	The figure is partially processed to obtain its shape. The shape is complicated, and a stone can be considered a figure regardless of the semantic interpretation. Though V. Danilenko claims the figure to be an image of a mammoth, this requires additional consideration. However, the stone is similar in shape to the latter. Moreover, according to V. Danilenko’s notifications, the figure is considered a mammoth after the blind tests on a broad audience (no published proof). The stone does not contain engravings; a few shallow marks are visible on the back side of its surface. Though the interpretation of the figure appears to be completed by V. Danilenko, the specimen remains unpublished.

Technological drawing front



Technological drawing back



Specimen’s ID	334
Image front	
Image back	
Length, cm	12
Width, cm	8
Weight, g	280
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A concretion in a shape of a segment. Contains linear engravings on its convex shape.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The stone is covered with desert varnish. Engravings on the front (convex) side are slightly deeper. The front side is darker than the back one. A shape is possibly processed.

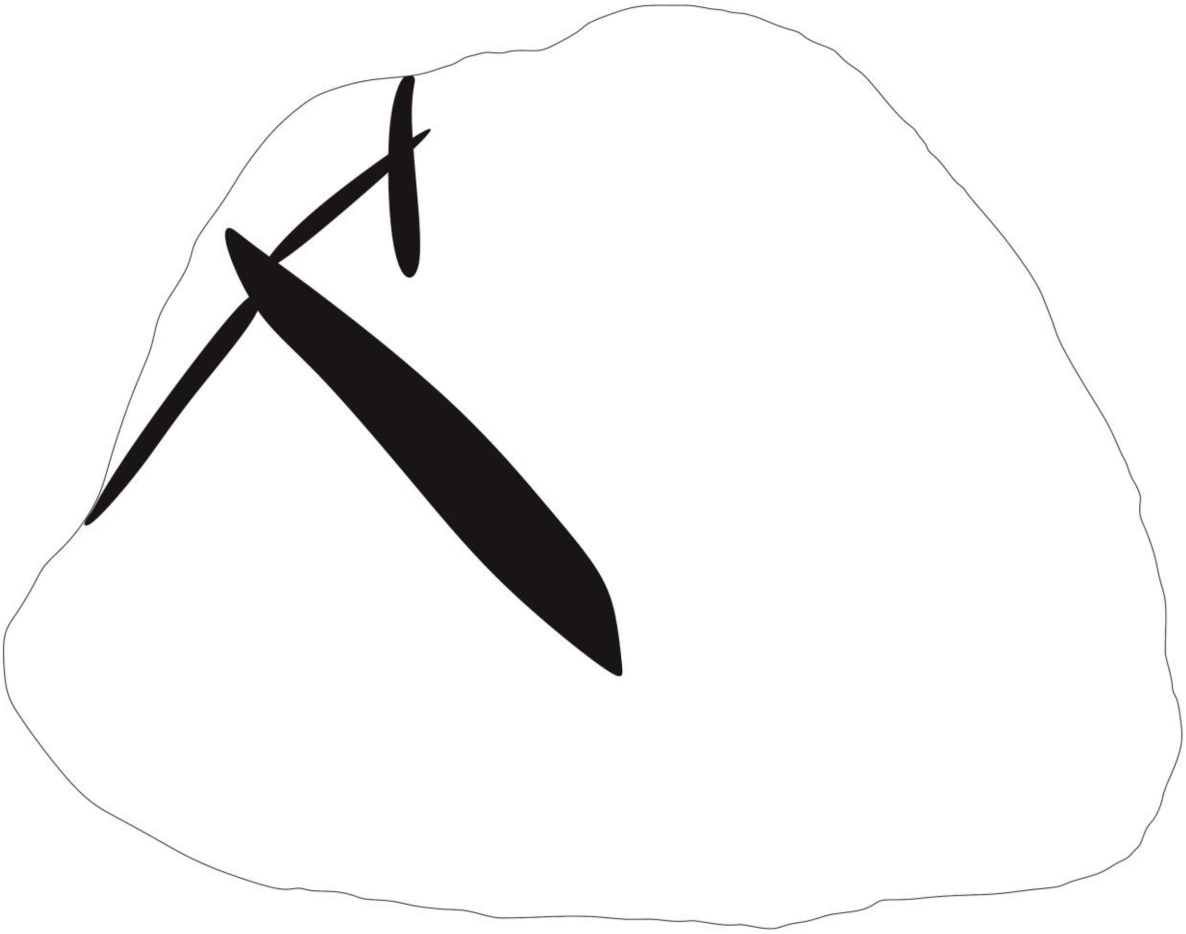
Specimen's ID	335
Image front	
Image right	
Image back	

Image left	
Length, cm	18
Width, cm	8.5
Weight, g	221
Volume, m^3	0.000112
Density, kg / m^3	1973.21429
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The concretion is in the shape of a segment similar to a churinga. Contains linear and geometric engravings from the front and back sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. The surface of the front side is eroded and covered with wide linear engravings with irregular and destructed profiles. One of these engravings contains several different profiles that change one another. The superimpositions are rare and non-informative.

Technological drawing front

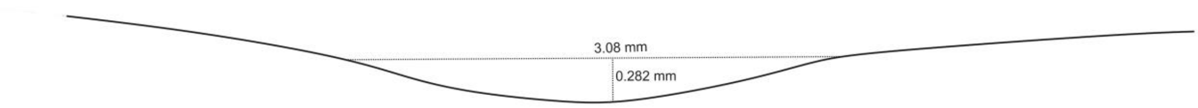
Technological drawing right

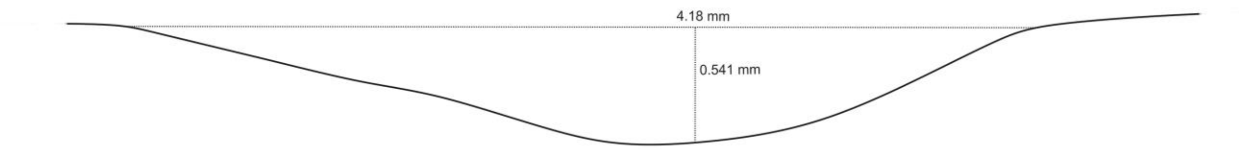
Technological drawing back

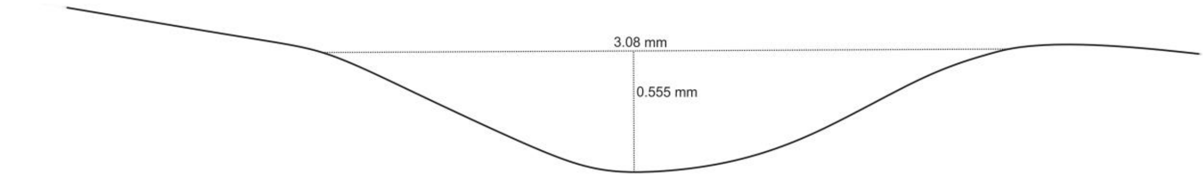


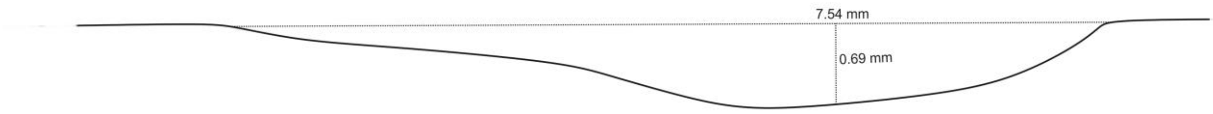
Technological drawing left

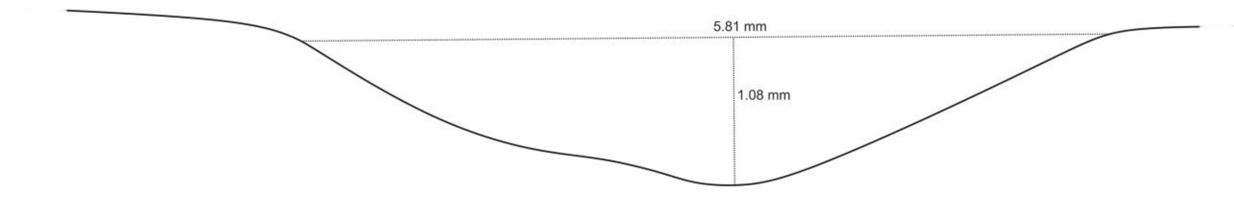
Profiles list

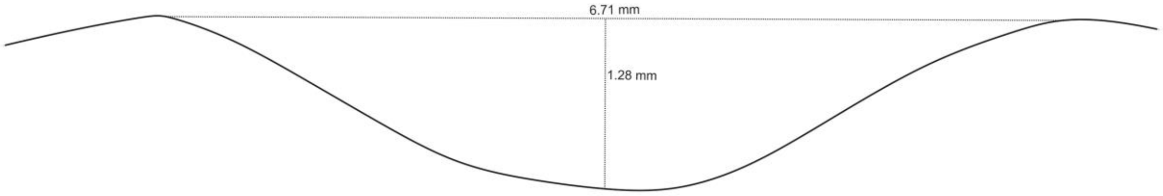


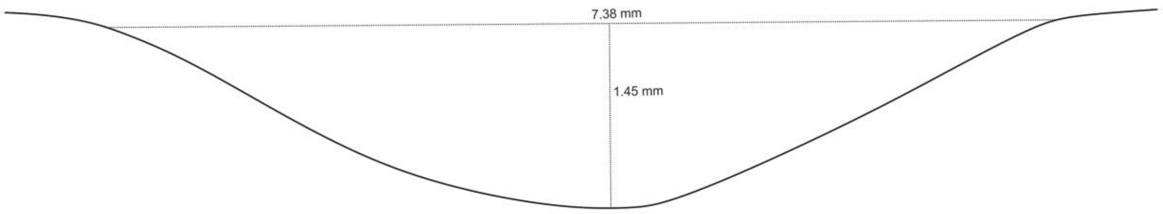


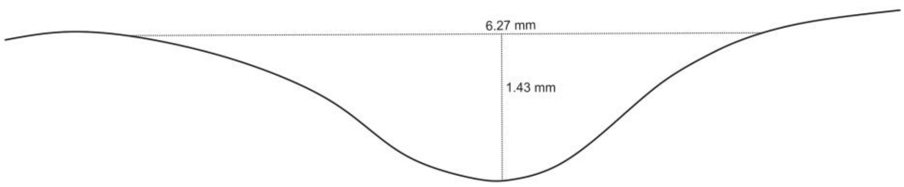







6.71 mm
1.28 mm


7.38 mm
1.45 mm


6.27 mm
1.43 mm

Specimen’s ID	336
Image front	
Image top	
Image back	
Image bottom	
Length, cm	6.5
Width, cm	8
Weight, g	497
Volume, m^3	0.000253
Density, kg / m^3	1964.42688

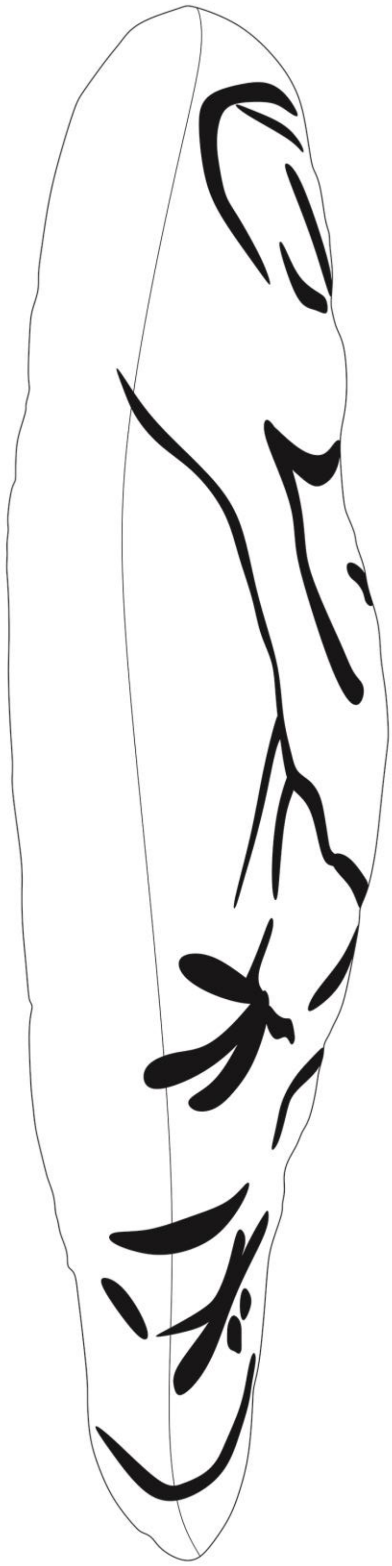
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A piece of a concretion in a shape of a segment with linear and geometric engravings on both sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. The whole surface is eroded. The block is covered with irregular linear and curved notches; most of them probably have a natural origin and do not have a regular and clear profile. Some incisions are parallel. The relative chronology is not informative.

Technological drawing front

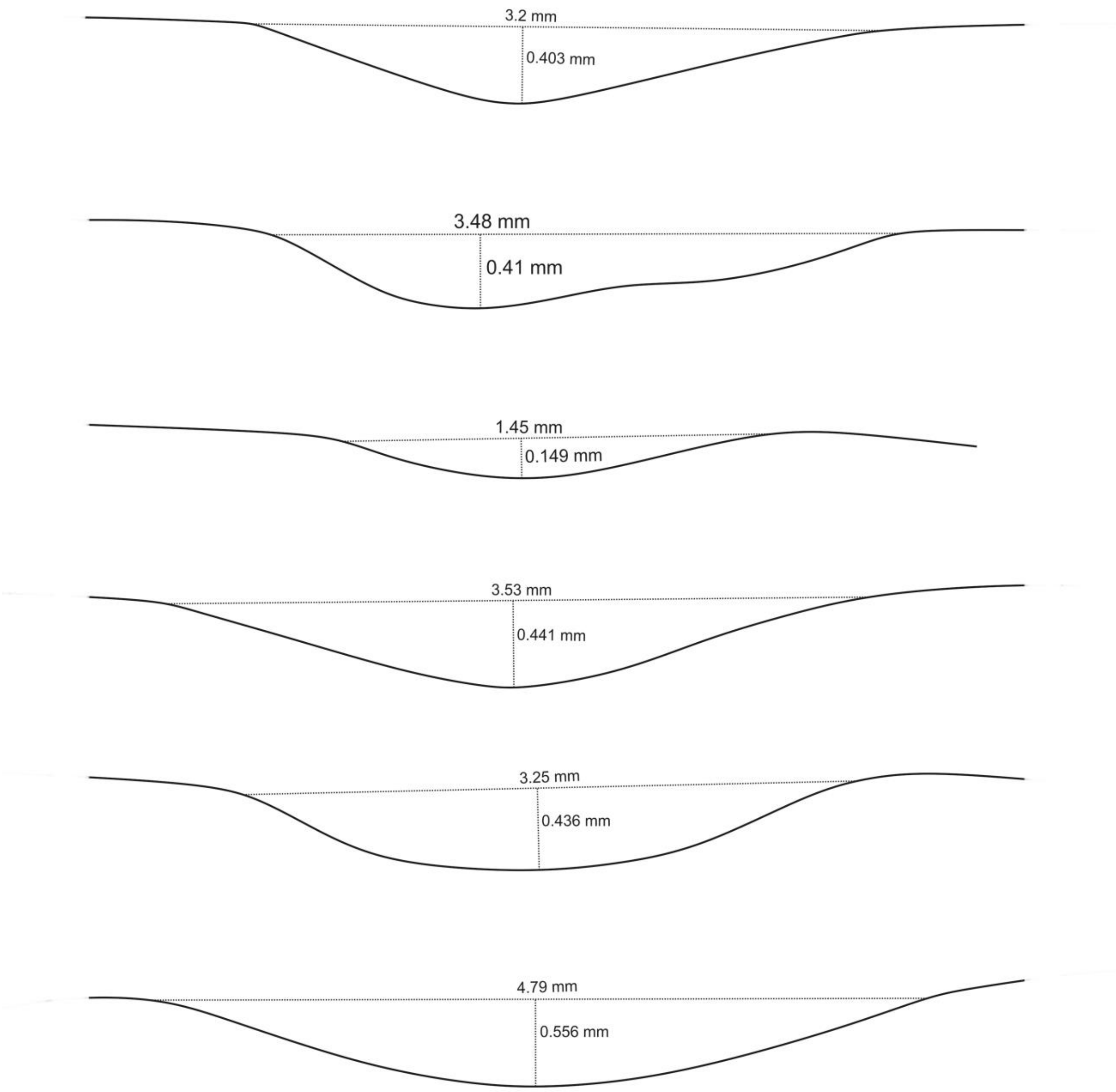
Technological drawing top

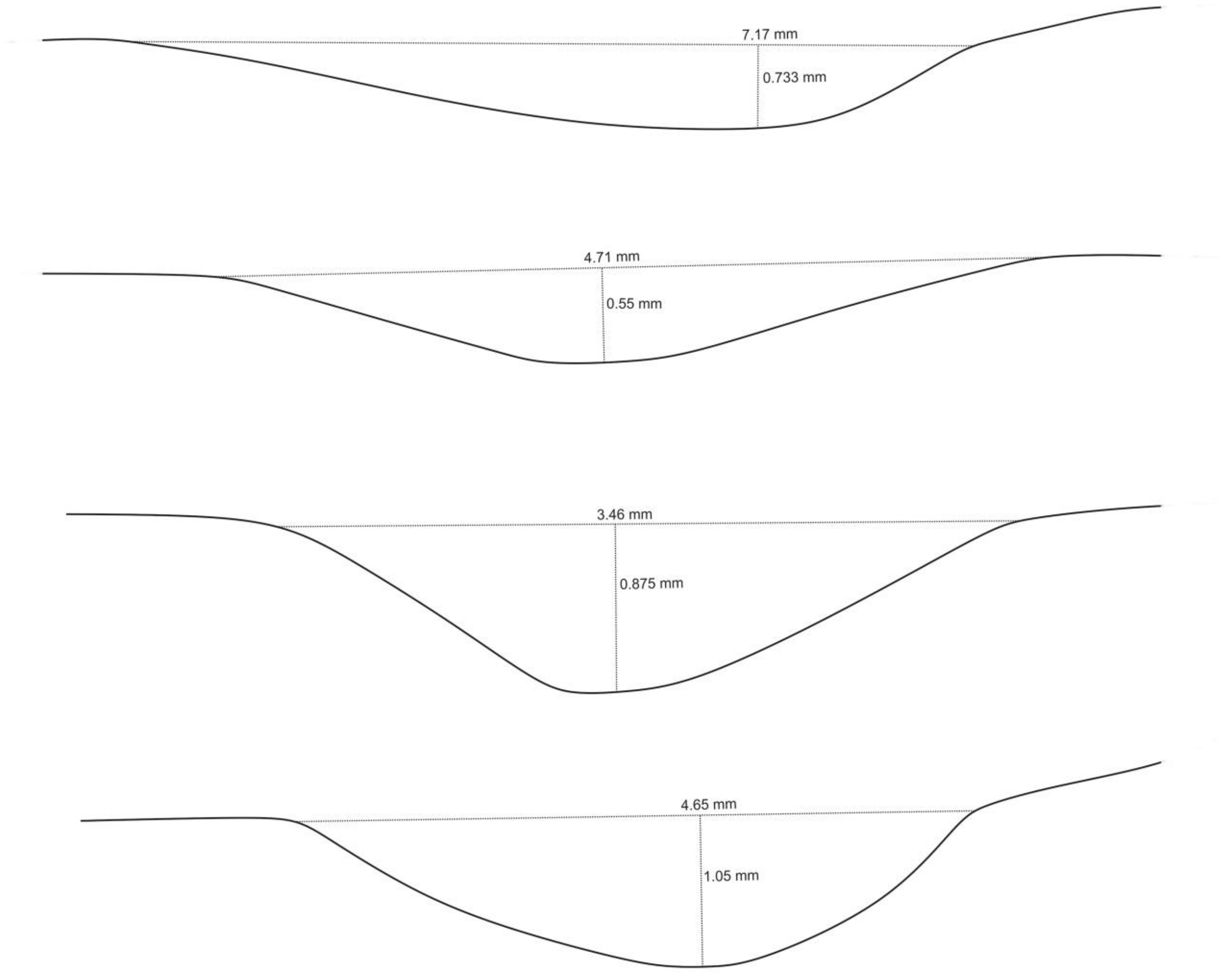
Technological drawing back

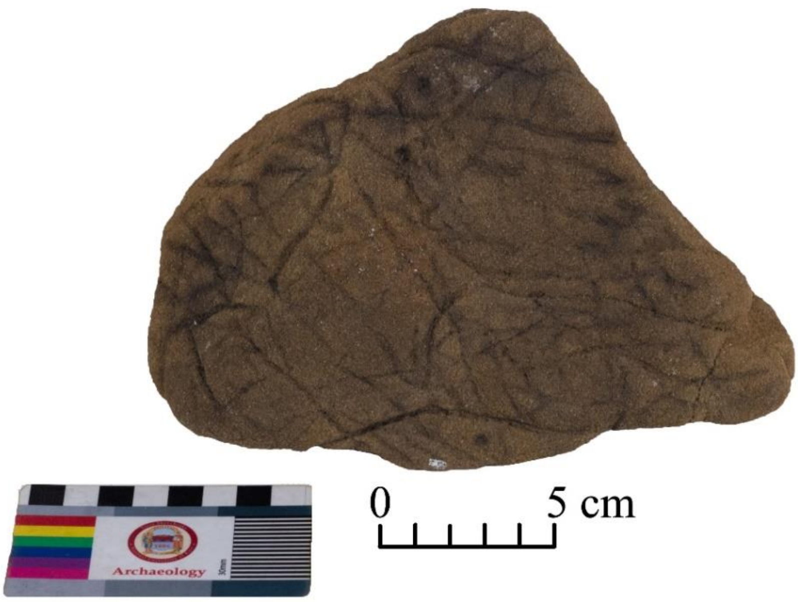
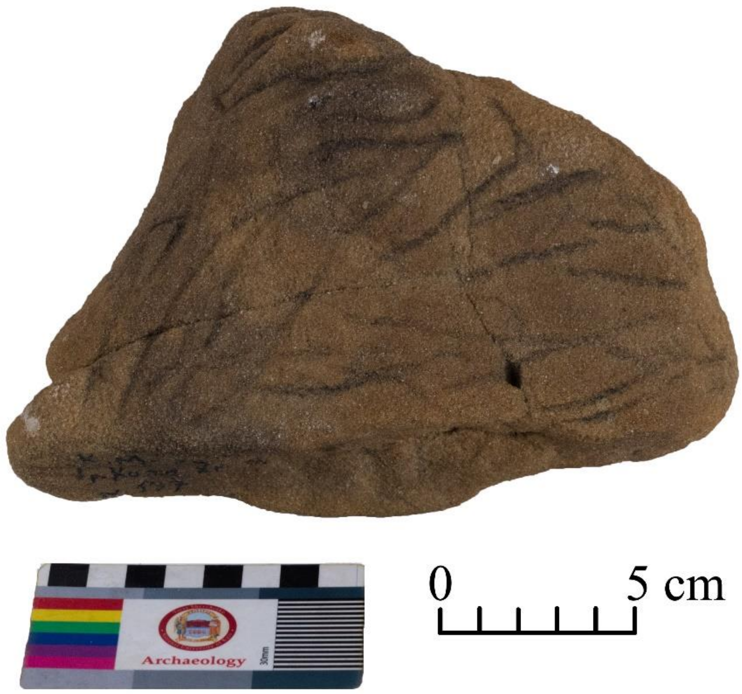
Technological drawing bottom



Profiles list



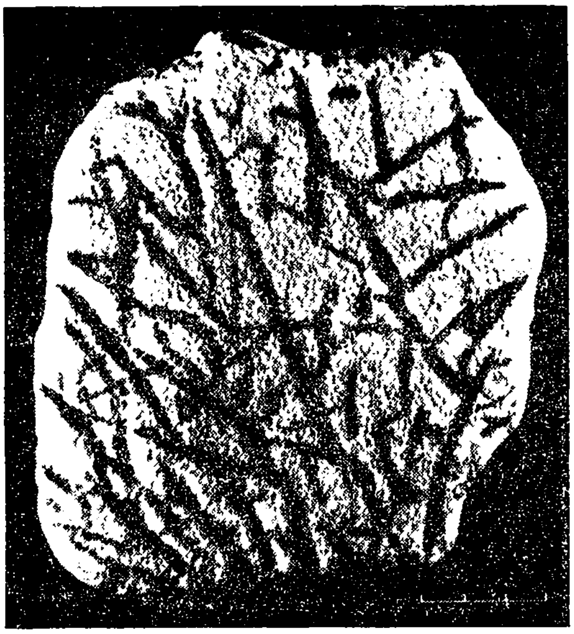
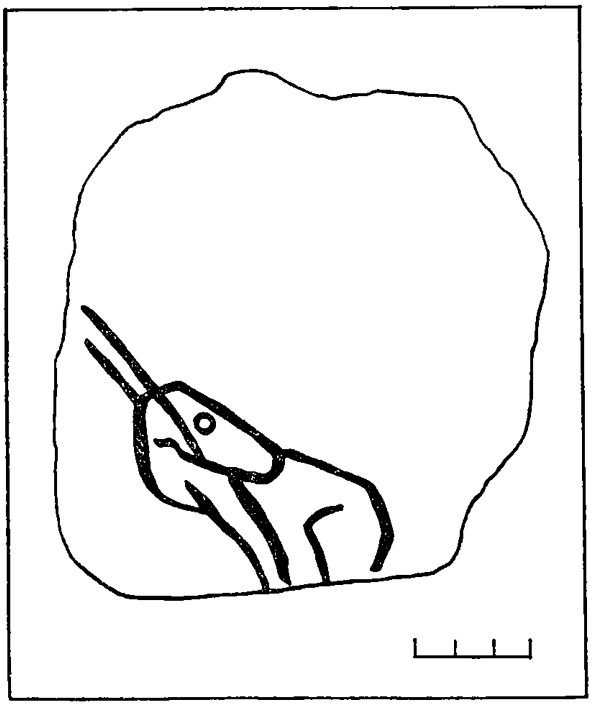

7.17 mm
0.733 mm
4.71 mm
0.55 mm
3.46 mm
0.875 mm
4.65 mm
1.05 mm

Specimen’s ID	337
Image front	
Image back	

Bottom image	
Length, cm	19.5
Width, cm	13
Weight, g	1381
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A subtriangular piece of a block with two-sided linear and geometric engravings (reticulated ornamentation).
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The stone is covered with desert varnish from all sides. The bottom side is polished. Both front and back sides are featured with reticulated ornamentation (engraved). Few natural cracks cross the stone by a vertical and horizontal axis.

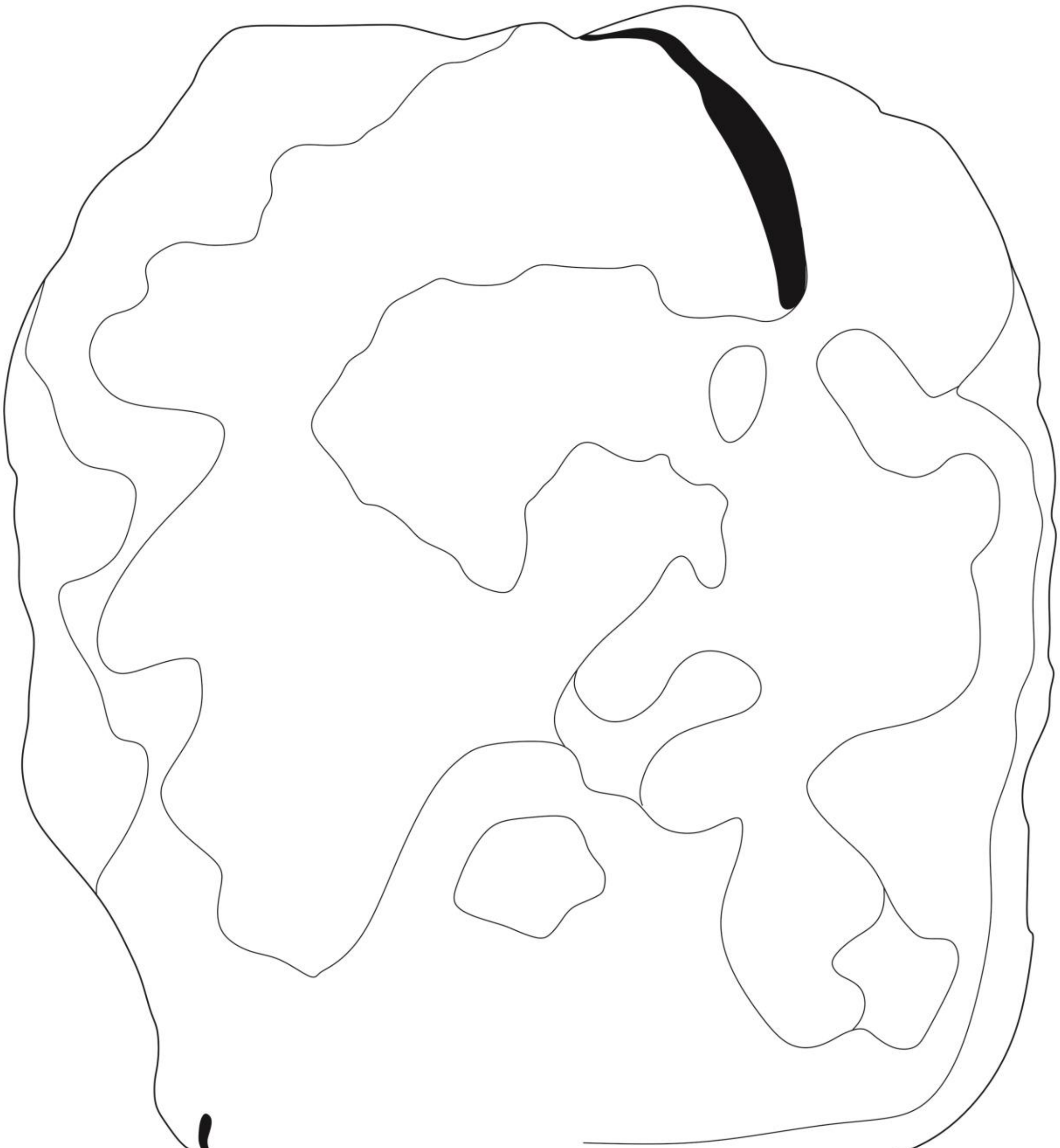
Specimen's ID	338
Image front	
Image back	
Length, cm	13
Width, cm	12

Weight, g	540
Volume, m^3	0.000285
Density, kg / m^3	1894.736842
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	Subrectangular block with linear and geometric engravings on the one side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	One of the most elegant specimens of pre-Historic art is block No. 338. The upper part of a tile matches its irregular wavy length. The left lower angle of its engraved side is covered with an image of an animal. This is an image of a deer turned left with a head turned right. The legs are slightly bent. The animal may be lying. The right part of the block is crossed with a diagonal line with the branches. This might be considered a tree as a symbolic representation of forest fauna. The hip of a deer is crossed with a wide line representing a spear (without any branches). An animal is killed or instead injured. An eye is widely open. Taking this into account, the deer, as a part of a rock art complex from the Wizard’s cave, is a specific motif that repeats several times and corresponds to a specific mythical motif.

Descriptive image	 
Description 2 source	Danilenko 1986: 96—99
Note	The block is covered with desert varnish from both sides. The surface is highly damaged from the front and back sides. Engravings interpreted as an image of a deer are heterogeneous and have different shapes and profiles. Such an interpretation is dubious and requires additional archaeological interpretation. Subparallel notches are profound, and according to the relative chronology, sequences were created during the same episode of the block's life cycle.

Technological drawing front

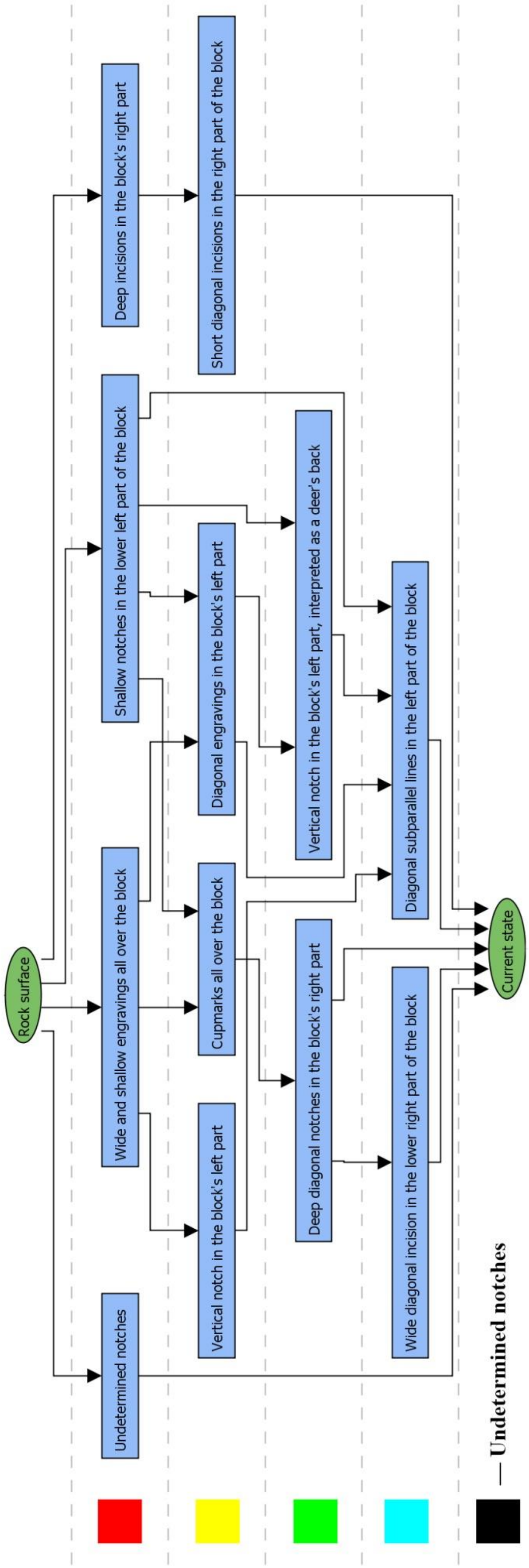
Technological drawing back



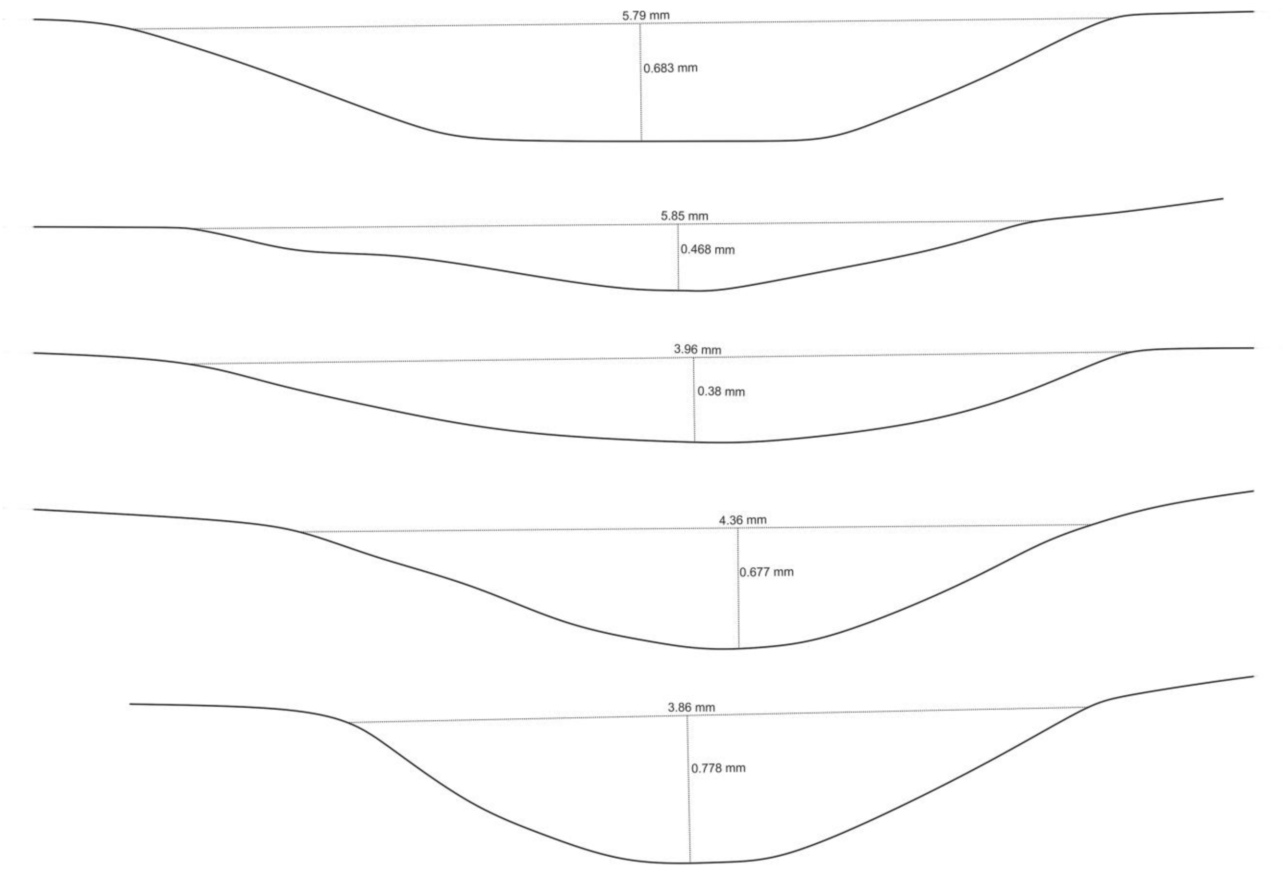
Engravings interpreted by V. Danilenko as an image of a deer

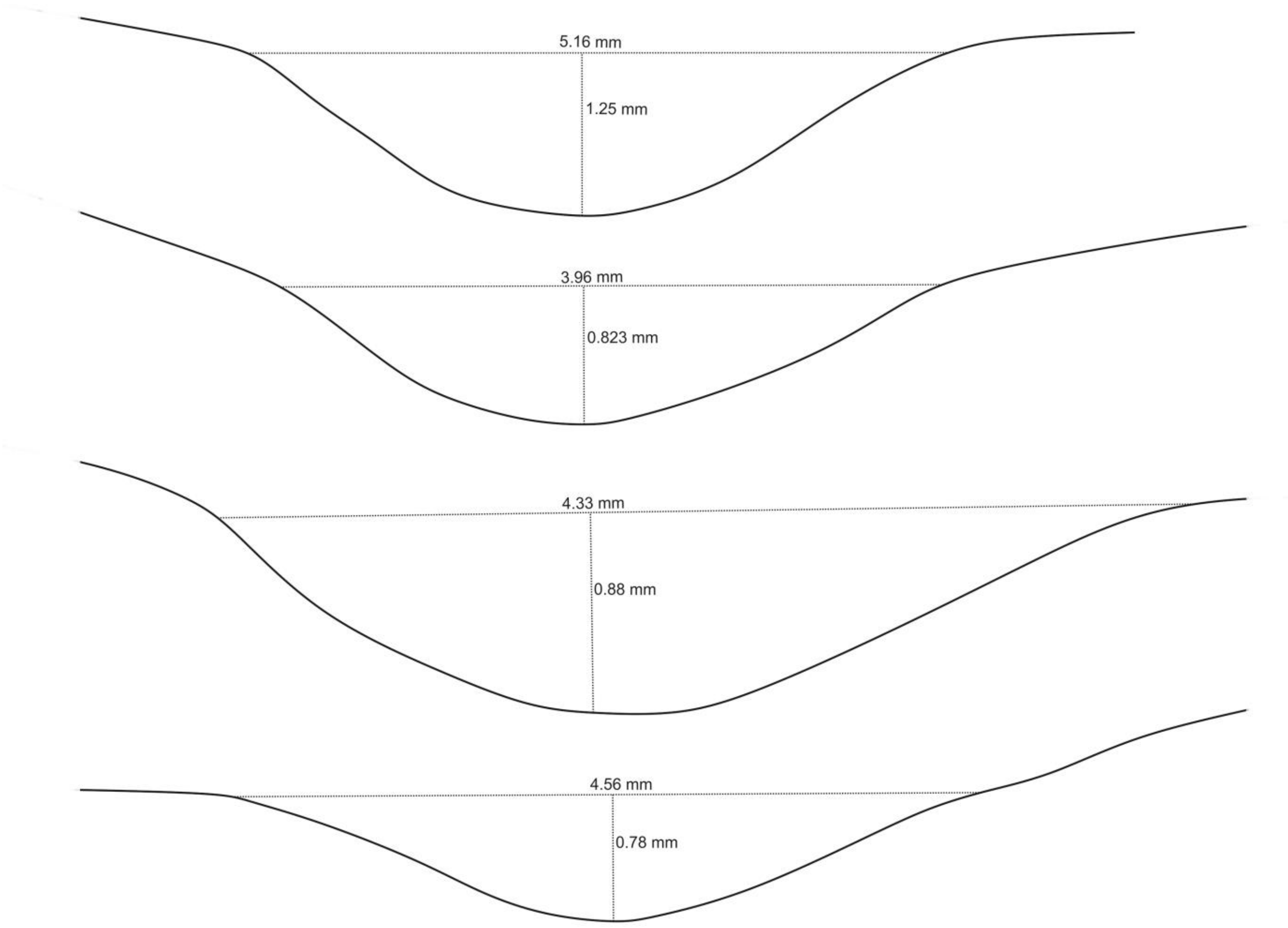
Relative chronology drawing front

Harris matrix front



Profiles list

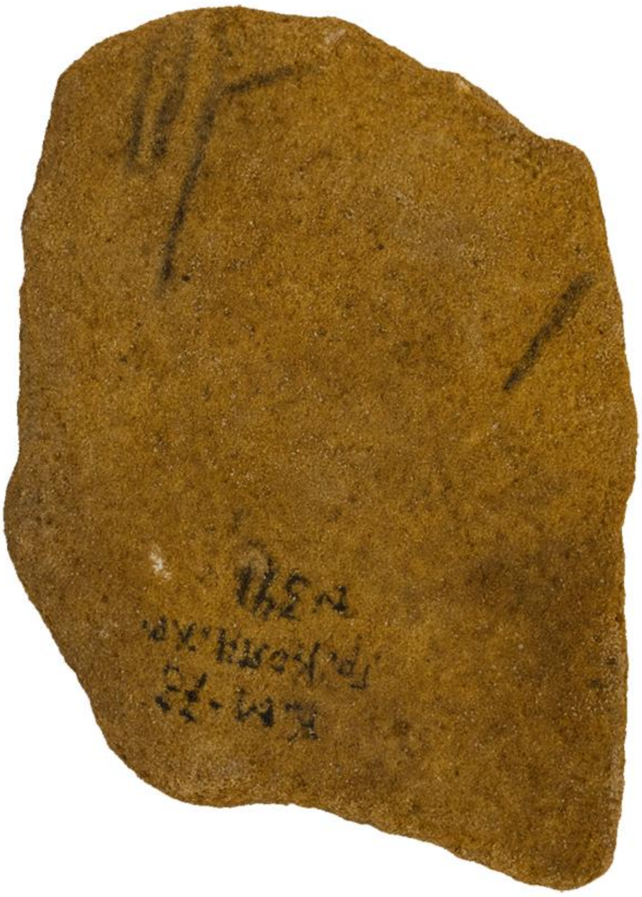




5.16 mm
1.25 mm
3.96 mm
0.823 mm
4.33 mm
0.88 mm
4.56 mm
0.78 mm

Specimen's ID	339
Image front	
Length, cm	40
Width, cm	24.5
Weight, g	4084
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A block of irregular seven-angular shape intensively covered with linear engravings (reticulated ornamentation) on its convex shape. Singular engravings are placed on the flat side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	A big stone is broken into three parts, probably after 1974. It is covered with desert varnish and reticulated ornamentation (many curved lines) from the front (convex) side.

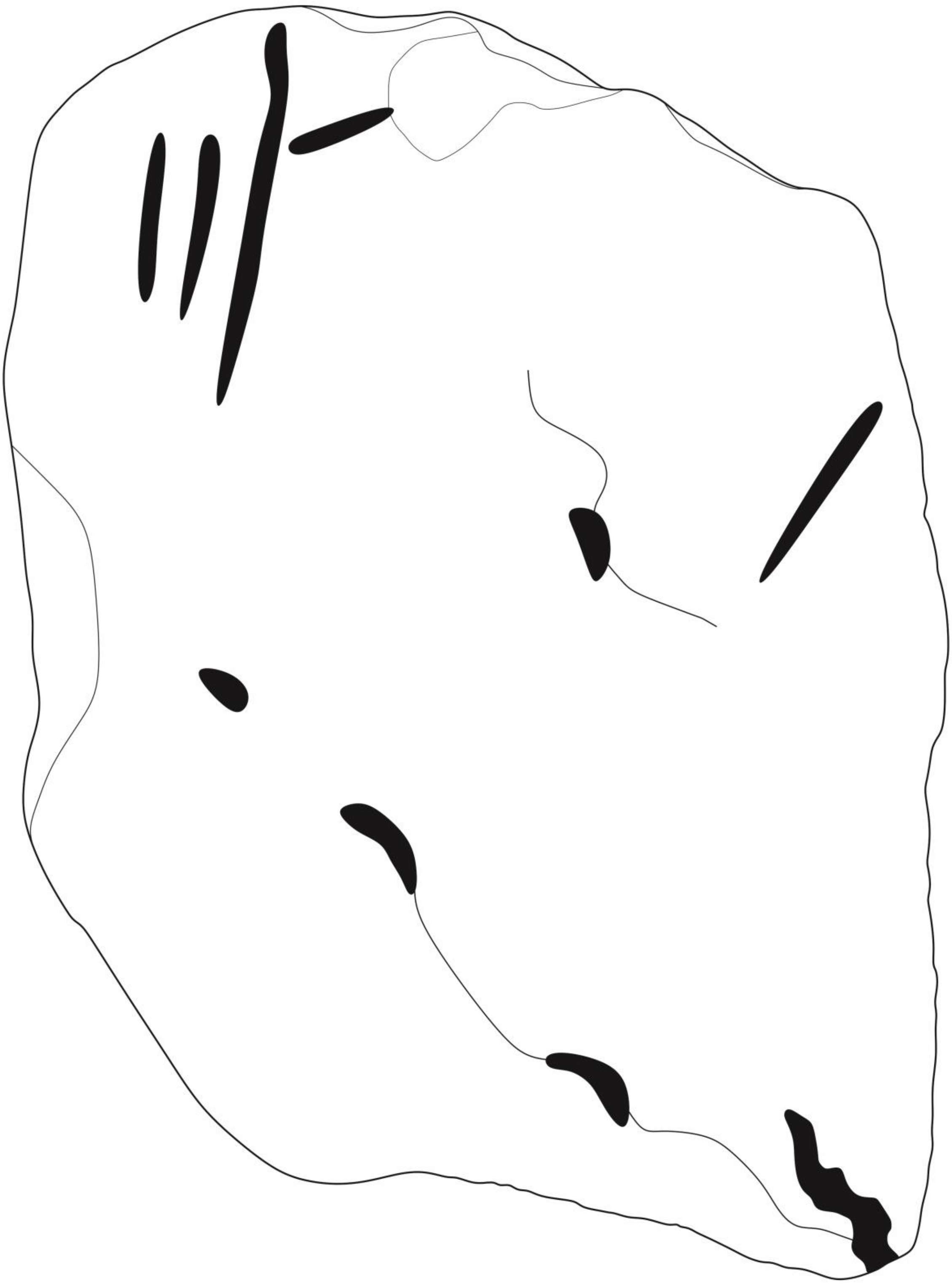
Specimen’s ID	340
Image front	
Image back	
Length, cm	9
Width, cm	8
Weight, g	236
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A subrectangular block with linear and geometric engravings from the both sides.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The shape of the stone is artificially processed. It is covered with desert varnish. Linear engravings feature the stone both from the front and back sides. Small cupmarks are on the back side of the stone.

Specimen’s ID	341
Image front	
Image back	
Length, cm	13
Width, cm	10

Weight, g	375
Volume, m^3	0.000198
Density, kg / m^3	1893.939393
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	A block of irregular shape with five angles and intense linear engravings from the front side. A few notches are also presented on the block's flat (back) side. It has been damaged during transportation and lacks two small pieces.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. The whole surface of the front side is irregular and eroded. The block is covered with linear and curved notches that create reticulated ornamentation. The incisions probably have different origins. Some of them are parallel or subparallel. Others are singular. The composition or a motif of any kind is not evident. The back side of the block also contains three parallel notches. Probably, the description given by V. Danilenko belongs to another churinga. The stone marked as “No. 341” does not contain any signs of damage caused after 1973 (during transportation).

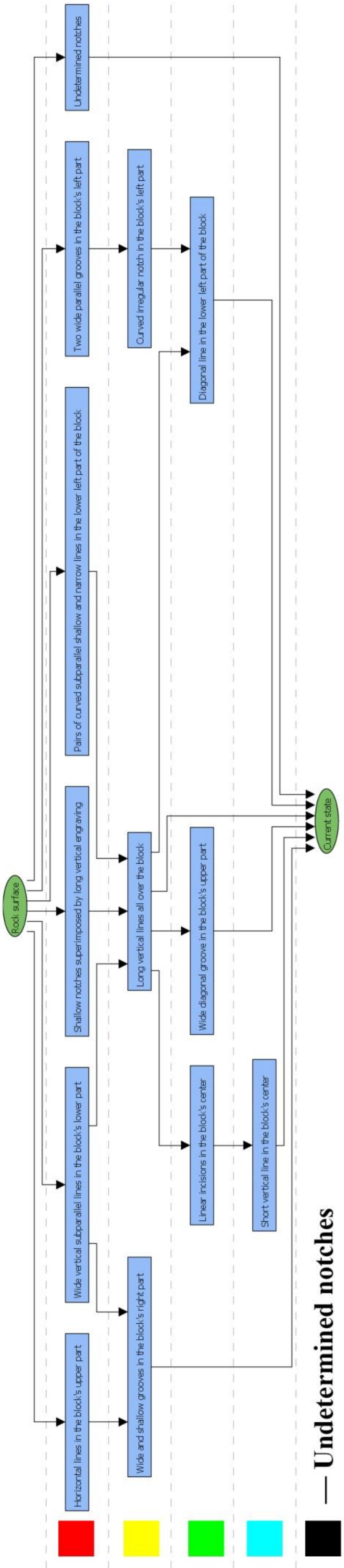
Technological drawing front

Technological drawing back

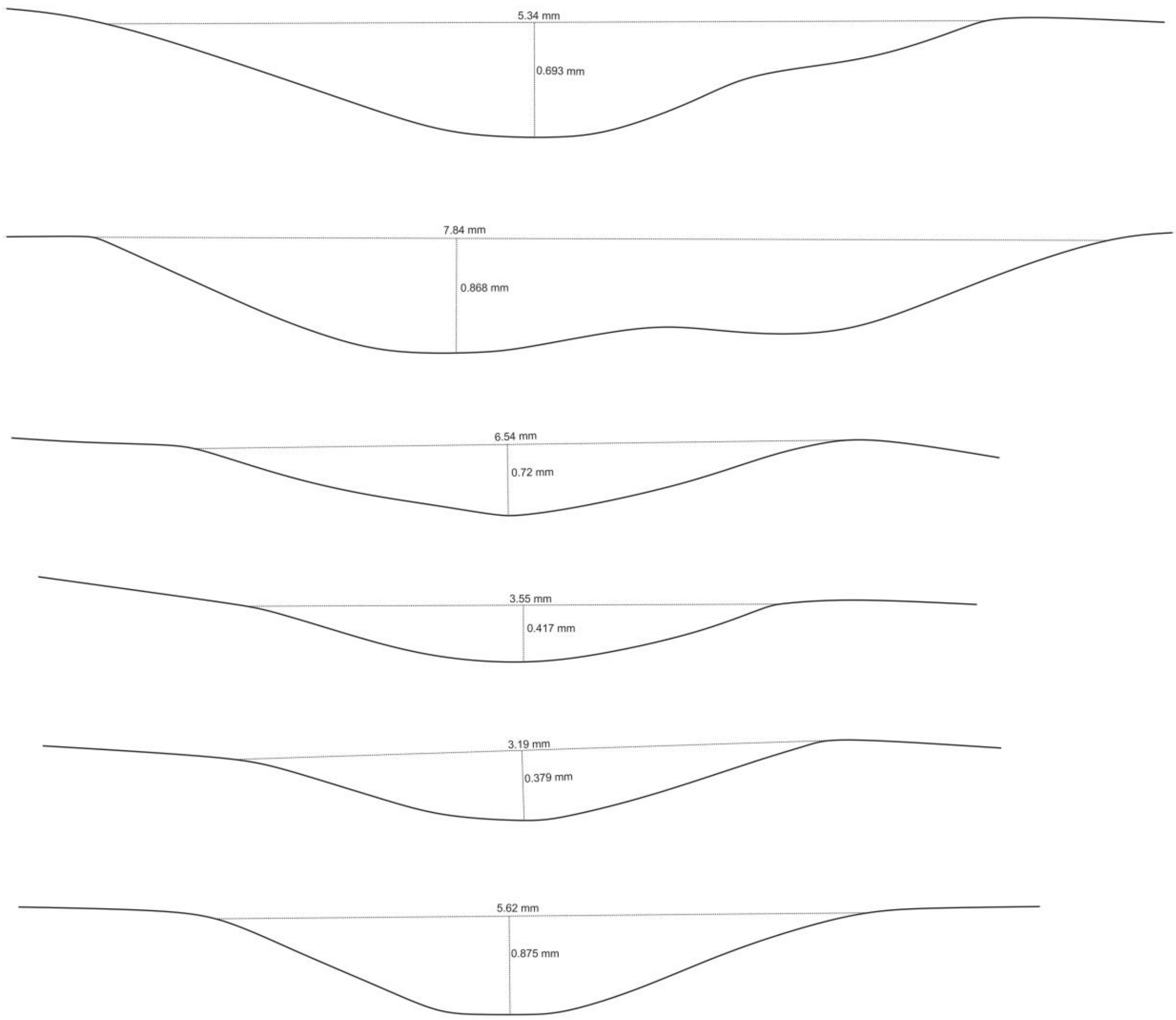


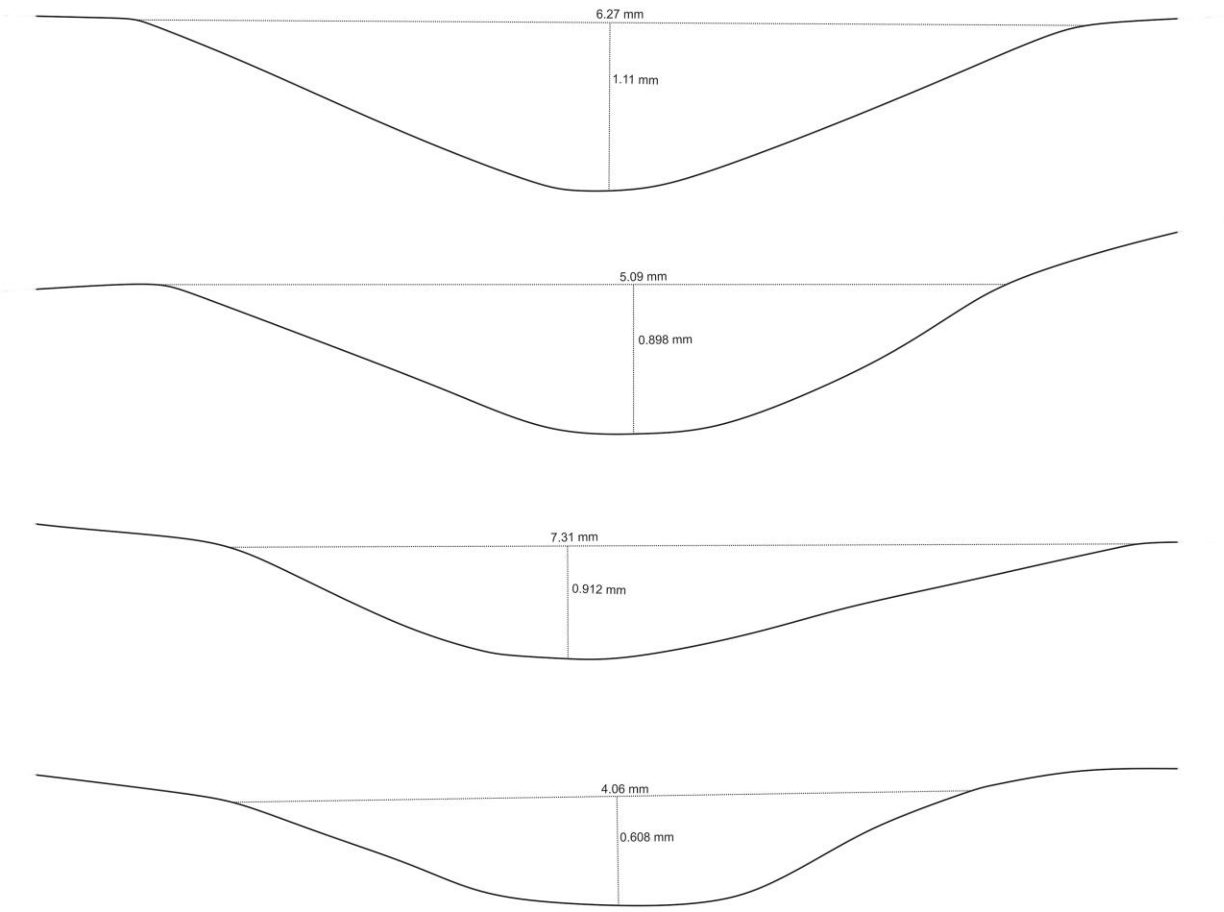
Relative chronology drawing front

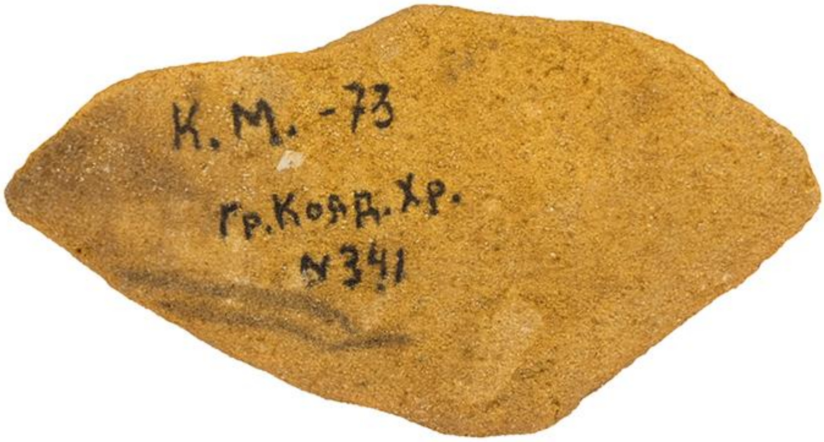
Harris matrix front



Profiles list



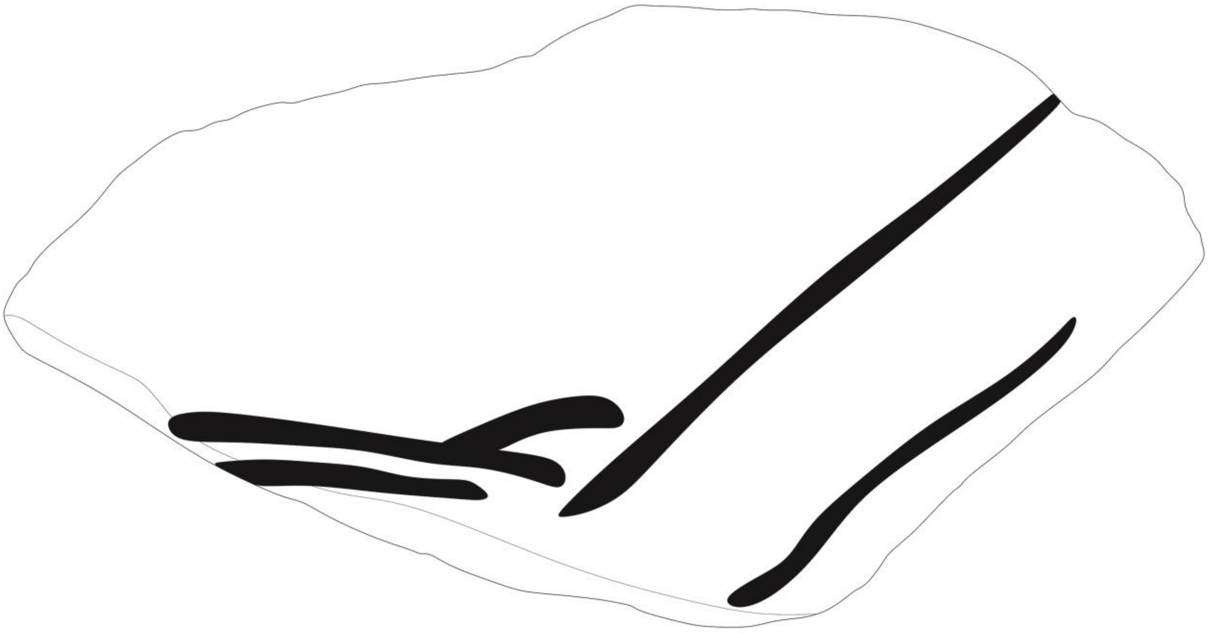

6.27 mm
1.11 mm
5.09 mm
0.898 mm
7.31 mm
0.912 mm
4.06 mm
0.608 mm

Specimen's ID	341a
Image front	
Image back	
Length, cm	13
Width, cm	7
Weight, g	222
Volume, m^3	0.000111
Density, kg / m^3	2000.0000
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A block of irregular shape with five angles and intense linear engravings from the front side. A few notches are also presented on the block's flat (back) side. It has been damaged during transportation and lacks two small pieces.
Description source	The storage list of Institute of Archaeology in Kyiv

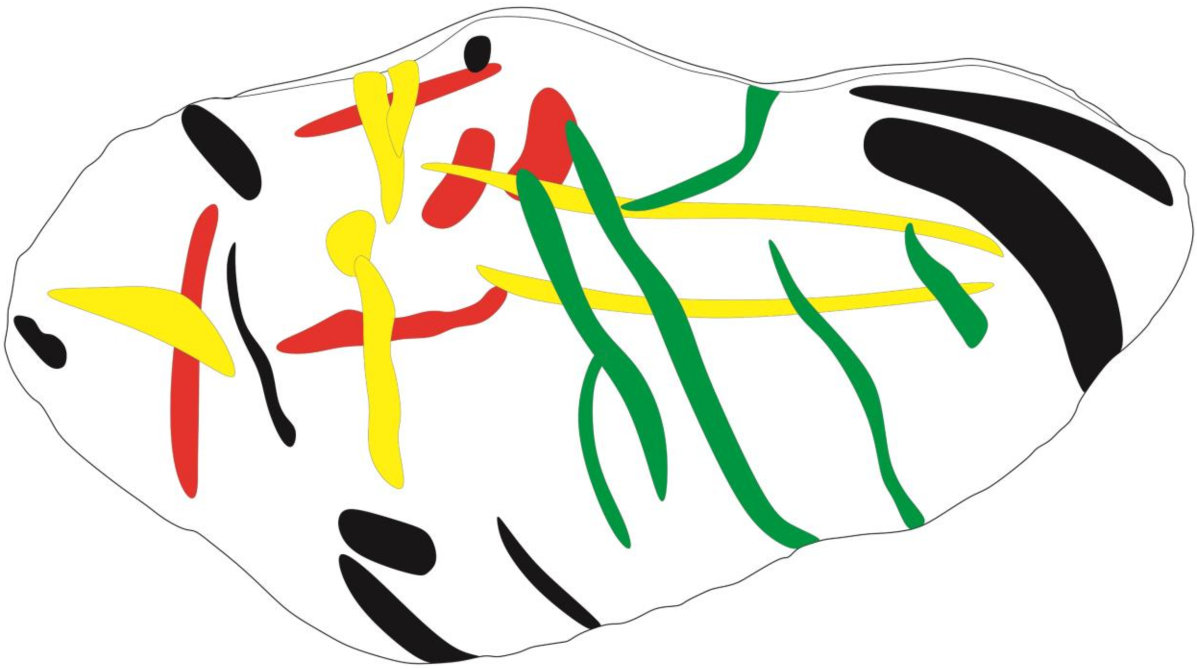
Note	The block is intensively covered with desert varnish from the front side and much brighter from the back. The front side is covered with linear incisions that do not create any structured ornamentation. The incisions probably have different origins and differ in their parameters and profiles. Some of them are parallel or subparallel. Others are singular. The composition or a motif of any kind is not evident. The back side of the block also contains a few parallel notches. Probably, the description given by V. Danilenko belongs to another churinga. The stone marked as “No. 341” does not contain any signs of damage caused after 1973 (during the transportation). Though three different stones are marked with No. 341, only one of them corresponds to the description given by V. Danilenko.

Technological drawing front

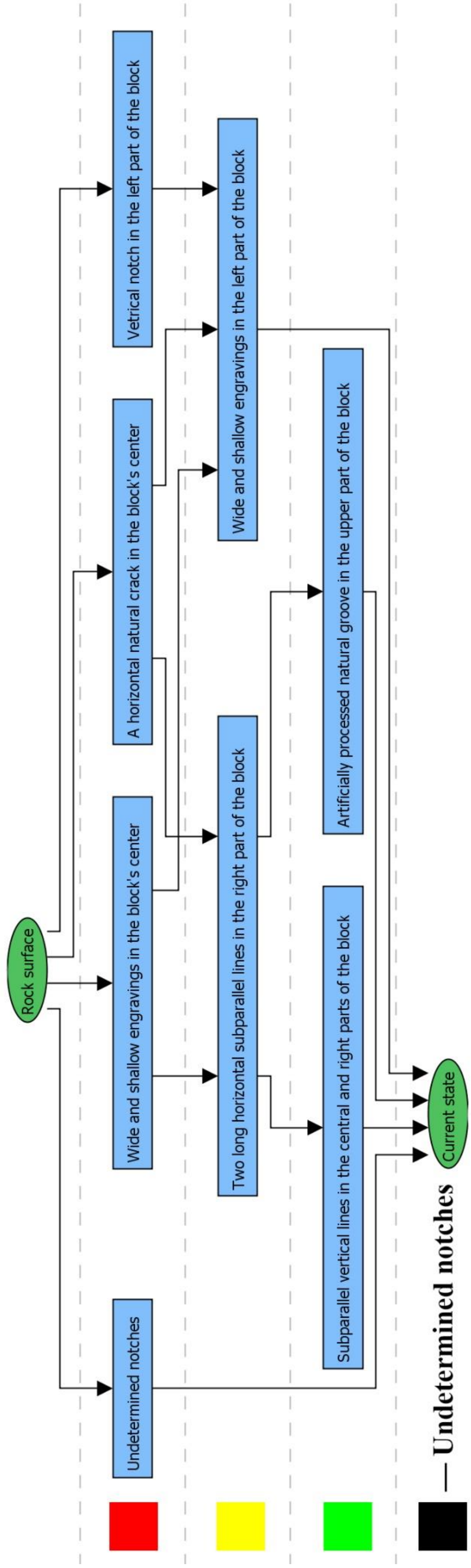
Technological drawing back



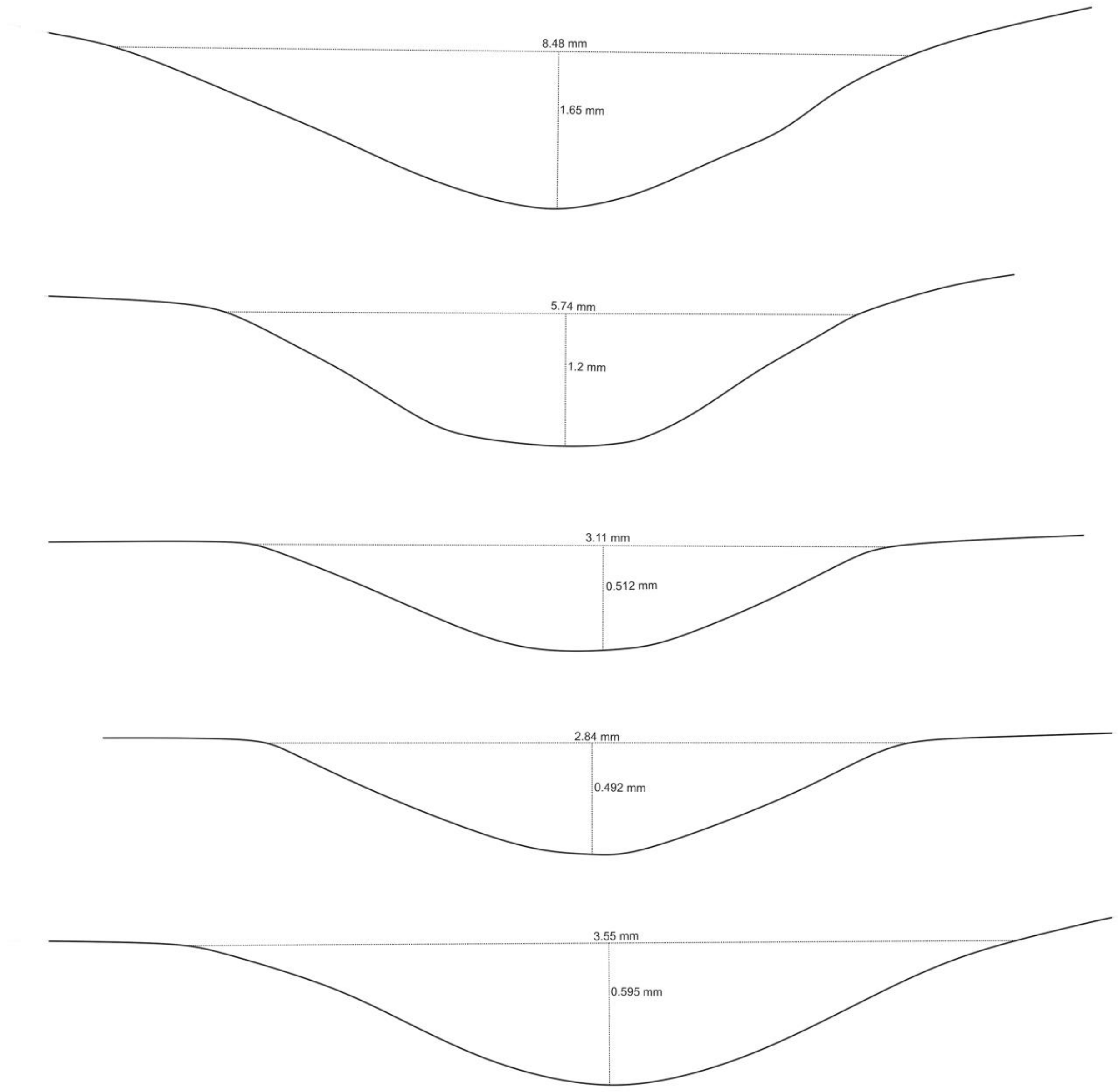
Relative chronology drawing front

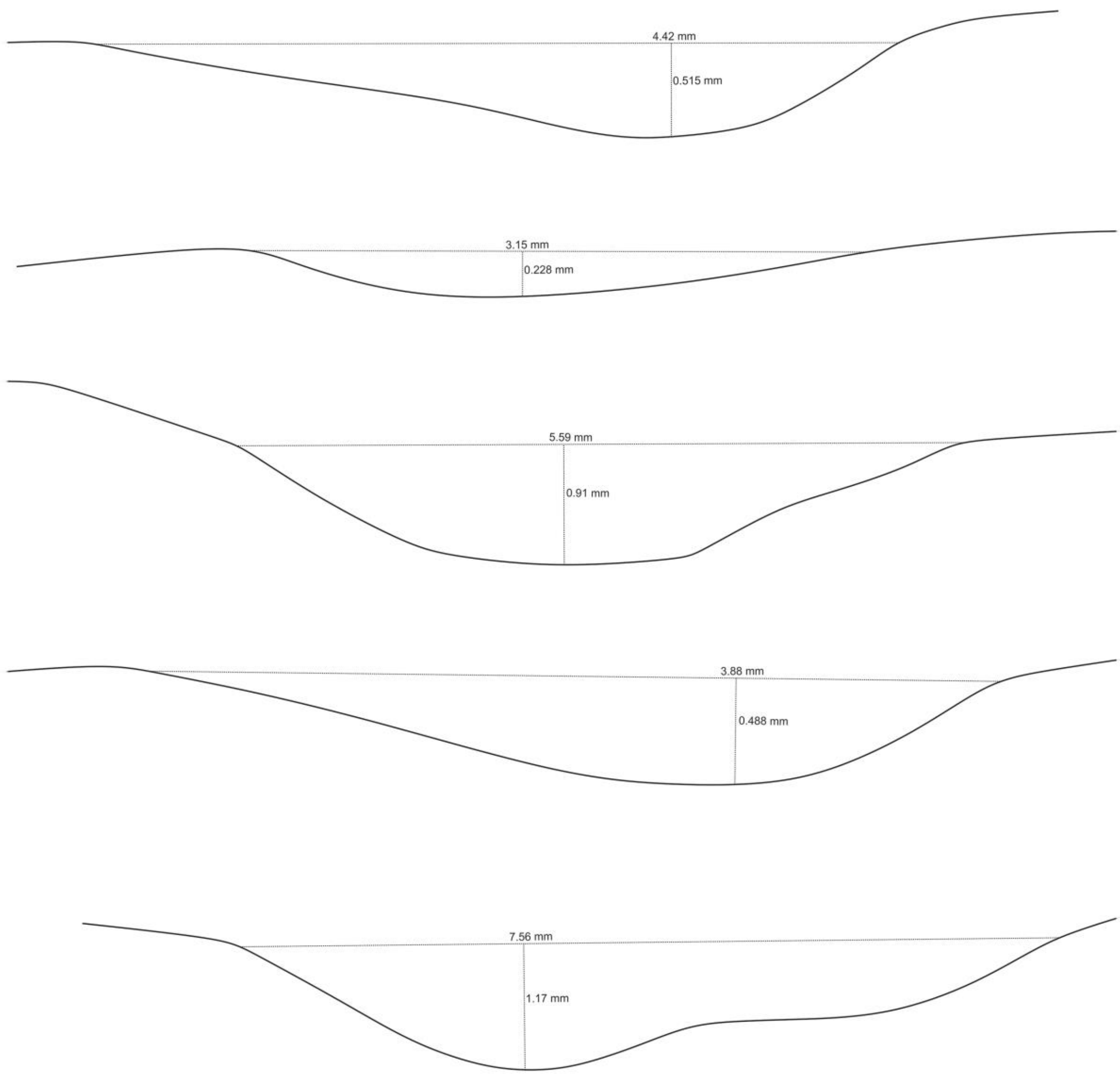


Harris matrix front



Profiles list

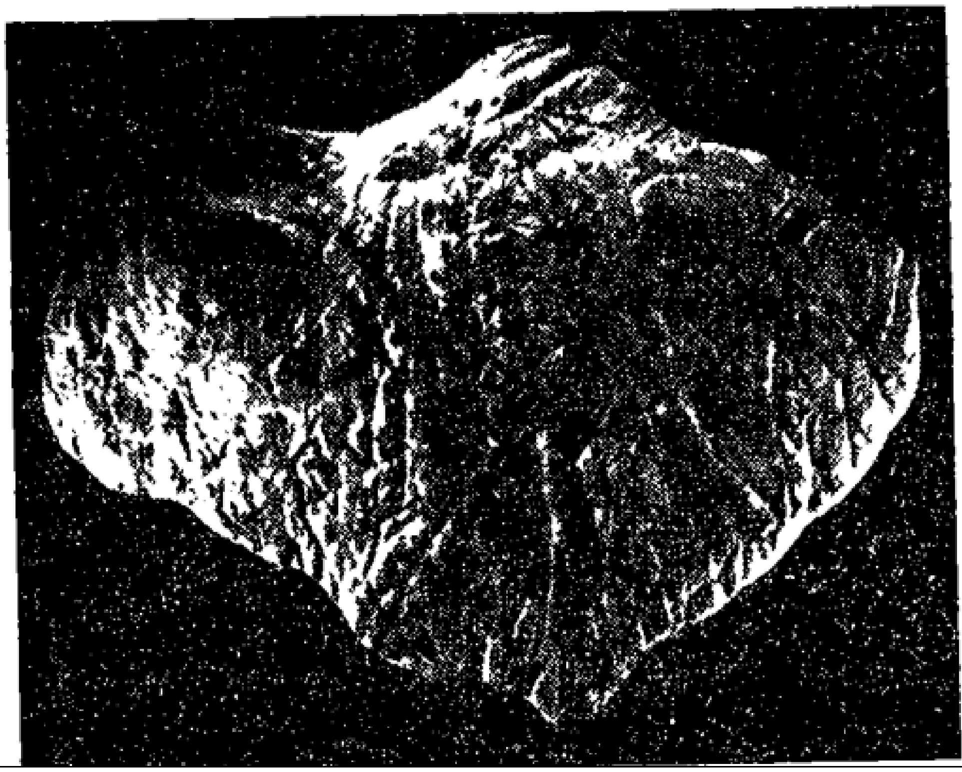


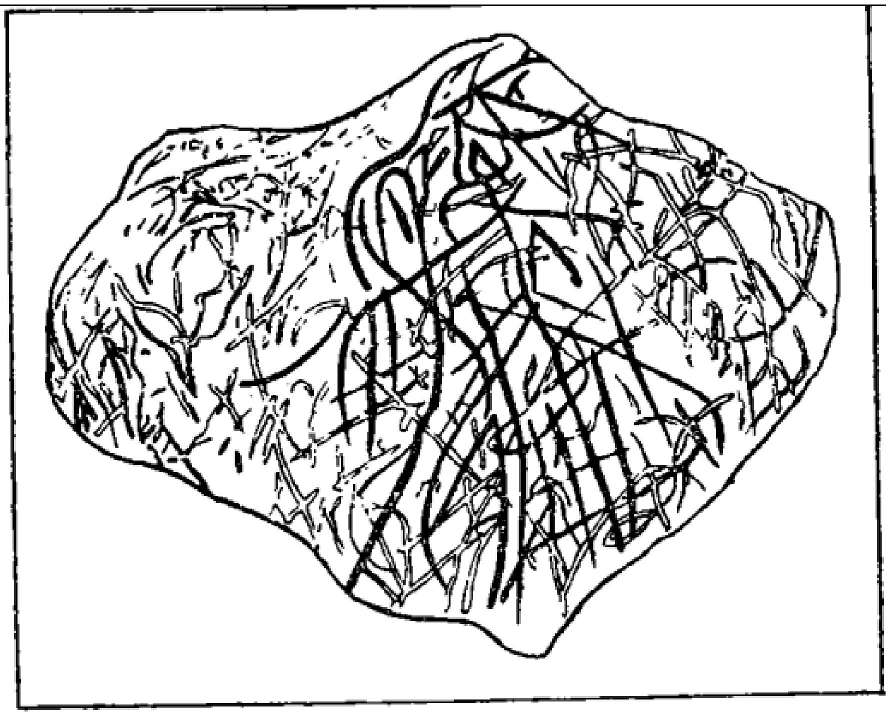

4.42 mm
0.515 mm
3.15 mm
0.228 mm
5.59 mm
0.91 mm
3.88 mm
0.488 mm
7.56 mm
1.17 mm

Specimen’s ID	341б
Image front	
Image back	
Length, cm	48.3
Width, cm	32.7
Weight, g	3420
Date of discovery	1973
Finder	V. Danilenko

Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	A stone of irregular shape (5 angles). Intensively featured reticulated ornamentation on the convex side and separate linear engravings on the flat. It was broken during transportation and lacked two small pieces.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The Stone’s surface was artificially processed. The front side is darker, covered with desert varnish and linear engravings, including long and deep parallel lines.

Specimen's ID	342
Image front	
Image back	
Length, cm	44
Width, cm	34
Weight, g	9800
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52

Current location	Institute of Archaeology, Kyiv
Description	A stone of irregular shape with seven angles, intense linear and geometric engravings on the convex part, and separate ones on the flat side. Collected from two pieces.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	Images are located on the more flat front side of the churinga. Pictures are linear and geometric (reticulated ornamentation), but their meaning remains uncovered. Only long and tedious work interpreting this block led to unexpected conclusions about the composition featured with a profound meaning. Placing a wavy part of the churinga up (and an angular part — to the bottom), one can observe the composition as it should be observed. Careful observation of the front side of the central and upper part of the block reveals an image of a bird. The middle part of the block contains a clear image of a waistline; lower, closer to the bottom part of the block, a tent-like part of a figure (tail) is recognized. The left zone is more precise than the right one. The upper part of a mammoth is depicted to the right of the figure. A rhinoceros is placed under this mammoth. To the left of the bird is an object that is considered a turned upside-down image of a bird with the swan's (or duck's or goose's) beak. Other objects of non-recognized meaning are located around the central figure. It is possible to assume that here one probably can observe a globally spread myth that presents a raven as a creator of the world, while a duck is its arranger.
Description source 2	Danilenko 1986: 101 (fig. 53)
Descriptive image	
Descriptive image 2	

	
Note	The description from the storage list is wrong, related to another churinga. Meanwhile, description 2 (after Danilenko 1986) appears to be correct. The back side is not flat, similar to a natural shape. The front side is covered with desert varnish and reticulated ornamentation. The block is huge and might be considered instead as a piece of a big block than as a portable rock art specimen.

Specimen's ID	342a
Image front	
Image top	
Image back	

Image bottom	
Length, cm	15
Width, cm	9
Weight, g	566
Volume, m^3	0.000291
Density, kg / m^3	1945.01718
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	An irregular block in the shape if a segment with intense linear and geometric engravings on a convex side and singular ones on a flat side. The block consists of two parts.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The block is covered with desert varnish from both sides. The whole surface of the front side is irregular and slightly darker than the back one. The block is covered with linear parallel and subparallel notches that create reticulated ornamentation. Different orientation of the linear engravings corresponds to the relevant episode of the block’s relative chronology. The composition or a motif of any kind is not evident. The back side of the block also contains a set of deep parallel notches.

Technological drawing front

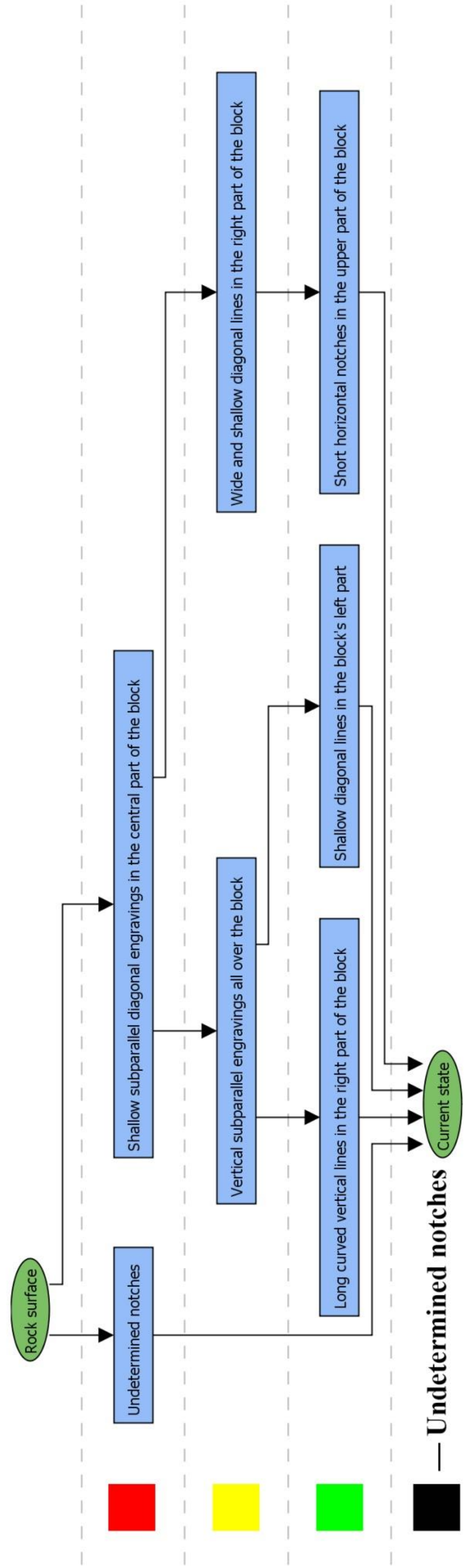
Technological drawing top

Technological drawing back

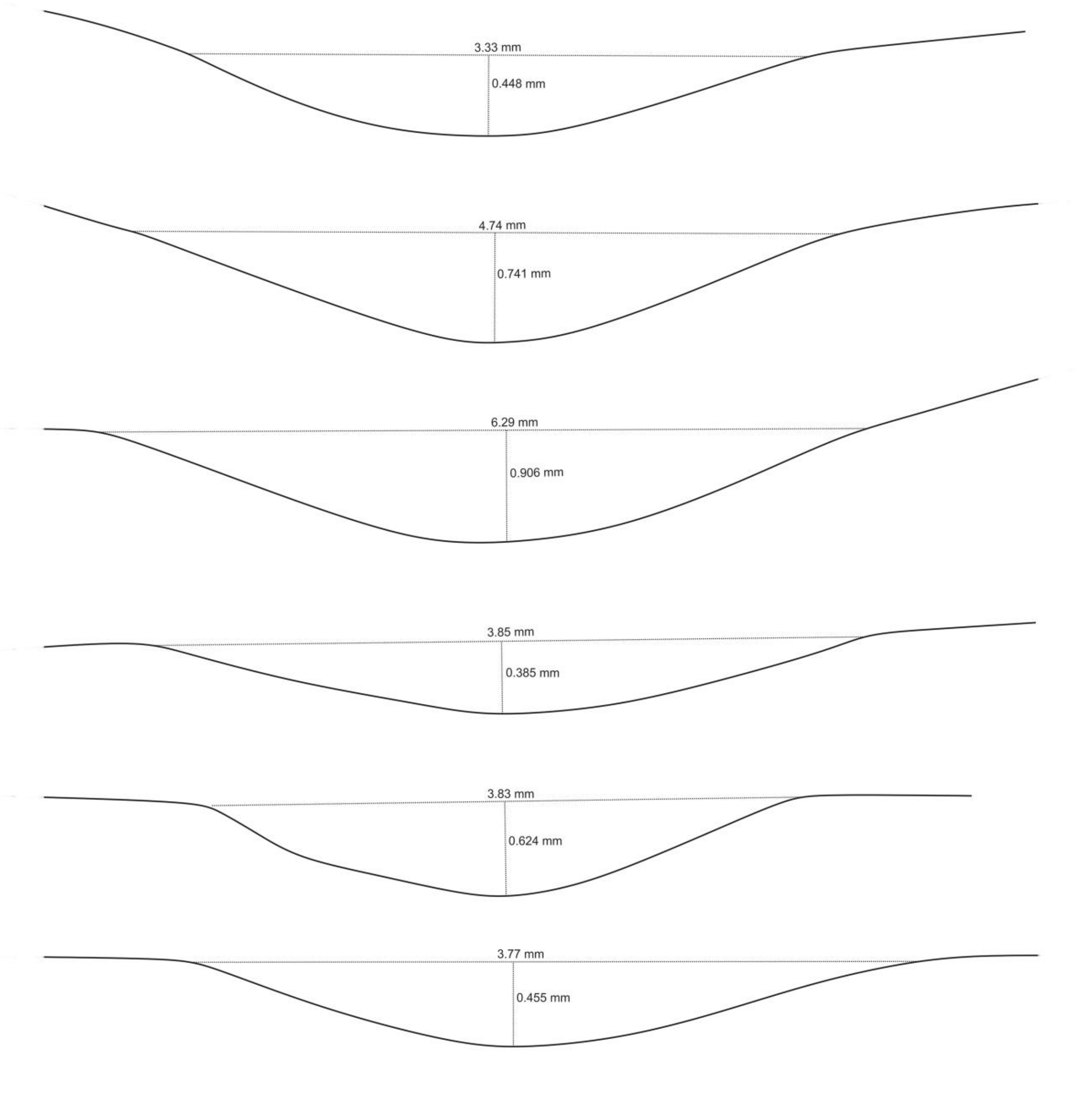
Technological drawing bottom

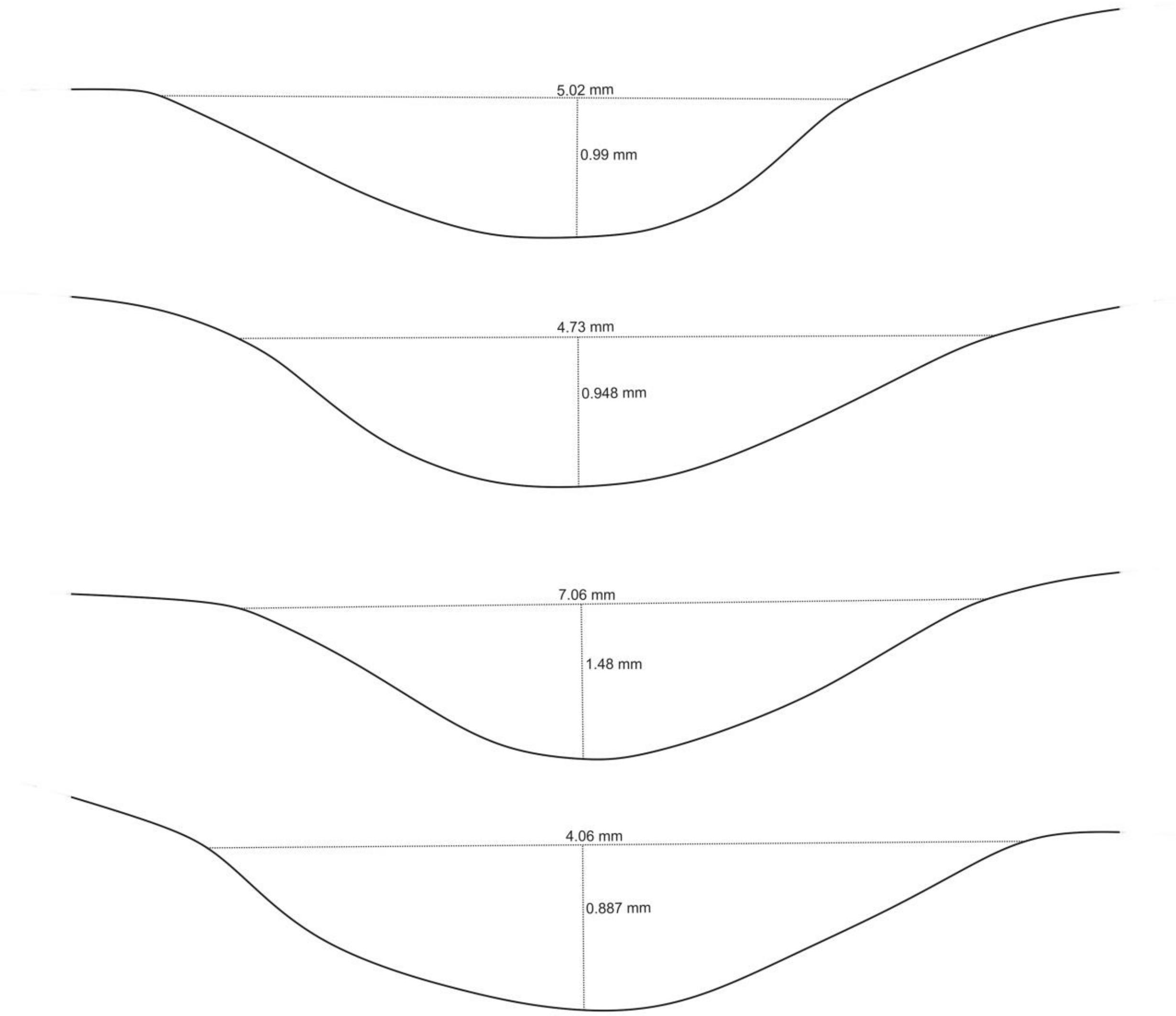
Relative chronology drawing front

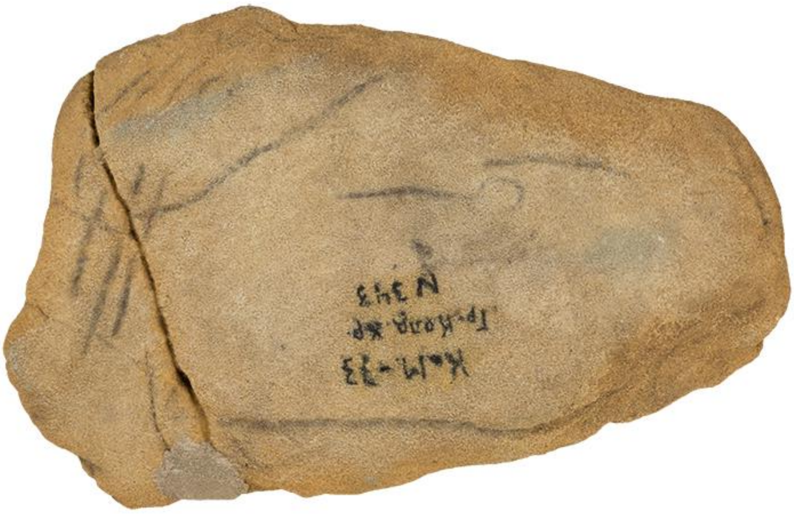
Harris matrix front



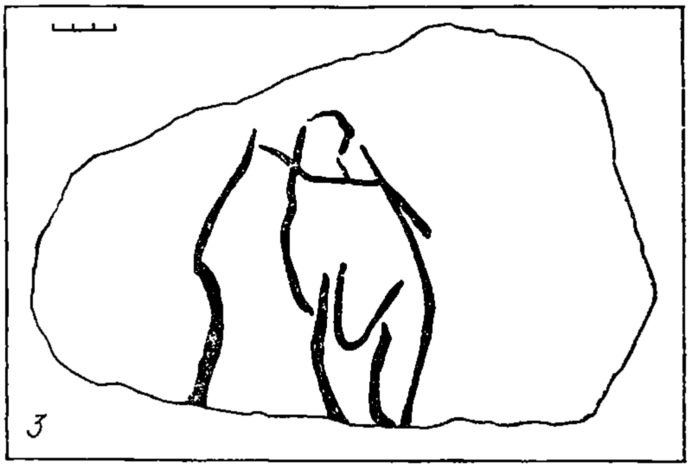
Profiles list




5.02 mm
0.99 mm
4.73 mm
0.948 mm
7.06 mm
1.48 mm
4.06 mm
0.887 mm

Specimen's ID	343
Image front	
Image top	
Image back	
Length, cm	27
Width, cm	18
Weight, g	2997
Volume, m^3	0.001565
Density, kg / m^3	1915.01597
Date of discovery	1973

Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The tile is in the shape of an irregular oval with numerous linear and geometric engravings on the convex side and rare ones on the flat side. It is glued into two parts.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	The composition is on one side of the massive irregularly suboval tile (length 27.9 cm, width — 18.5 cm). The composition includes a series of chaotically placed engraved lines. Only some parts of them might be interpreted. The center of the engraved space includes the techtiform (?) figure that might be considered a tent-like dwelling. Left from its center, the construction of this dwelling is superimposed by the image of an adult woman. Her head and neck are located over the dwelling’s roof. The figure is interpreted as an entity without details. It is pictured in the profile. The face is turned left. The breath, stomach, and legs are fat but not enormous (fig. 71). The composition may repeat the meaning of the images on blocks No. 308 and 298. Worth noticing that on block No. 343, we are dealing with an image of an adult woman that is somehow similar to the schematic marl sculptures from Kostenki 1.

Descriptive image	  
Description 2 source	Danilenko 1986: 116—117
Note	The block is covered with desert varnish from both sides. The whole surface of the front side is irregular and slightly darker than the back one. The block is covered with linear parallel and subparallel notches that create reticulated ornamentation. Some engravings are much more profound than others; usually, they are created relatively later. Though V. Danilenko publishes an image of an adult woman on the block, the composition or a motif of any kind is not evident. The back side also contains a few parallel notches. The block has been broken into two parts and glued by V. Danilenko.

Technological drawing front

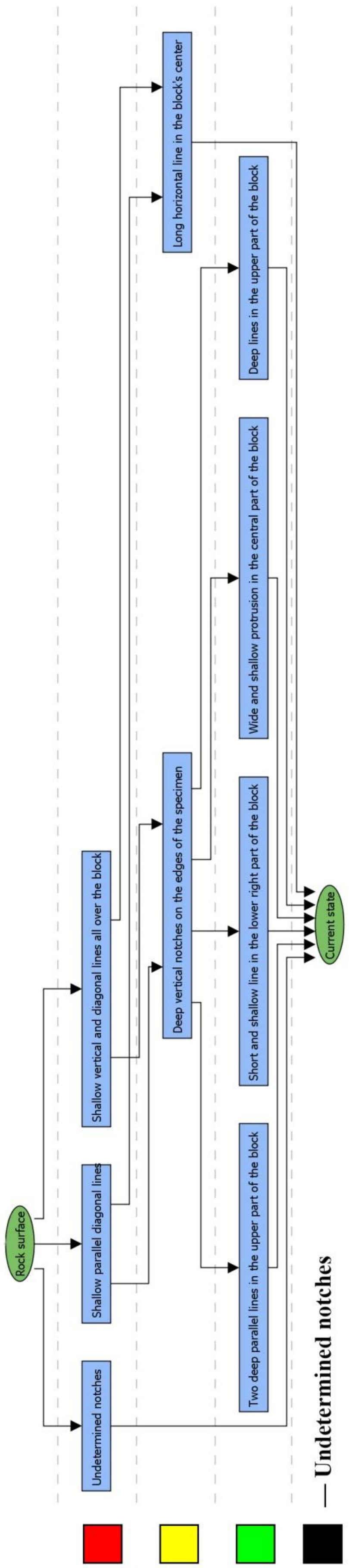
Technological drawing bottom

Technological drawing back

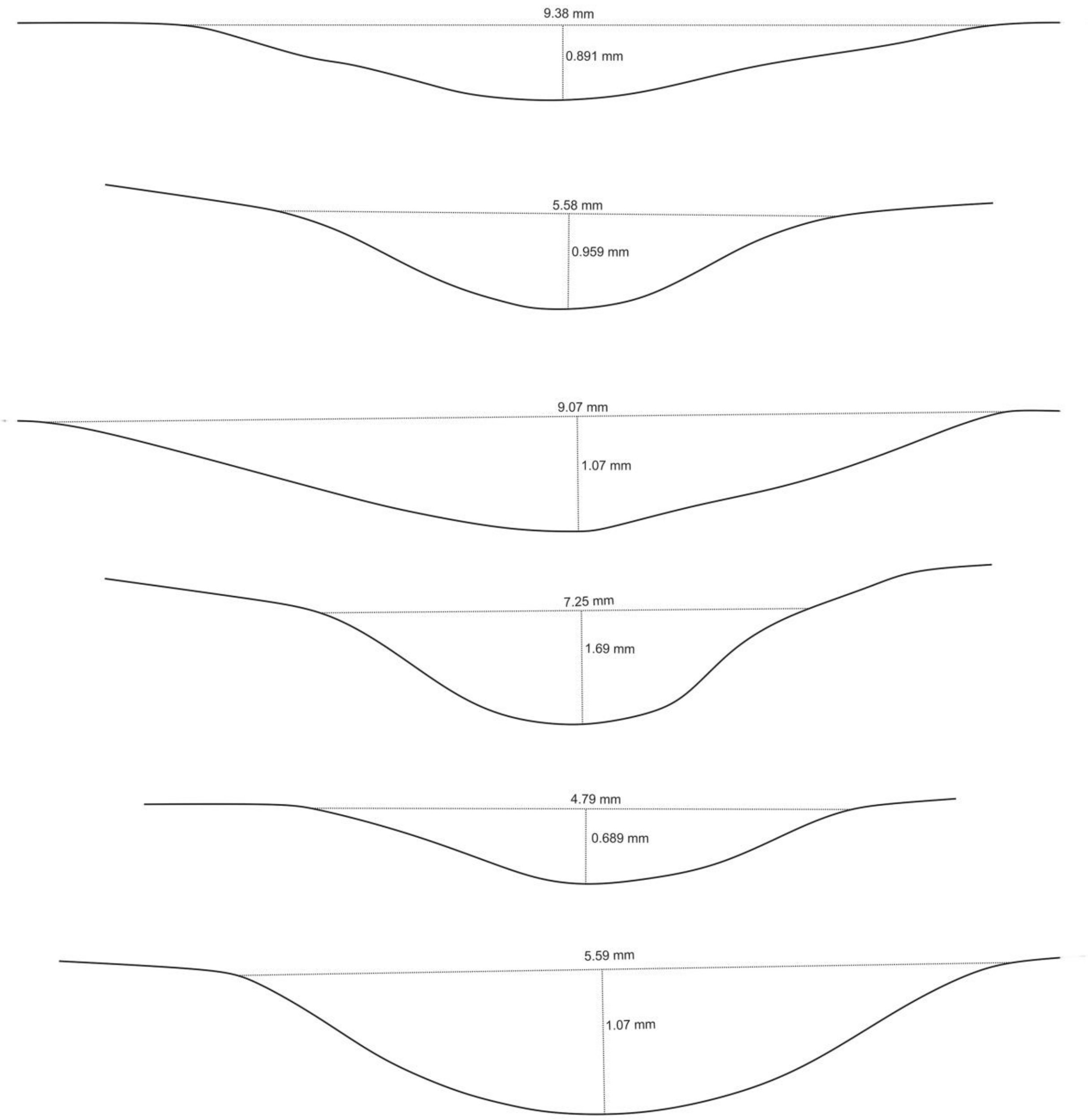
Drawing interpretation after Danilenko

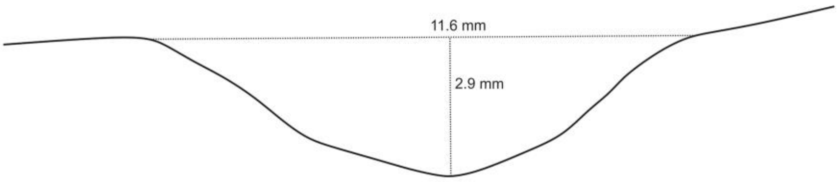
Relative chronology drawing front

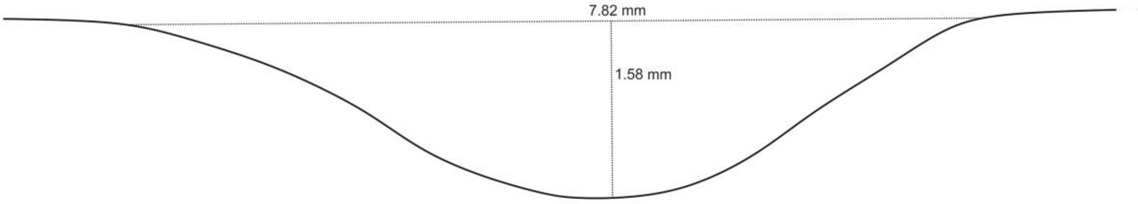
Harris matrix front

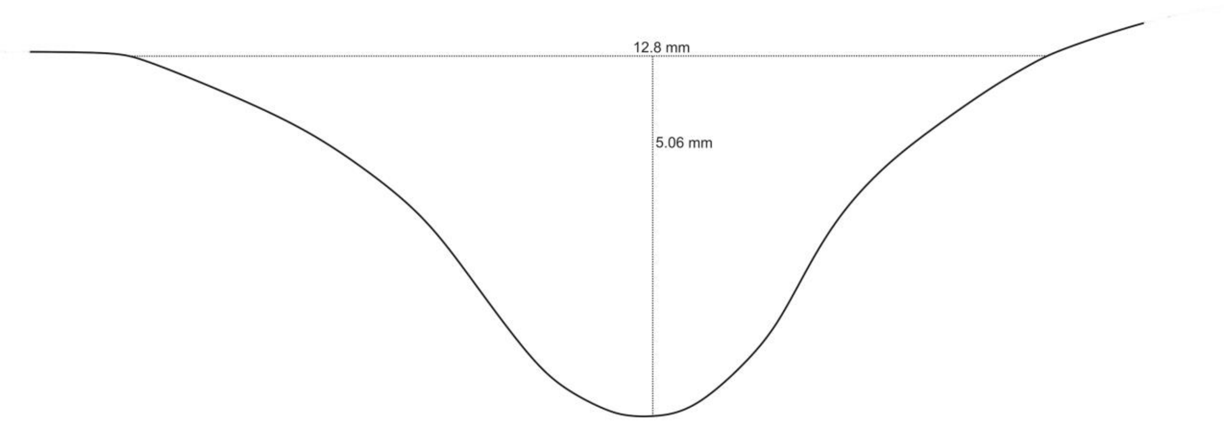


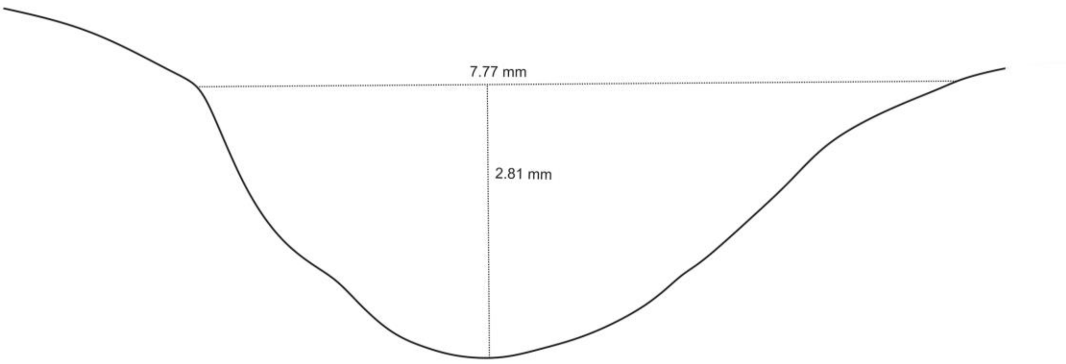
Profiles list




11.6 mm
2.9 mm


7.82 mm
1.58 mm


12.8 mm
5.06 mm


7.77 mm
2.81 mm

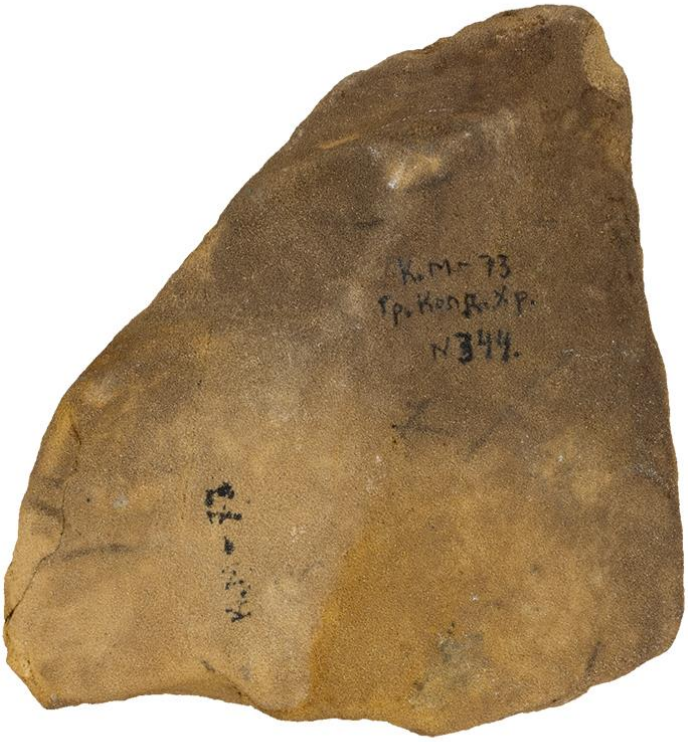
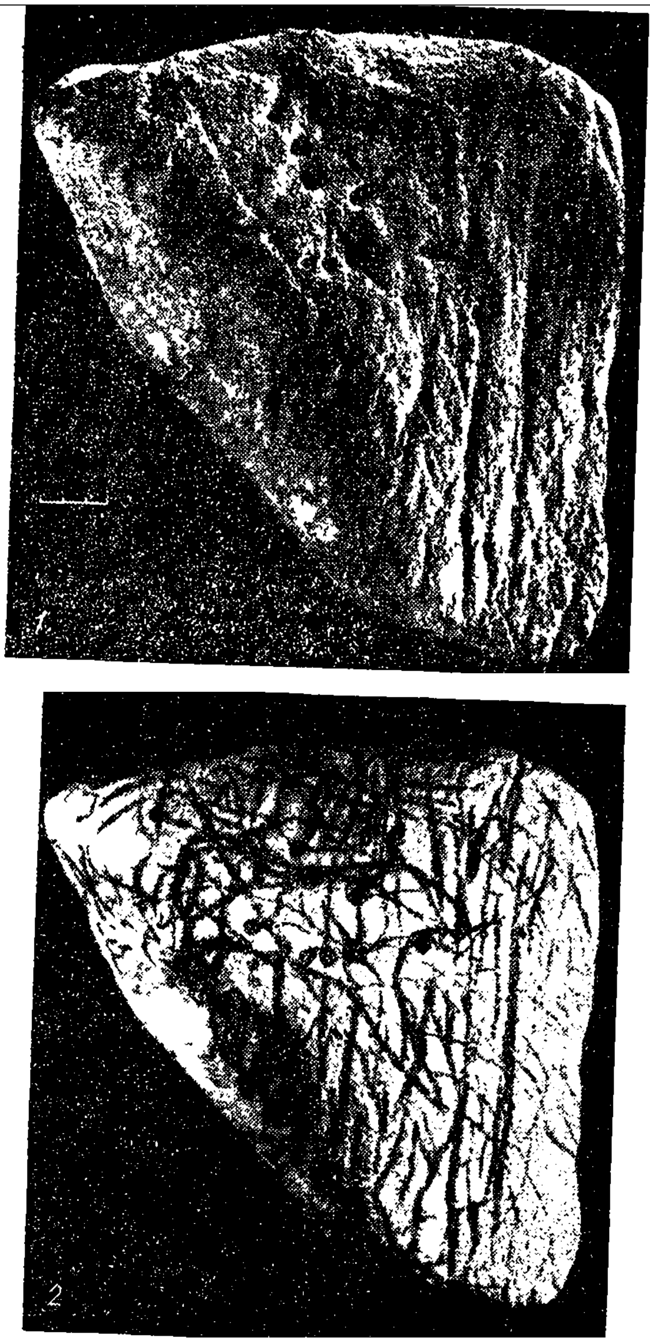
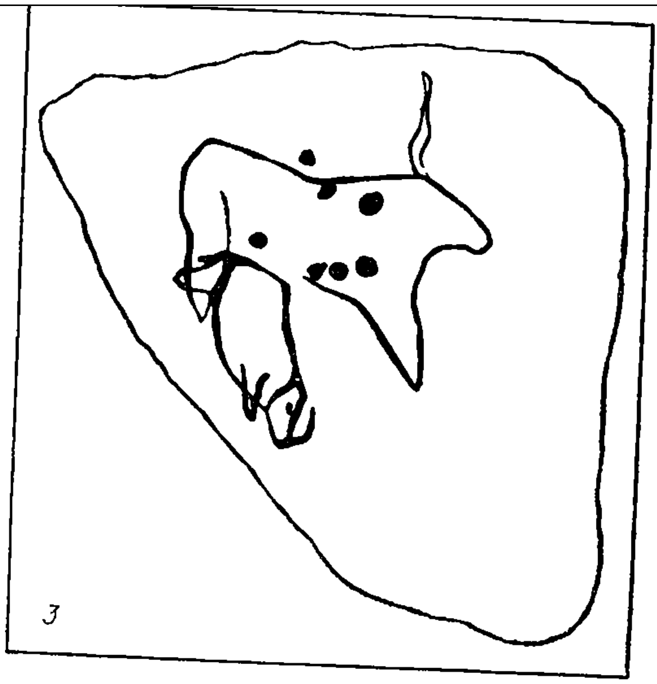
Specimen's ID	344
Image front	
Image top	
Image back	

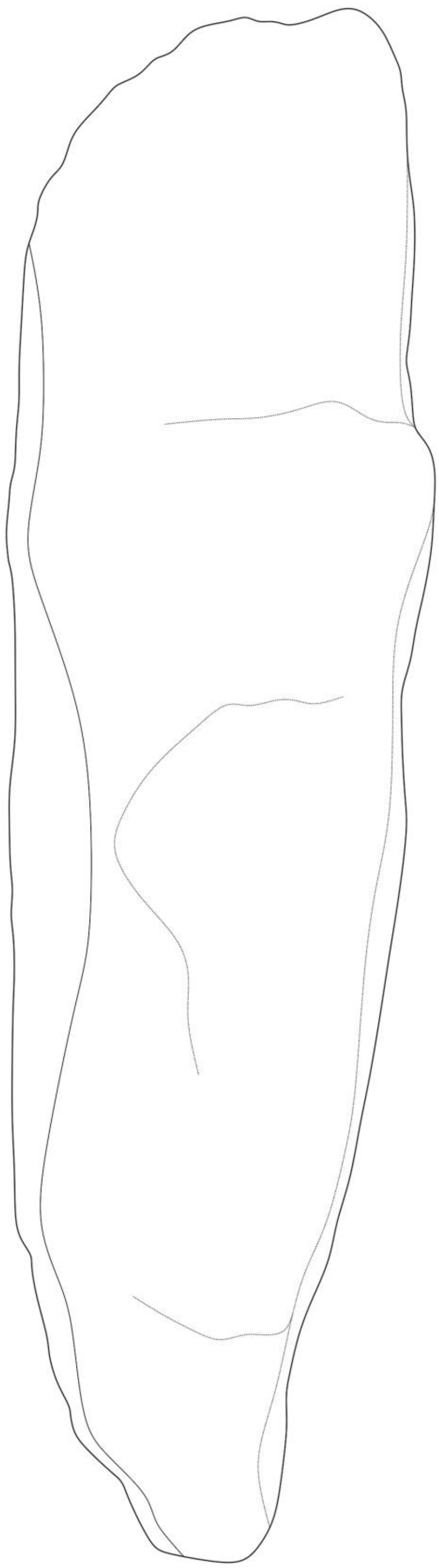
Image bottom	
Length, cm	28
Width, cm	25.5
Weight, g	4484
Volume, m^3	0.002298
Density, kg / m^3	1951.26197
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The tile has a subtriangular shape with linear and geometric engravings on one side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	To prove the existence of rhinoceroses’ images among the Wizard’s cave’s engravings, the composition on the front side of block No. 344 is mainly interesting. The block is subtriangular with a right angle and sides of 23.5 cm, 23 cm, and 31.5 cm. The main background of the tile is presented by massive comparatively vertical lines, crossed by more fluent one. This is similar to a fence from block No. 345. Closer to the middle part of the engraved part of the tile, there is a profile image of a massive bull with a massive head, legs, and wavy horns. This may be an image of aurochs that is inside the fence. An animal is wounded — there are eight deep points inside the contour of its body. We consider this image in connection with the previous one because of its particular location and the fact that the hind leg of the aurochs crosses the hind legs of another animal described further (fig. 52). The latter has a

	massive angular corpus, a big snout with an eye, short and massive legs and a big horn on its nose that is curved further to its center and is slightly higher than the animal’s eye (fig. 52). This image is similar to the figure of an old rhinoceros under the rock (due to its location on the edge of a tile). It is hunting prey. Due to such an estimation of the interpreted motif (a fence, a wounded aurochs, and — most important — a rhinoceros), one can assume the particular scientific and cognitive meaning of a tile No. 344. The numerous examples prove that the complex motifs of a profound meaning exist among the engravings of Wizard’s cave.
Descriptive image	

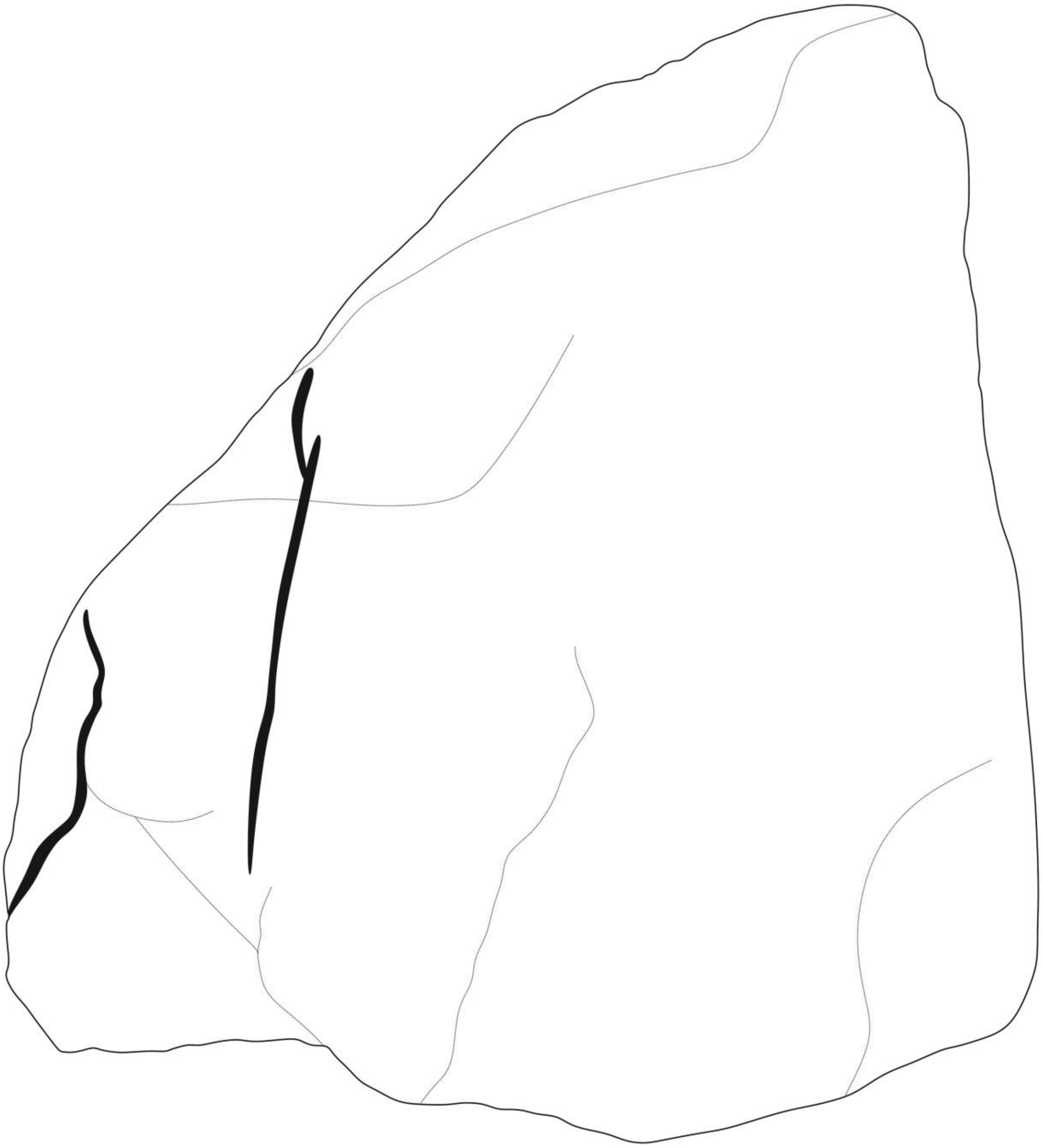
	
Description 2 source	Danilenko 1986: 99—100
Note	The block is covered with desert varnish from both sides. The block is covered with linear parallel and subparallel notches that create reticulated ornamentation. Long and deep vertical ones mostly superimpose short horizontal notches. A series of small cupmarks create the most relatively recent phase. Though V. Danilenko reconstructs an image of a bull and rhinoceros on the stone's front side, it is not evident on the block's surface. The composition or a motif of any kind is also not evident. Different orientation of the linear engravings corresponds to the relevant episode of the block's relative chronology.

Technological drawing front

Technological drawing right

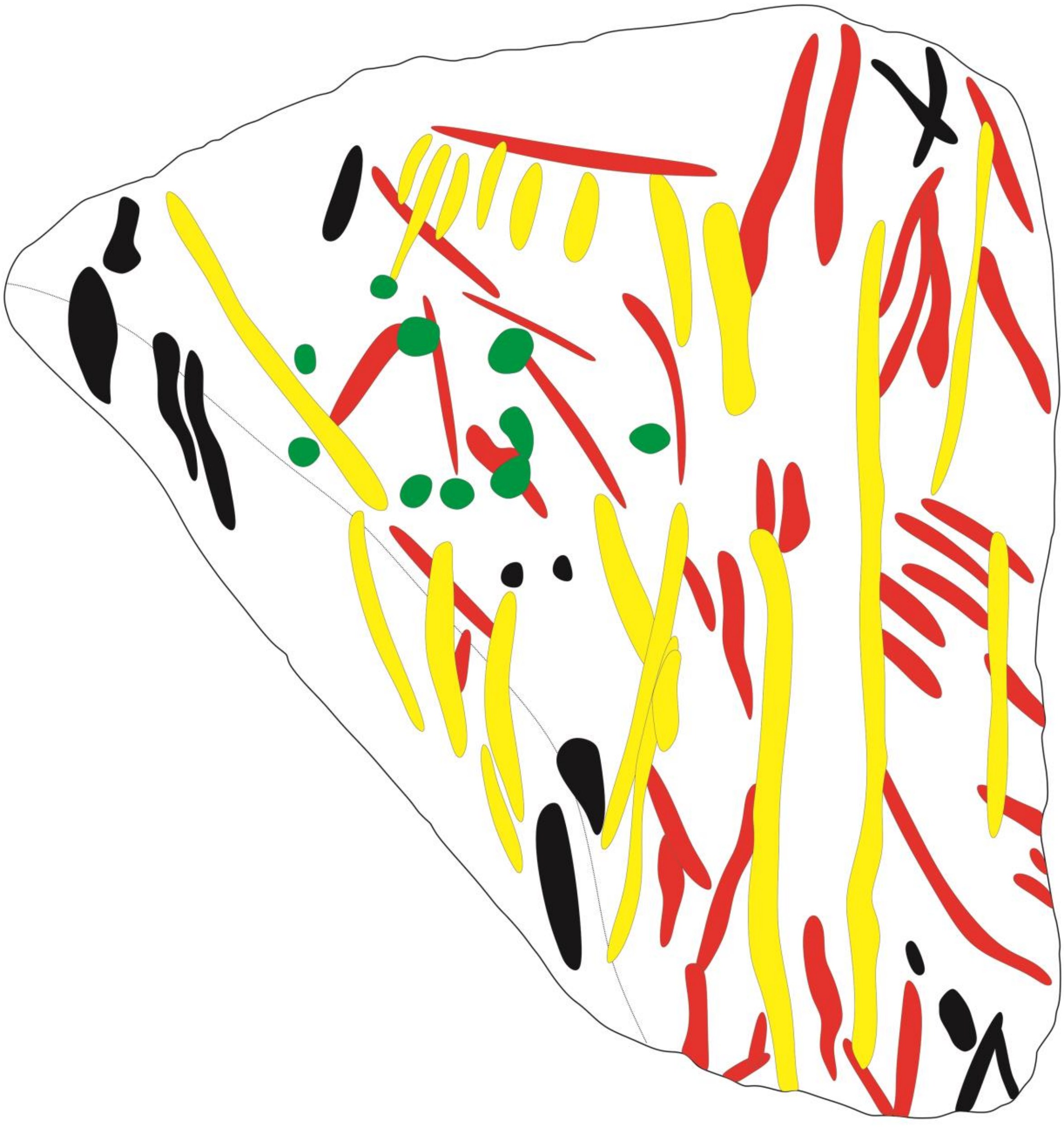


Technological drawing back

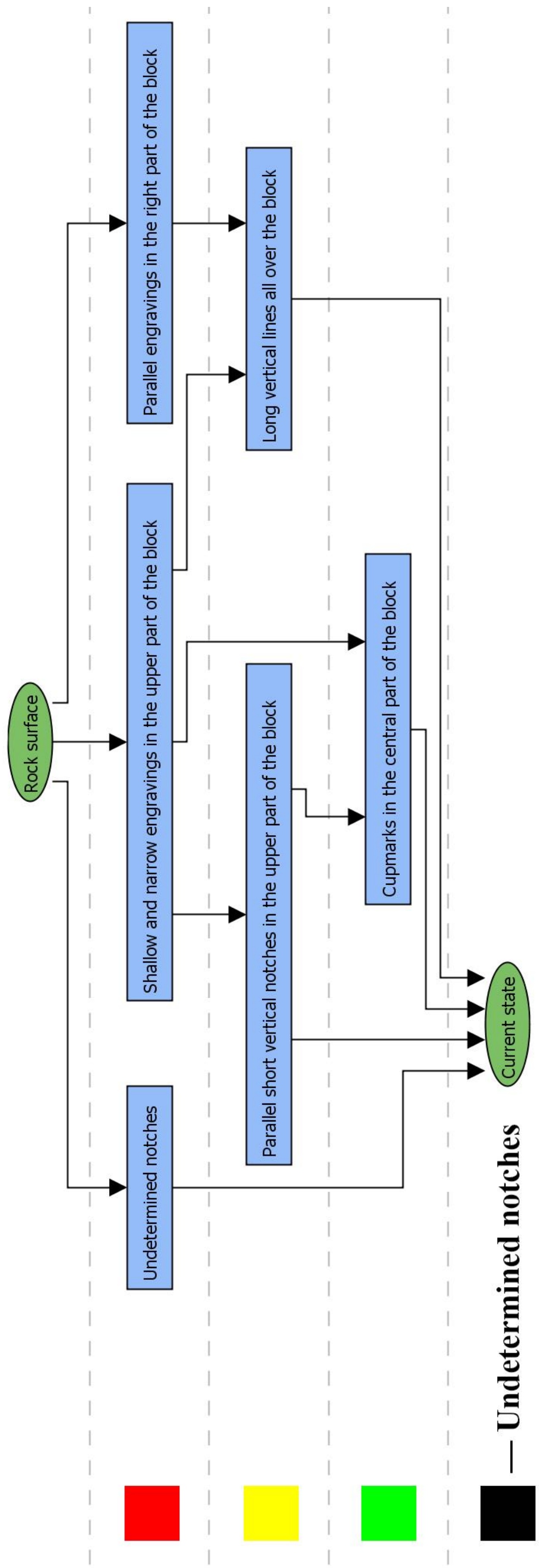


Technological drawing left

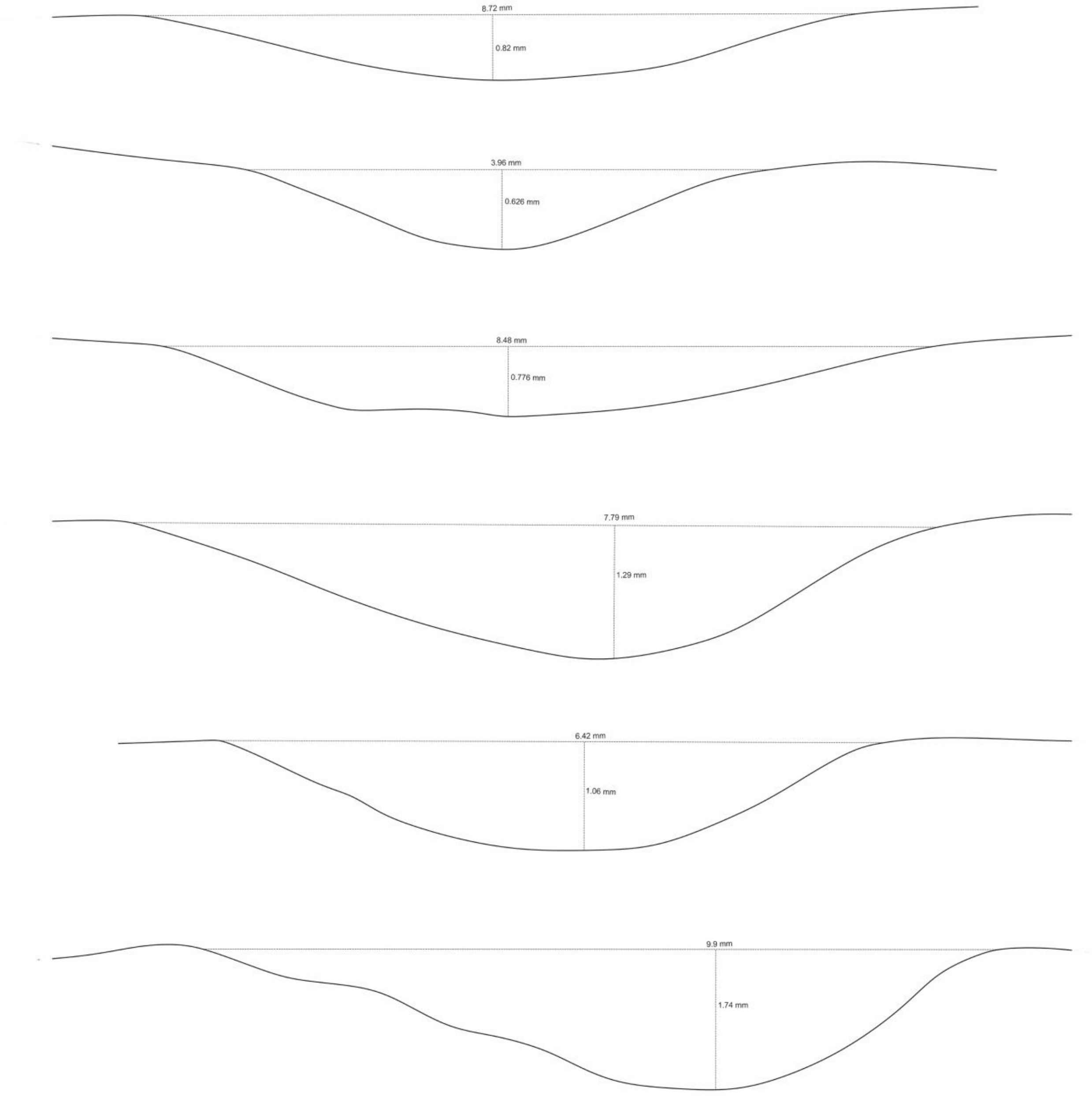
Relative chronology drawing front

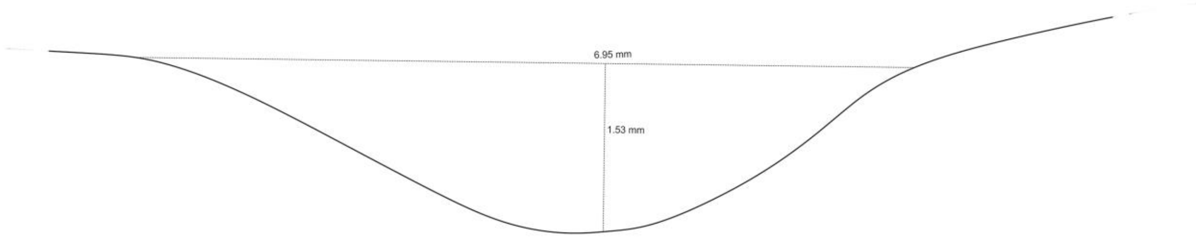


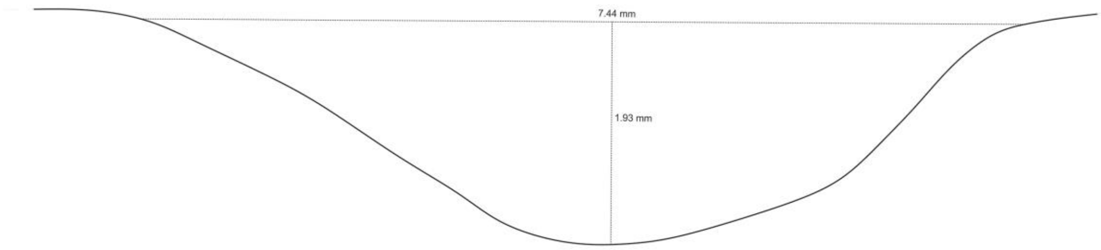
Harris matrix front

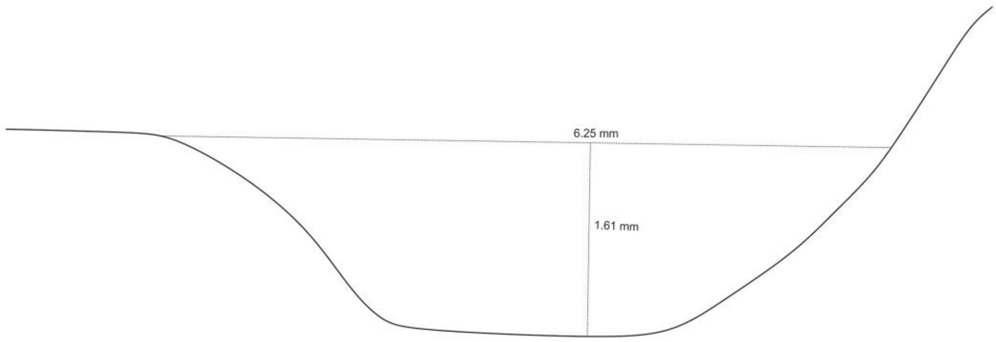


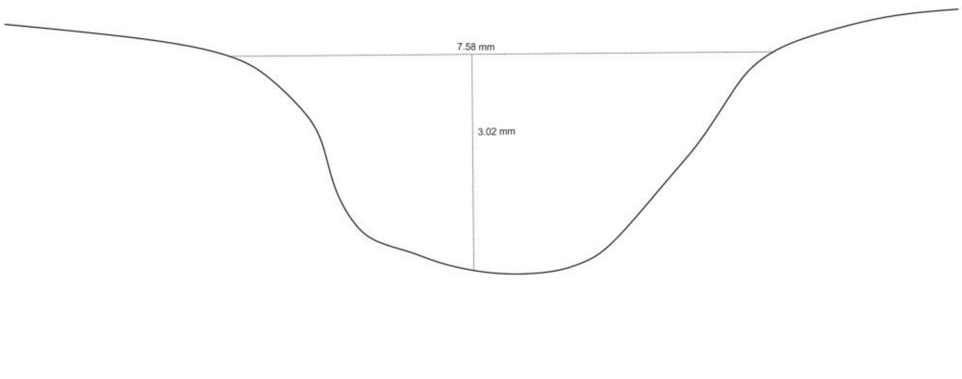
Profiles list



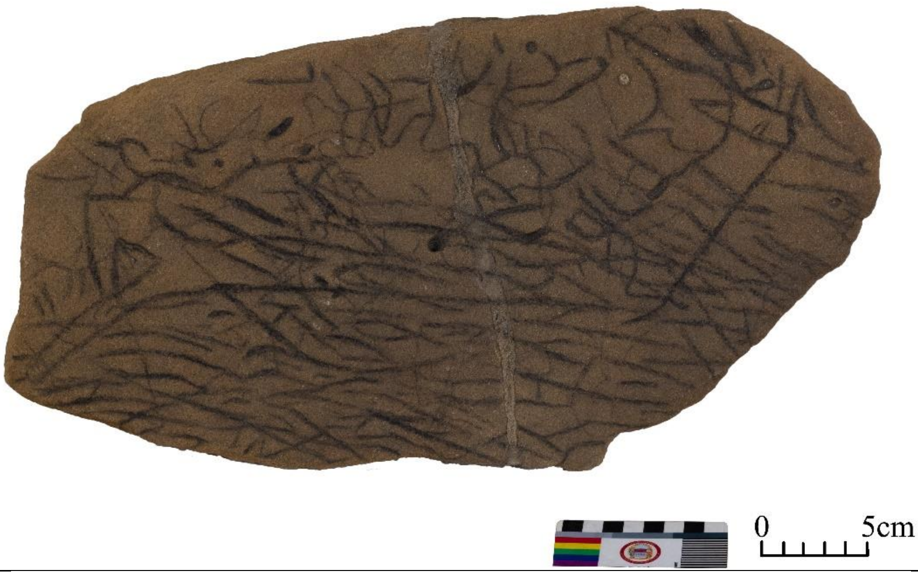

6.95 mm
1.53 mm


7.44 mm
1.93 mm


6.25 mm
1.61 mm


7.58 mm
3.02 mm

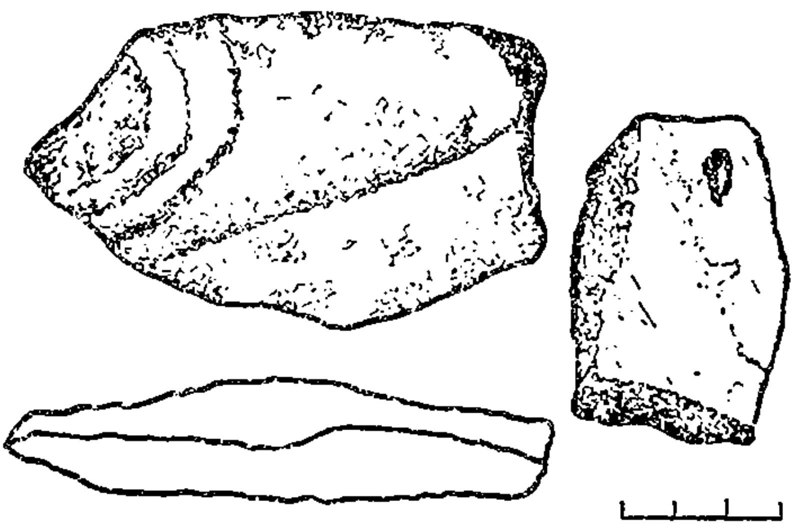
Specimen’s ID	345
Image front	
Image back	
Length, cm	40
Width, cm	22
Weight, g	6900
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	The irregular block is in the shape of a trapeze. Contains linear engravings on the front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The stone is covered with desert varnish from the front side. This side is darker. The front side is intensively covered with linear engravings, most parallel. The back side contains a few parallel lines. Cupmarks on the front side are artificially perforated.

Specimen's ID	346
Image front	
Image back	
Length, cm	48
Width, cm	23
Weight, g	4523
Date of discovery	1973
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	The block of irregular oval shape. The linear and geometric engravings are on the front side.
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Description source 2	—
Descriptive image	—
Note	The block broke up in two pieces and was glued after 1973. The front side is darker; both sides are covered with desert varnish. It contains linear and curvilinear engravings that create a kind of reticulated ornament. Cupmarks are artificially perforated. The shape has been modified, probably by polishing.

Specimen’s ID	355
Image front	
Image back	
Image bottom	

Image top	
Length, cm	8.5
Width, cm	6.3
Weight, g	136
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The stone is not described in the storage list or Danilenko’s book. It is covered with red desert varnish and intensively crumbling. The stone's front, back, and bottom sides were polished to their shape. Block does not contain any engravings.

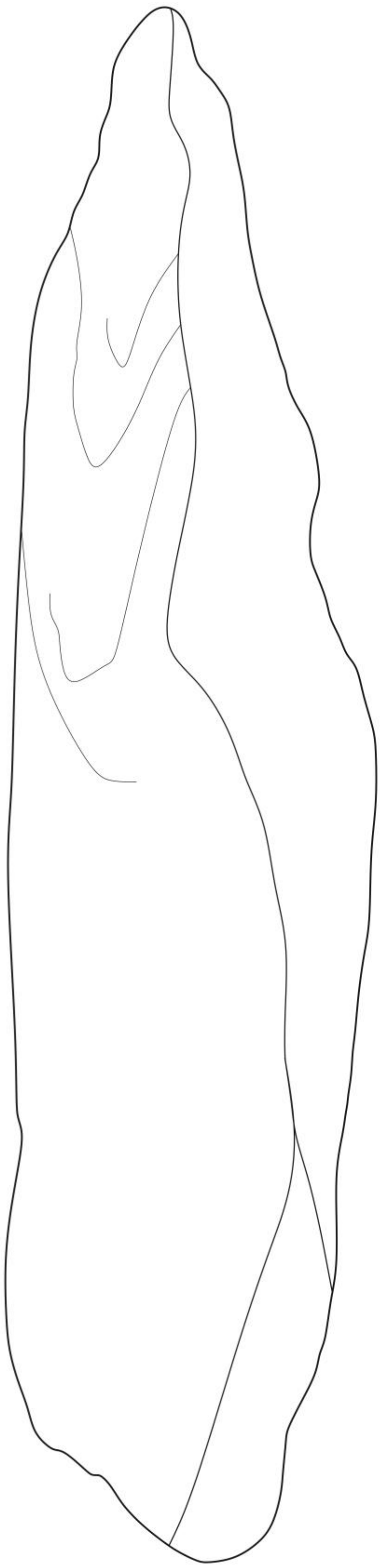
Specimen’s ID	356
Image front	
Image right	
Image back	

Image left	
Length, cm	11.2
Width, cm	7.1
Weight, g	213
Volume, m^3	0.000090
Density, kg / m^3	2366.66667
Date of discovery	1973
Finder	V. Danilenko
Location	"Churinga's" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	There are parts of different tools … including axes, "saws," tools for polishing made of sandstone that can be connected with the creation of stone, polished and perforated tools (fig. 25).
Descriptive image	

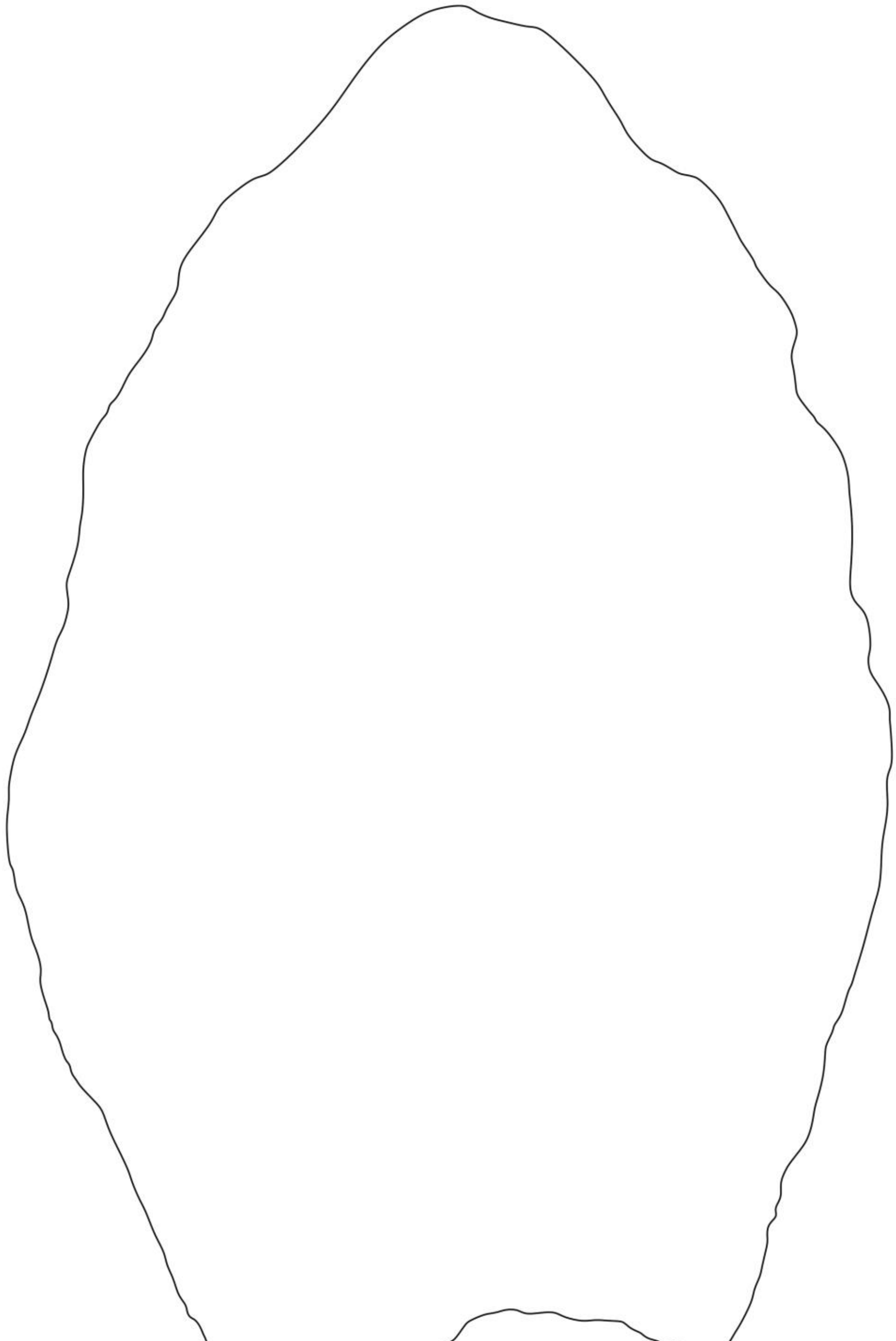
Description source	Danilenko 1986: 70, 74
Note	The stone was considered by V. Danilenko and later B. Mykhailov as a tool for the creation of engravings on churingas and inside the caves of Kamyana Mohyla. B. Mykhailov assumed (in personal conversation) that the tool was used due to the outer red layer with the high concentration of iron (Fe). However, the density of sandstone from that tool is more or less similar to the density of other churingas. Other properties of sandstone remain valid: it crushes and crumbles. Using such a specimen for the engraving would cause significant destruction of the stone's sharp edge and be noticeable on the tool's surface at once. Besides, the fragility of the iron-rich stone is higher than one of the most stones from Kamyana Mohyla as the iron in sandstone is concentrated in Fe_2O_3 (rust). Therefore the idea of this tool being used to create rock art instances appears to be false.

Technological drawing front

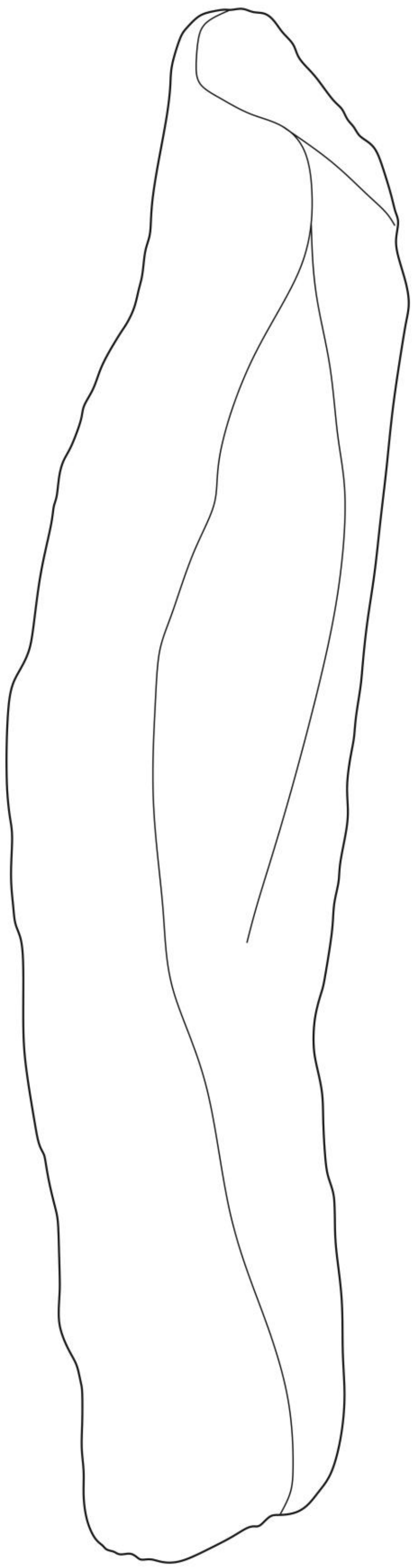
Technological drawing right



Technological drawing back



Technological drawing left



Specimen's ID	359
Image front	
Image back	
Length, cm	9.7
Width, cm	8.5
Weight, g	320
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The stone is not described in the storage list or Danilenko's book. It is covered with desert varnish from all sides. The front, back, and left sides of the stone were almost flat and polished to their shape. Block does not contain any engravings or other types of notches.

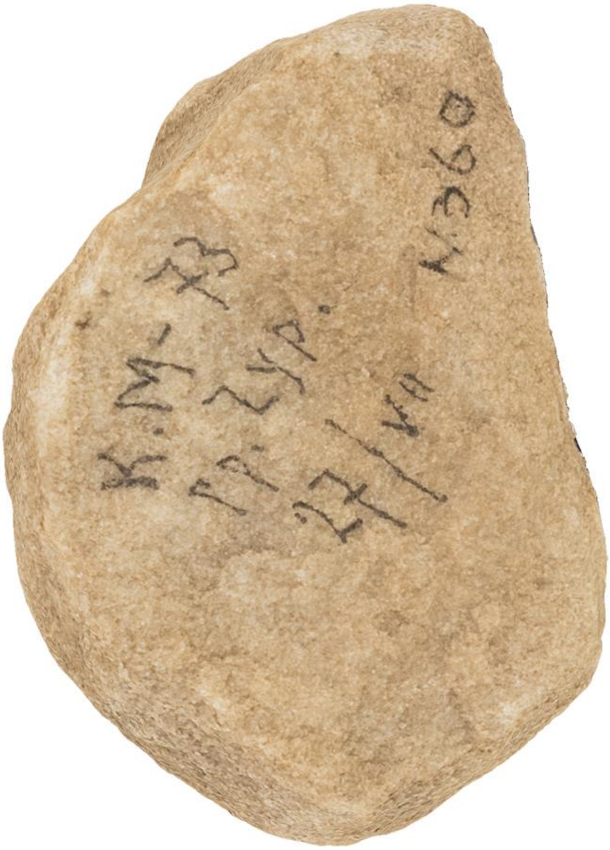
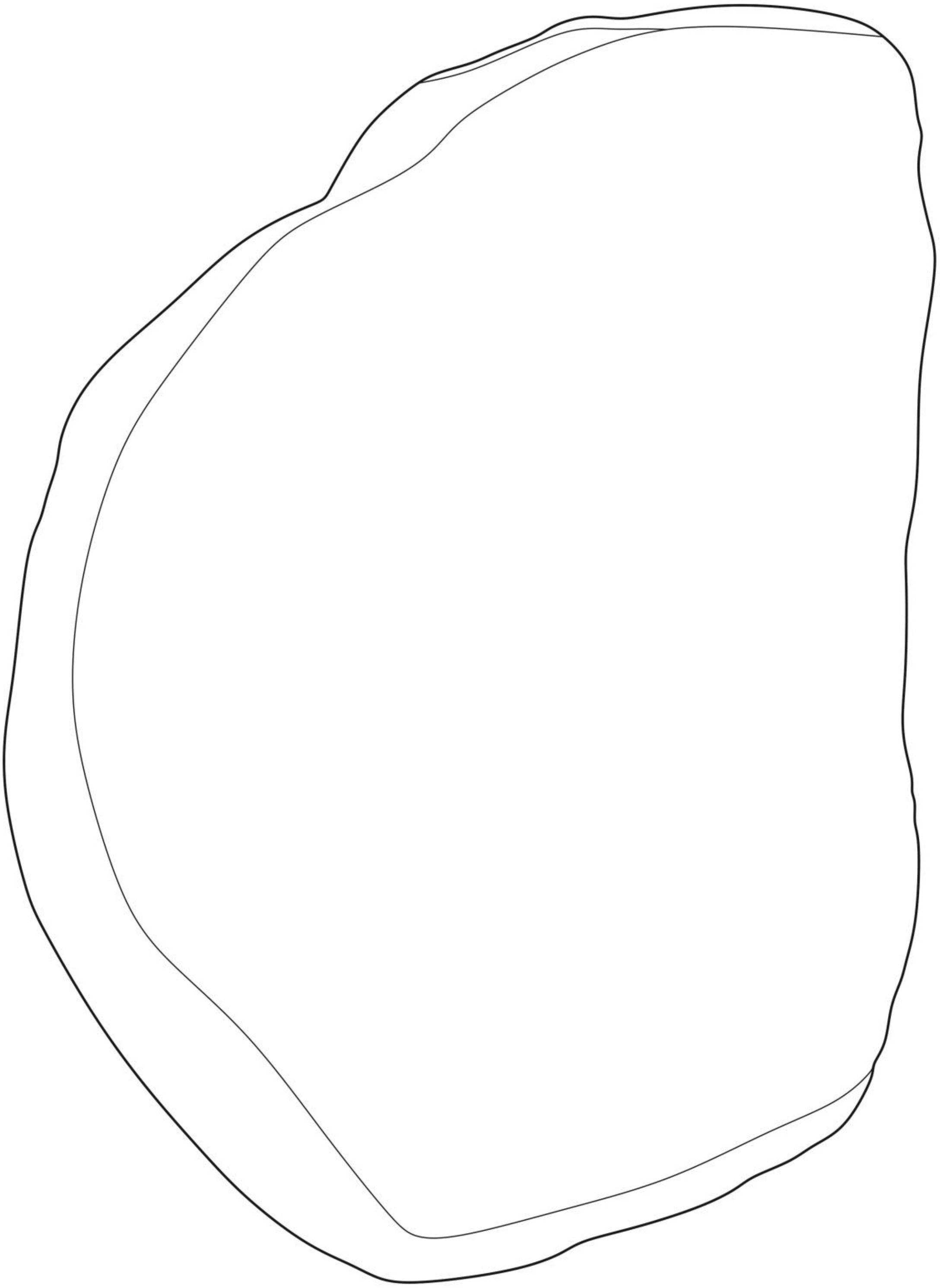
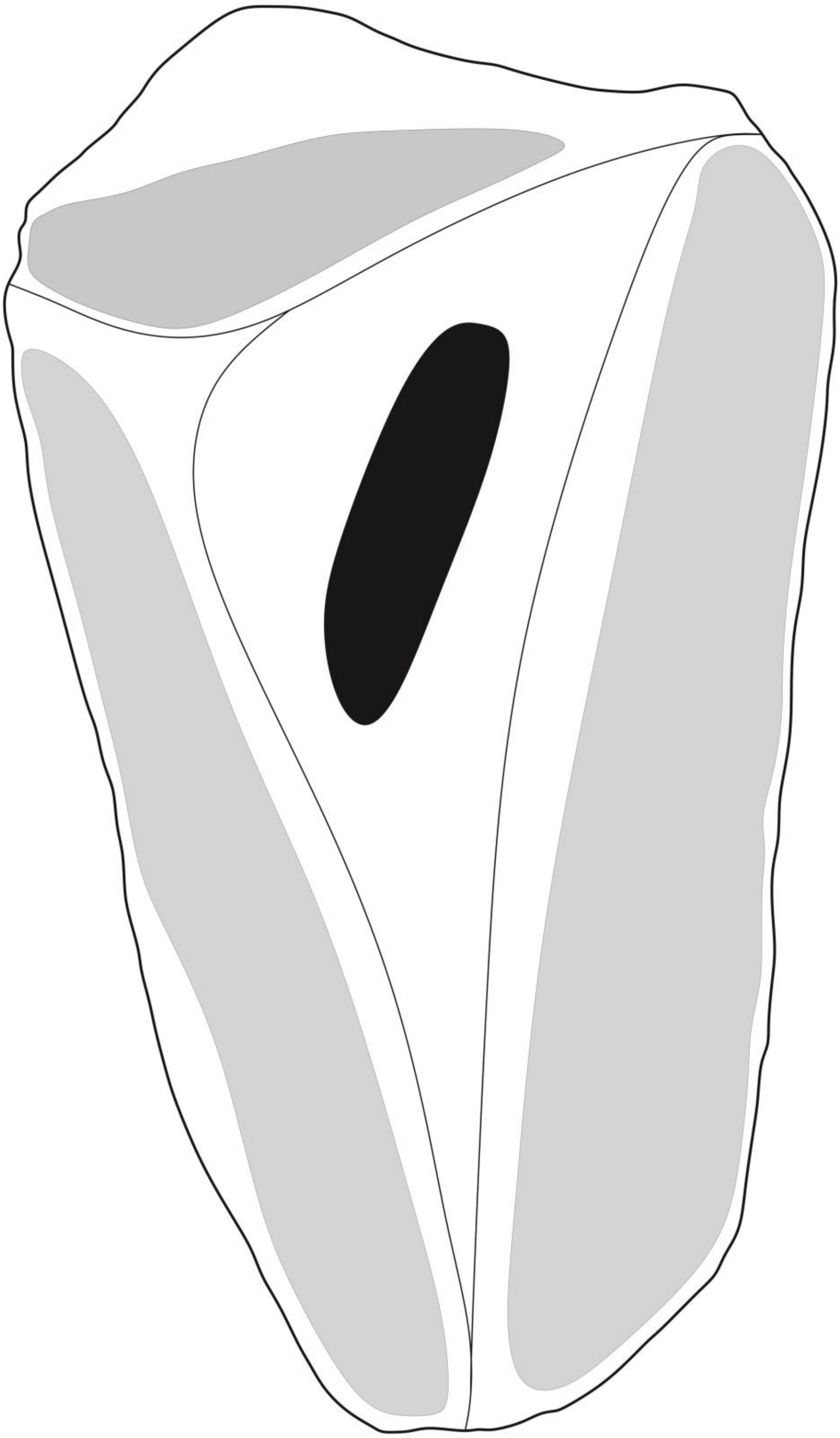
Specimen's ID	360
Image front	
Image left	

Image back	
Length, cm	8.8
Width, cm	6.6
Weight, g	209
Volume, m^3	0.000084
Density, kg / m^3	2488.09524
Date of discovery	1973
Finder	V. Danilenko
Location	"Churinga's" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	A piece of bright and dense sandstone without any engravings and notches. It is not covered with desert varnish. However, the left part (the narrow surface) contains traces of intense polishing. The specimen was described neither in any list nor in V. Danilenko's book.

Technological drawing front



Technological drawing left



Technological drawing back

Specimen's ID	361
Image front	
Image back	
Length, cm	6.5
Width, cm	4.2
Weight, g	—
Date of discovery	1973
Finder	V. Danilenko
Location	"Churingas" cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The stone is not described in the storage list or Danilenko's book. It is covered with desert varnish from the front and back sides. A few short linear engravings are located both on the front and back.

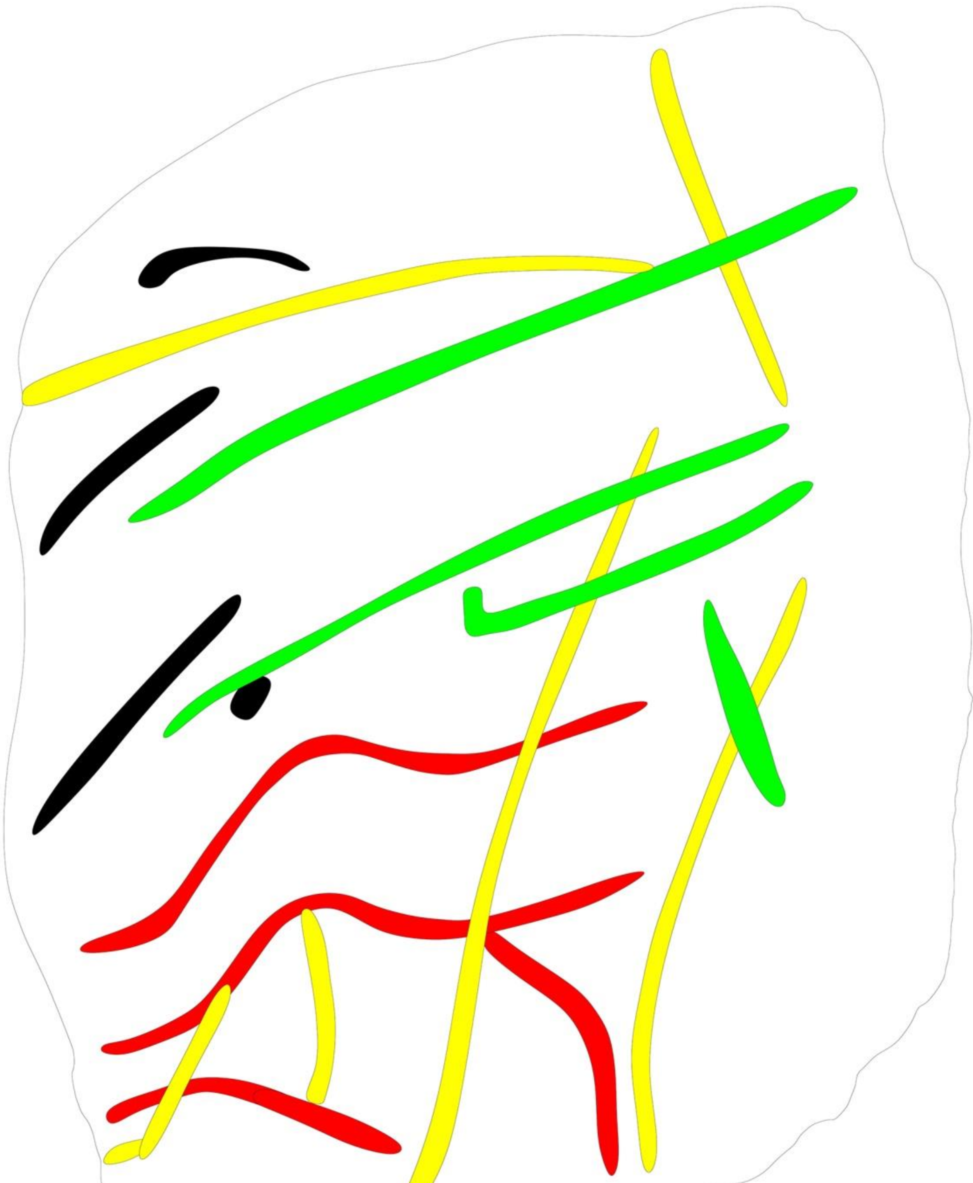
Specimen’s ID	363
Image front	
Image bottom	
Length, cm	7
Width, cm	8
Weight, g	190
Date of discovery	1973
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52, Scynia
Current location	Institute of Archaeology, Kyiv
Description	Hardly damaged churinga with linear engravings and a destroyed number
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The stone is broken into many parts. The sand under the desert varnish appeared not concreted and crumbled, creating hollowness ‘inside’ a churinga. The stone is covered with desert varnish and contains shallow non-figurative linear engravings on its front side. The number is reconstructed by examining the small pieces of desert varnish. The destruction probably happened during transportation or after 1973, when the stone was located in the Institute storage in Kyiv.

Specimen’s ID	367
Image front	
Image back	
Length, cm	5
Width, cm	4.5
Weight, g	—
Date of discovery	1973
Finder	V. Danilenko
Location	“Churingas” cave, No. 54
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The stone is described neither in the storage list not in Danilenko’s book. It is covered with red-ish desert varnish from the back side and yellow-ish from the front one. Both these sides are polished and almost flat. The stone is not engraved and not contains other types of notches.

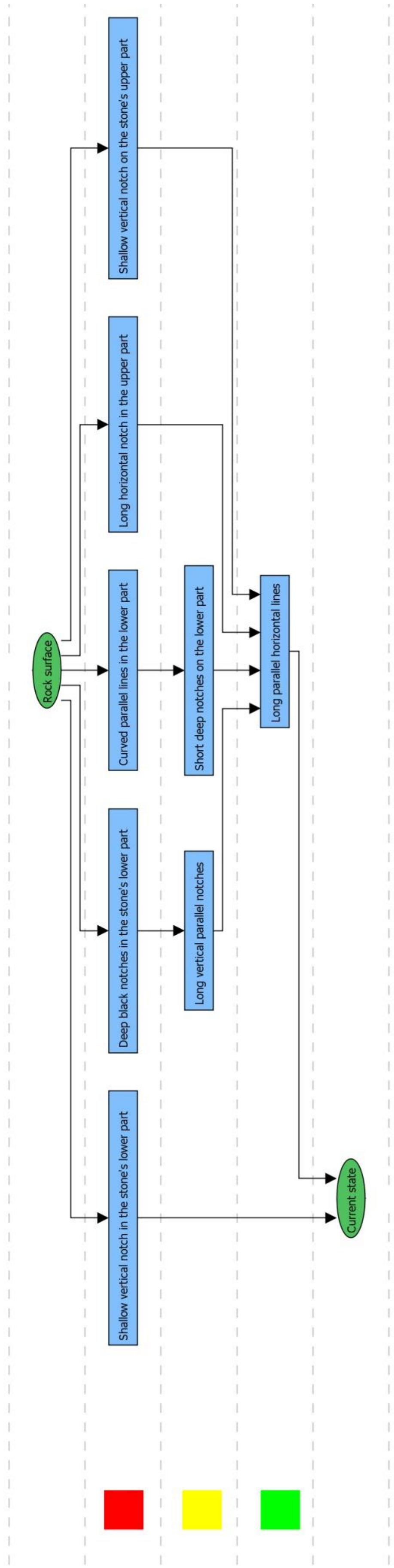
Specimen’s ID	KM74—1
Image	
Length, cm	11
Width, cm	15
Weight, g	696
Volume, m^3	0.000358
Density, kg / m^3	1944.134
Date of discovery	1974
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The lower third part of the block is occupied by an image of an animal with a long tail, probably a bull. His head is turned right. Four legs are engraved; no ears. The middle part of the bull has been crossed by the big lines that probably mark the spears. Under the image of the bull, linear notches are situated. Their meaning is undetermined. The upper quarter of the block is covered with the schematic image of an animal that moves right: its tail is elongated, and the head is turned down. Following the analogies from the Wizard’s cave, one can assume that this creature is a well-known character of a cave lion. Its breaths and hip are crossed with broad lines (the spears).
Description source	Danilenko 1986: 95—96

Technological drawing

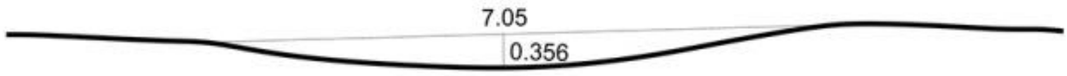
Relative chronology drawing

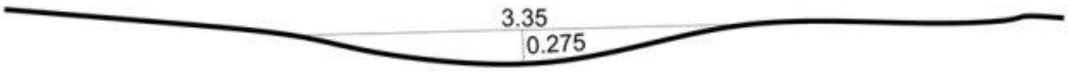


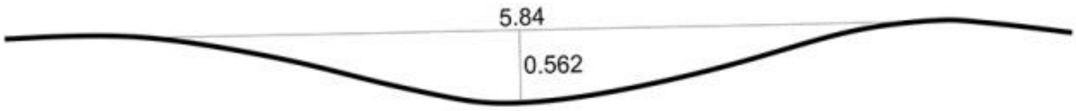
Harris Matrix, front side

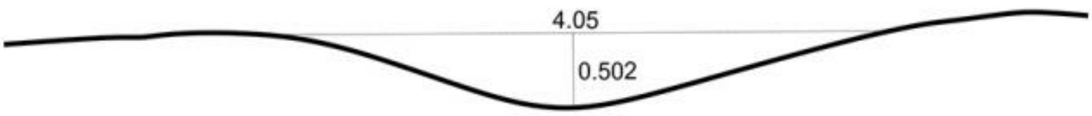


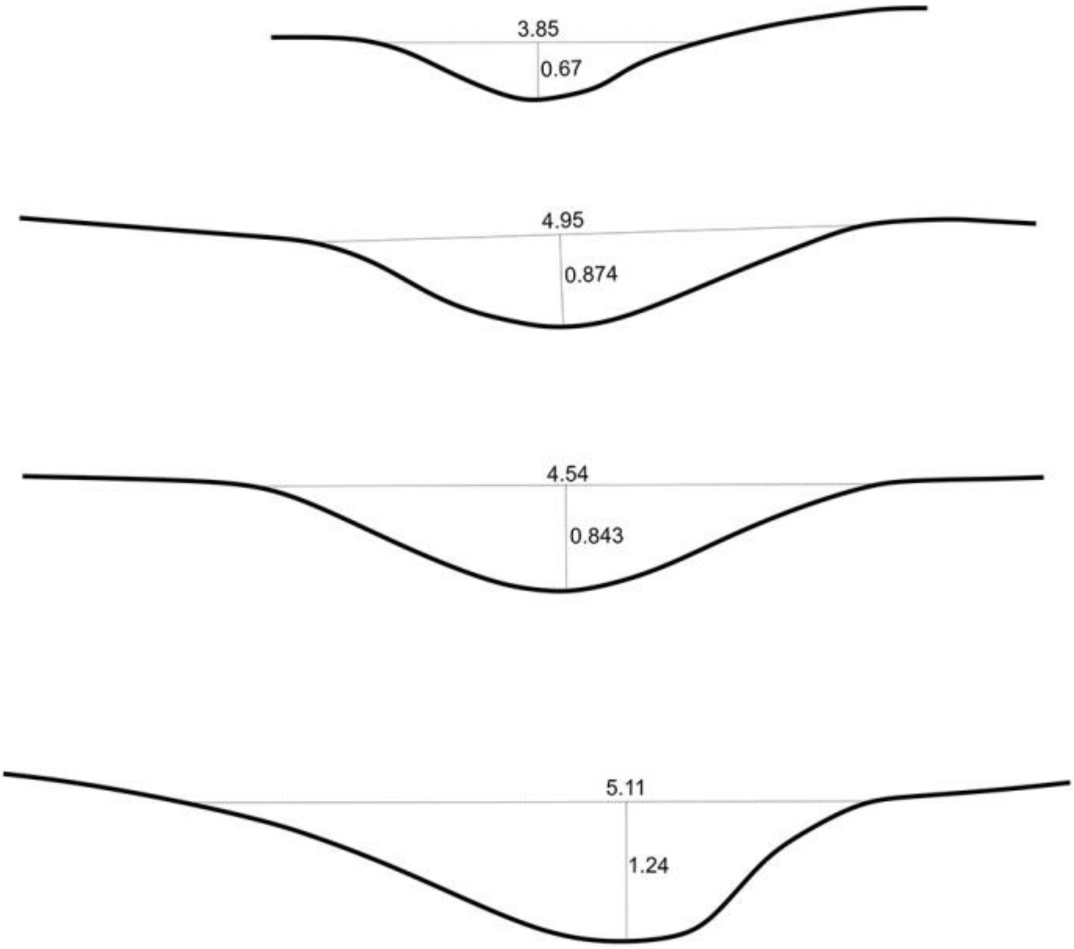
Profiles list









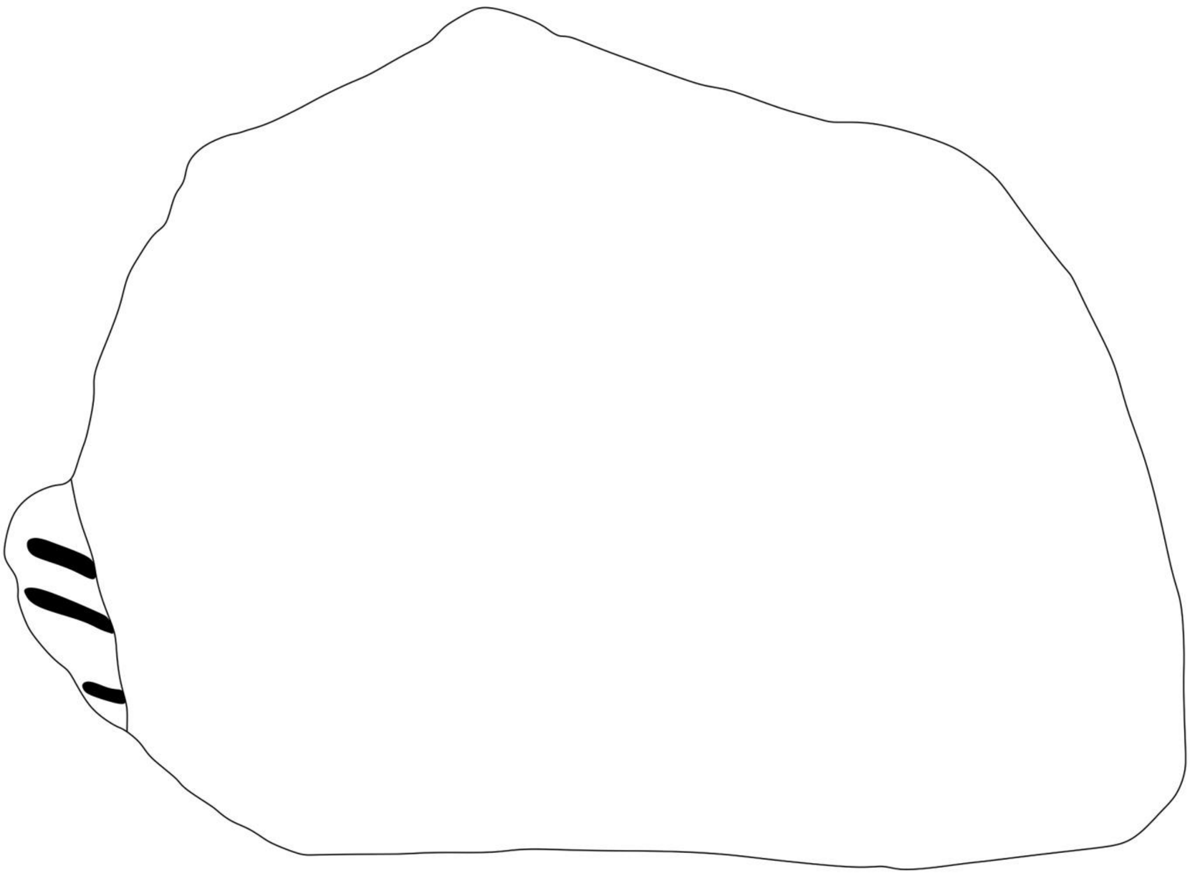

3.85
0.67
4.95
0.874
4.54
0.843
5.11
1.24

Specimen's ID	KM74—2
Image front	
Image back	
Length, cm	35
Width, cm	25
Weight, g	4044
Volume, m^3	0.002078
Density, kg / m^3	1946.102
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	Belongs to the blocks with the anthropomorphic meaning. It has a

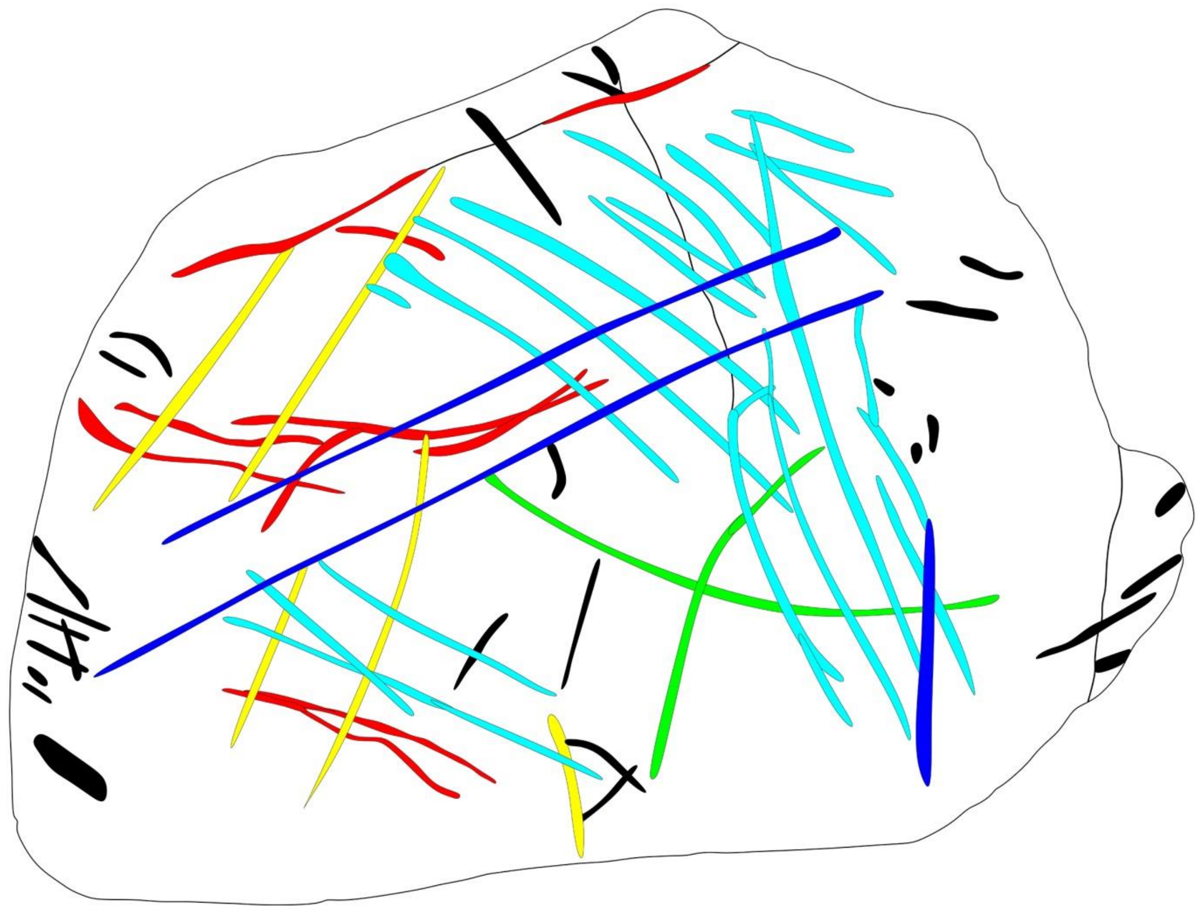
	wrong multiangular shape. All lines on a block are well visible and might be accurately fixated. However, the meaning of the composition is not entirely clear. The main types of engravings are linear and geometric. Others contain a sub-ellipsoid figure on a left side of a block. Other parts of the composition are more evidential — two parallel lines lower than the block's horizontal axis. Under the middle part of the block, there is a sub-triangular figure with the wrong semi-round incision in a middle part of a lower one. This might probably be a tent-like dwelling with a small entrance located near the river. To the right of it, there is a thick anthropomorphic figure, probably a man. The right edge of a block contains a complex curved anthropomorphic figure. This may be a man or a woman in a coitus state. It is essential that under these circumstances, the coitus happens with the cosmogony images on a background — en Earth, the Sky, the river, and the settlement.
Description source	Danilenko 1986: 114—115
Note	The cosmogony situation described by V. Danilenko is not evident on the stone block surface. However, the linear engravings are visible quite well. The churinga was broken in ancient times. Unlike the bigger one, the minor part contains desert varnish and engraved lines from both sides. V. Danilenko glued the block after 1974.

Technological drawing front

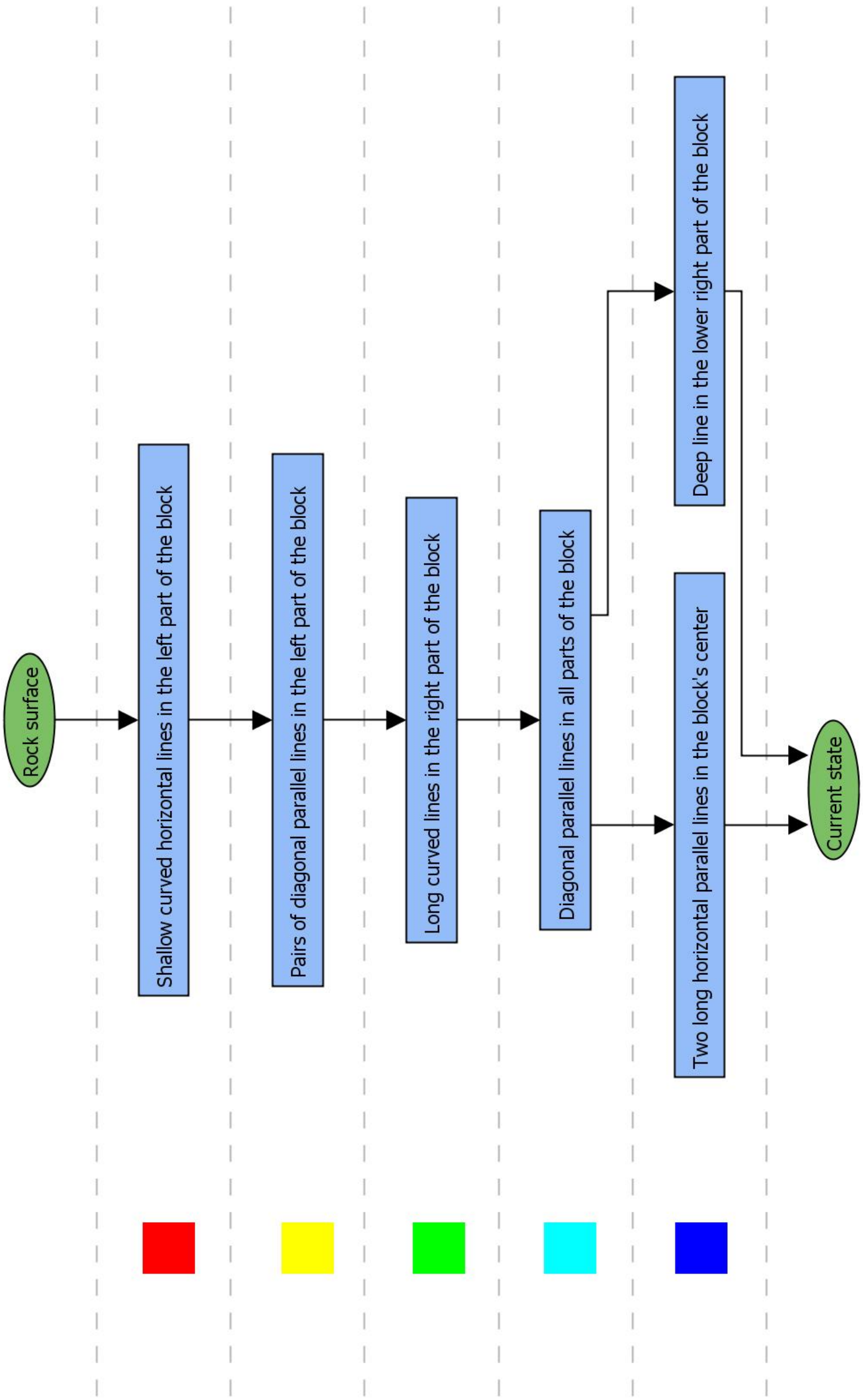
Technological drawing back



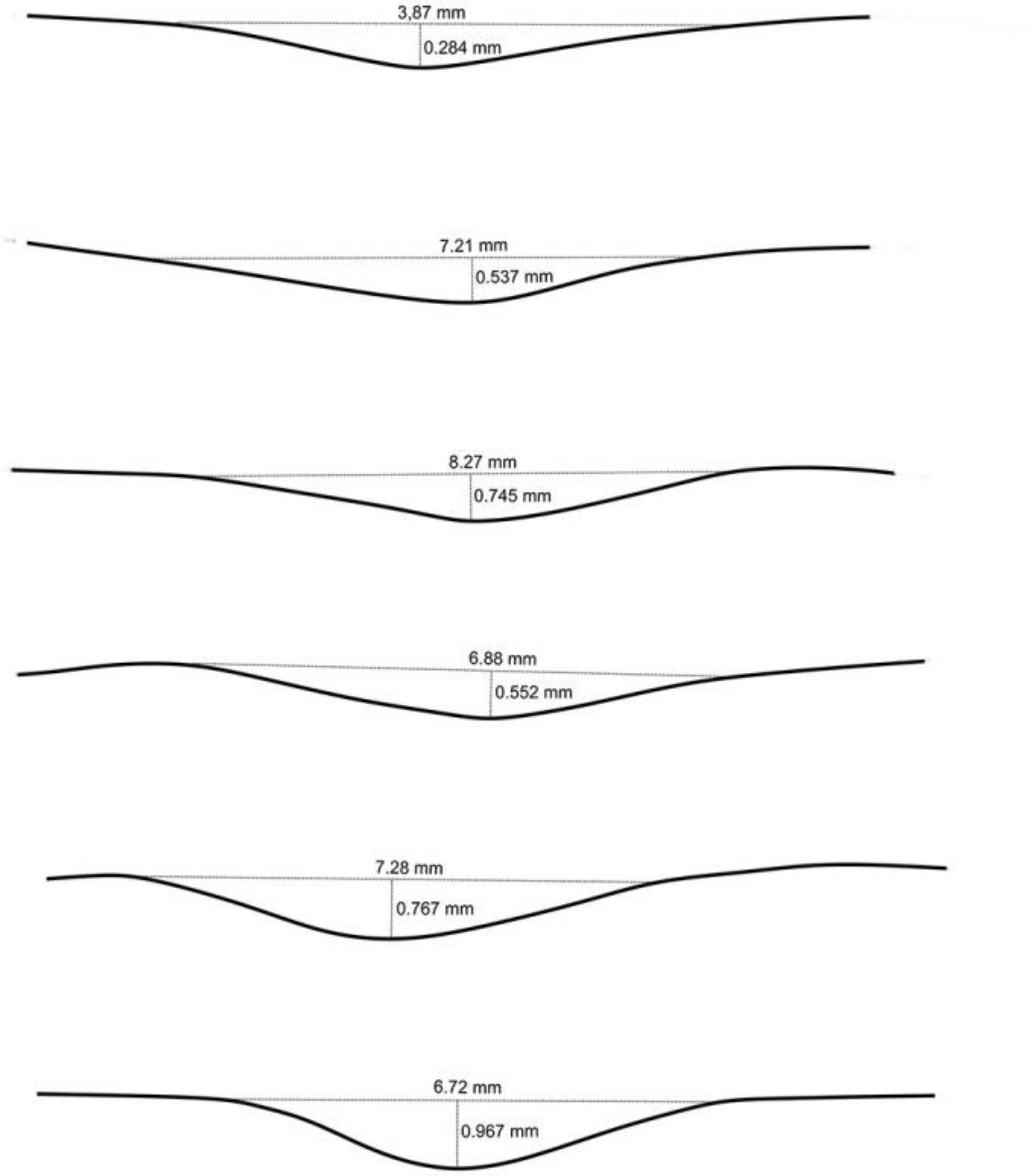
Relative chronology drawing front

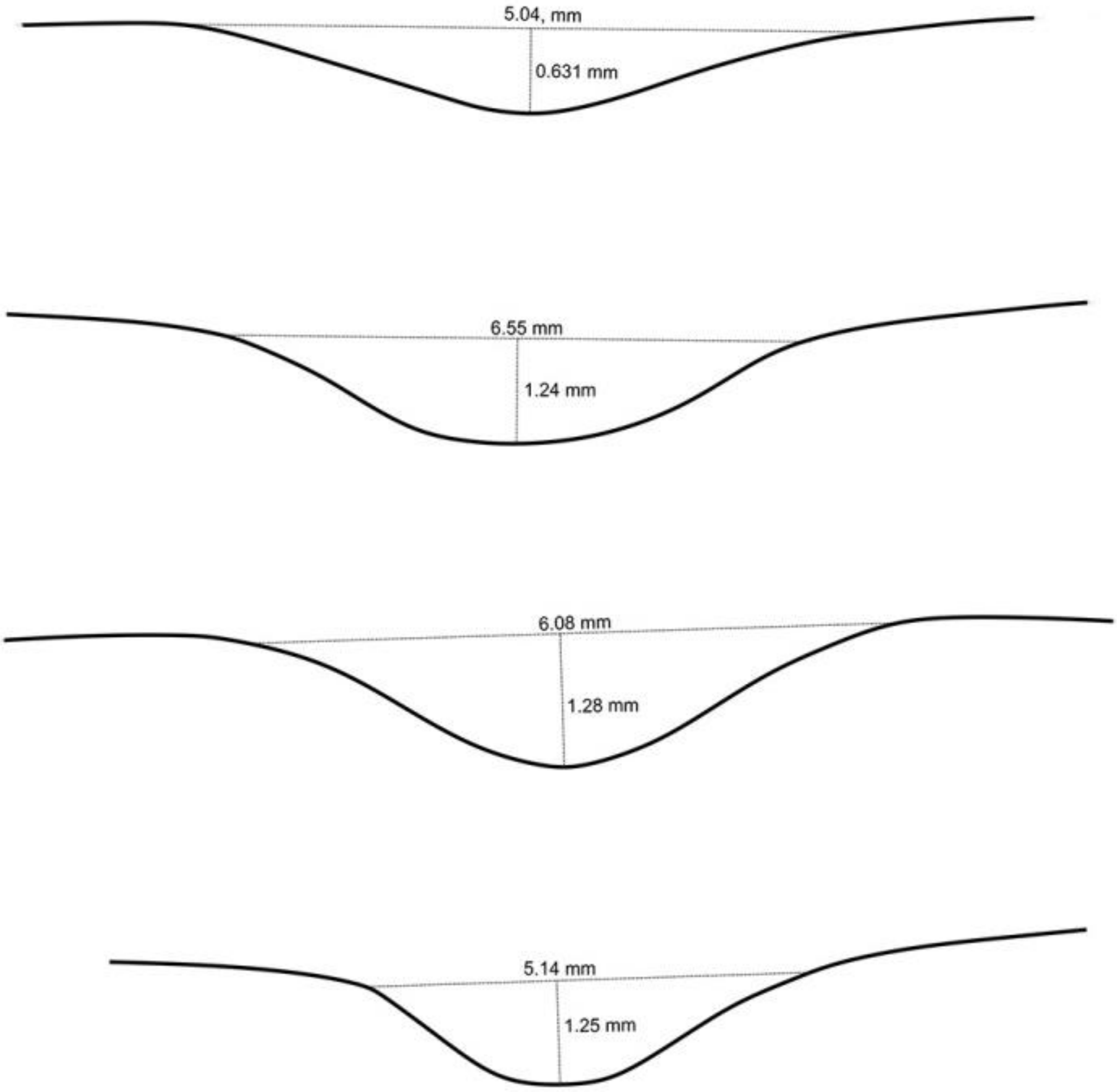


Harris Matrix, front side



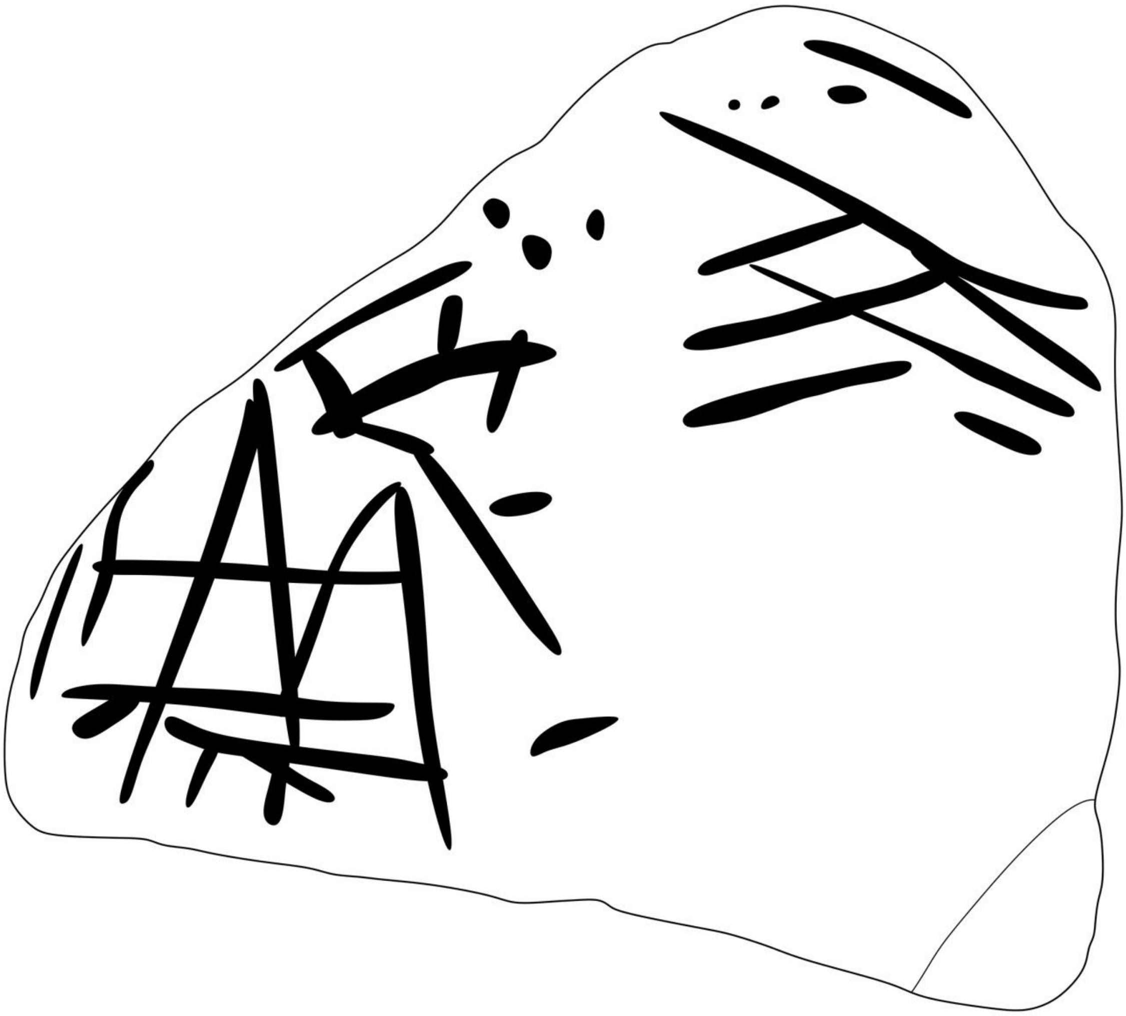
Profiles list




5.04, mm
0.631 mm
6.55 mm
1.24 mm
6.08 mm
1.28 mm
5.14 mm
1.25 mm

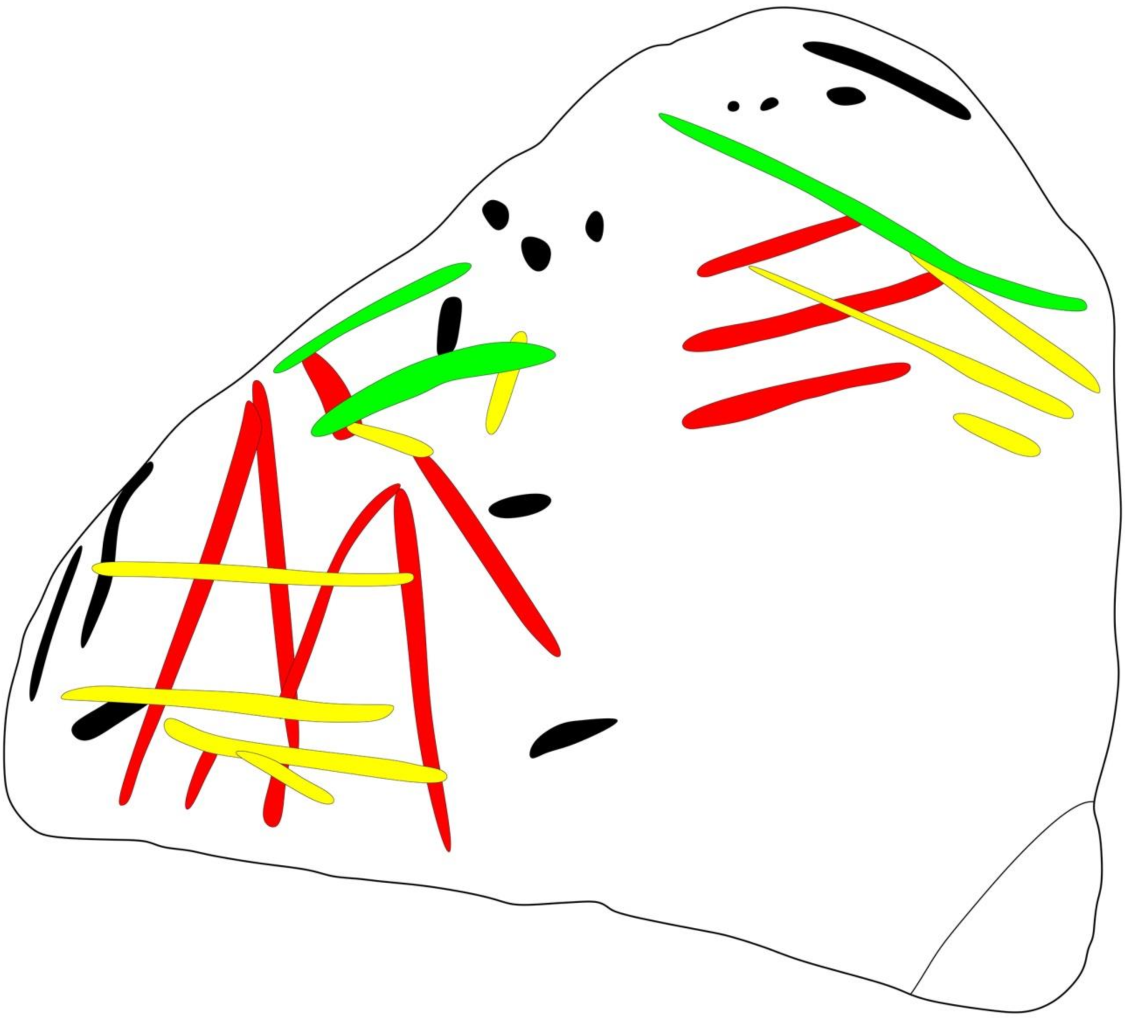
Specimen's ID	KM74—4
Image front	
Image back	
Length, cm	14
Width, cm	12
Weight, g	496
Volume, m^3	0.000255
Density, kg / m^3	1945.09804
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	The sequence drawing and the Harris matrix for the back side of the specimen are not created, as the engravings do not provide the required data.

Technological drawing front

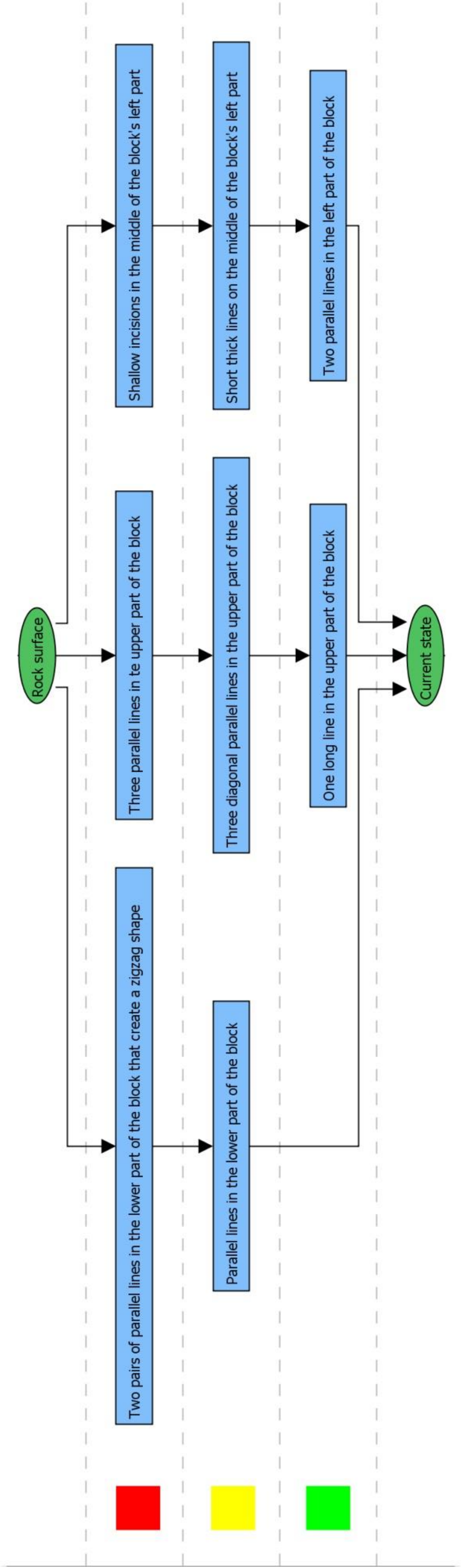


Technological drawing back

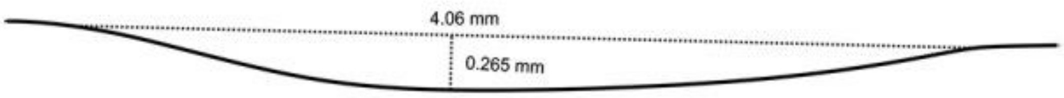
Relative chronology drawing front

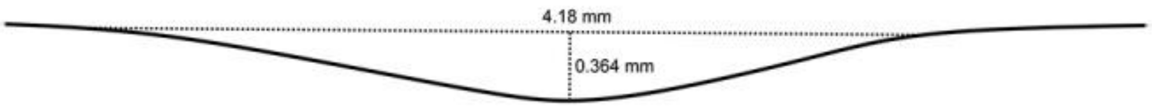


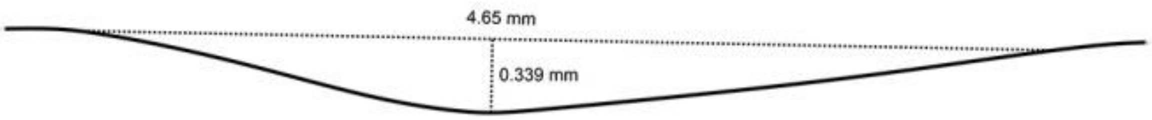
Harris Matrix

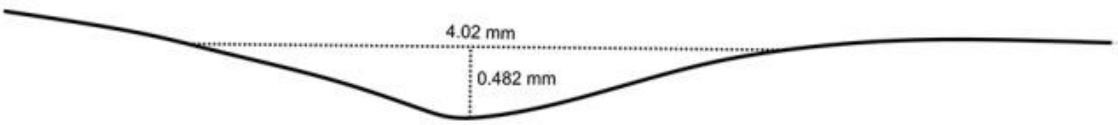


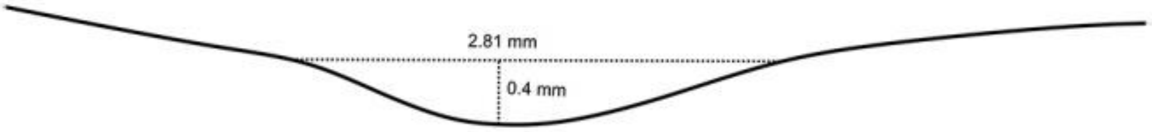
Profiles list

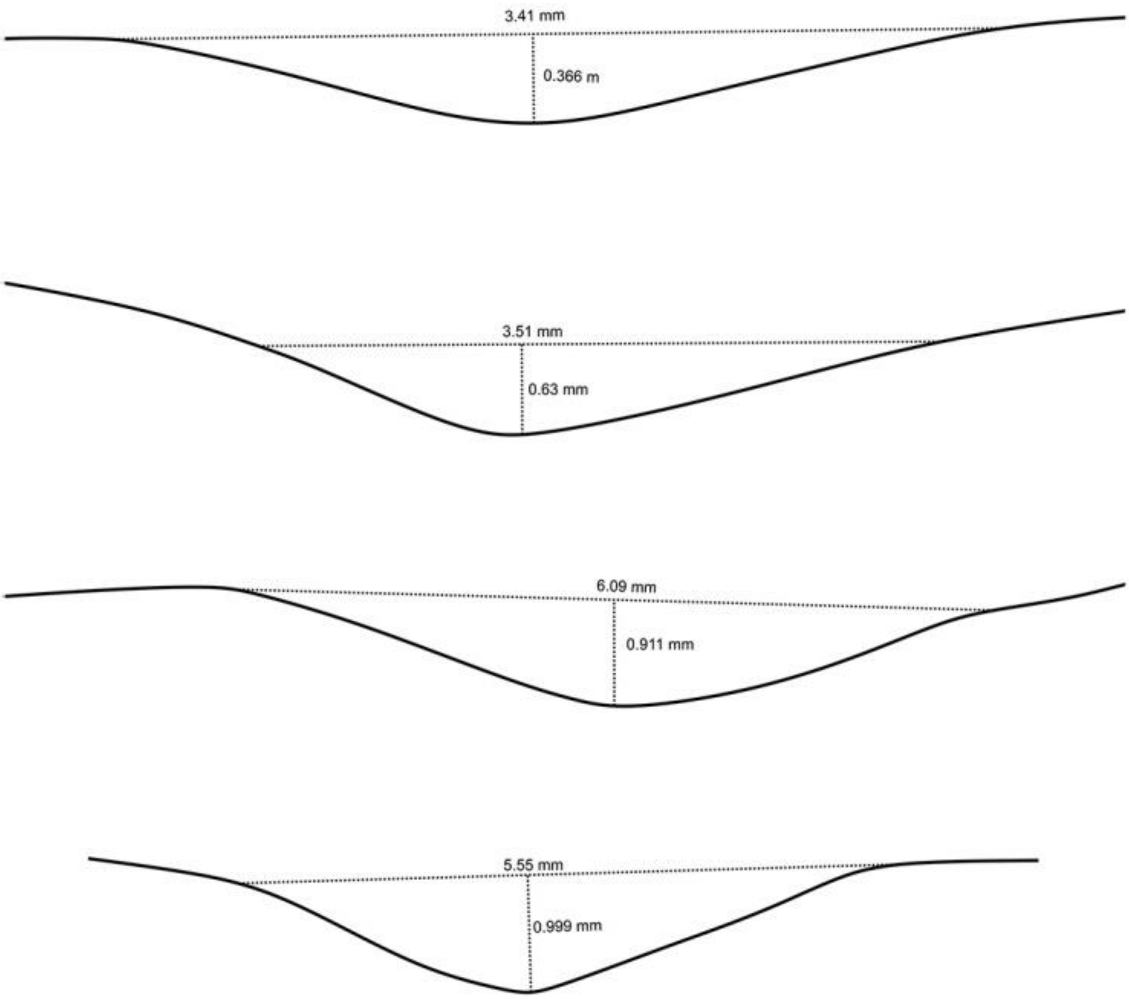


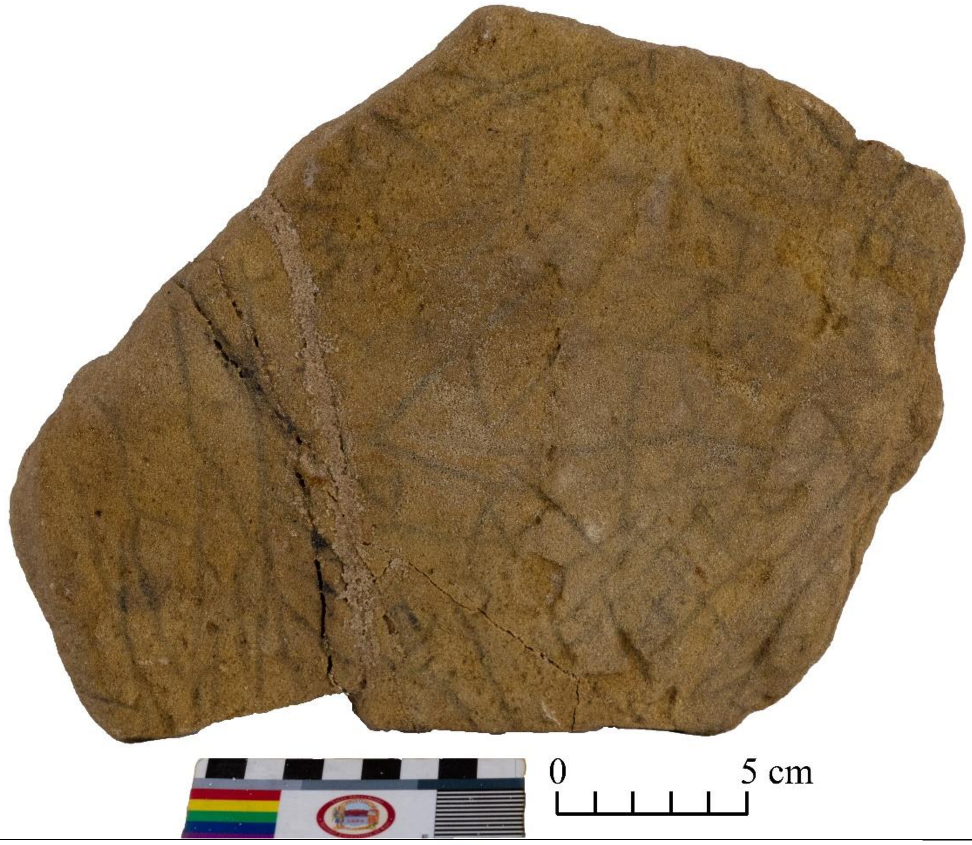


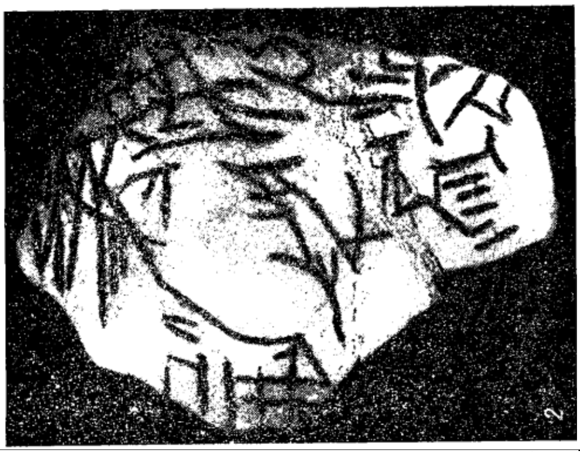


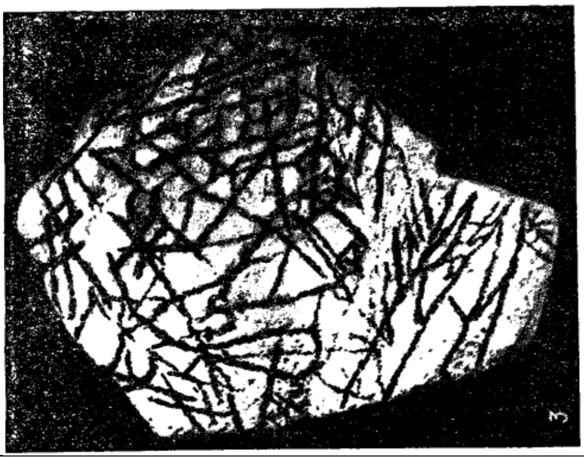





3.41 mm
0.366 m
3.51 mm
0.63 mm
6.09 mm
0.911 mm
5.55 mm
0.999 mm

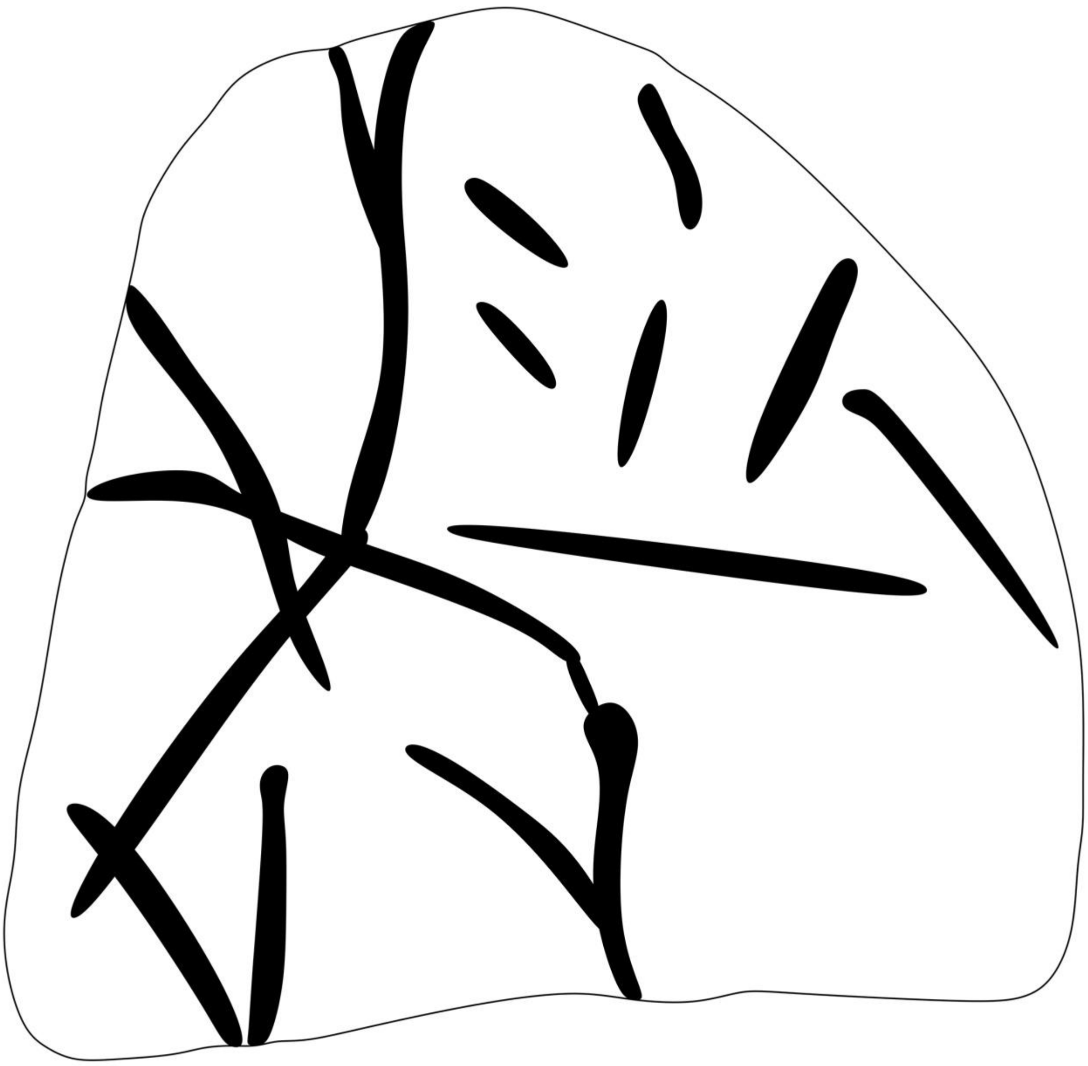
Specimen’s ID	KM 74—5
Image front	
Image back	
Length, cm	29
Width, cm	22
Weight, g	1788
Date of discovery	1974
Finder	V. Danilenko

Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The block with the image of mammoth, wounded with darts from both sides.
Description source	Danilenko 1986: 106—107
Description 2	A falling mammoth covers almost two-thirds of the front side with its head turned back. The head is pictured in two movements: the first line almost does not differ from the line that illustrates the back. Therefore the ancient artist reprocessed the head with a curved line and ended up with an impressive trunk. A front leg and stomach are pictured schematically. A hunt was not done with impunity — a schematically flattened anthropomorphic figure is lying near the mammoth’s head. A method of the mammoth’s murdering is also pictured. Below, from the stomach side, 40 short lines are placed. They are interpreted as wooden sticks that prevent the mammoth from breakout. A wooden fence made of branches shaped like a lattice is located beside the mammoth’s figure. It is evident at the same time that the fallen mammoth was killed by darts and spears, introduced as eight lines in the head of the animal. The back side of the block contains a complex composition without a clear meaning. All this side is covered with linear and geometric engravings. Meanwhile, accurate analysis of the composition provides an opportunity for its interpretation. Placing the block’s narrow side up, one can see a subtriangular figure in its lower part. This is probably a tent-like construction. The inner part contains a sitting creature, probably picturing a cave lion. A tent and a lion are popular motifs in the rock art of Kamyana Mohyla.
Descriptive image	
Descriptive image 2	

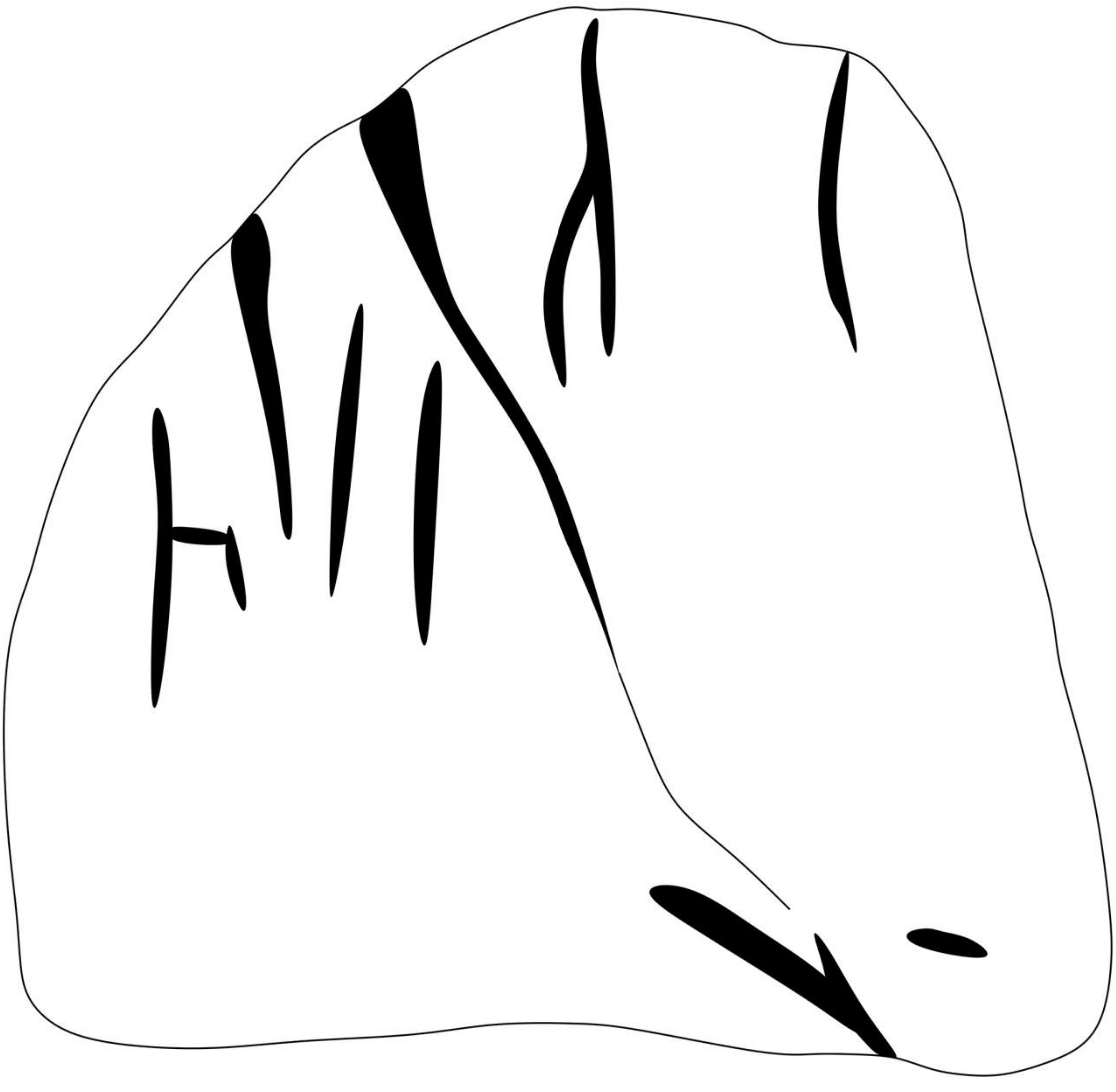
Descriptive image 3	
Note	The block was broken in two parts and then glued by V. Danilenko after 1974.

Specimen's ID	KM74—6
Image front	
Image back	
Length, cm	9
Width, cm	8
Weight, g	238
Volume, m^3	0.000121
Density, kg / m^3	1966.94215
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to both his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings that rarely cross each other. The incisions might be either anthropogenic or natural. No clear motifs or signs were presented. The sequence drawing and the Harris matrix for this specimen are not informative, as there are no visible sequences.

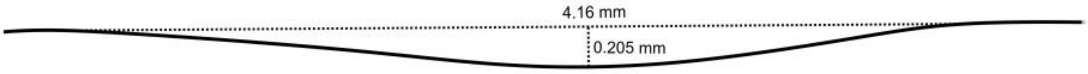
Technological drawing front

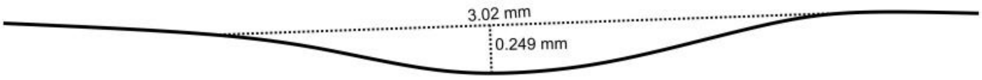


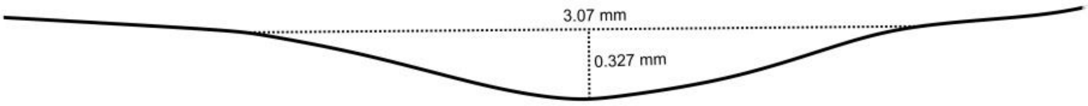
Technological drawing back

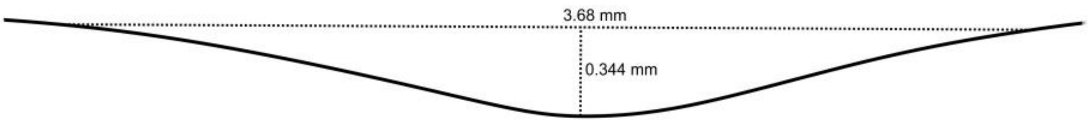


Profiles list

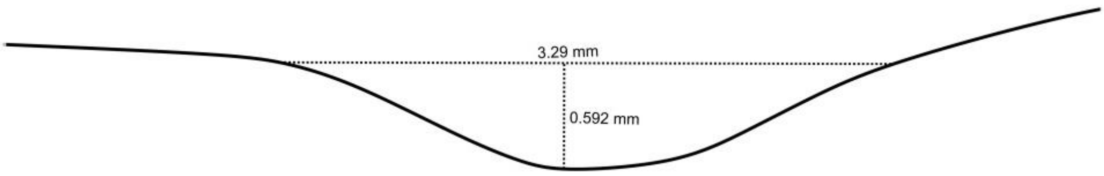


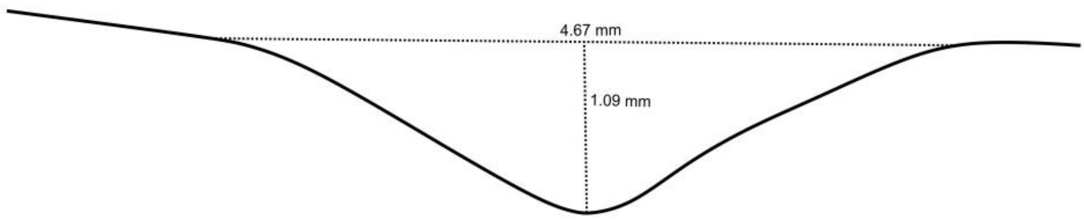






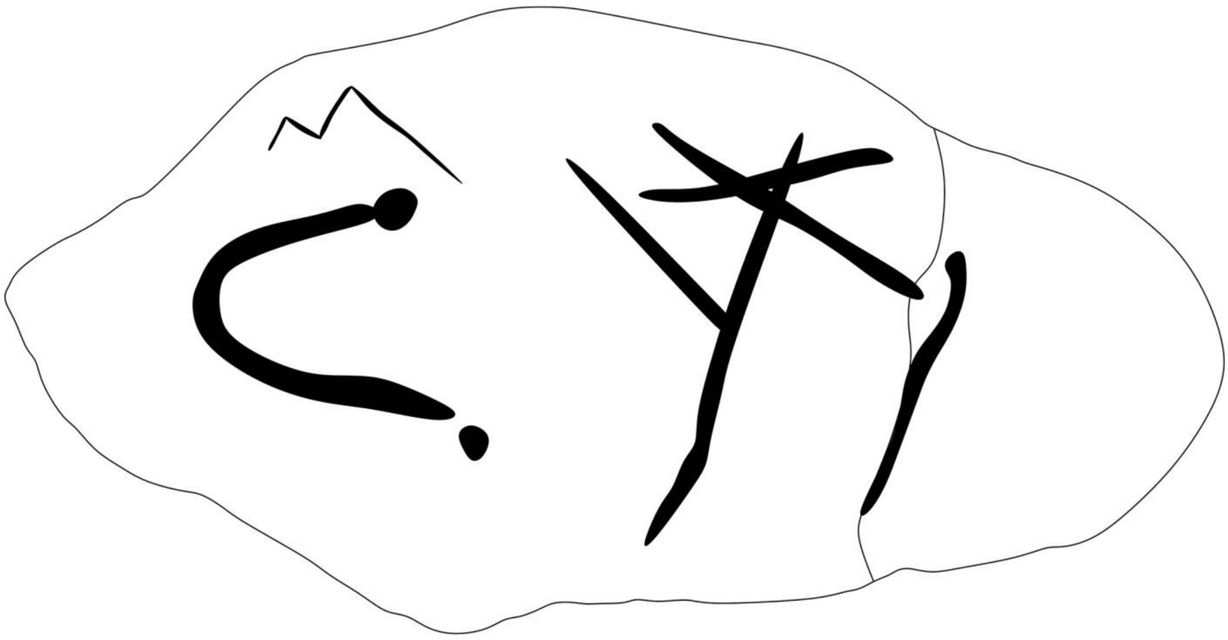

6.88 mm
0.669 mm


3.29 mm
0.592 mm

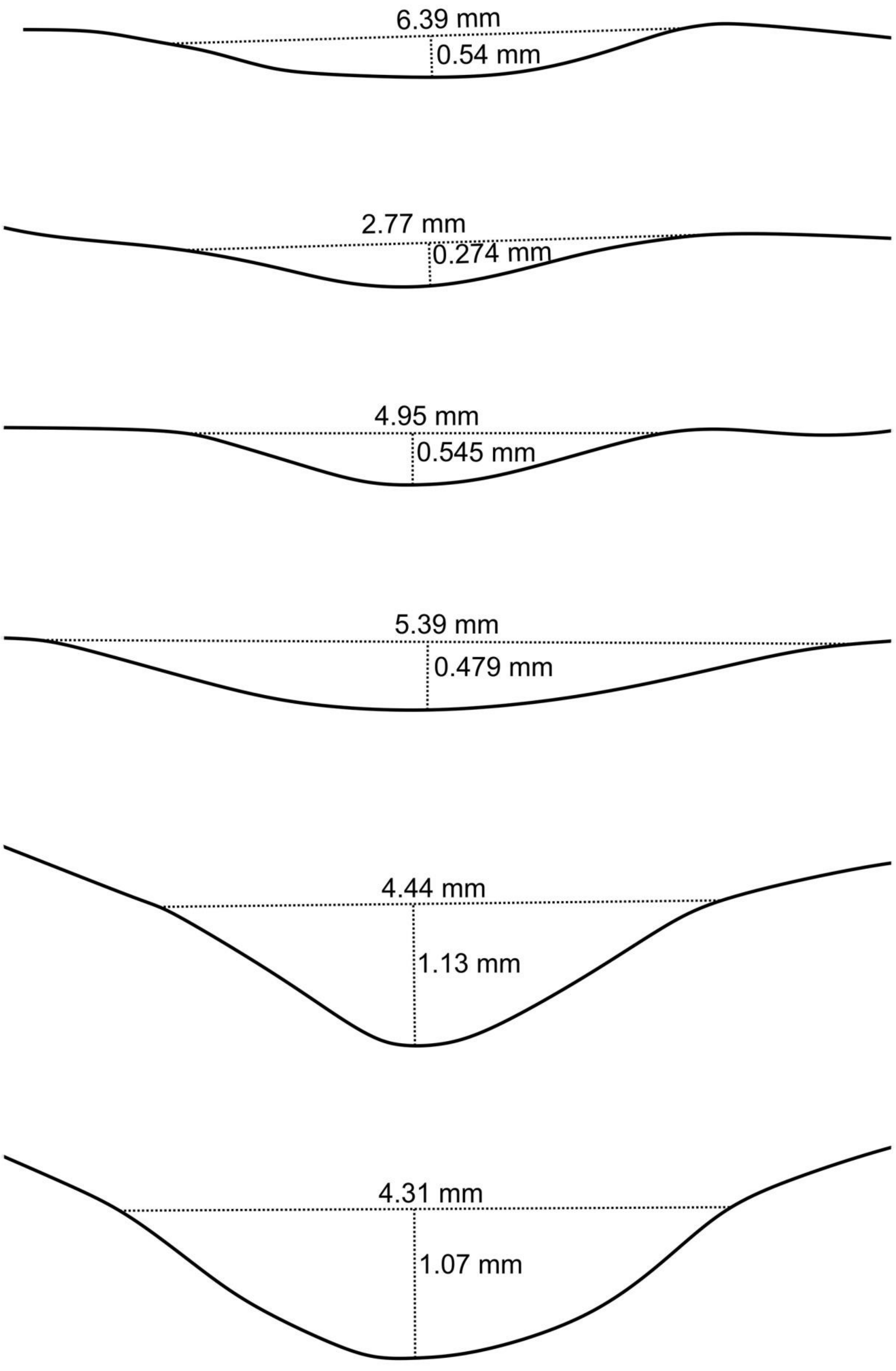

4.67 mm
1.09 mm

Specimen’s ID	KM74—7
Image front	
Image back	
Length, cm	15
Width, cm	7
Weight, g	275
Volume, m^3	0.000144
Density, kg / m^3	1909.72222
Date of discovery	1974
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings. Though they cross each other, the sequence of their creation remains unclear. Two pairs of shallow and barely visible parallel lines create a zigzag in the upper part of the specimen. Right under this, a small cup mark is located. The back side of the instance has been polished to create the right angle. The sequence drawing and the Harris matrix for this specimen are not informative, as there are no visible sequences.

Technological drawing front



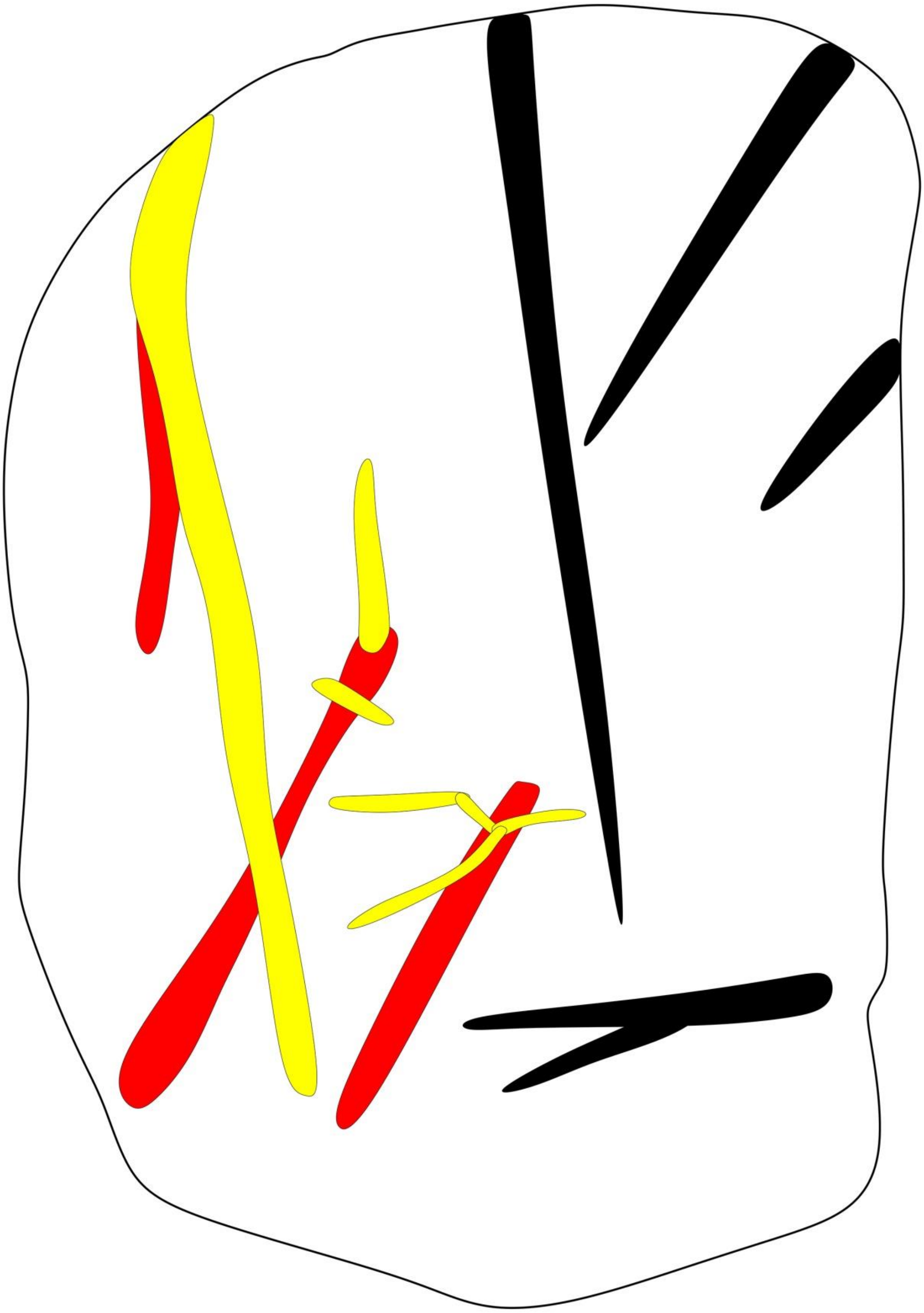
Profiles list



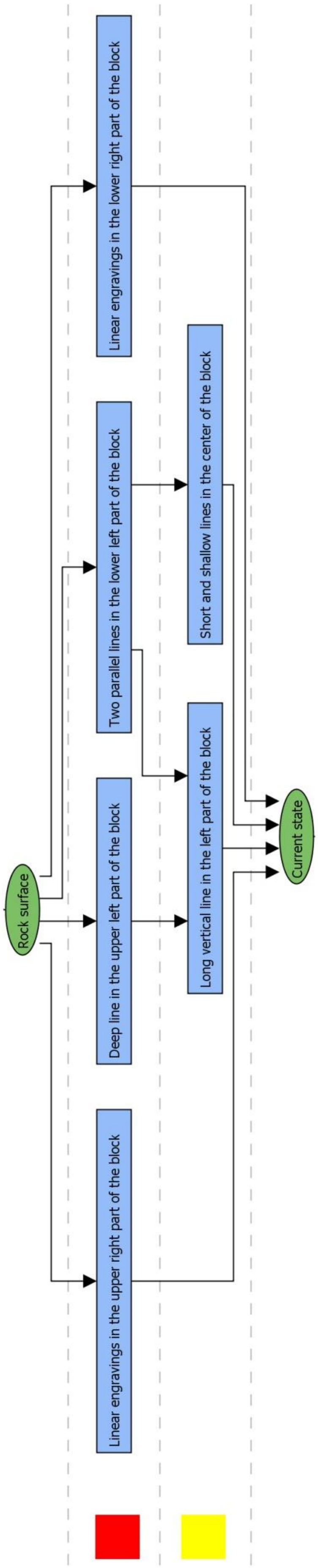
Specimen’s ID	KM74—8
Image front	
Image back	
Length, cm	8.5
Width, cm	5
Weight, g	170
Volume, m^3	0.000087
Density, kg / m^3	1954.02299
Date of discovery	1974
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings. The front and back side of a rectangular block has been polished to a flat state.

Technological drawing front

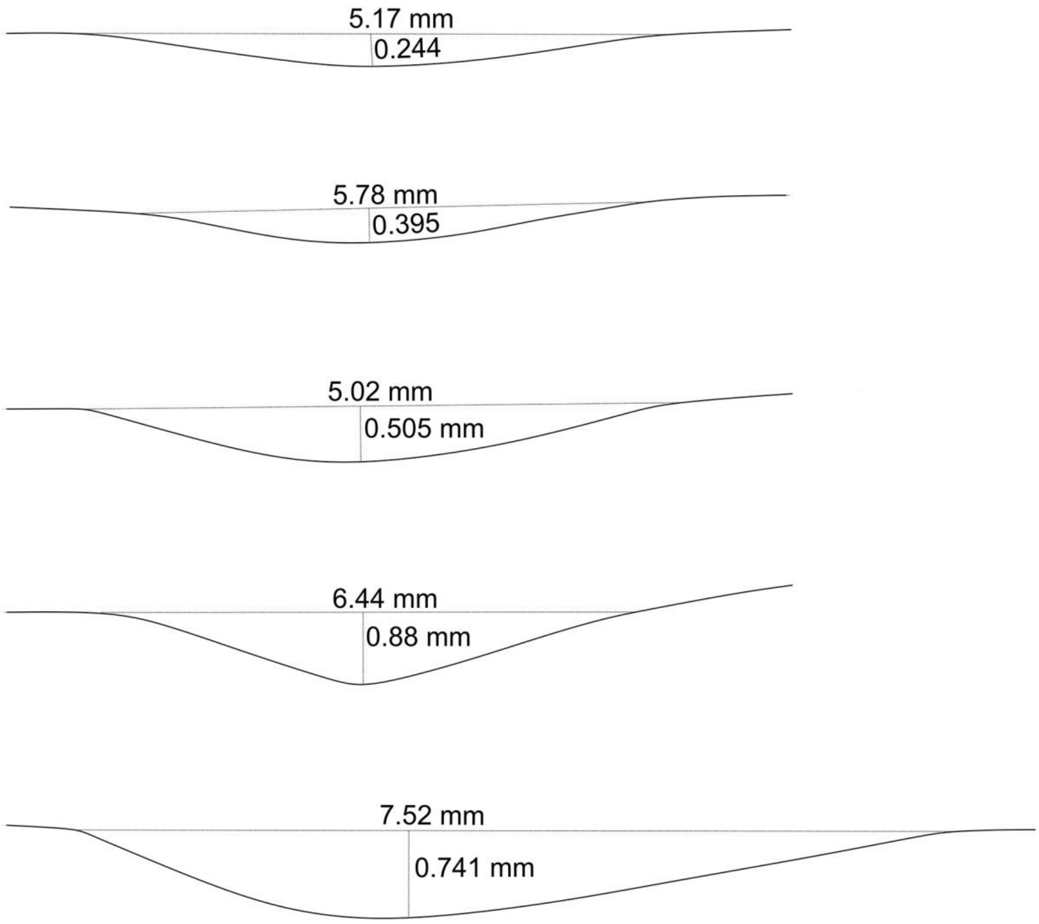
Relative chronology drawing front



Harris Matrix



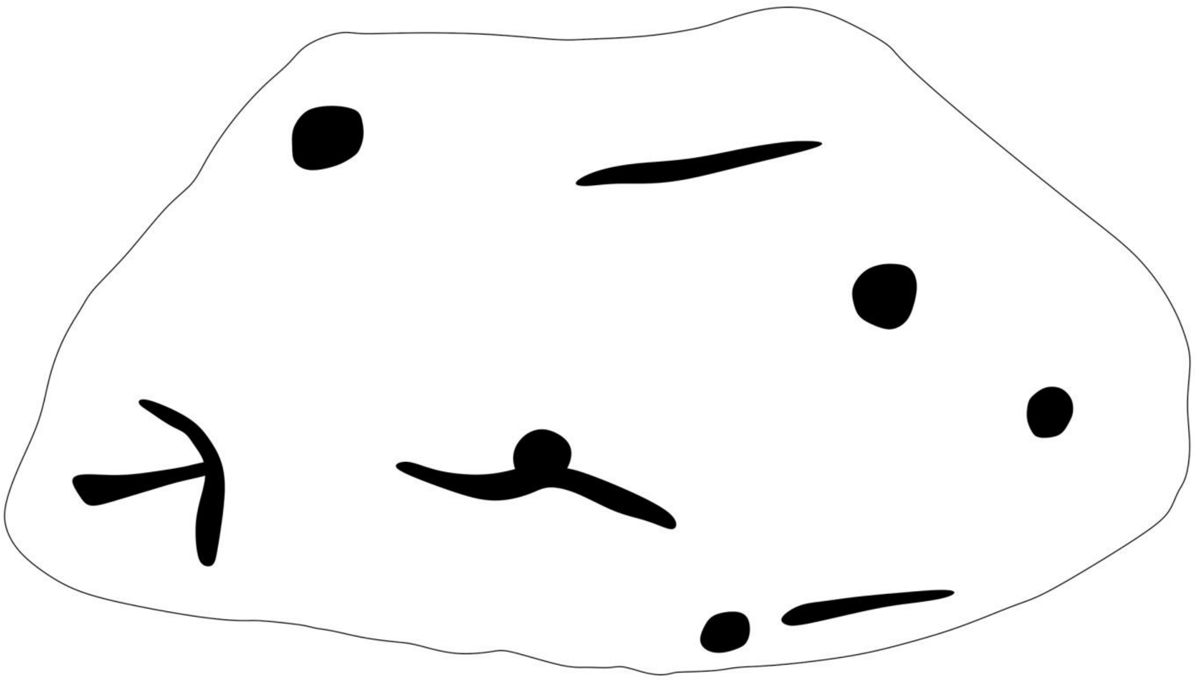
Profiles list



Specimen's ID	KM74—9
Image front	
Image back	
Length, cm	11
Width, cm	7
Weight, g	176
Volume, m^3	0.000091
Density, kg / m^3	1934.06593
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to both his paintings on the specimen and the 3D-mesh analysis, it contains a series of shallow linear engravings and small cupmarks. The analysis of the surface did not show any informative sequence, though some superimpositions are clear.

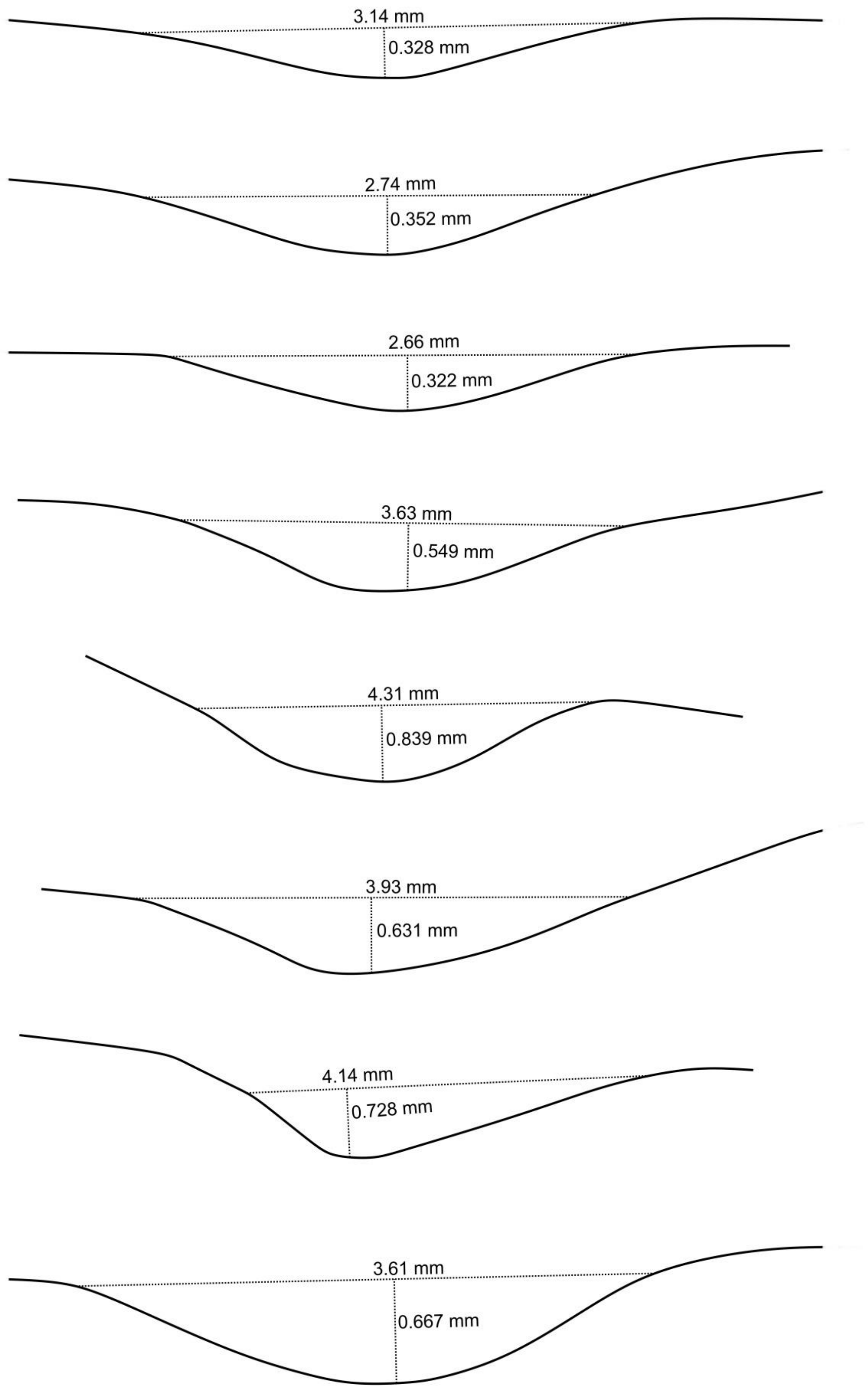
Technological drawing front

Technological drawing back

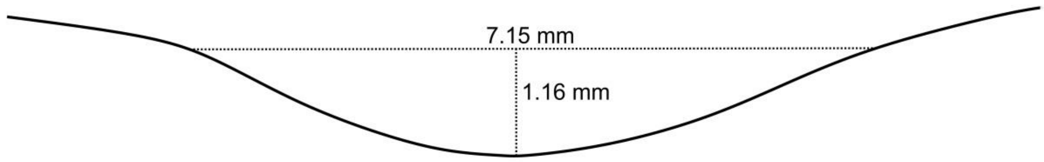


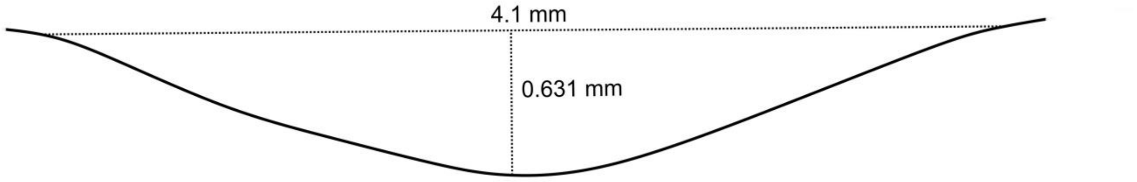
Relative chronology drawing front

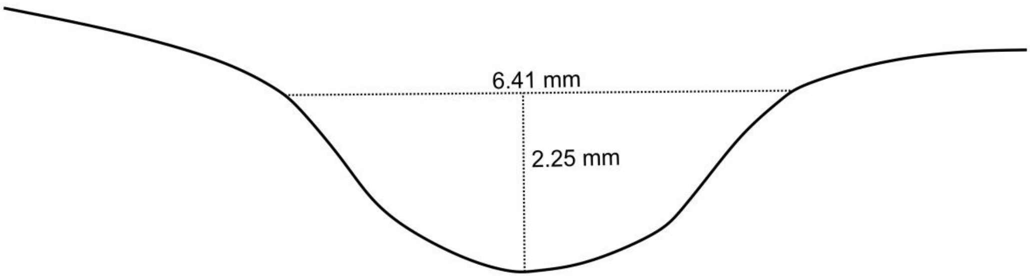
Profiles list

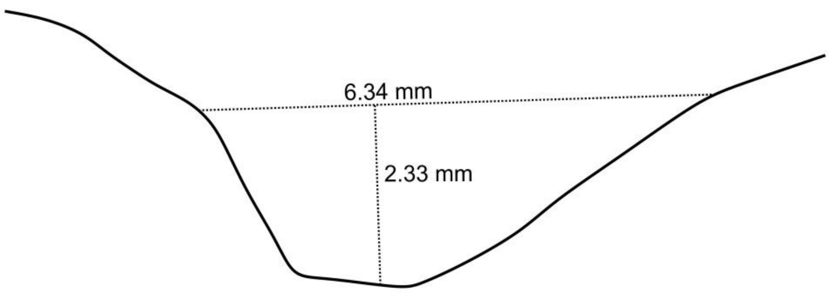


Cupmarks profiles list





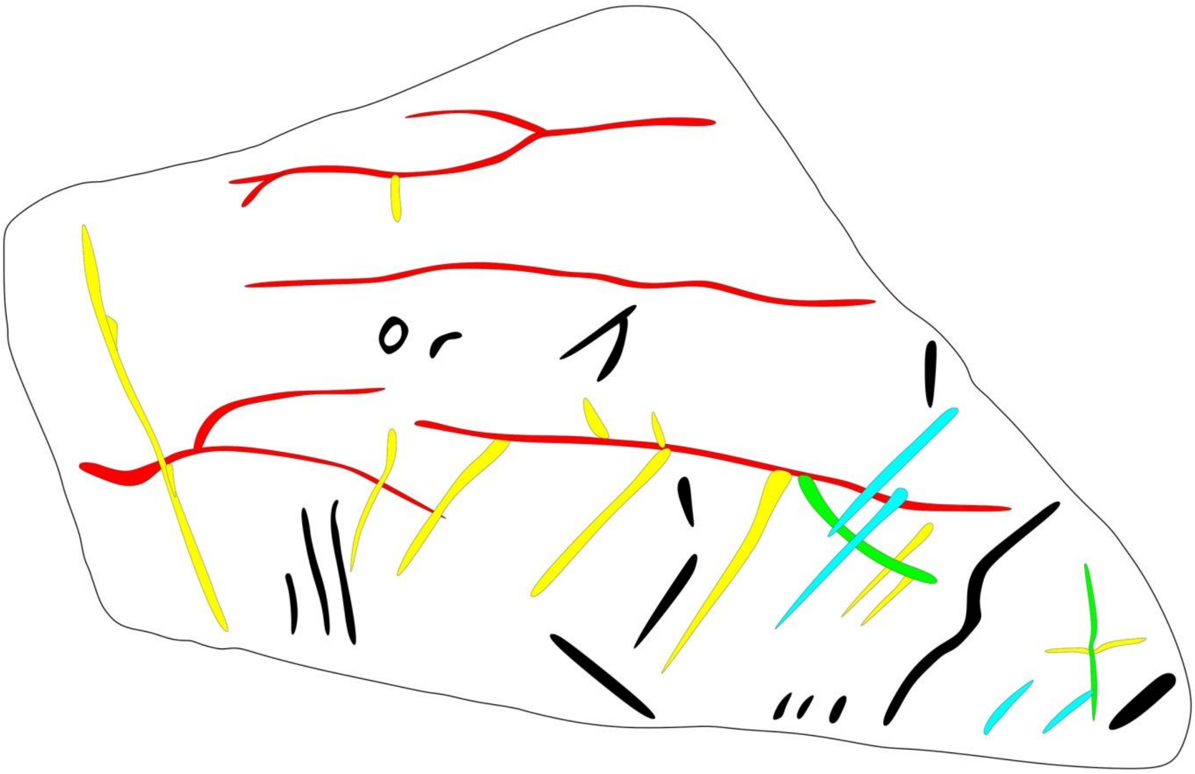




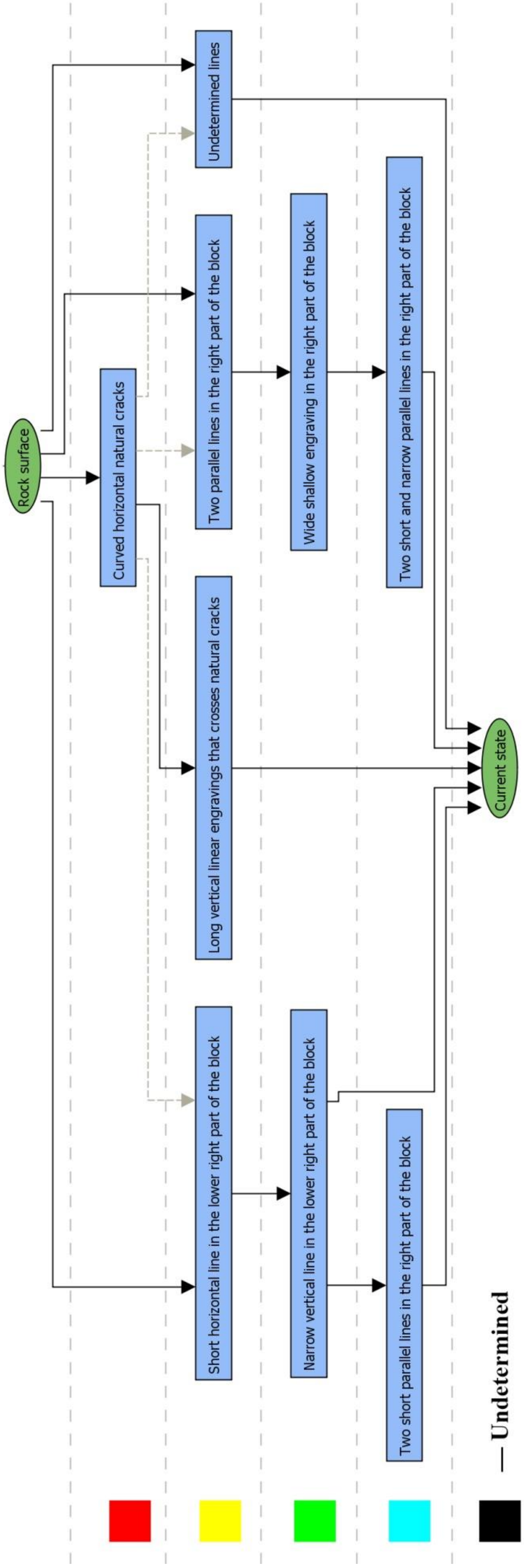
Specimen's ID	KM74—11
Image front	
Image back	
Length, cm	35
Width, cm	20
Weight, g	5800
Volume, m^3	0.002366
Density, kg / m^3	2451.39476
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to both his paintings on the specimen and the 3D-mesh analysis, it contains a series of shallow linear engravings. A huge block has been polished to create the right angles. The front and back sides of the block are flat; the front is covered with desert varnish, while the back is not. The density of white sandstone appears to be higher than the red one.

Technological drawing front

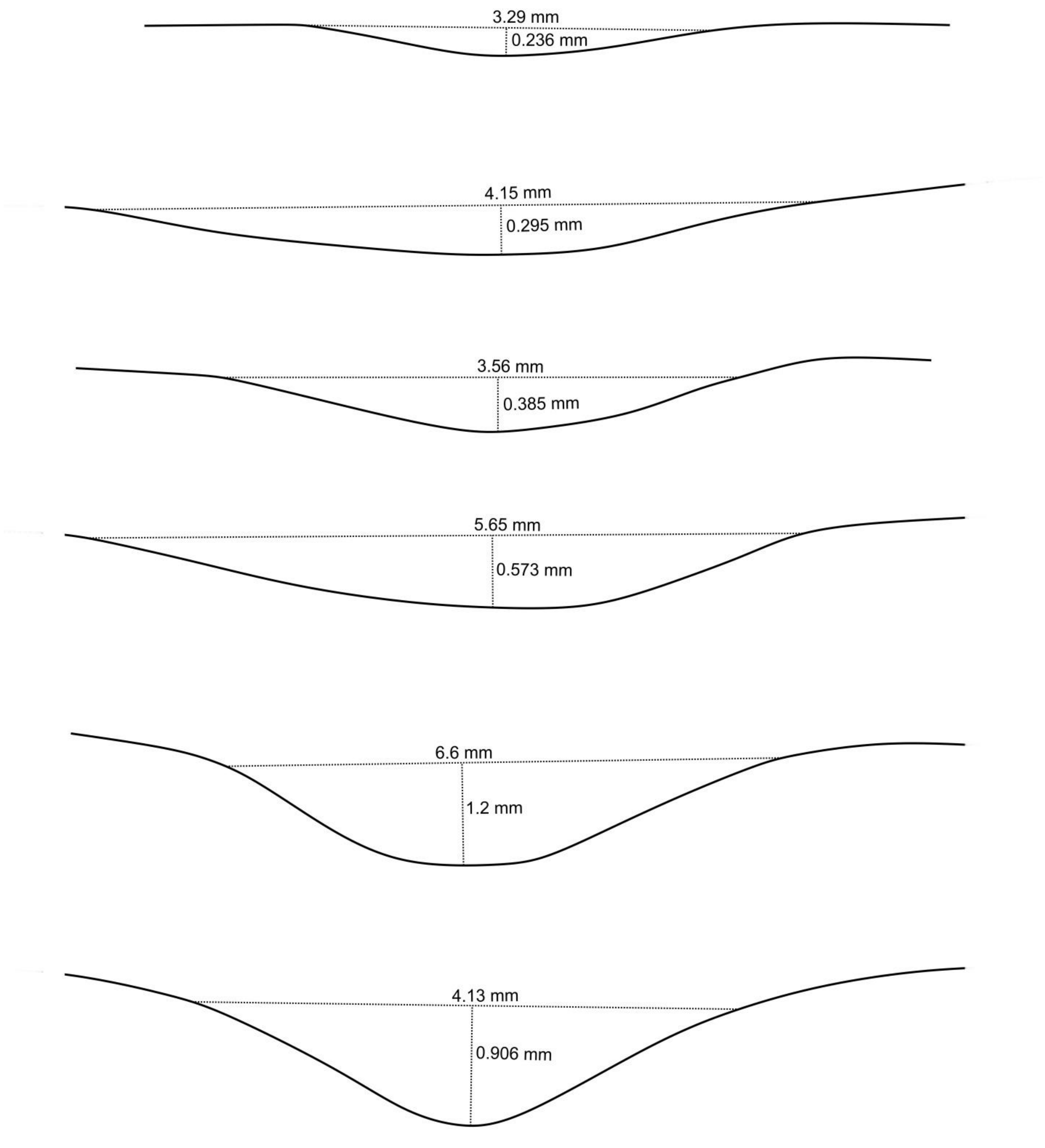
Relative chronology drawing front



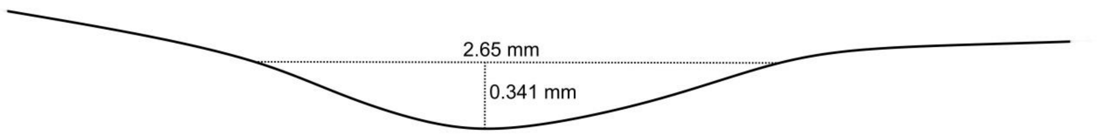
Harris matrix

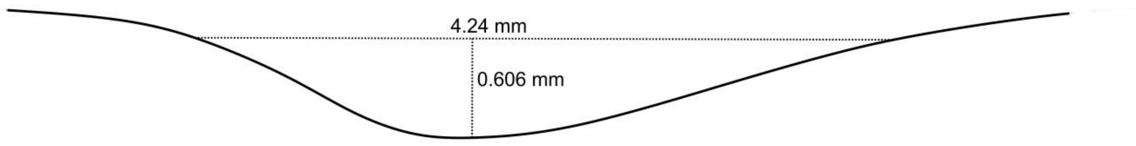


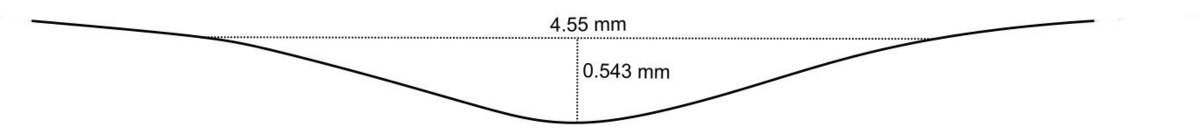
Profiles list

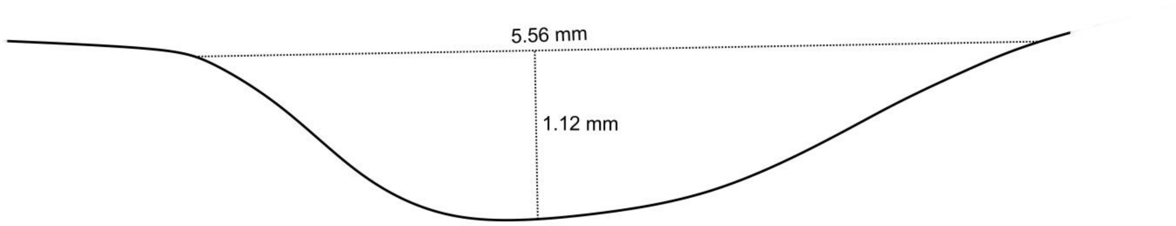


Cupmarks profiles list









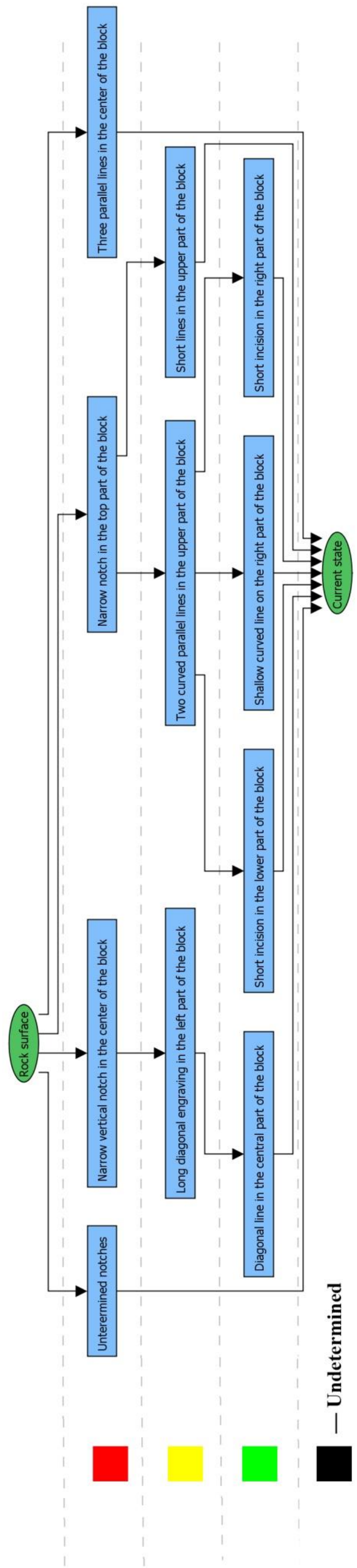
Specimen's ID	KM74—13
Image front	
Image back	
Length, cm	17
Width, cm	13
Weight, g	864
Volume, m^3	0.000451
Density, kg / m^3	1915.74279
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	The block of the specific importance from the deciphering point of view. The one-sided image survived entirely. The horned figure occupies the whole right part of the block, hands down. The figure stays. Probably it has the tail. Under its head, the back part of an

	animal is engraved. The animal's back continues further left and almost crosses the upper part of the block. The unique feature of the anthropomorphic figure is its obesity, which might signify that this is a female. Left from the figure, in the middle of the block, another figure, a thick one (probably a man) depicted. Its left leg is bent and turned right, the same as the face. This marks the movement to the right, where the woman is located. This symbolically means the alliance of the man and the woman. There is a complex geometric figure between the man and the woman, probably the hut. The left part of the block is occupied with several linear engravings of unclear meaning. This composition is linked with the figures of the horned dancers, incised in the right part of the Wizard's cave. This similarity caused the idea of the synchronism between the blocks and rock art instances.
Description source	Danilenko 1986: 95—96.
Drawing by Danilenko (1986, fig. 44)	
Note	The block is coded as "KM74—13" and published (probably, accidentally) as "KM74—10". The number of engravings evident on the rock art specimen surface is much lower than V. Danilenko describes. Some of the lines introduce parallel engravings. The surface is not flat, probably damaged. The specimen was broken into two parts and then glued after 1974.

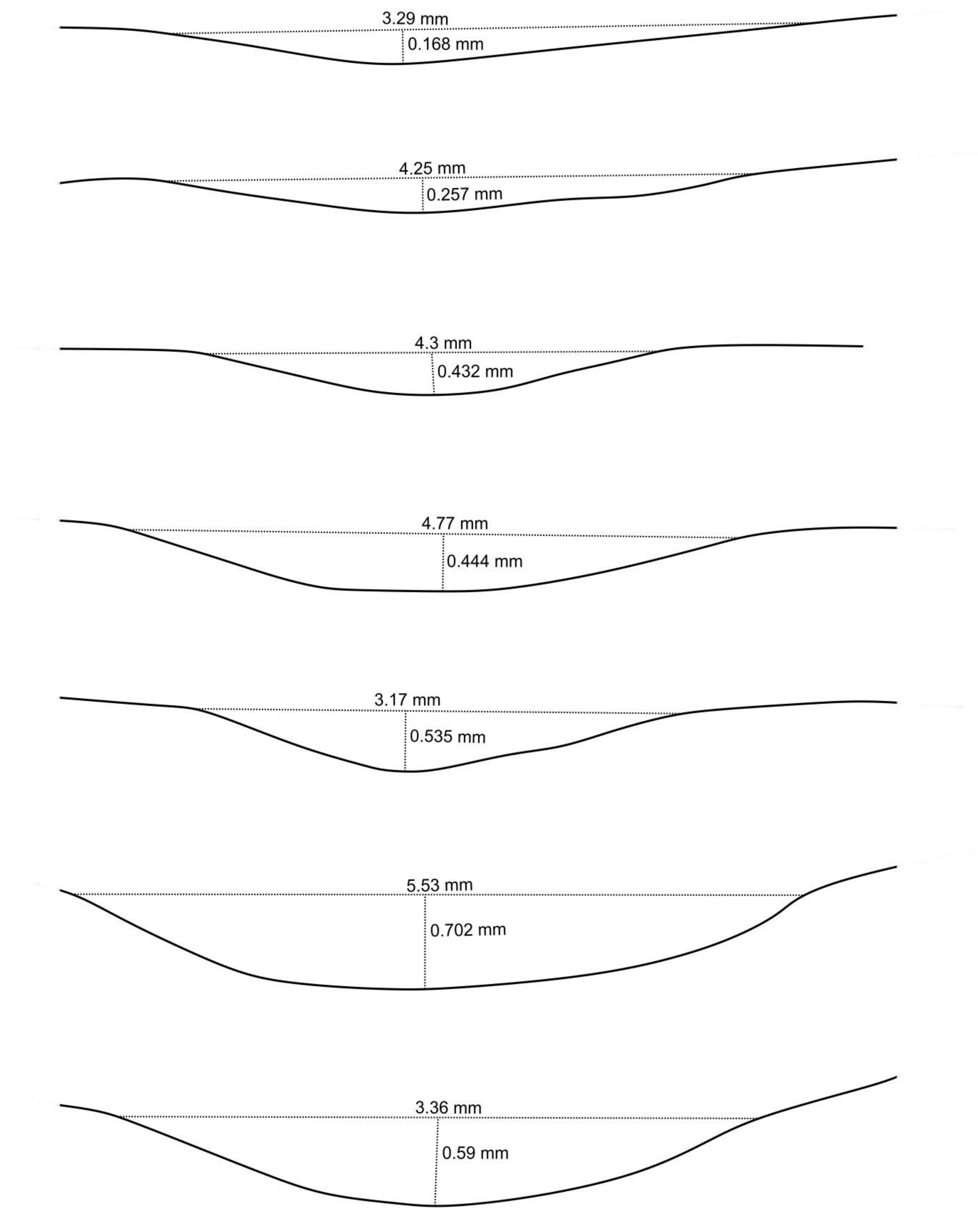
Technological drawing front

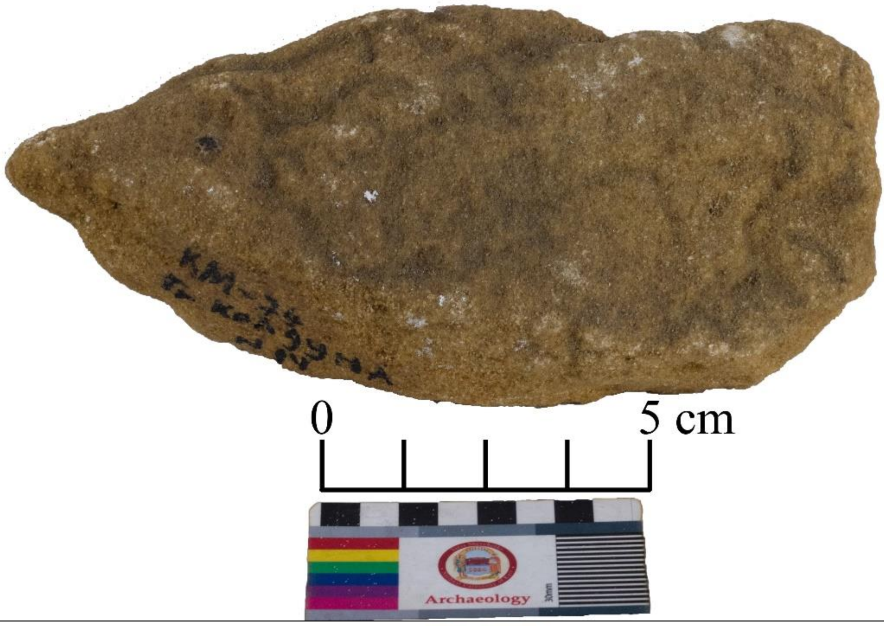
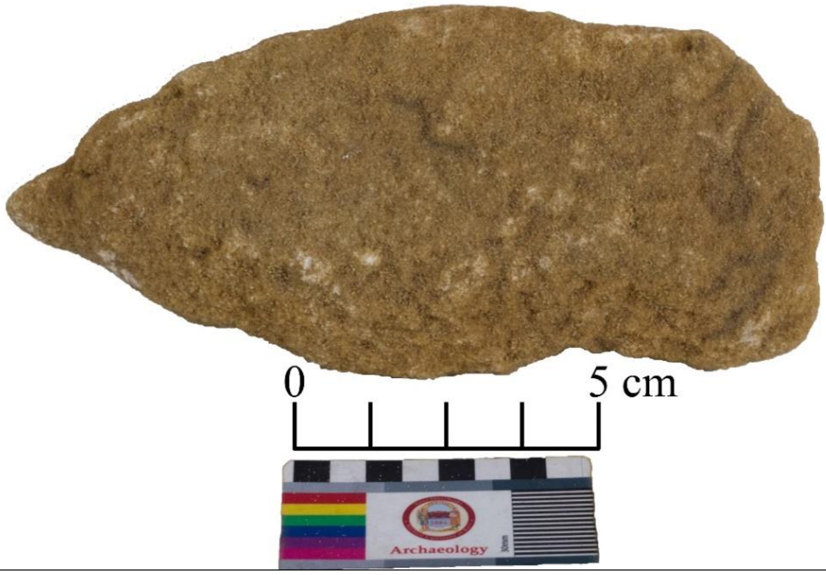
Relative chronology drawing front

Harris matrix



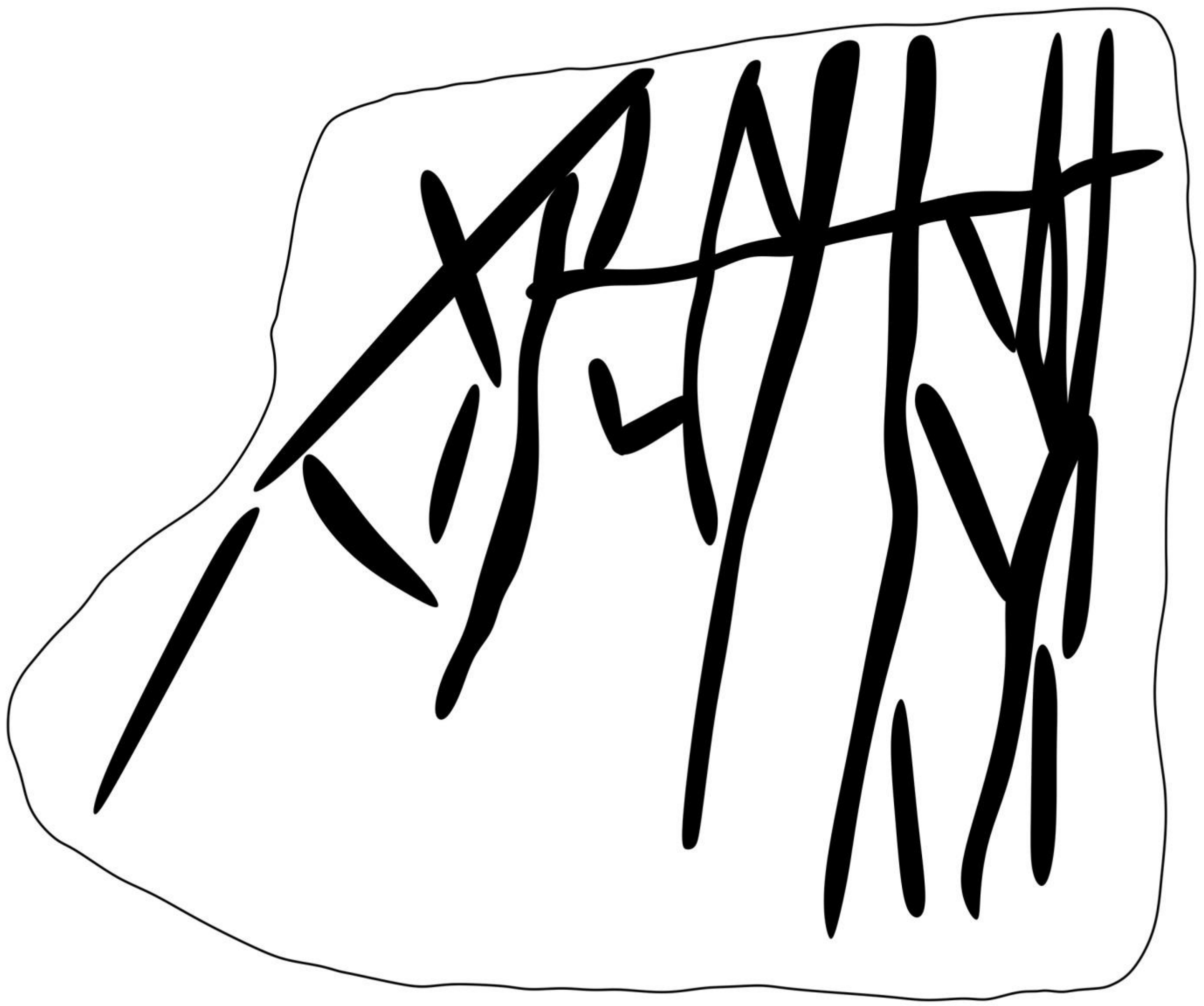
Profiles list



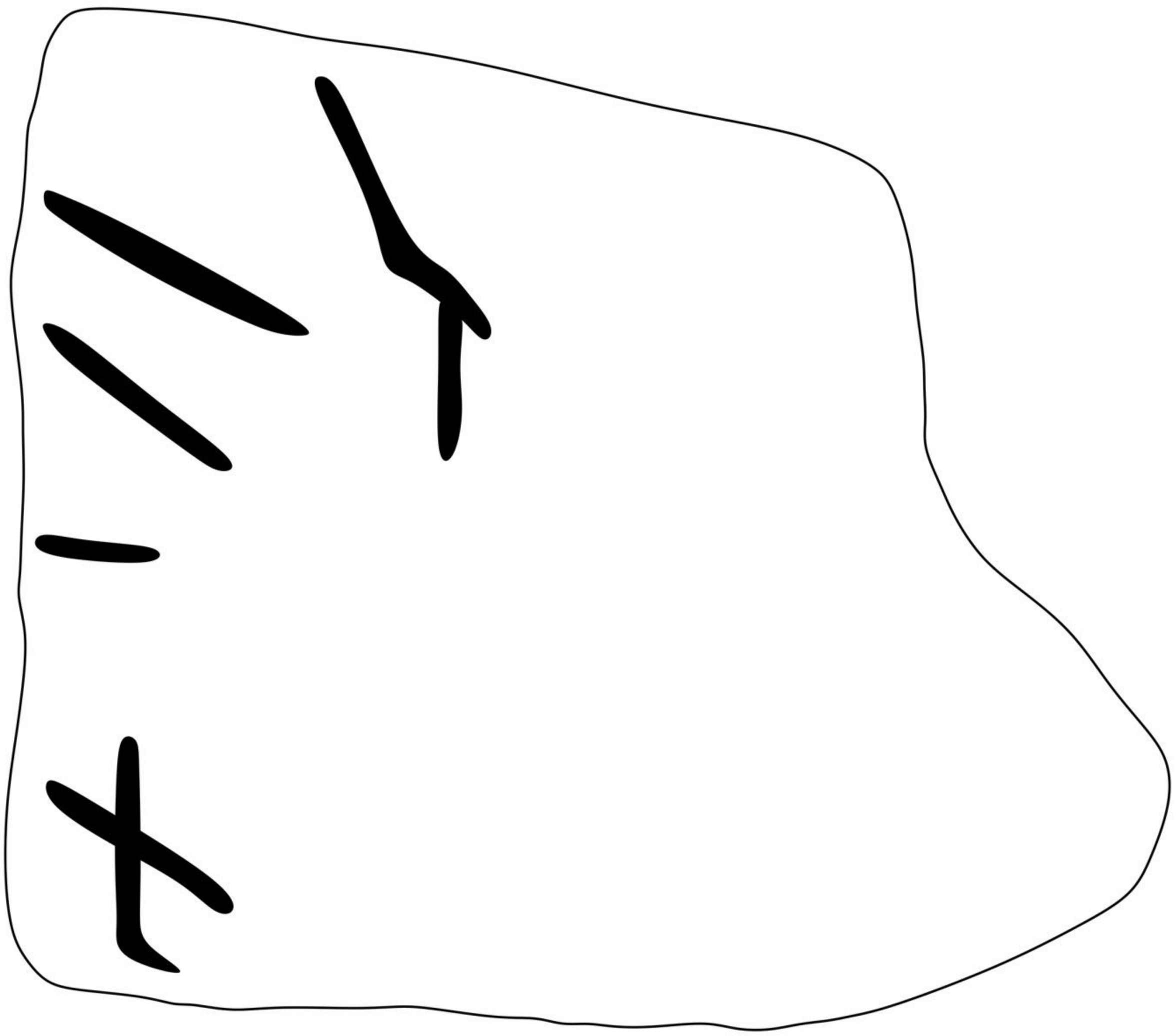
Specimen's ID	KM 74—14
Image front	
Image back	
Length, cm	13
Width, cm	6
Weight, g	165
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	—

Specimen’s ID	KM74—15
Image front	
Image back	
Length, cm	10
Width, cm	9
Weight, g	289
Volume, m^3	0.000150
Density, kg / m^3	1926.66667
Date of discovery	1974
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to both his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings.

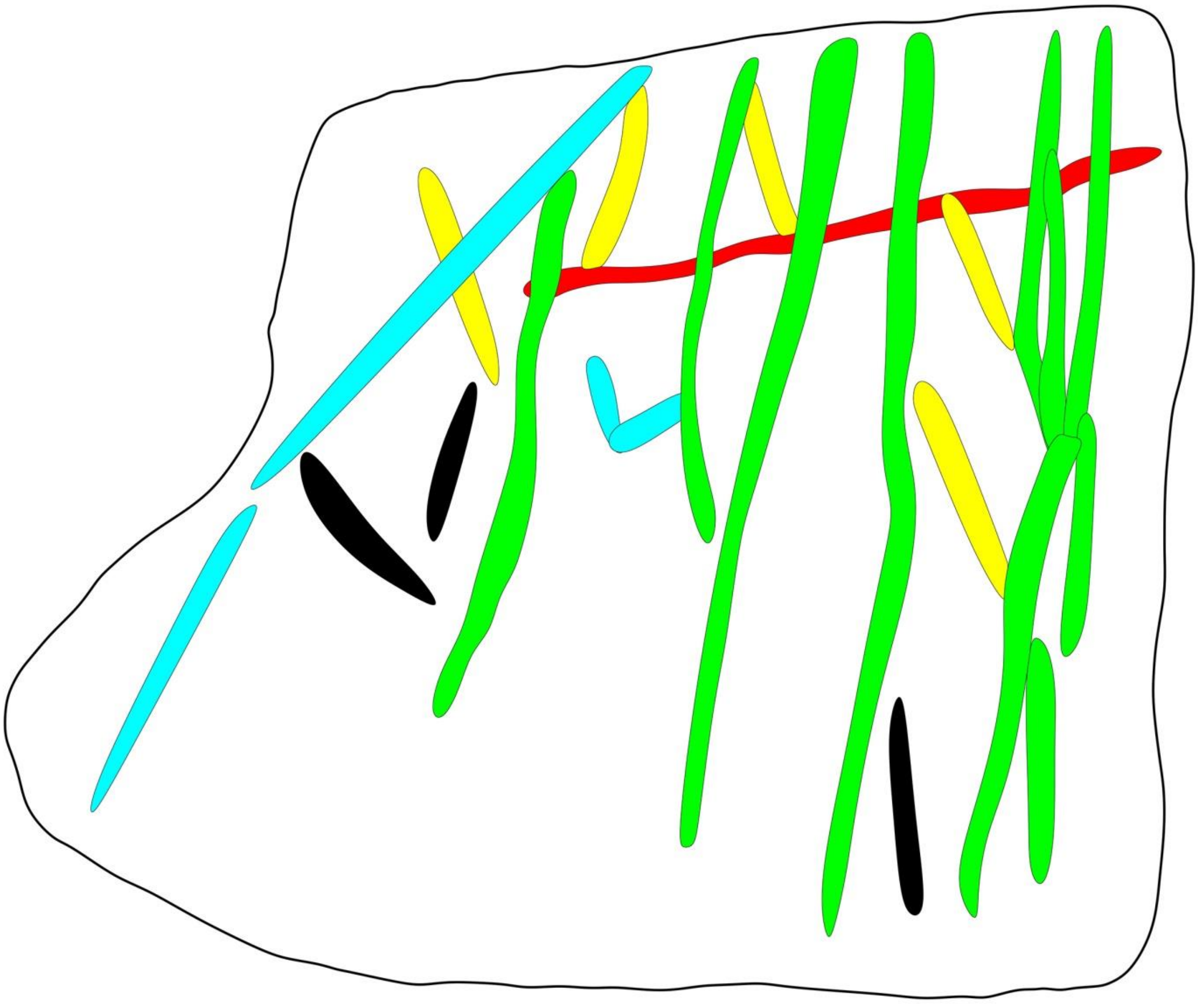
Technological drawing front



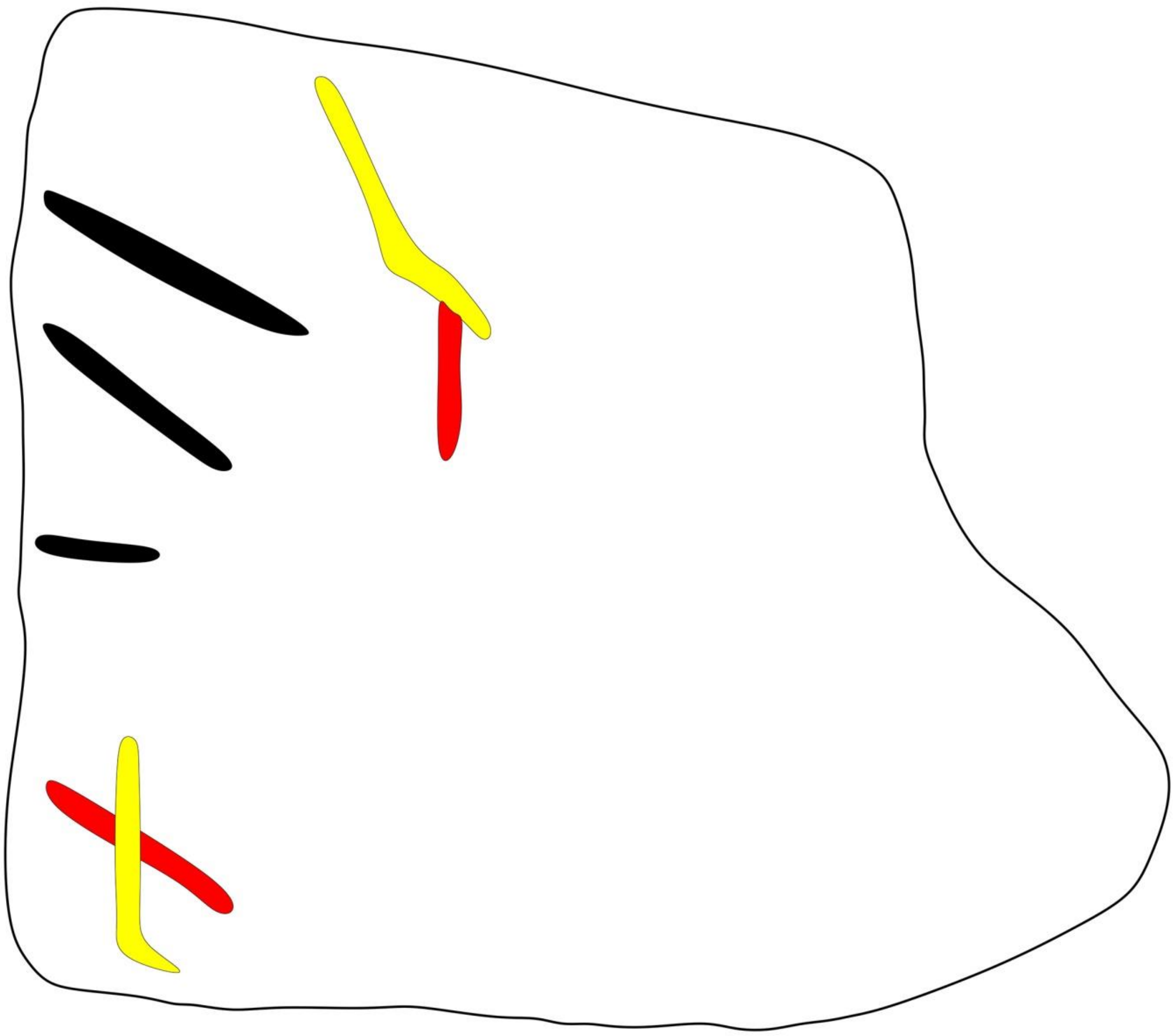
Technological drawing back



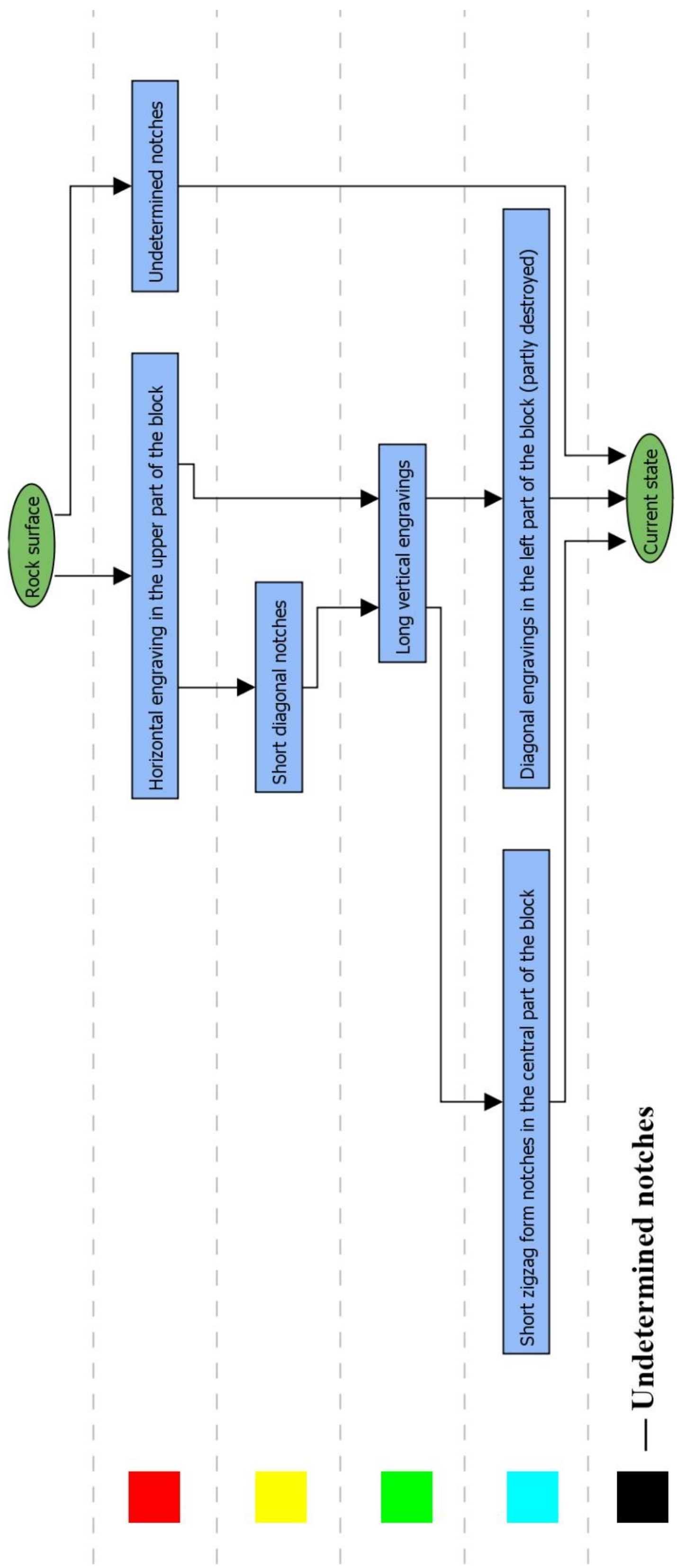
Relative chronology drawing front



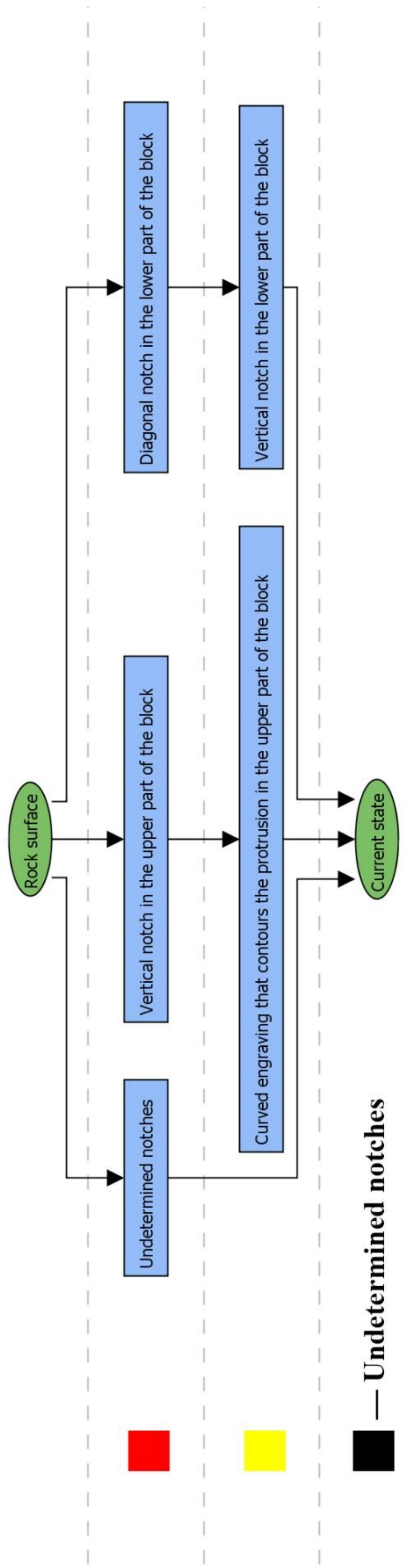
Relative chronology drawing back



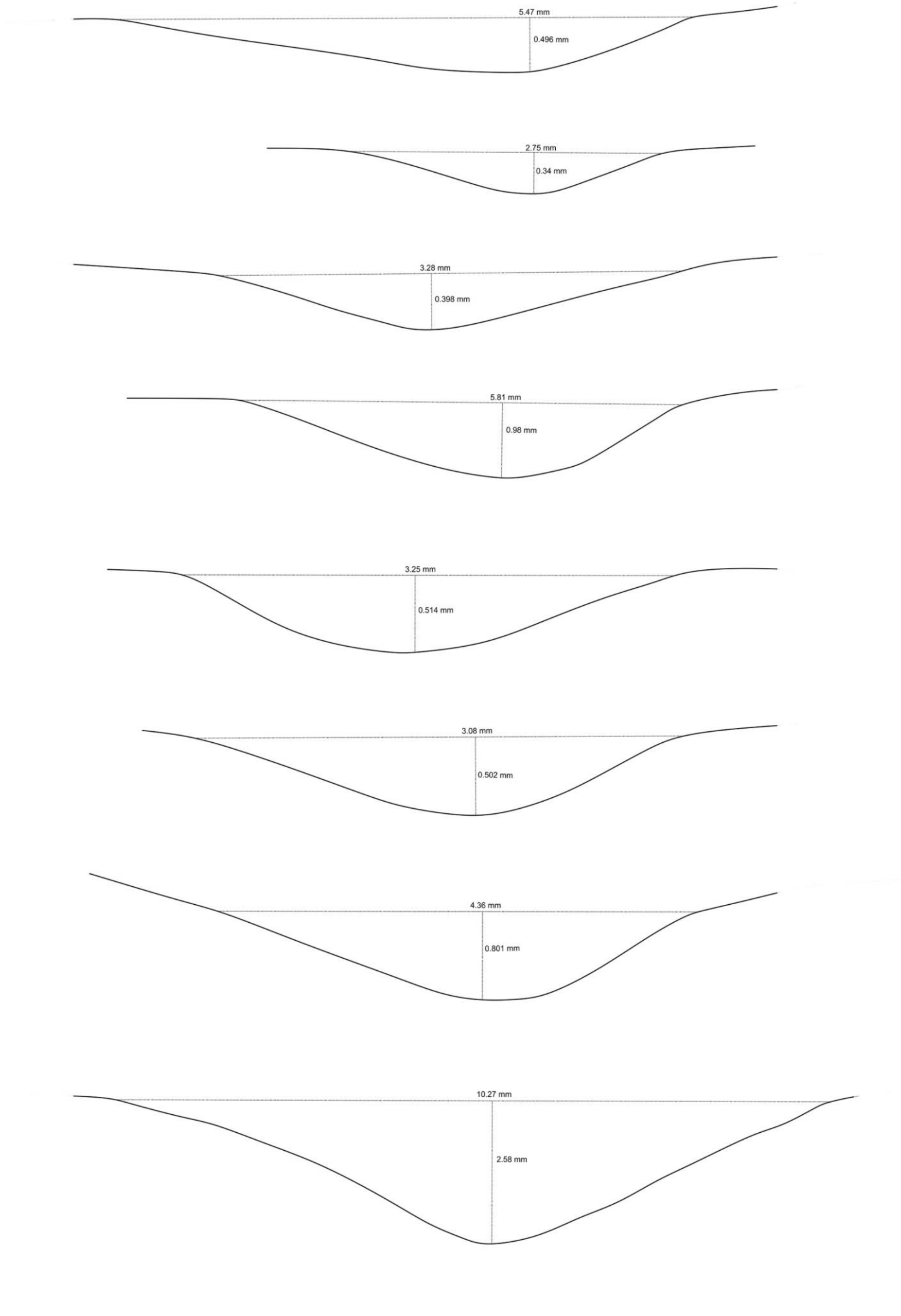
Harris matrix front



Harris matrix back



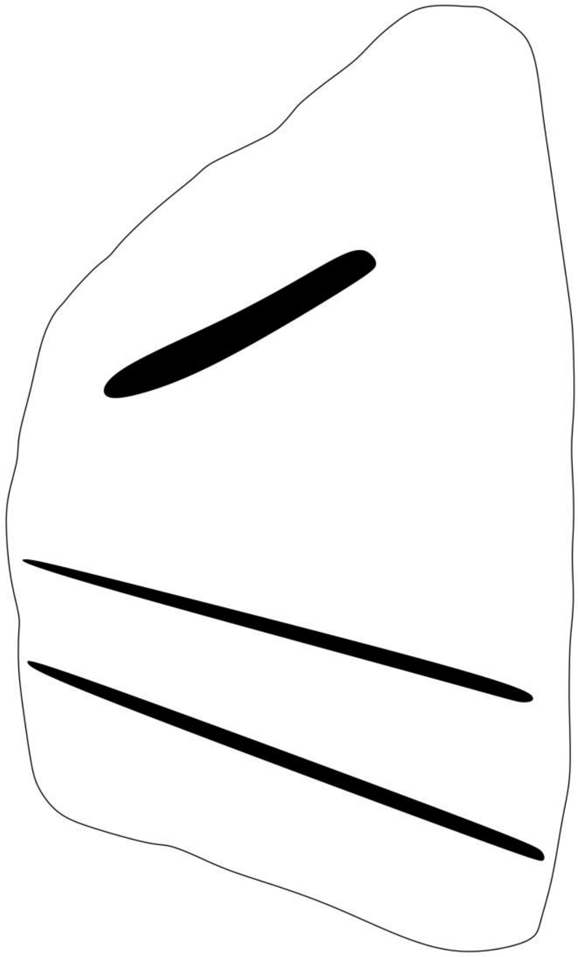
Profiles list



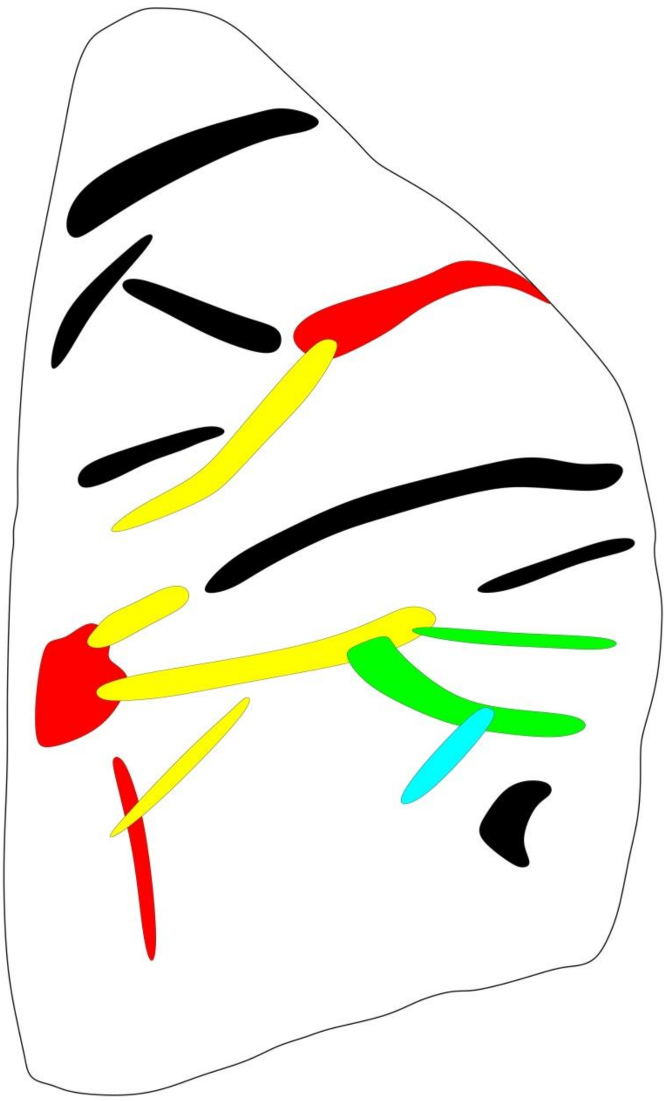
Specimen's ID	KM74—16
Image front	
Image back	
Length, cm	9
Width, cm	5.5
Weight, g	112
Volume, m^3	0.000057
Density, kg / m^3	1964.91228
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings. According to V. Danilenko, the specimen might be considered an anthropomorphic figure divided by horizontal notches in three sections. However, this is not evident and very debatable. The specimen is slightly polished to obtain its shape. There are a few linear engravings on its back side.

Technological drawing front

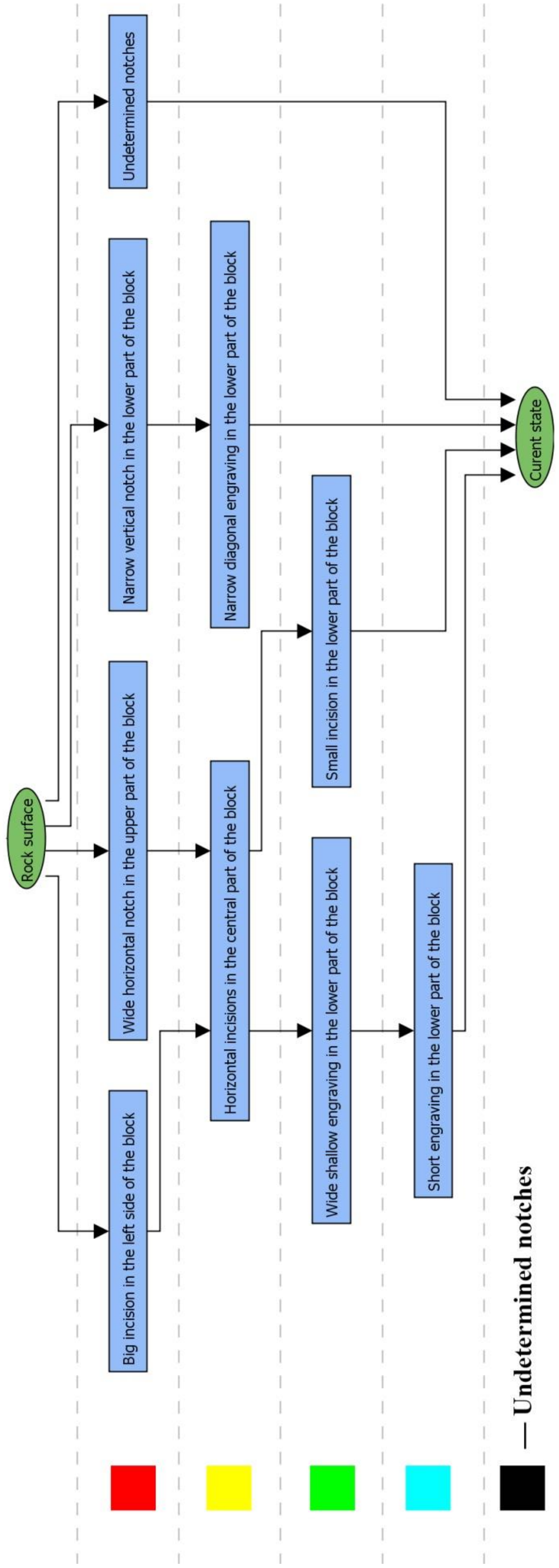
Technological drawing back



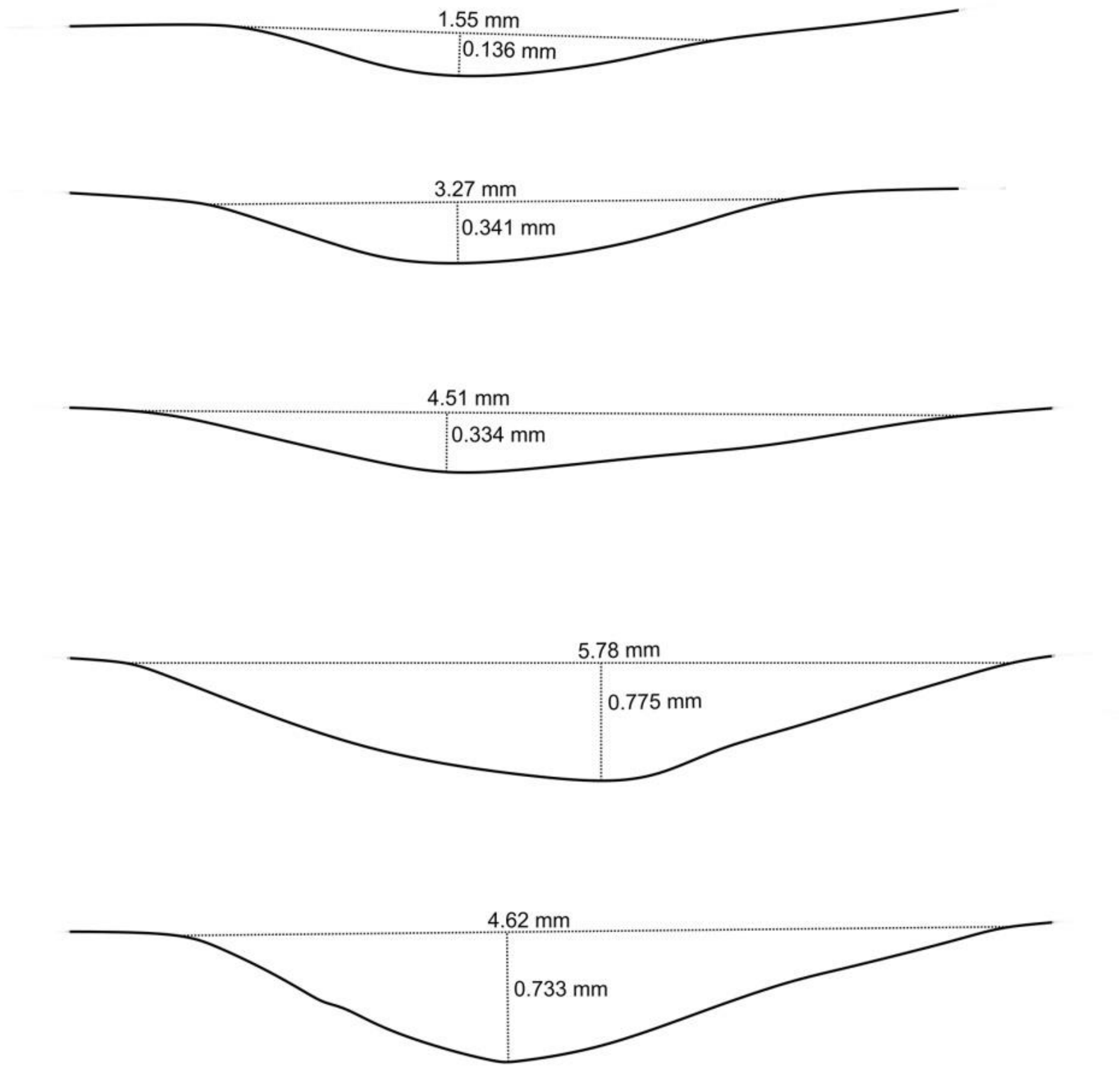
Relative chronology drawing front

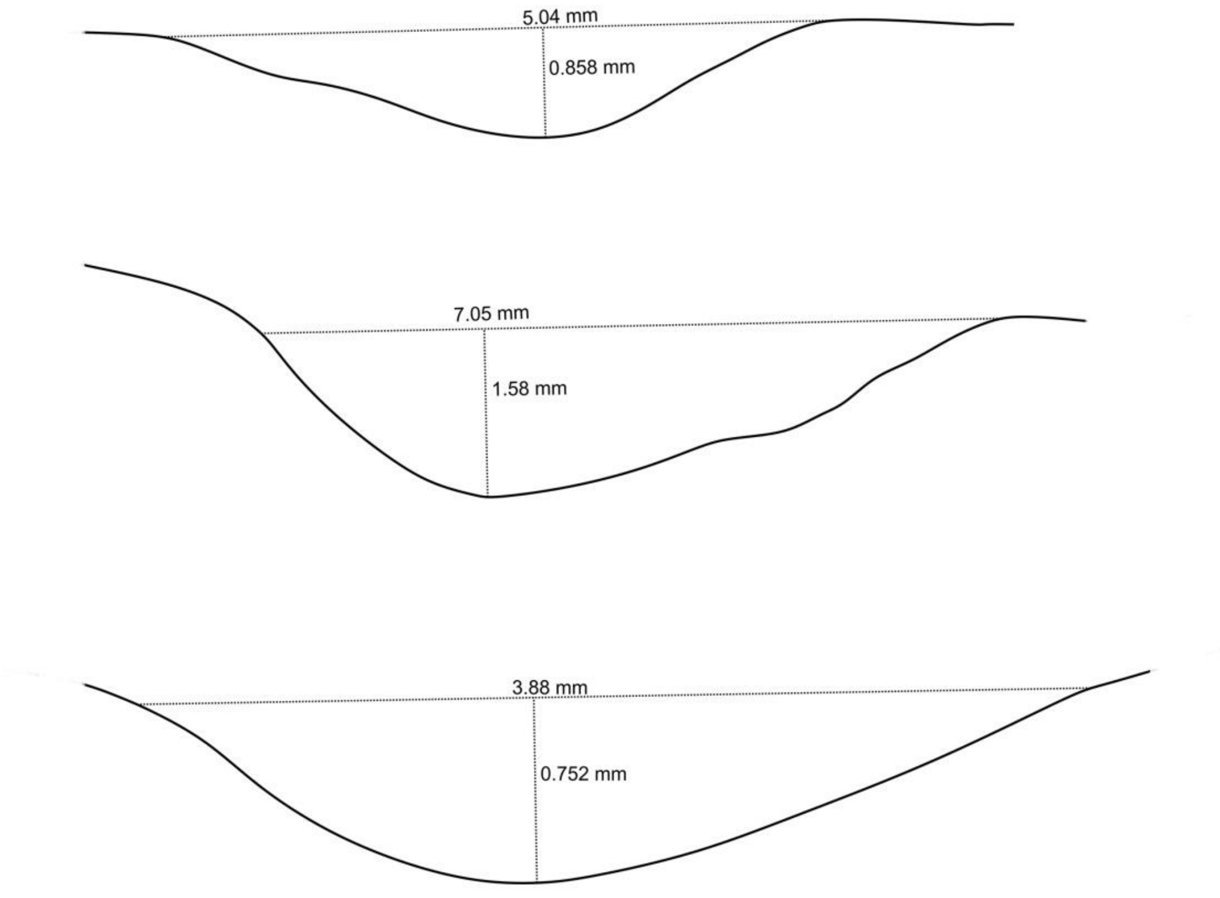


Harris matrix front



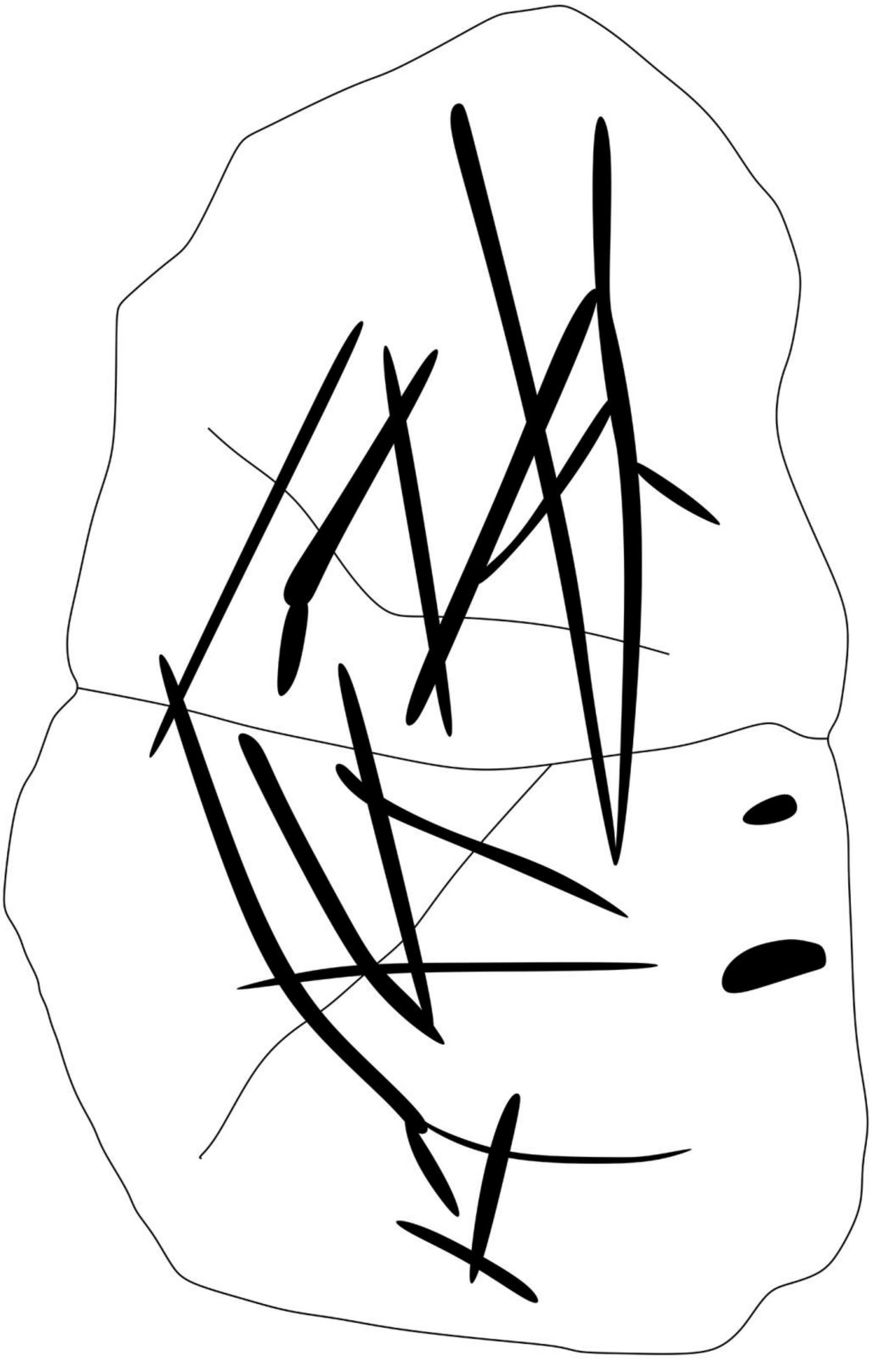
Profiles list



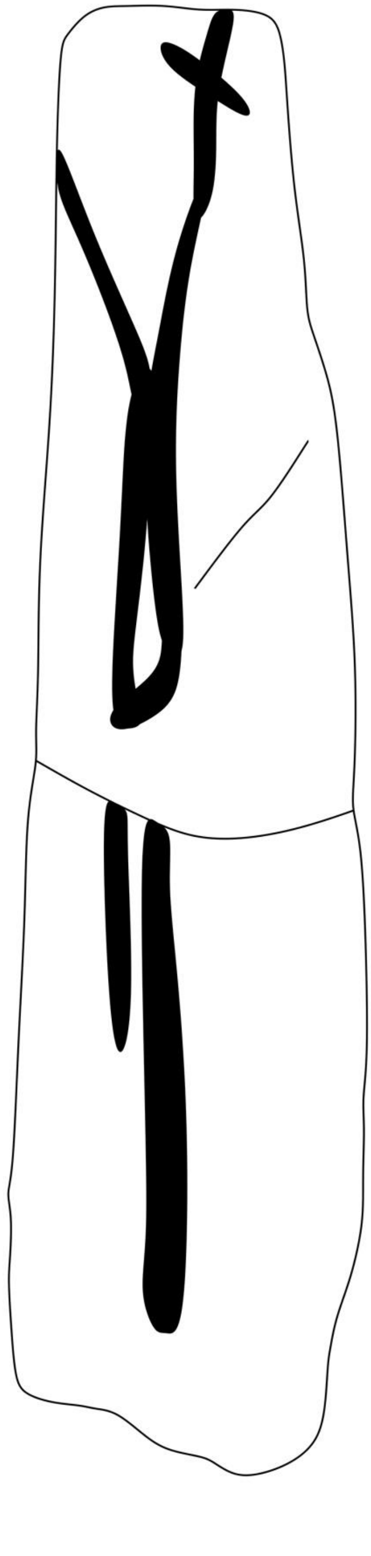

5.04 mm
0.858 mm
7.05 mm
1.58 mm
3.88 mm
0.752 mm

Specimen's ID	KM74—17
Image front	
Image side	
Image back	
Length, cm	20.4
Width, cm	17.6
Weight, g	1373
Volume, m^3	0.000667
Density, kg / m^3	2058.47076
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings. The determination of the sequence is impossible as the notches are too shallow. The block contains wide engravings on its side. It was broken into two parts after the notches were created and then reconstructed by V. Danilenko after 1974.

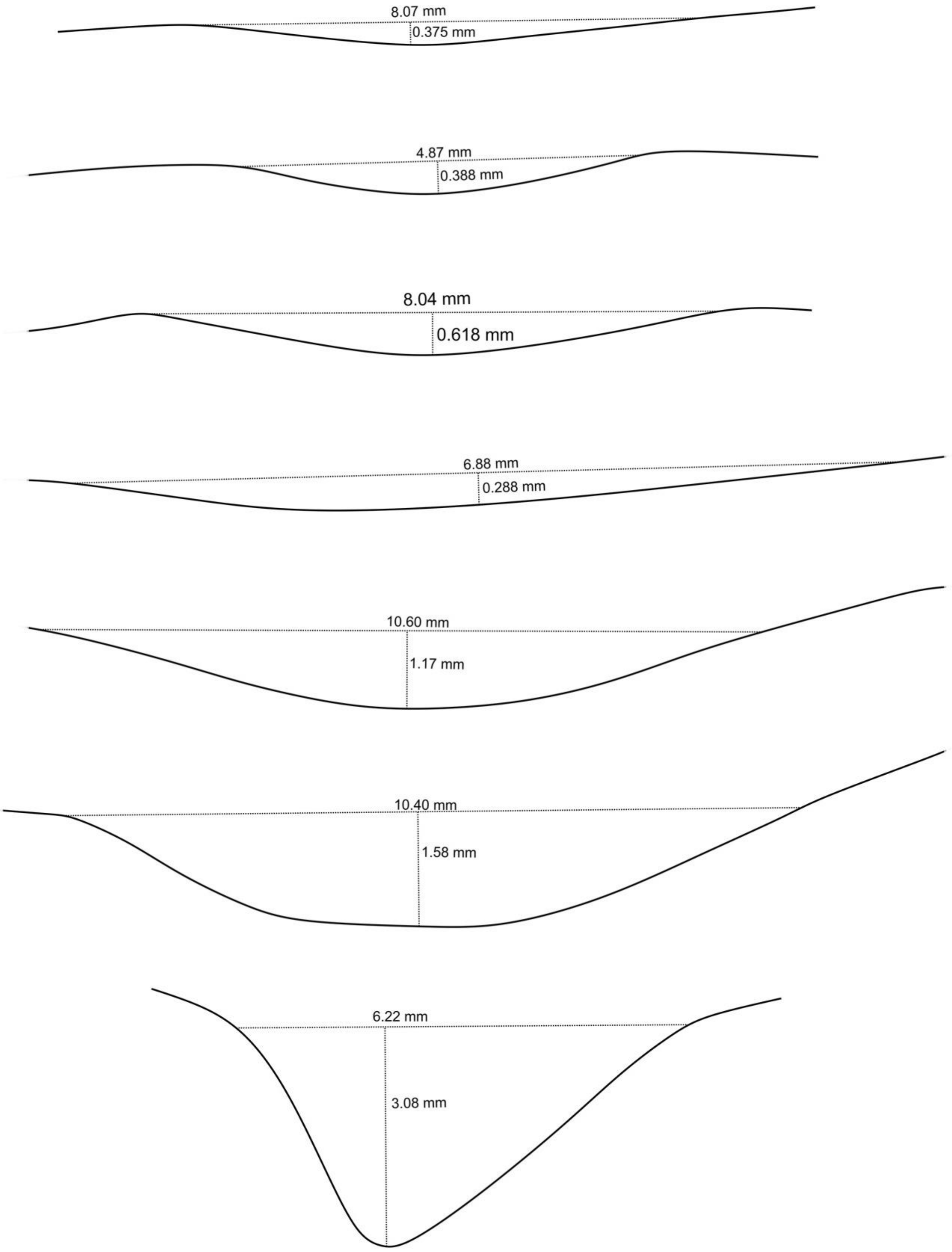
Technological drawing front



Technological drawing side



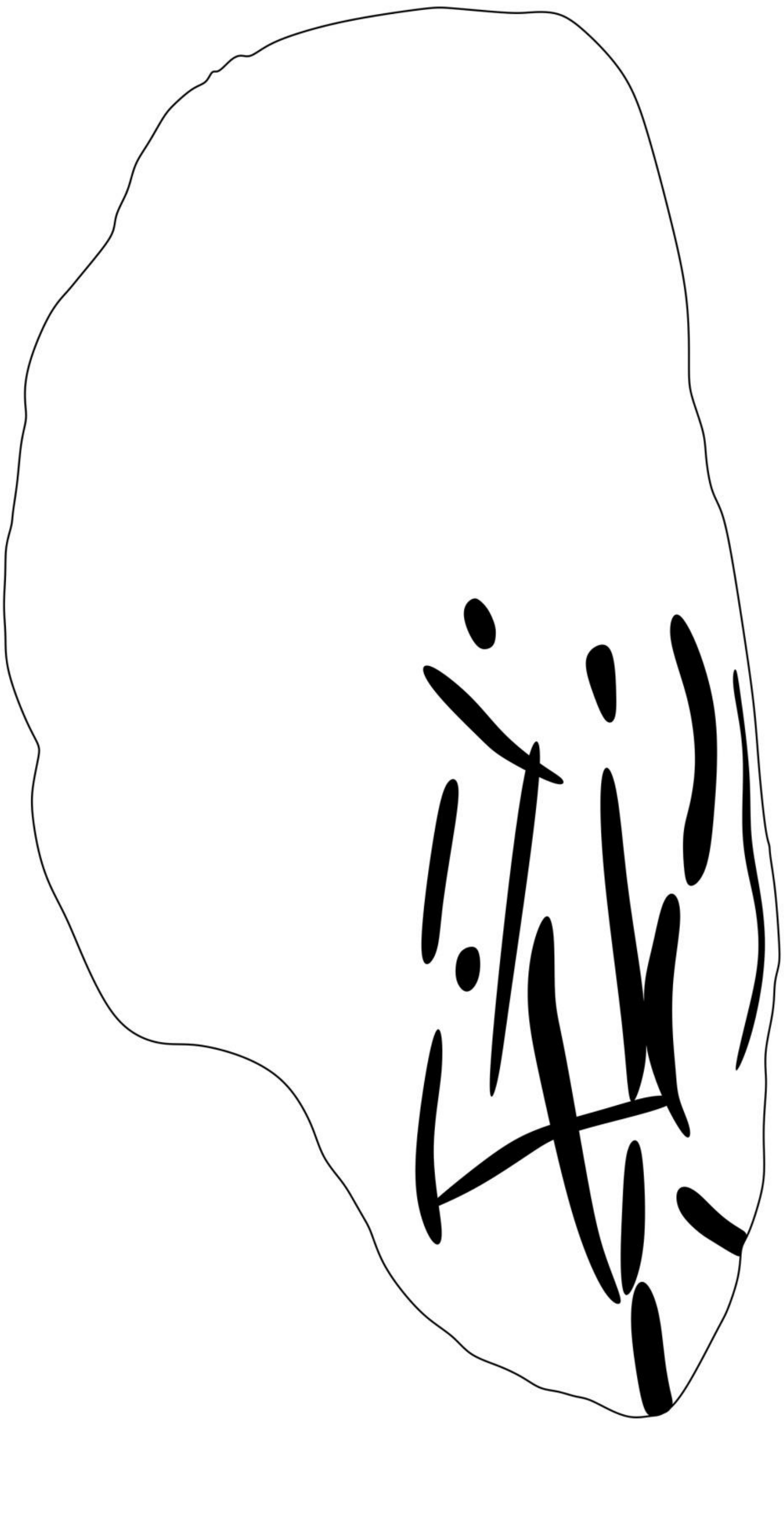
Profiles list



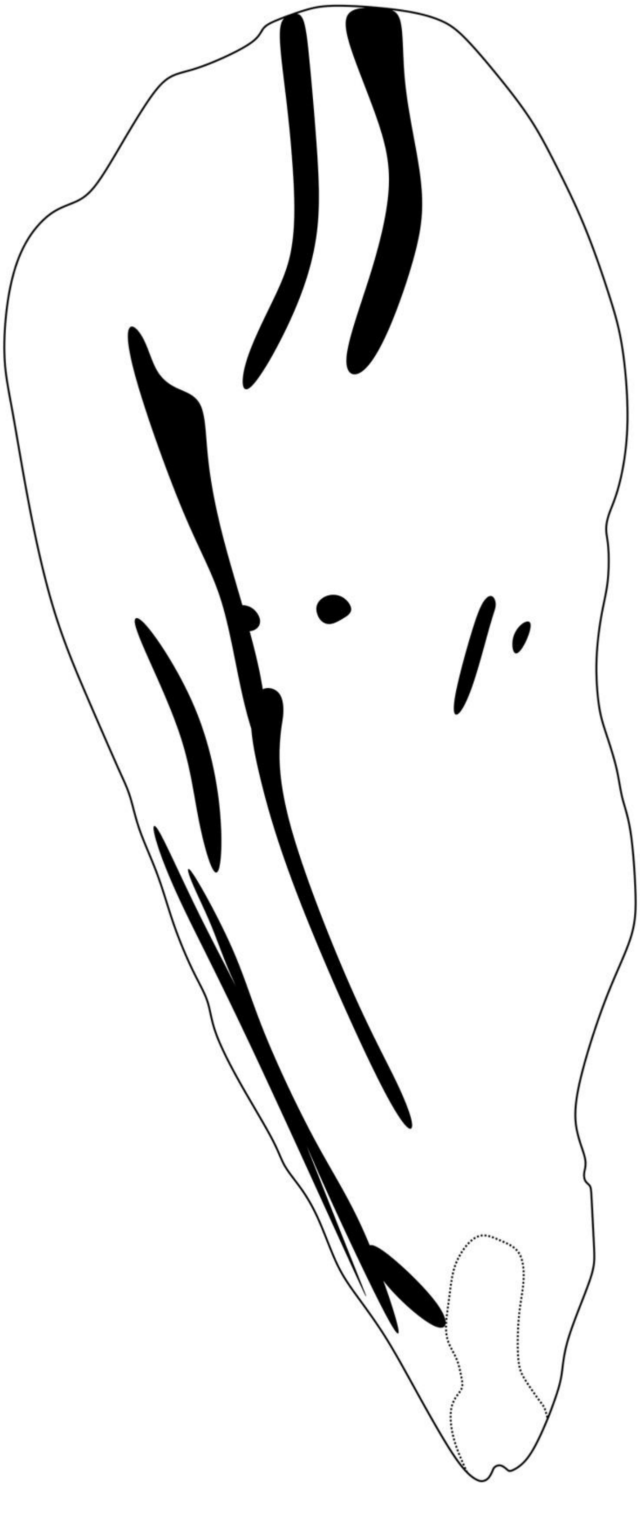
Specimen’s ID	KM74—18
Image front	
Image side	
Image back	
Length, cm	16
Width, cm	9
Weight, g	586
Volume, m^3	0.000316
Density, kg / m^3	1854.43038
Date of discovery	1974
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52

Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings. Unlike most of the other blocks, this one was not polished or reshaped in any manner. It might be considered as a part of a bigger stone block. The stone contained traces of recent damage when part of the block cracked out. The surface is rough and irregular.

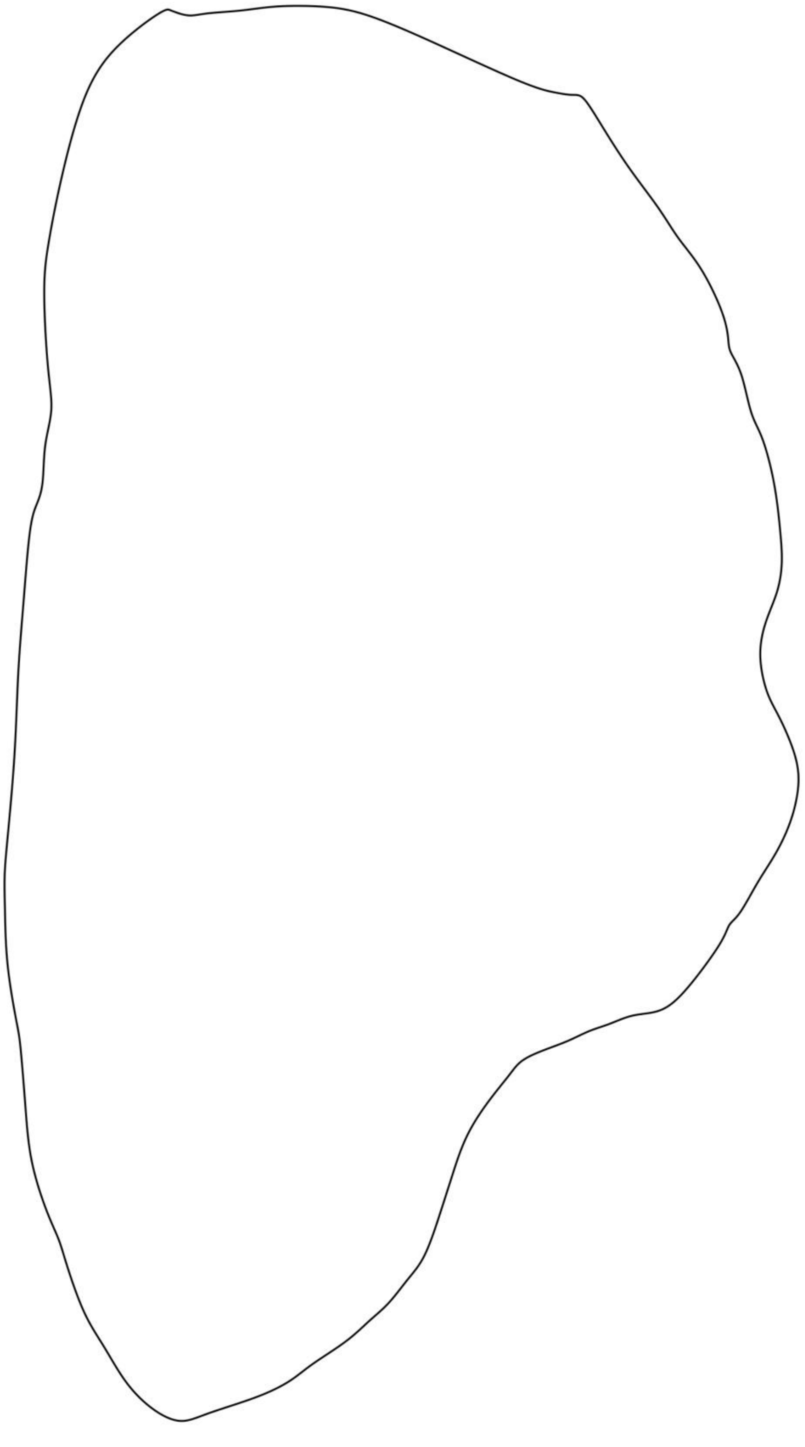
Technological drawing front



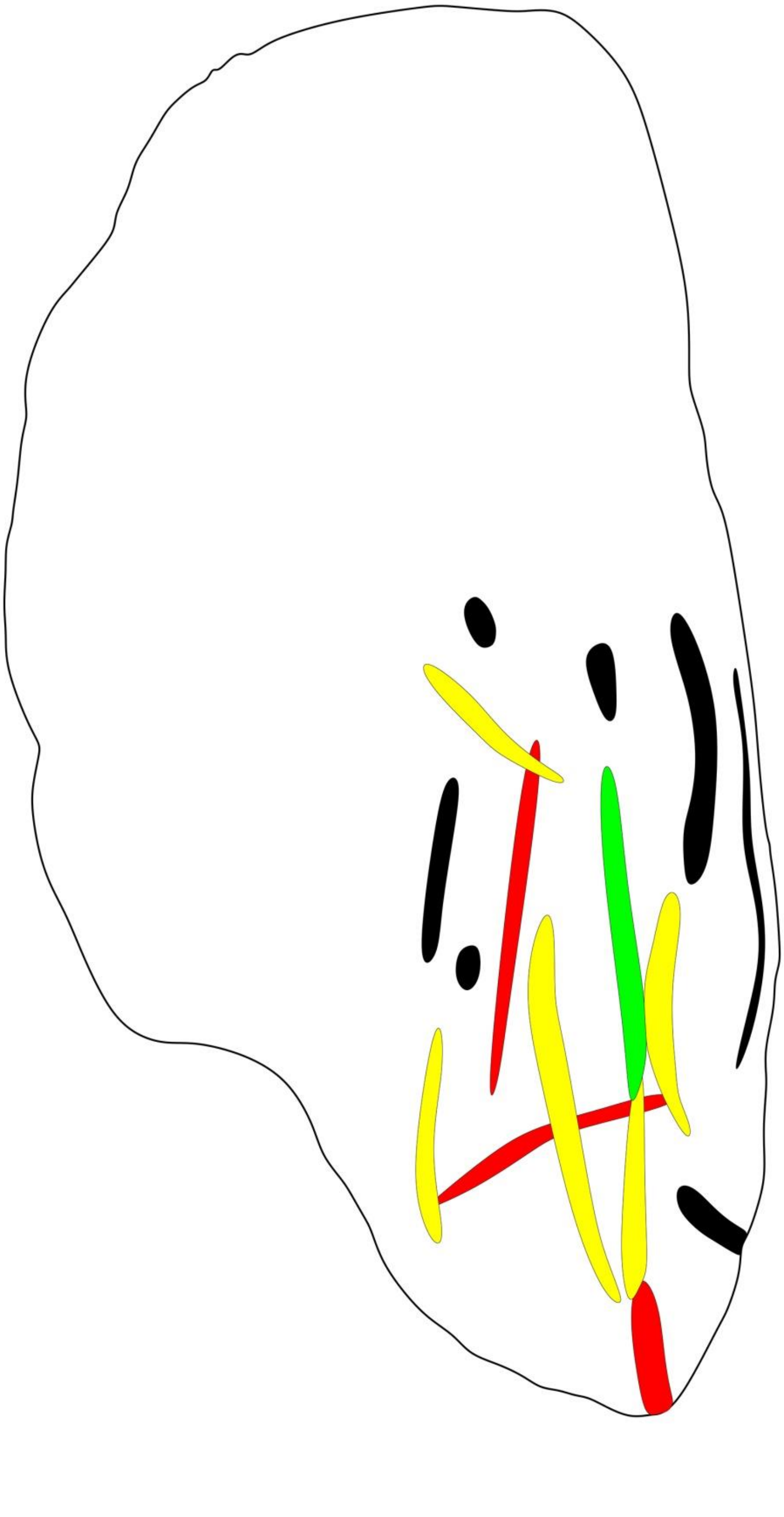
Technological drawing right



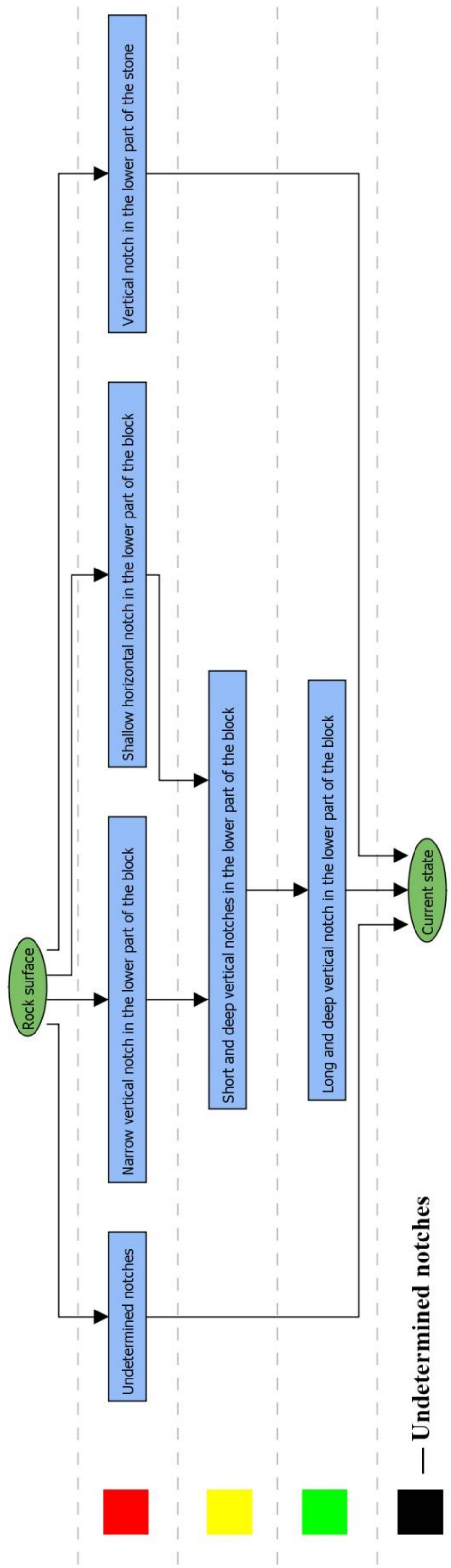
Technological drawing back



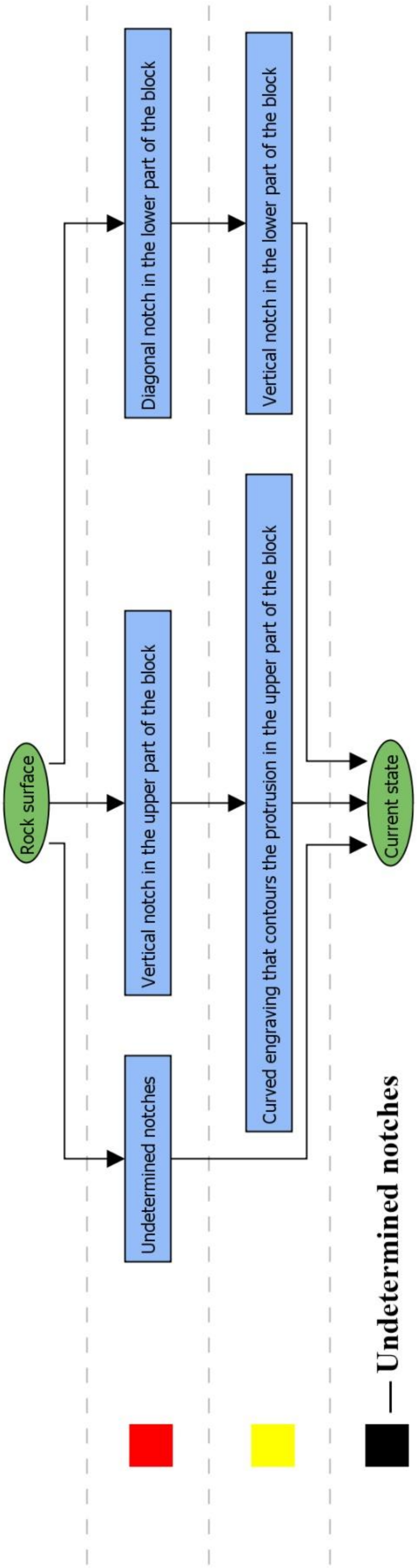
Relative chronology drawing front



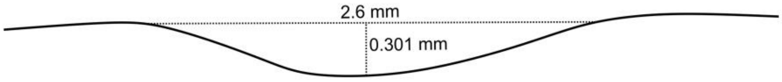
Harris matrix front

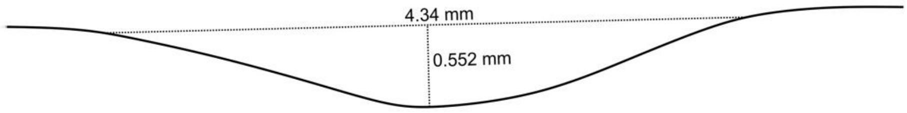


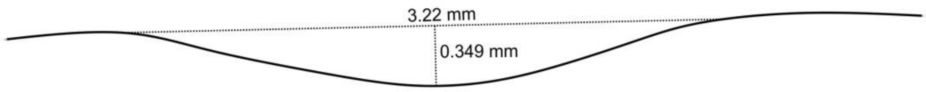
Harris matrix back

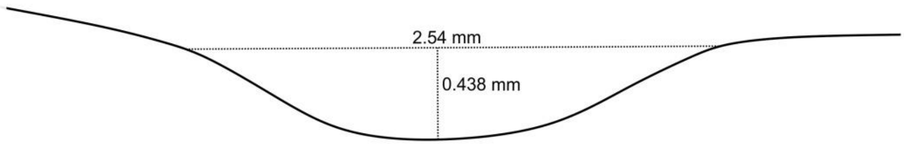


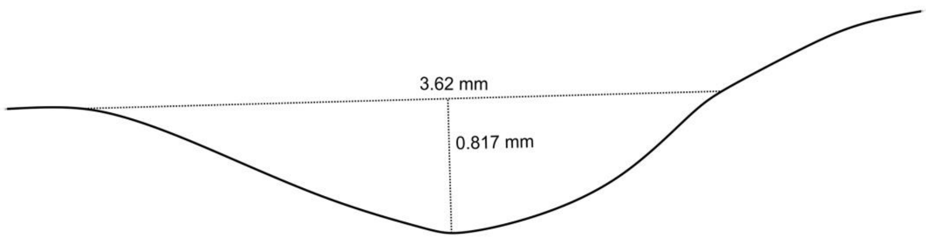
Profiles list

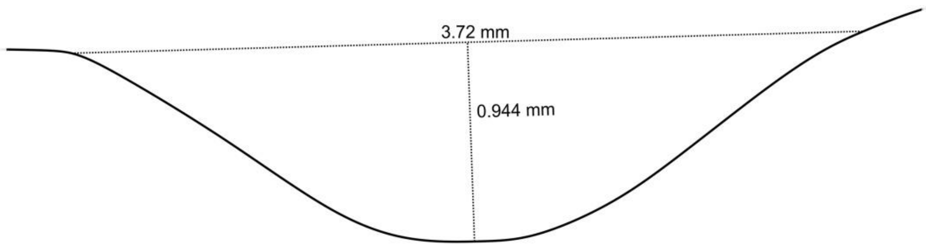










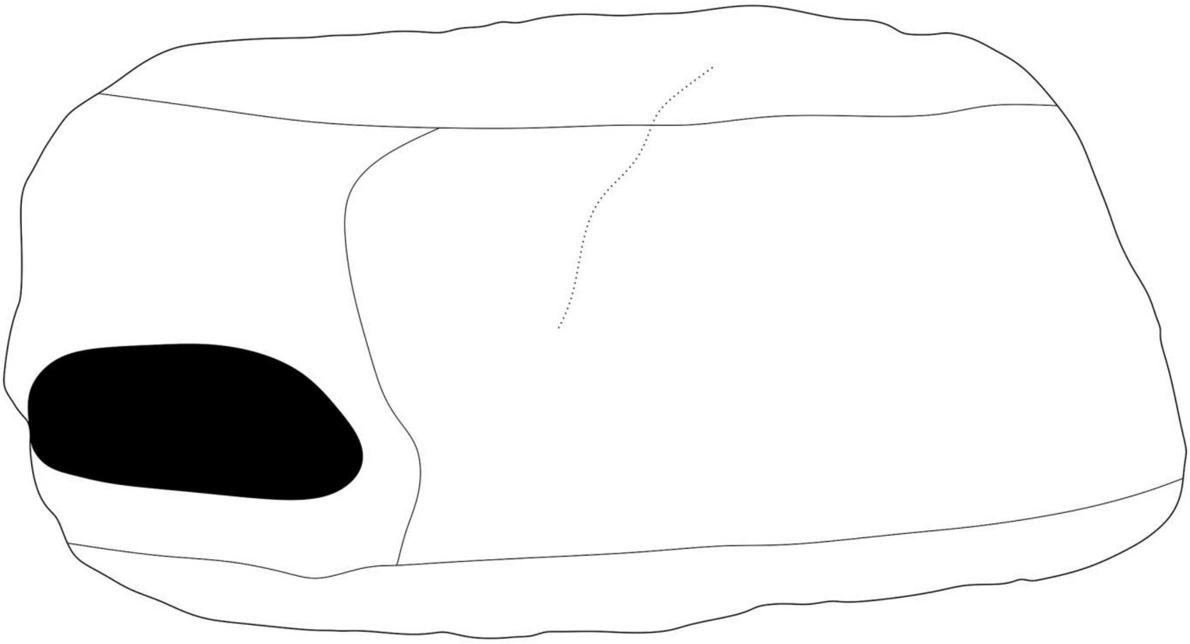


Specimen’s ID	KM74—19
Image front	
Image top	
Image back	
Length, cm	21.7
Width, cm	13.5
Weight, g	2222
Volume, m^3	0.001150
Density, kg / m^3	1777.60000
Date of discovery	1974
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it

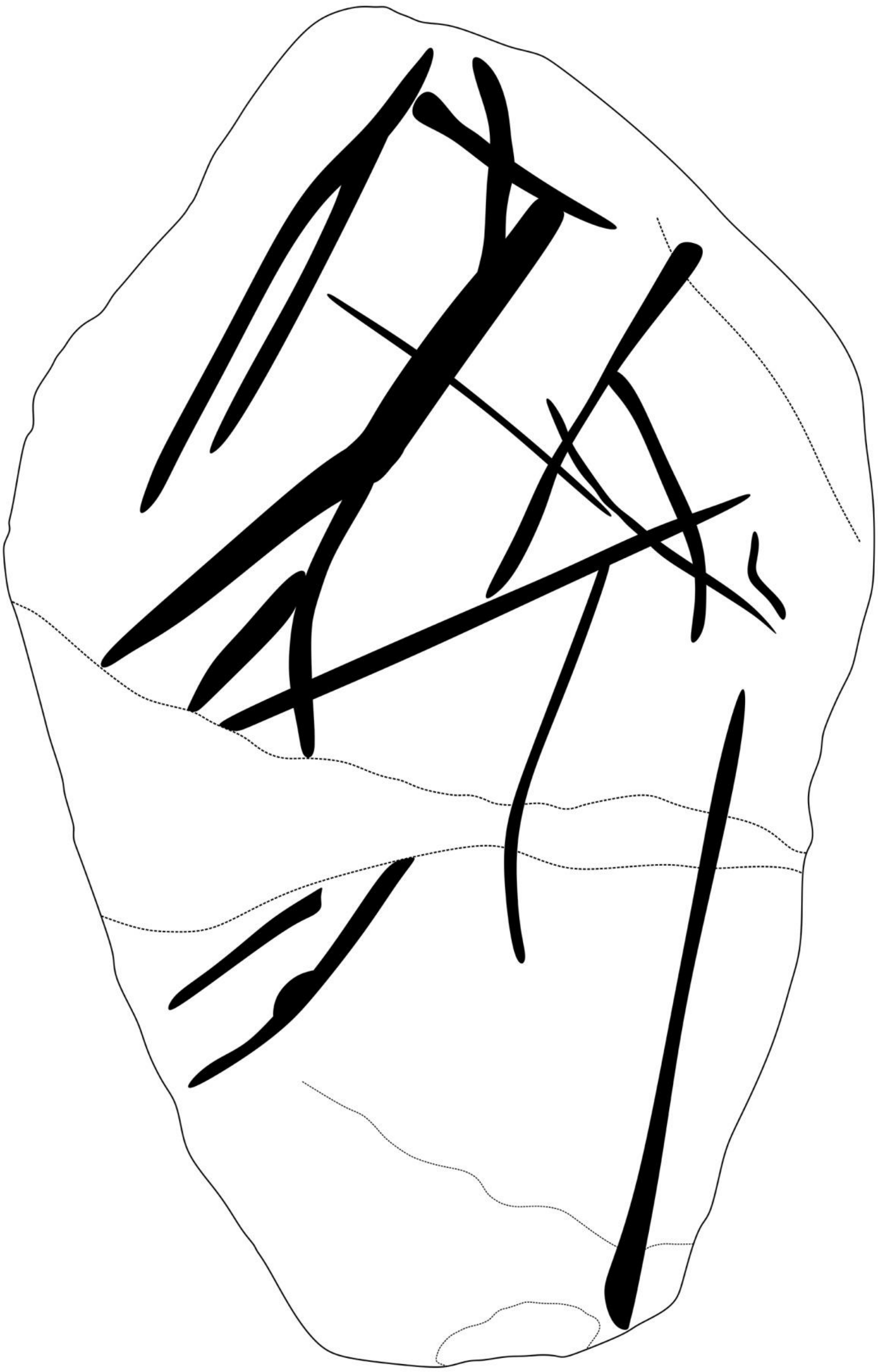
	contains a series of linear engravings. The block of irregular subrectangular shape has been broken into numerous parts and glued by V. Danilenko. Some parts were lost. A block contains several shallow linear engravings on its front and back sides and one wide, deep notch in the top part. The front part of the block does not contain any informative intersections to define the relative chronology. The sequence of the block's back incising shows that engravings were created before and after the natural cracks appeared but before the block fell in parts.

Technological drawing front

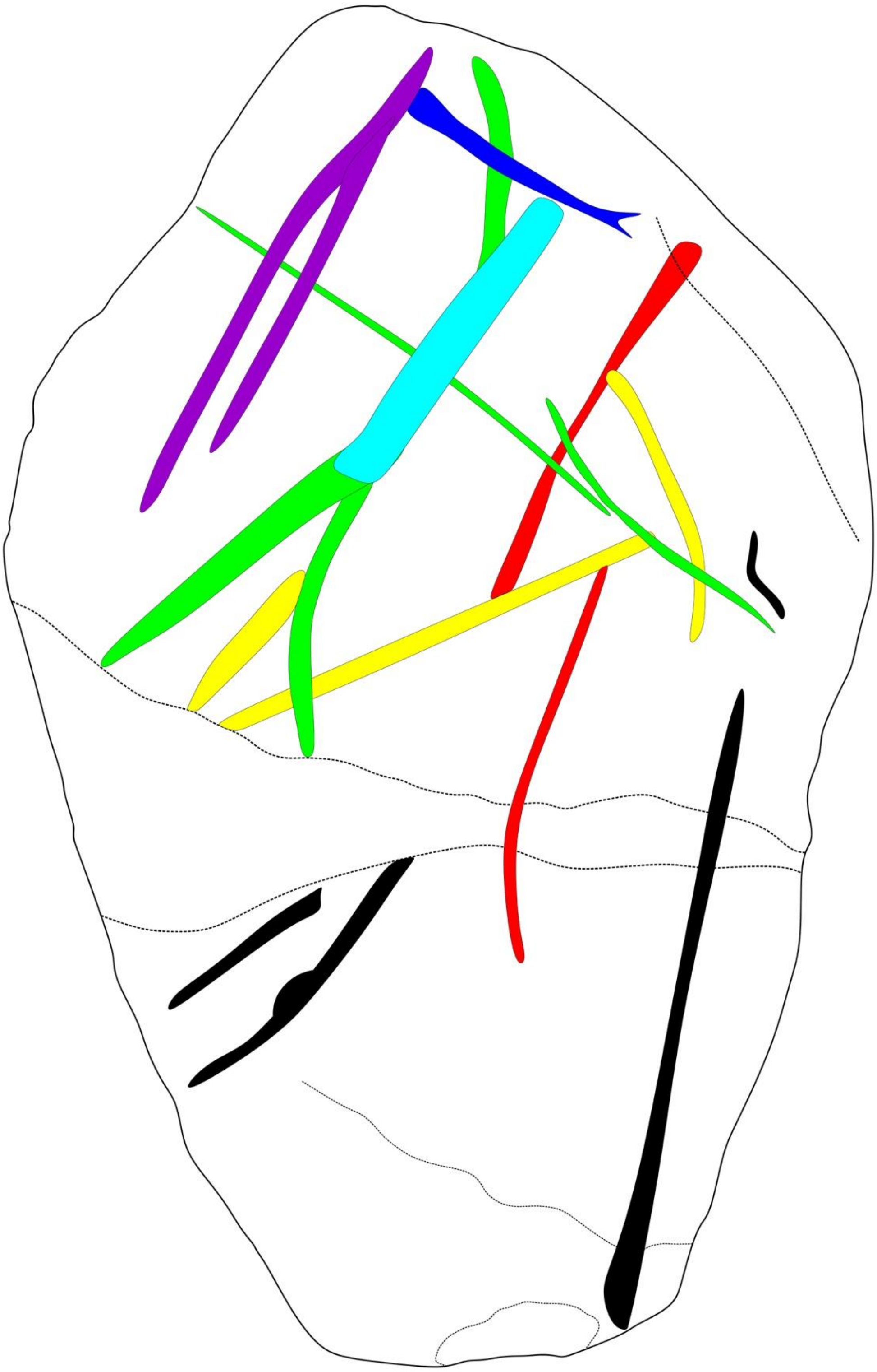
Technological drawing top



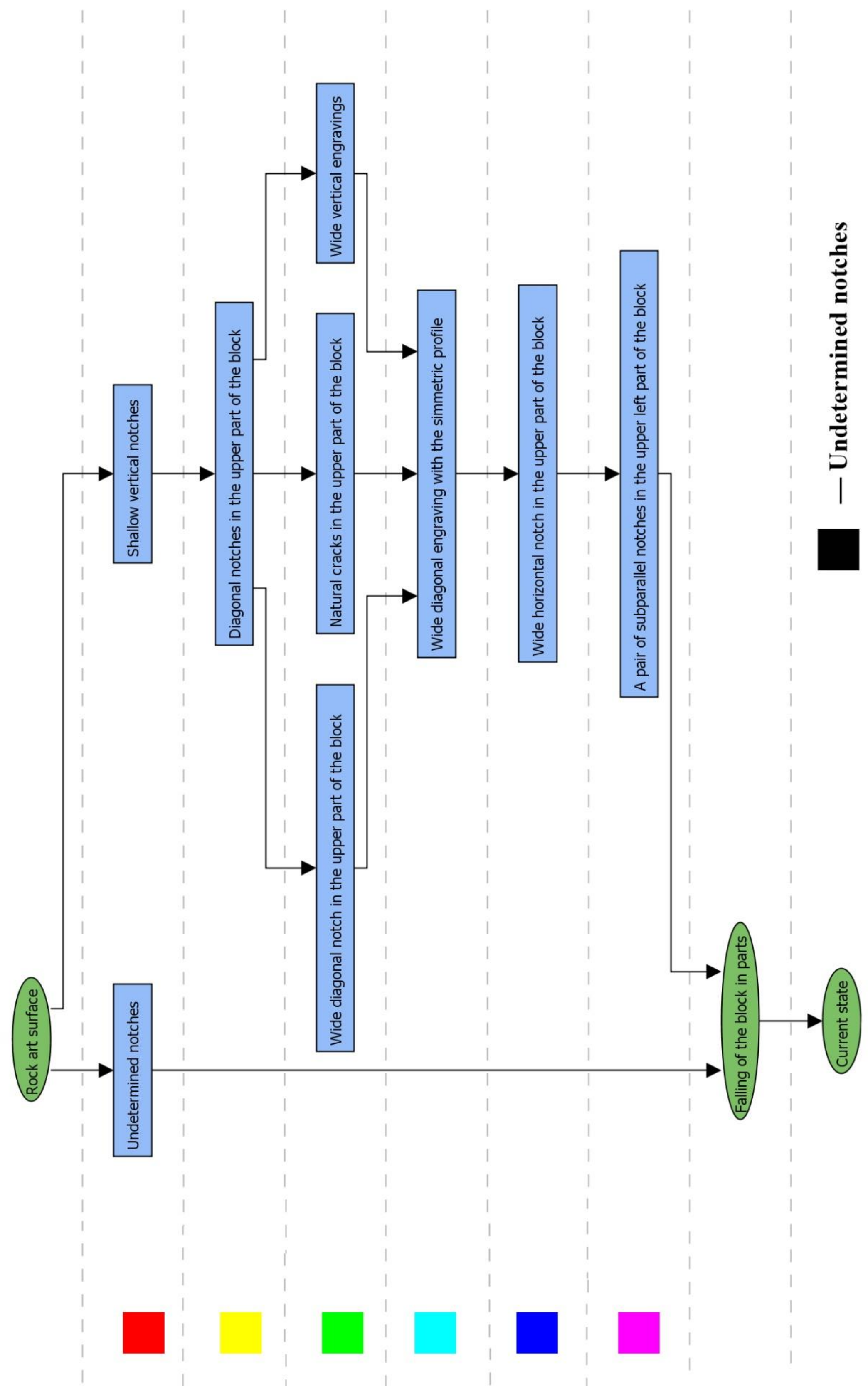
Technological drawing back



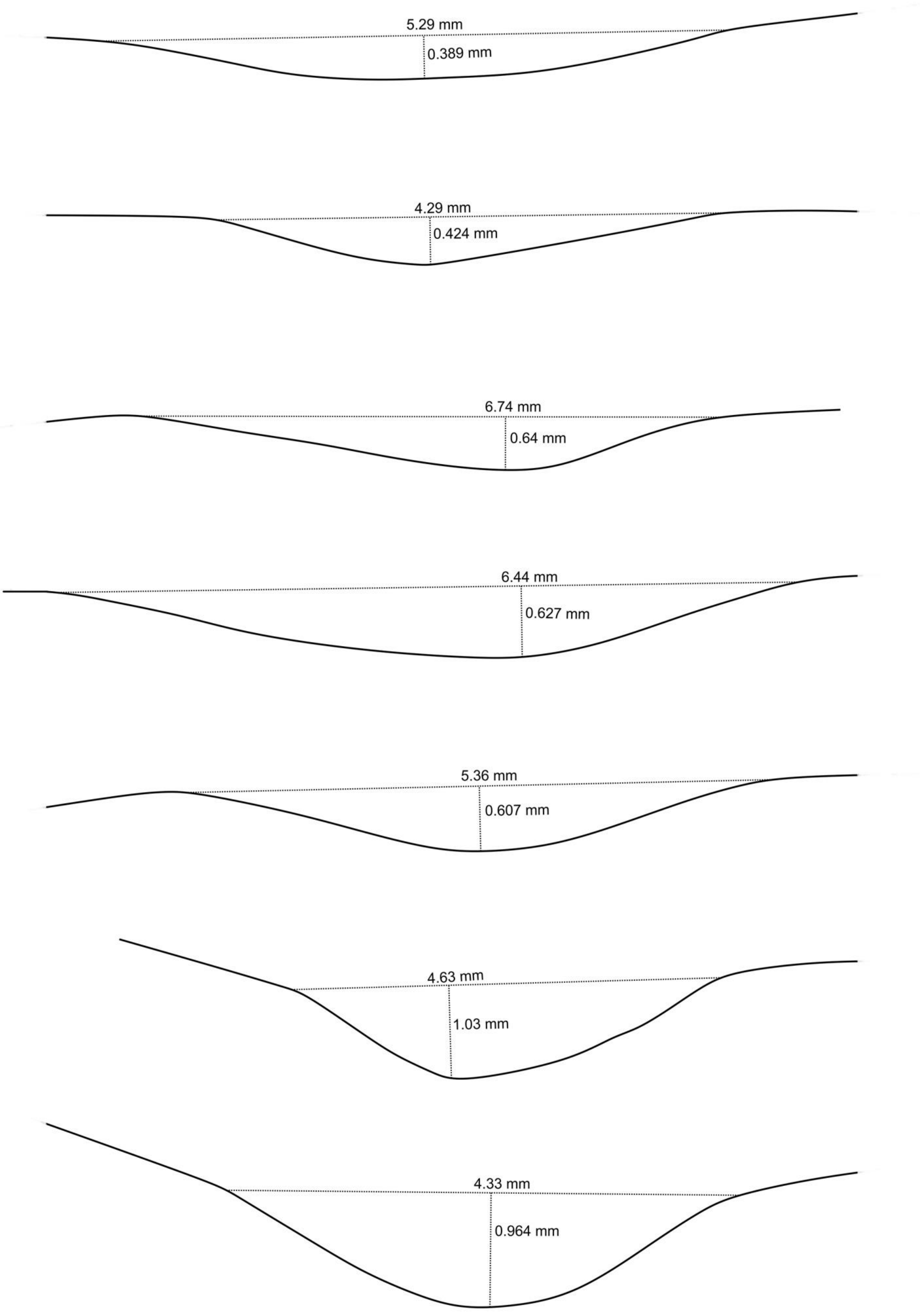
Relative chronology drawing back

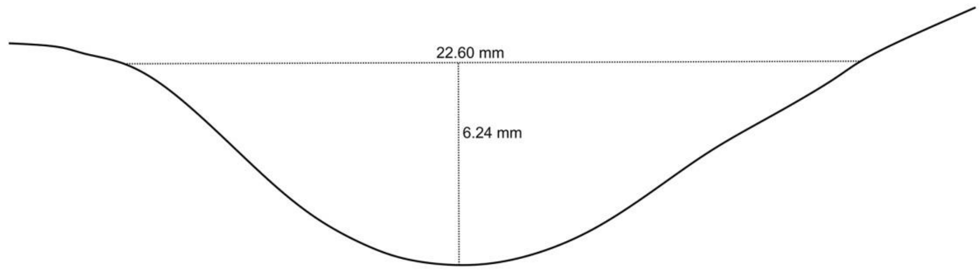


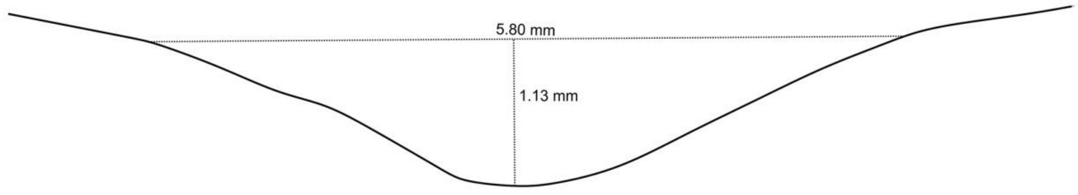
Harris matrix back

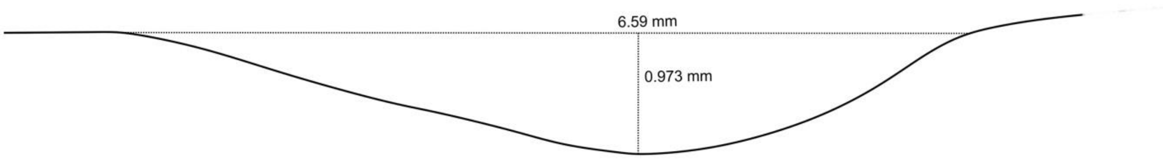


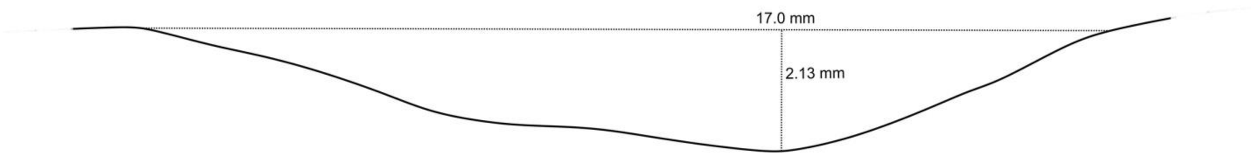
Profiles list




22.60 mm
6.24 mm

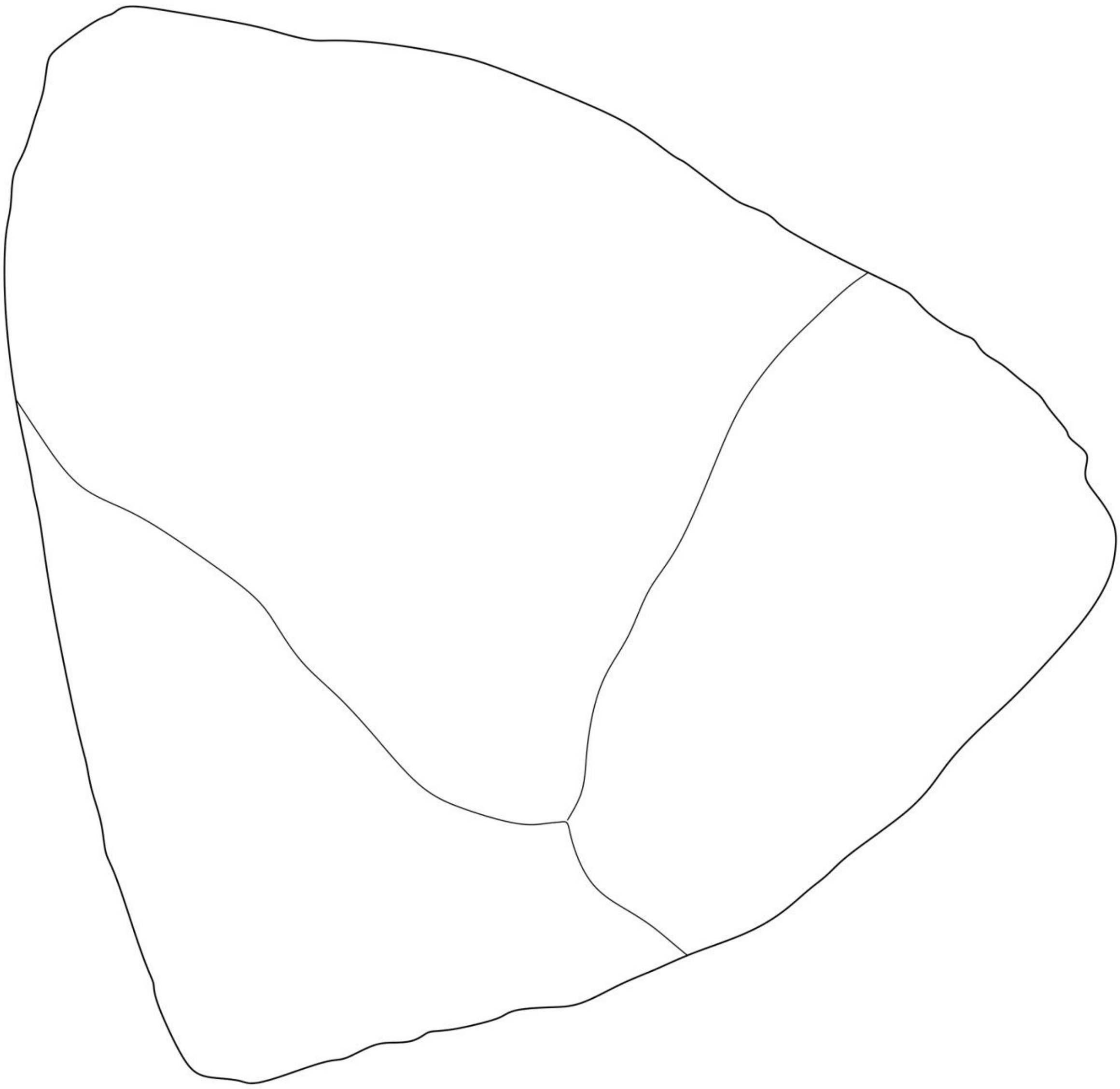

5.80 mm
1.13 mm


6.59 mm
0.973 mm

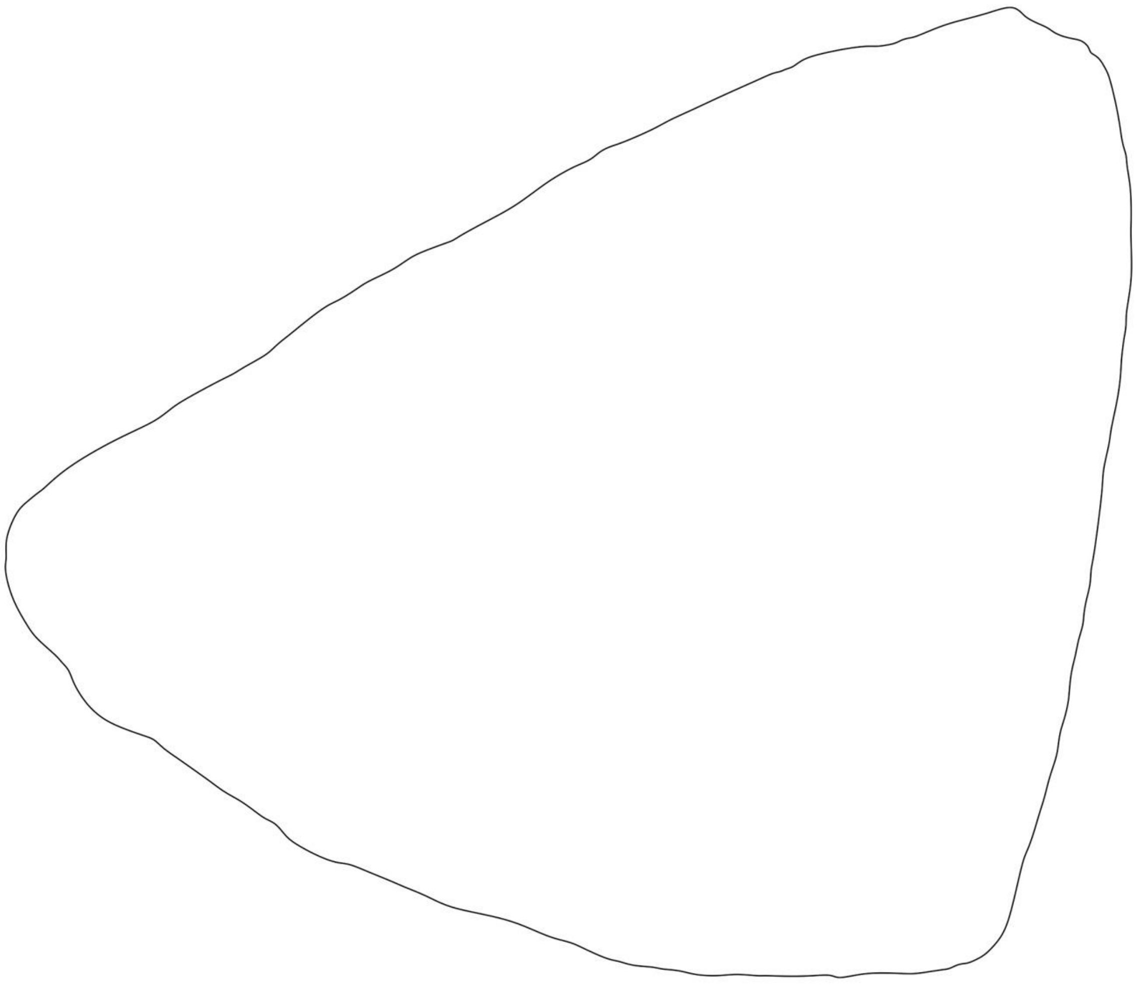

17.0 mm
2.13 mm

Specimen's ID	KM74—20
Image front	
Image back	
Length, cm	7.8
Width, cm	6
Weight, g	160
Volume, m^3	0.000079
Density, kg / m^3	2025.31646
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. The specimen is slightly polished from the back side and contains a few natural cracks.

Technological drawing front

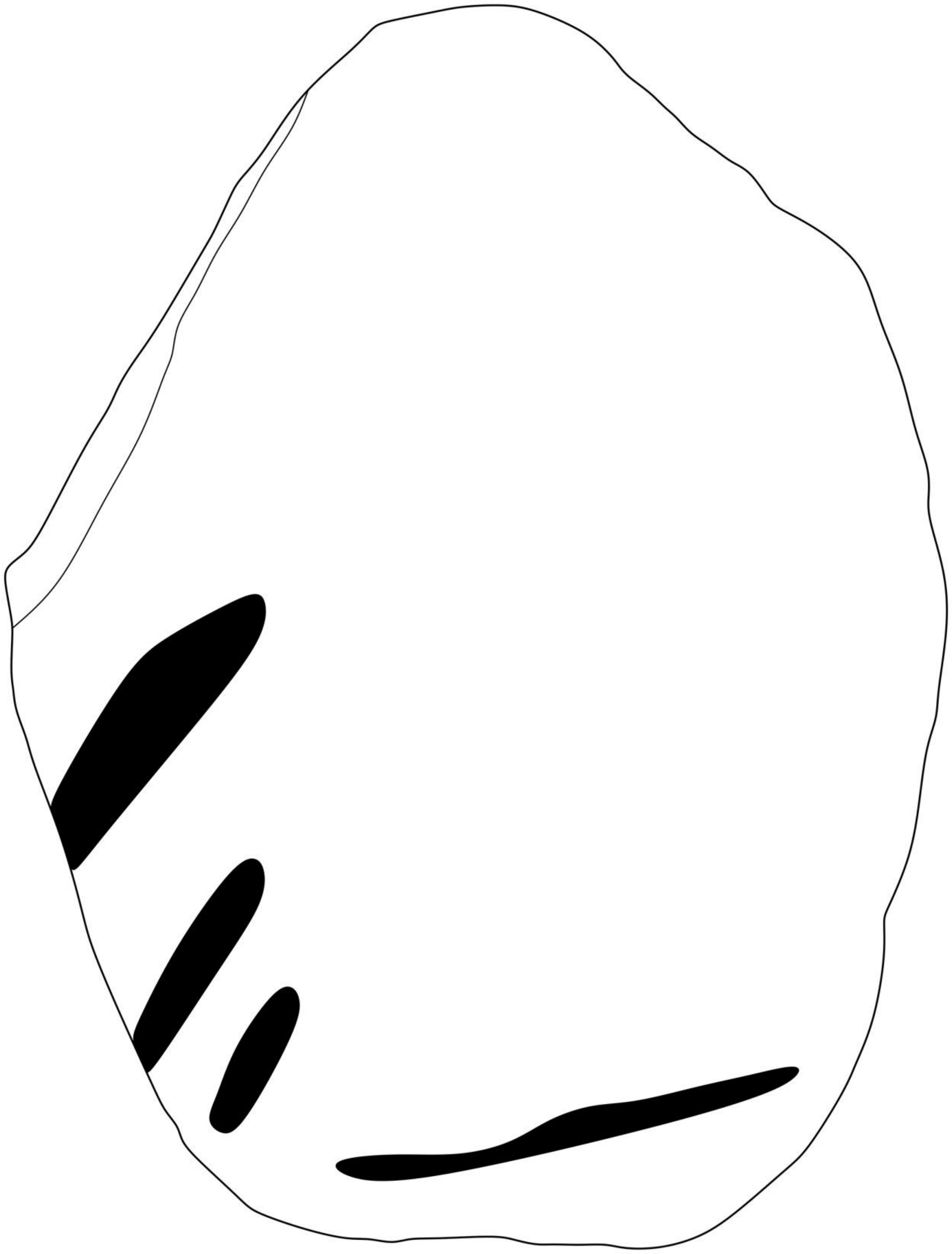


Technological drawing back

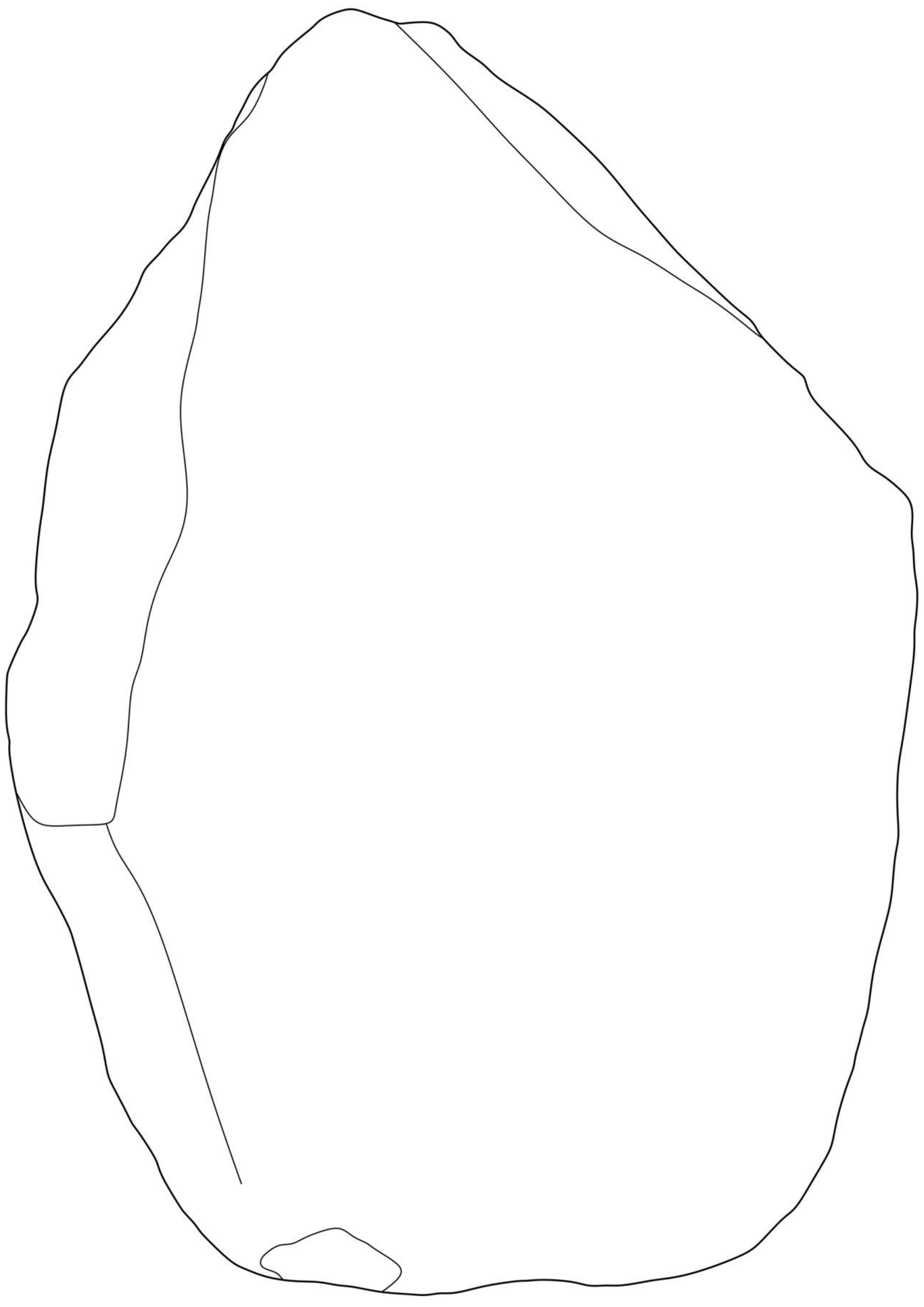


Specimen's ID	KM74—21
Image front	
Image back	
Length, cm	6.9
Width, cm	5.2
Weight, g	92
Volume, m^3	0.000047
Density, kg / m^3	1957.44681
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings. The specimen has been broken. Some parts were lost. The block has been covered with conservation glue to prevent further destruction.

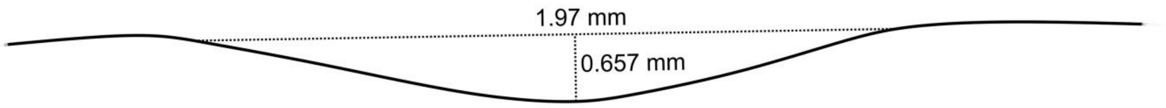
Technological drawing front

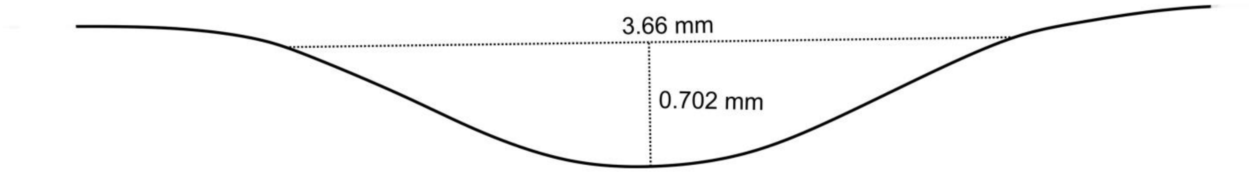


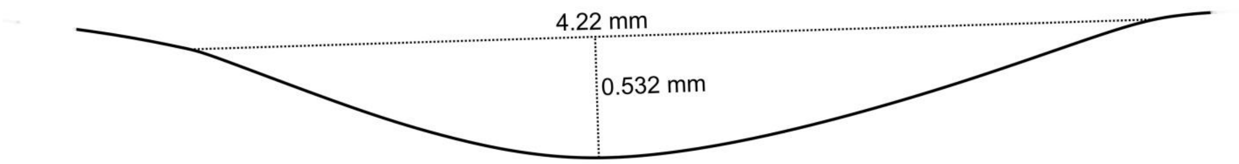
Technological drawing back

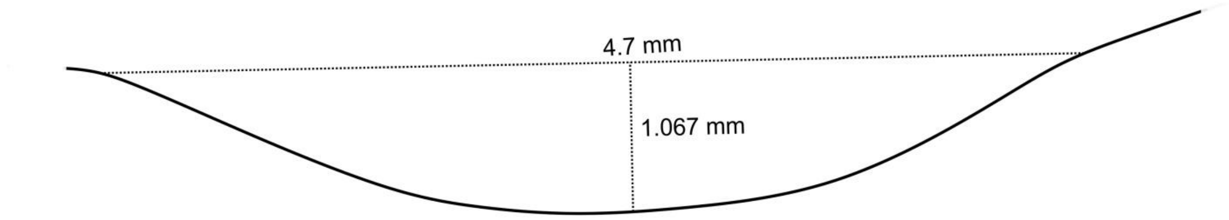


Profiles list





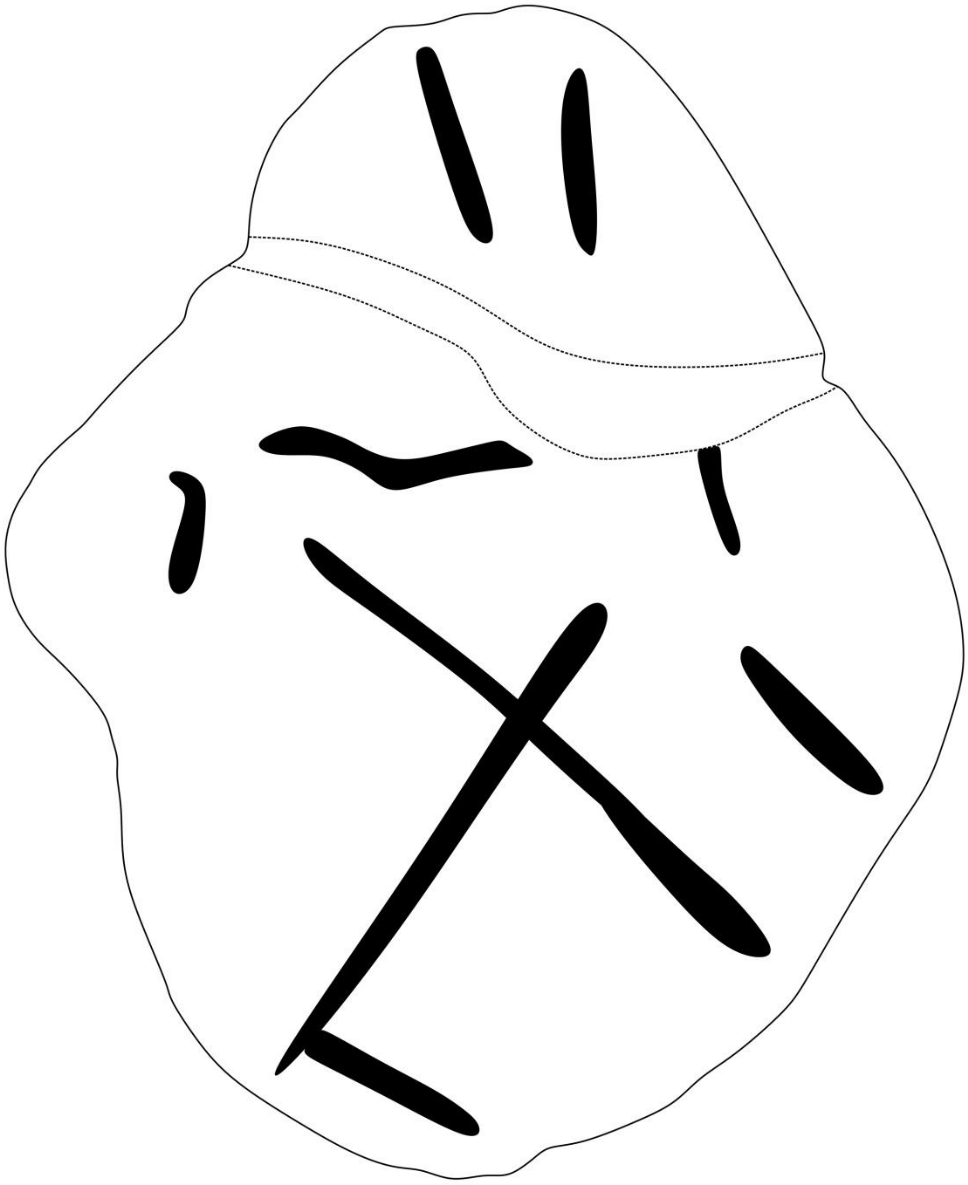




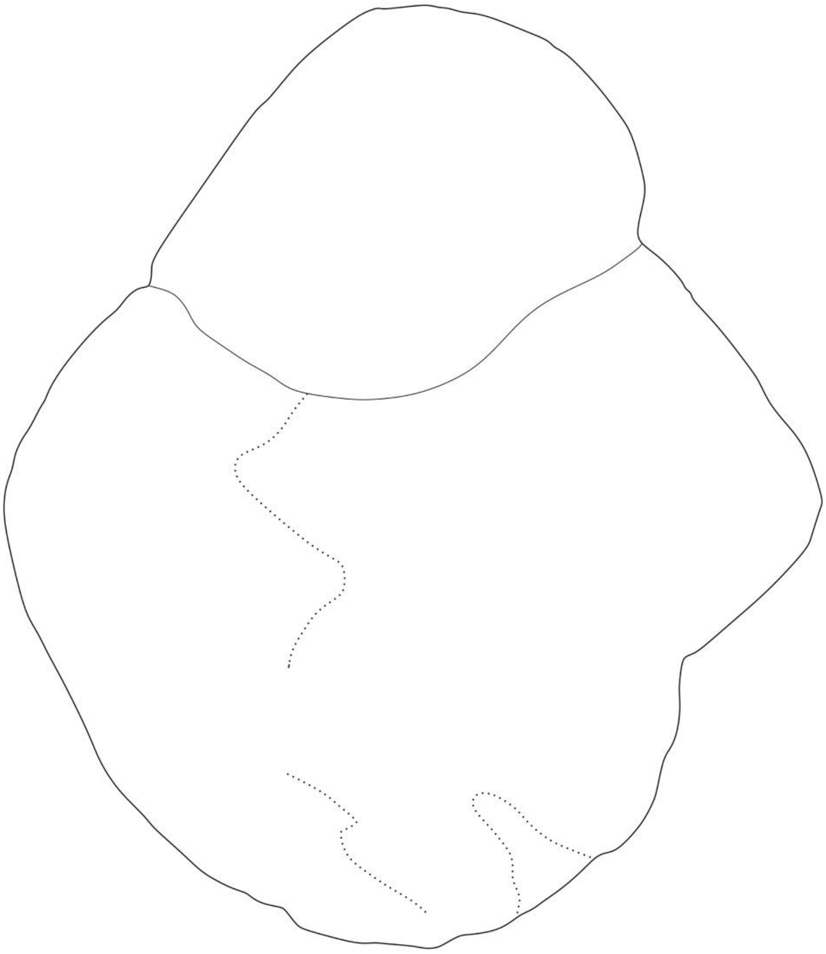
Specimen's ID	KM 74—22
Image front	
Image back left part	
Image back right part	
Length, cm	12.3
Width, cm	4.8
Weight, g	387
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave", No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Note	The rectangular stone with polished rectangulated sides break in two parts.

Specimen's ID	KM74—23
Image front	
Image back	
Length, cm	9.5
Width, cm	8
Weight, g	101
Volume, m^3	0.000053
Density, kg / m^3	1905.66038
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings. The block has been broken in parts and then glued by V. Danilenko.

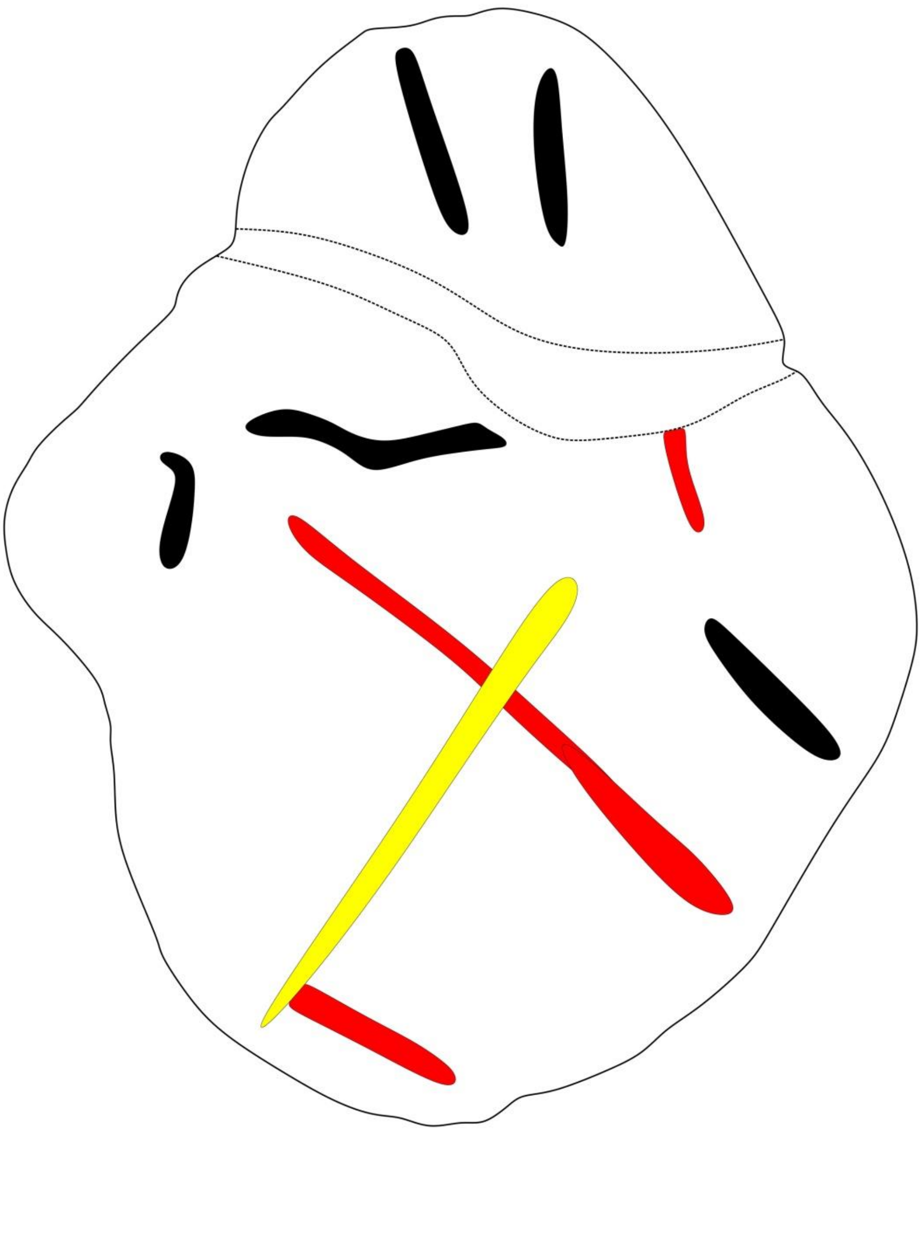
Technological drawing front



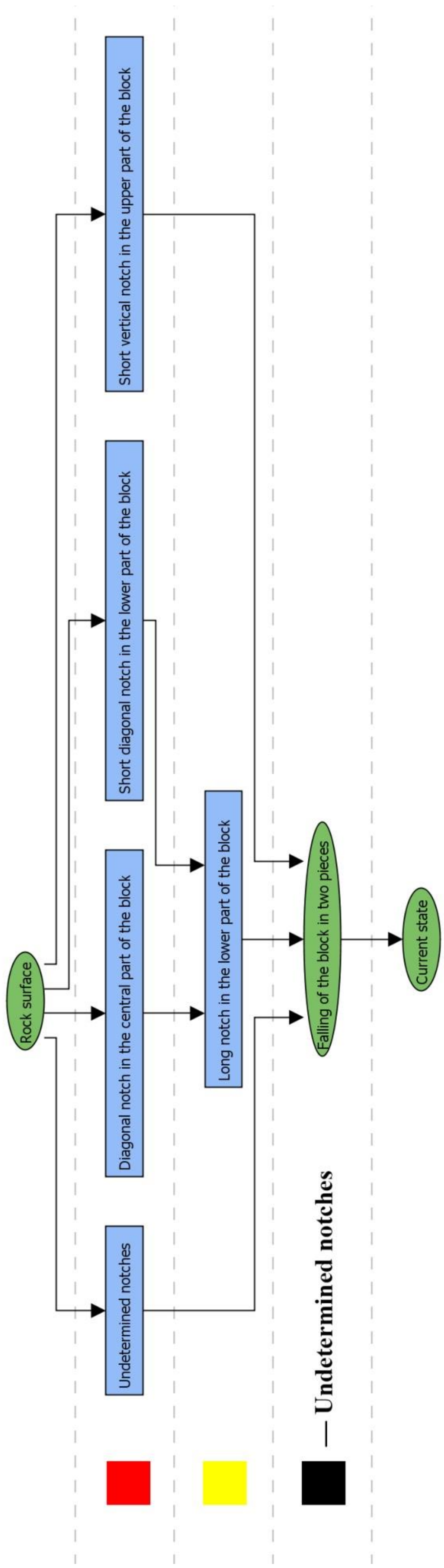
Technological drawing back



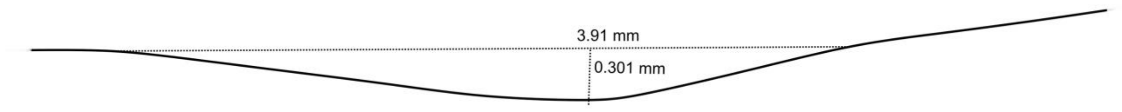
Relative chronology drawing front

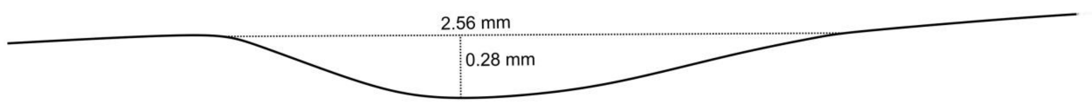


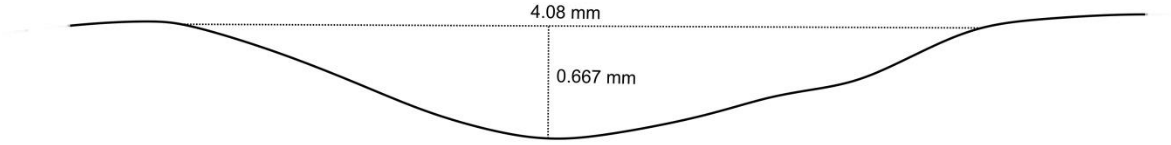
Harris matrix

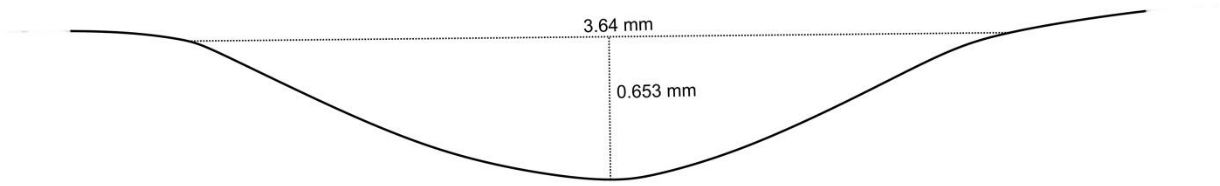


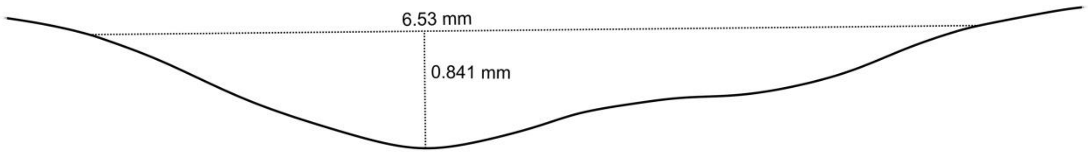
Profiles list

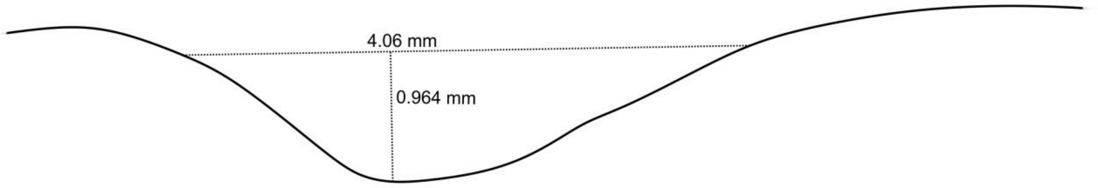




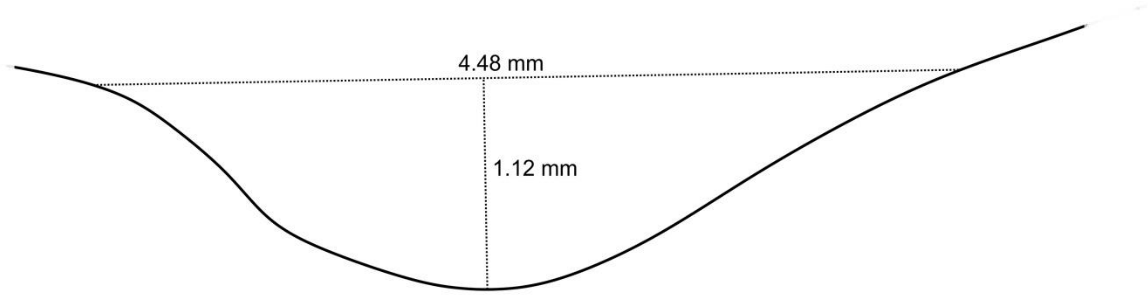


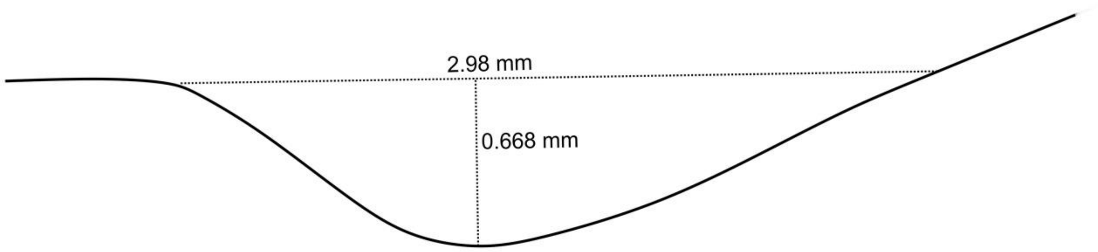






Natural cracks list

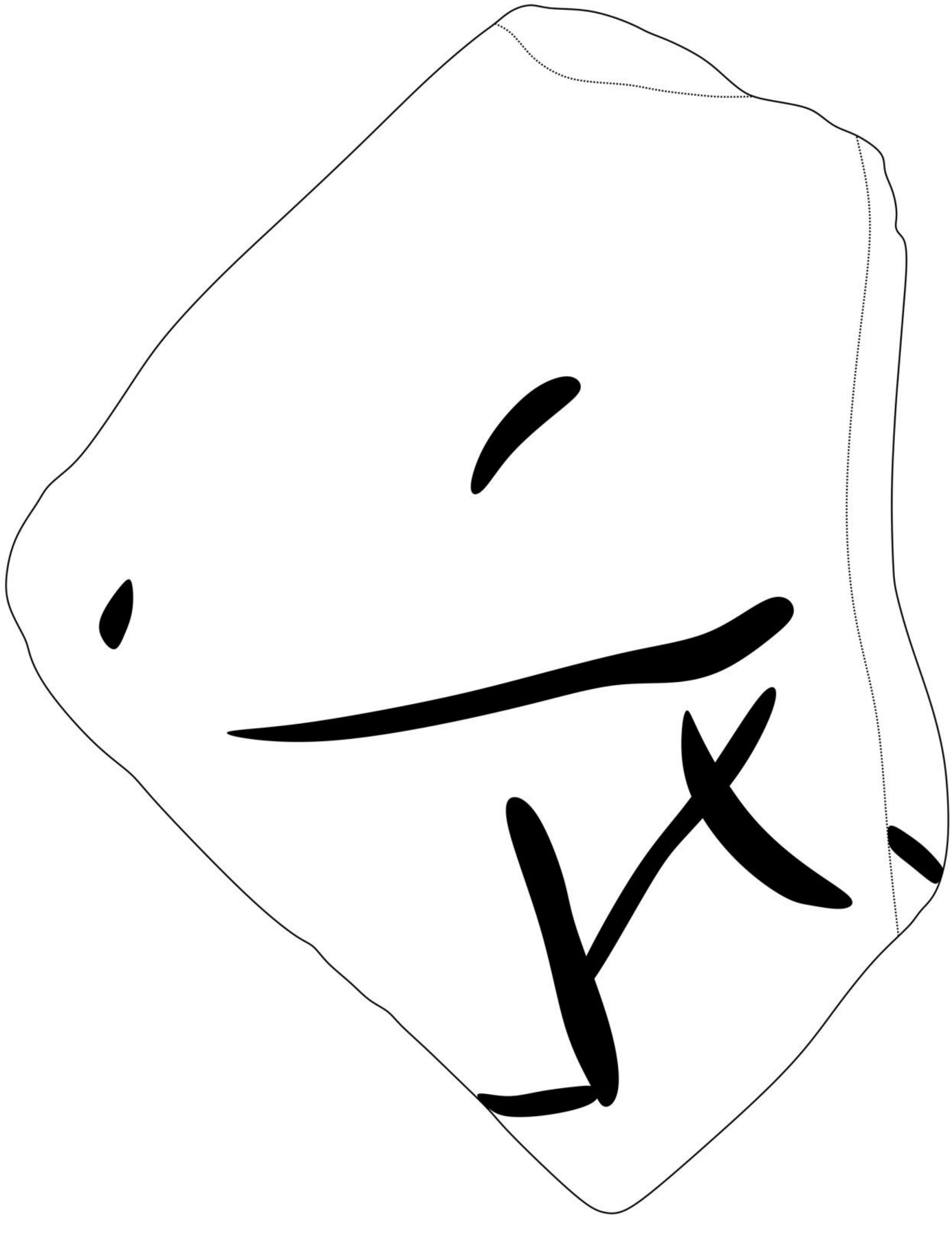




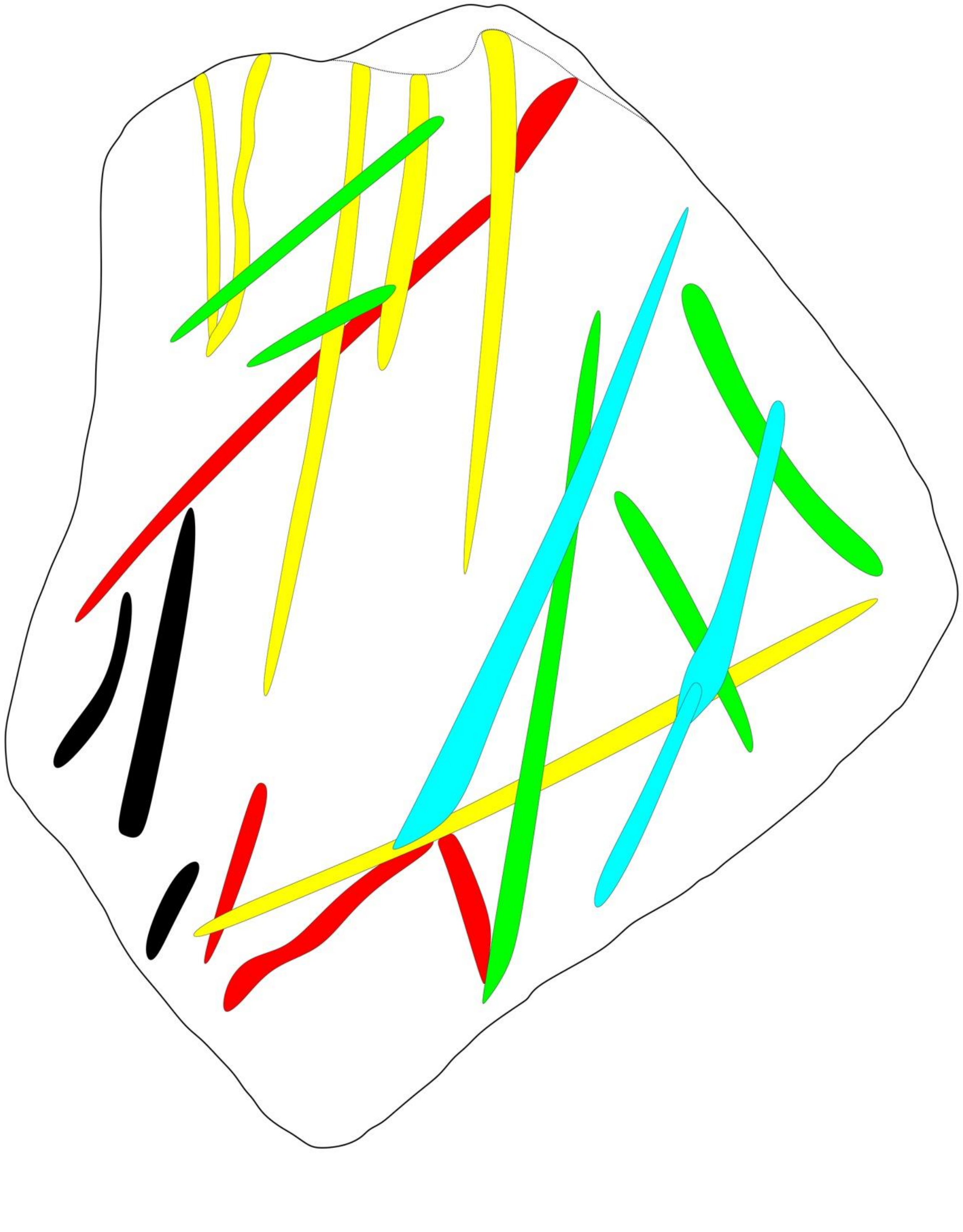
Specimen’s ID	KM74—24
Image front	
Image back	
Length, cm	12
Width, cm	10
Weight, g	297
Volume, m^3	0.000149
Density, kg / m^3	1993.28859
Date of discovery	1974
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	—
Note	V. Danilenko did not describe the specimen in his book or the archaeological report. According to his paintings on the specimen and the 3D-mesh analysis, it contains a series of linear engravings.

Technological drawing front

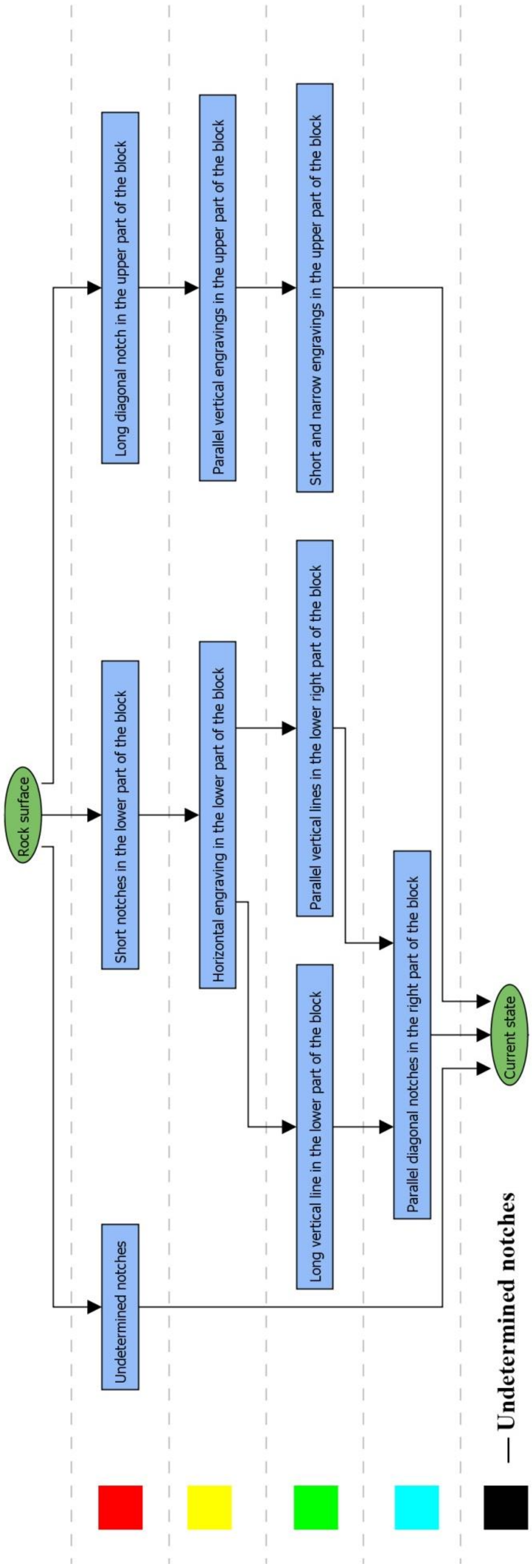
Technological drawing back



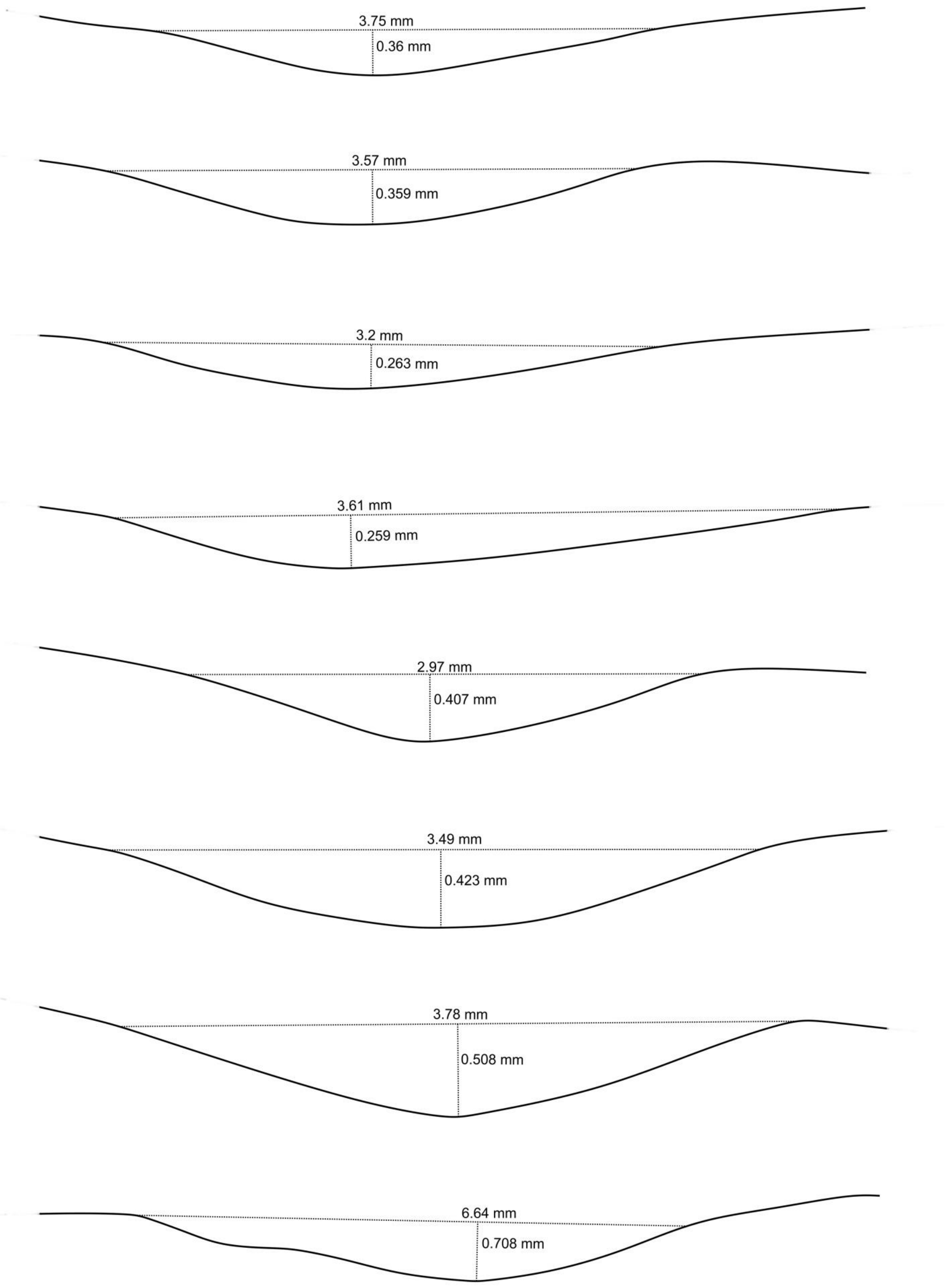
Relative chronology drawing front



Harris matrix front



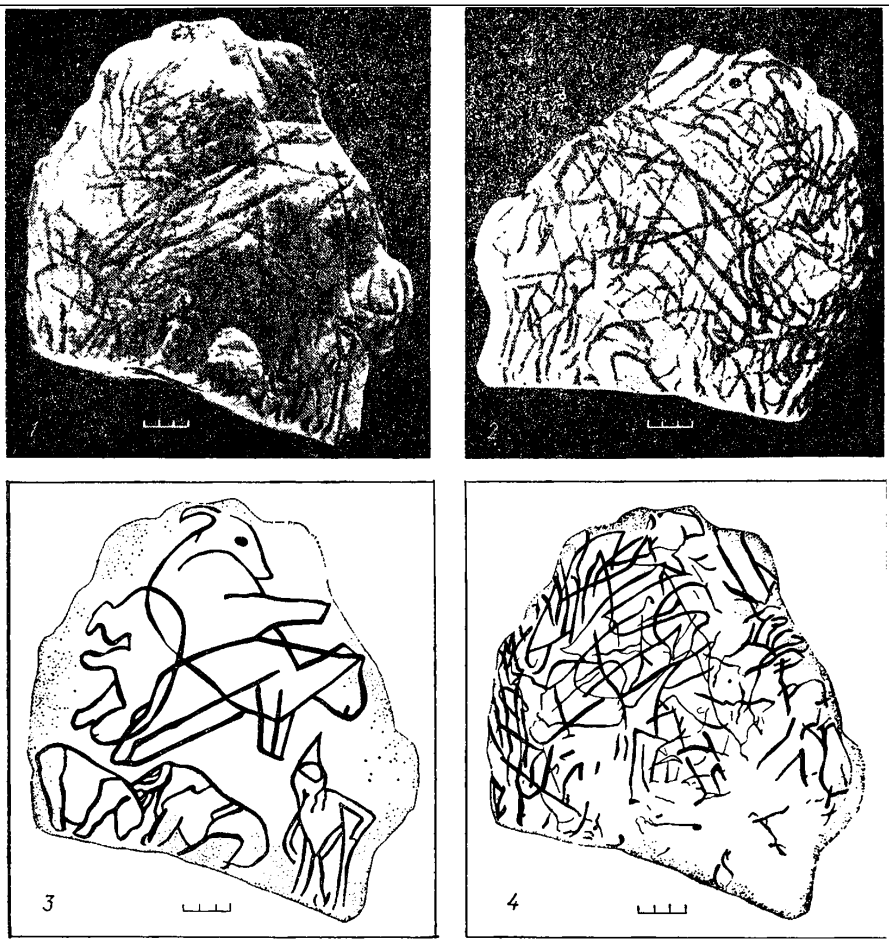
Profiles list



Specimen's ID	KM 74—25
Image front	
Image bottom	
Length, cm	22
Width, cm	12.9
Weight, g	2034
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone break in two parts and then was glued by V. Danilenko after 1974.

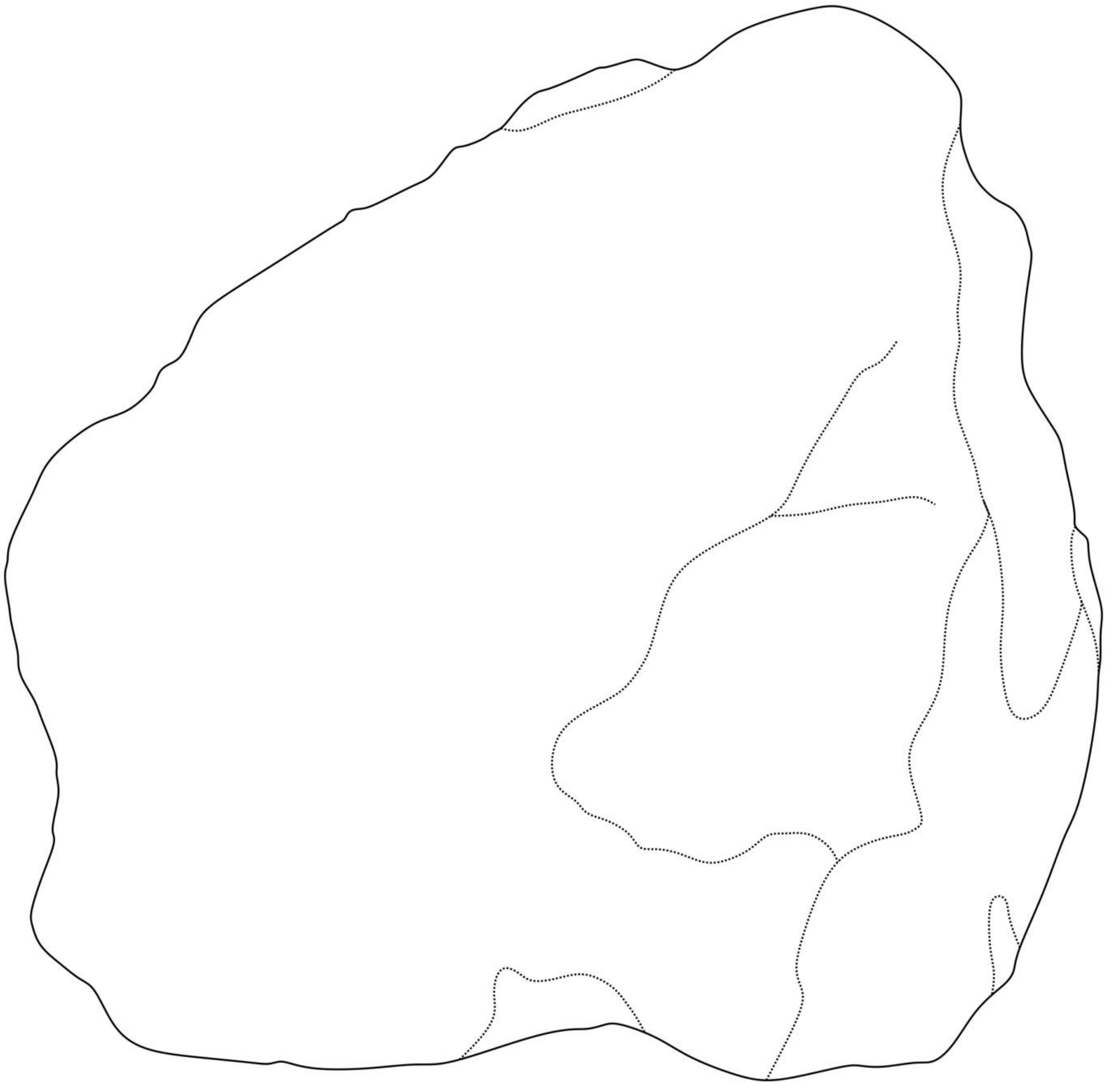
Specimen's ID	KM74—27
Image front	
Image back	
Length, cm	24
Width, cm	21.5
Weight, g	5100
Volume, m^3	0.003304
Density, kg / m^3	1543.58354
Date of discovery	1974
Finder	V. Danilenko
Location	"Wizard's" cave, No. 52
Current location	Institute of Archaeology, Kyiv

Description	Comparatively small subrectangular part of the block KM74 No. 27 gave a complex and rich composition. Its main background might be considered a series of random lines that create an unclear linear and geometric image. However, the central part of geometric lines creates the zoomorphic composition. One of them is even anthropomorphic. The upper part of the composition reconstructs the shape of a moving goat with its head turned left. The most attention is paid to the head with an eye, a horn, and a well-painted nose. The neck, lines of the back, and stomach are unclear. The right angle of the block contains the figure of a barefoot man, a dart in his left hand and a right hand near his hip. On his head, he has a hat. Left to this figure, there is an image of a predator that is similar to a lion. Further left — the cave bear with the specific posture of his legs; his head is turned right and down and is located close to the head of the abovementioned predator — the lion. The line that creates the back of this cave bear is the first line of the figure of another one that stays on his hind legs and crosses the figure of a goat. An animal's front legs are stretched in the direction of a hunter. Below and to the left of this bear is a figure of a third one. It is profiled to the right; this one has a massive back and curved legs, a big long neck, and a typical head of oval shape. The semantic basis for the composition is the group of three bears. The lion is indifferent to them or is against this group. The predator is also not aggressive to the hunter. It might even be considered that he follows the latter. The figure of the goat is a separate part of a composition that is entirely "ignored" by hunters, bears, and lions. This leads to the idea that the goat and its surroundings form a different part of a composition from the hunter and four predators.

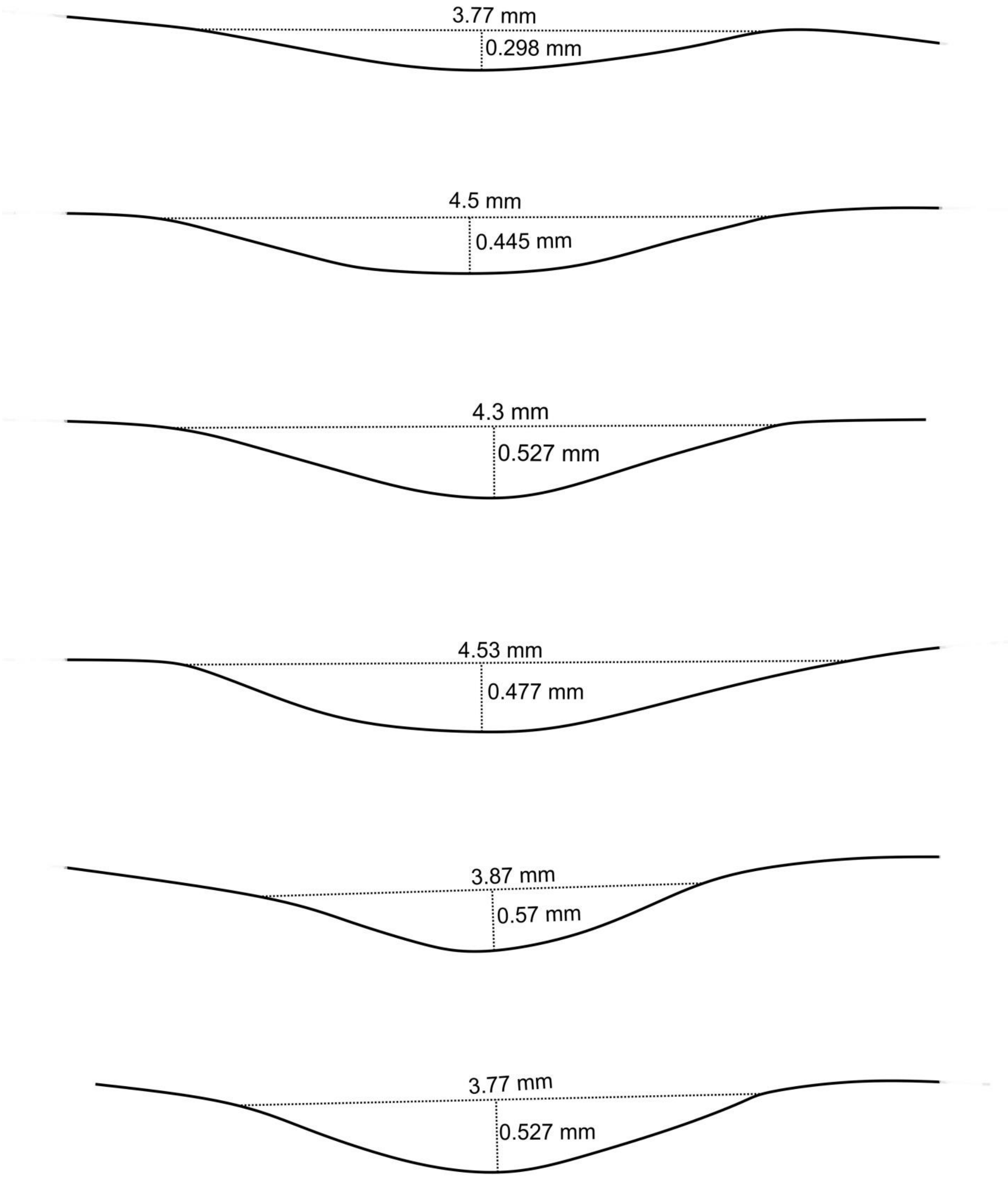
Descriptive image	
Description source	Danilenko 1986: 108—109
Note	The block is one of the most massive ones in the collection. There are no signs of any engravings or compositions with a particular semantic meaning. The images that V. Danilenko has considered animals are not evident both in incisions and the block surface. Most of the notches are too shallow to define any reliable relative chronology and do not create any recognizable system. Those that V. Danilenko has defined as the contours of creatures are primarily invisible if they exist. The back side of the block is clear and does not contain any notches or drawings of V. Danilenko. The back side of the block does not contain any traces of rock art motifs or even the desert varnish. The block may be the part of a cave wall that braked off. The shape of the block is irregular. Both its front and back side probably were not polished. The natural cracks in the right part of the block appeared after the notches were created.

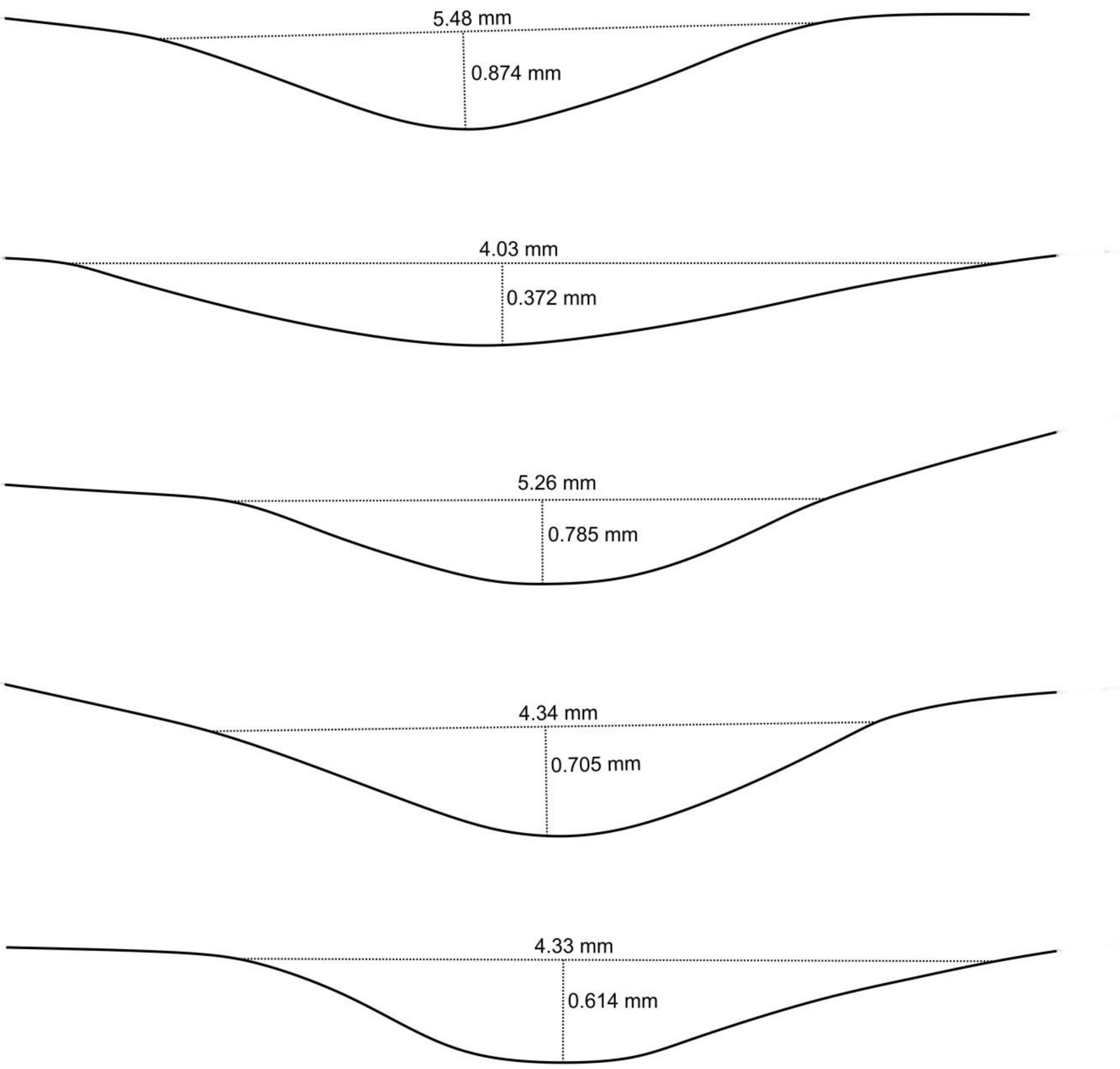
Technological drawing front

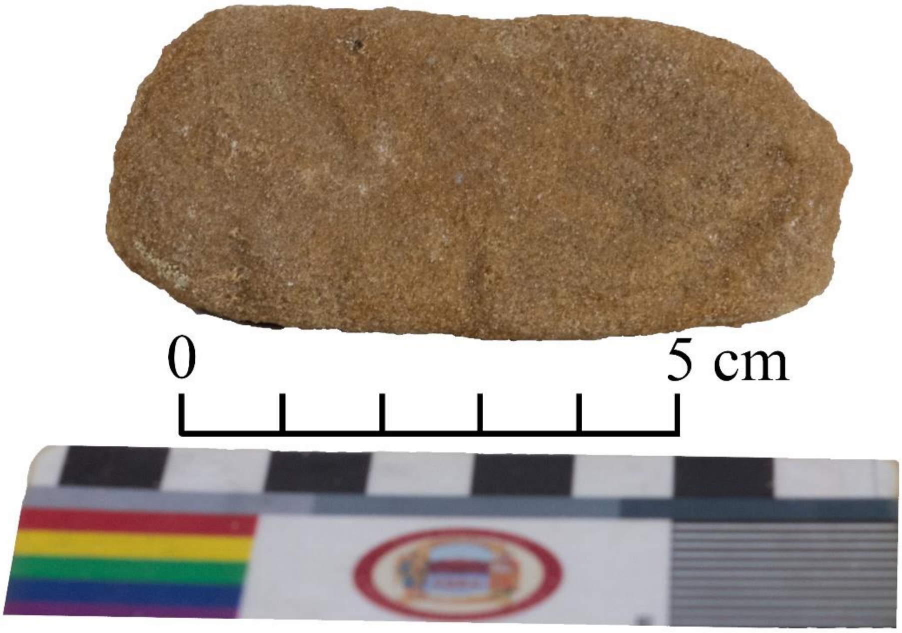
Technological drawing back



Profiles list




5.48 mm
0.874 mm
4.03 mm
0.372 mm
5.26 mm
0.785 mm
4.34 mm
0.705 mm
4.33 mm
0.614 mm

Specimen's ID	KM 74—28
Image front	
Image back	
Bottom image	

Length, cm	7.5
Width, cm	3
Weight, g	77
Date of discovery	1974
Finder	V. Danilenko
Location	“Wizard’s” cave, No. 52
Current location	Institute of Archaeology, Kyiv
Description	—
Description source	The storage list of Institute of Archaeology in Kyiv
Description 2	—
Descriptive image	—
Note	The stone has been slightly polished from both sides. The surface is artificially modified.

Annex E

The portable rock art objects from Gobustan National Historical Artistic preserve as studied from image-based 3D-models

Parameters of PC used for image processing and 3D modeling procedures

Processor	AMD Ryzen 5 3600 (100-000000031) AM4 TRAY
Clock rate	3.6—4.2 GHz
RAM	16 Gb
Visual processor	AMD Radeon RX 6500 XT 4GB GDDR6 ITX PowerColor
Operational system	Windows 10, 64bit
Software	Agisoft Metashape v. 1.5.4 build 8885

Parameters of alignment and sparse point cloud

No	Number of images taken / aligned	Tie points	Accuracy	Matching time	Alignment time	Control points error, mm	Check points error, mm	Control points error, pix	Check points error, pix
N12 A87	158 / 158	138 317	Highest	15m18s	34s	0.437	0.576	0.383	0.431
N14 A87	124 / 124	125 111	Highest	16m 23s	20s	0.402	0.476	0.48	0.364
N11 A87	138 / 138	139 319	Highest	19m 19s	19s	0.385	0.495	1.115	0.69
N15 A87	136 / 136	41 706	High	2m 15s	18s	0.281	0.298	0.537	0.443
N13 A87	144 / 144	94 488	High	2m 48s	16s	0.299	0.435	0.697	0.475
N15 A87 - 2	120 / 179	22 626	Medium	59s	15s	0.274	0.372	0.646	0.594
kurgan N3 1969	174 / 174	167 982	Highest	10m 6s	20s	0.14	0.222	0.497	0.244
F/N 588	117 / 117	121 010	High	2m 1s	15s	0.27	0.227	0.807	0.65
F/N 1270	113 / 113	118 878	Highest	6m 26s	38s	0.351	0.465	0.816	0.716
F/N 2236	139 / 139	143 701	Highest	8m 1s	21s	0.414	0.459	0.488	0.611
N 1094	129 / 163	106 319	Highest	6m 46s	38s	0.206	0.458	0.737	0.466
Unnumbered	140 / 140	150 710	Highest	9m 38s	20s	0.293	0.417	0.913	0.449
F/N 205	124 / 124	139 523	Highest	14m 42s	15s	0.261	0.327	1.611	1.725
F/N 1068	127 / 127	131 617	High	2m 27s	22s	0.128	0.451	0.652	0.459
F/N 1803	133 / 133	71 810	Medium	1m 37s	20s	0.156	0.216	0.843	0.737

Parameter of dense point cloud and mesh reconstruction

No	Dense cloud points	Quality	Filtering mode	Depth map generation time	Dense cloud generation parameters	Number of faces	Interpolation	Processing time
N12 A87	2 895 609	High	Mild	19m 9s	30m 3s	7 121 208	Enabled	1m 14s
N14 A87	3 196 247	High	Mild	7m 56s	20m 4s	6 961 628	Enabled	1m 29s
N11 A87	3 318 308	High	Mild	15m 6s	25m 40s	8 000 000	Enabled	1m 53s
N15 A87	2 131 897	High	Mild	9m 25s	23m 12s	5 180 848	Enabled	1m 4s
N13 A87	1 121 900	High	Mild	8m 38s	20m 27s	2 765 988	Enabled	43s
N15 A87 - 2	1 557 397	High	Mild	7m 37s	20m 6s	3 841 582	Enabled	50s
kurgan N3 1969	5 943 045	High	Mild	23m 30s	42m 7s	8 000 000	Enabled	3m 17s
F/N 588	4 832 505	High	Mild	13m 49s	23m 21s	8 000 000	Enabled	2m 44s
F/N 1270	4 519 164	High	Mild	11m 6s	21m 46s	8 000 000	Enabled	2m 5s
F/N 2236	6 993 247	High	Mild	17m 59s	29m 17s	7 921 336	Enabled	3m 27s
N 1094	1 288 914	High	Mild	9m 50s	19m 57s	3 249 092	Enabled	43s
Unnumbere d	5 314 851	High	Mild	14m 12s	28m 57s	8 000 000	Enabled	2m 39s
F/N 205	6 718 158	High	Mild	25m 30s	30m 42s	8 000 000	Enabled	4m 2s
F/N 1068	4 807 438	High	Mild	18m 12	27m 34s	8 000 000	Enabled	2m 33s
F/N 1803	5 220 065	High	Mild	13m 32s	32m 36s	7 965 160	Enabled	2m 44s

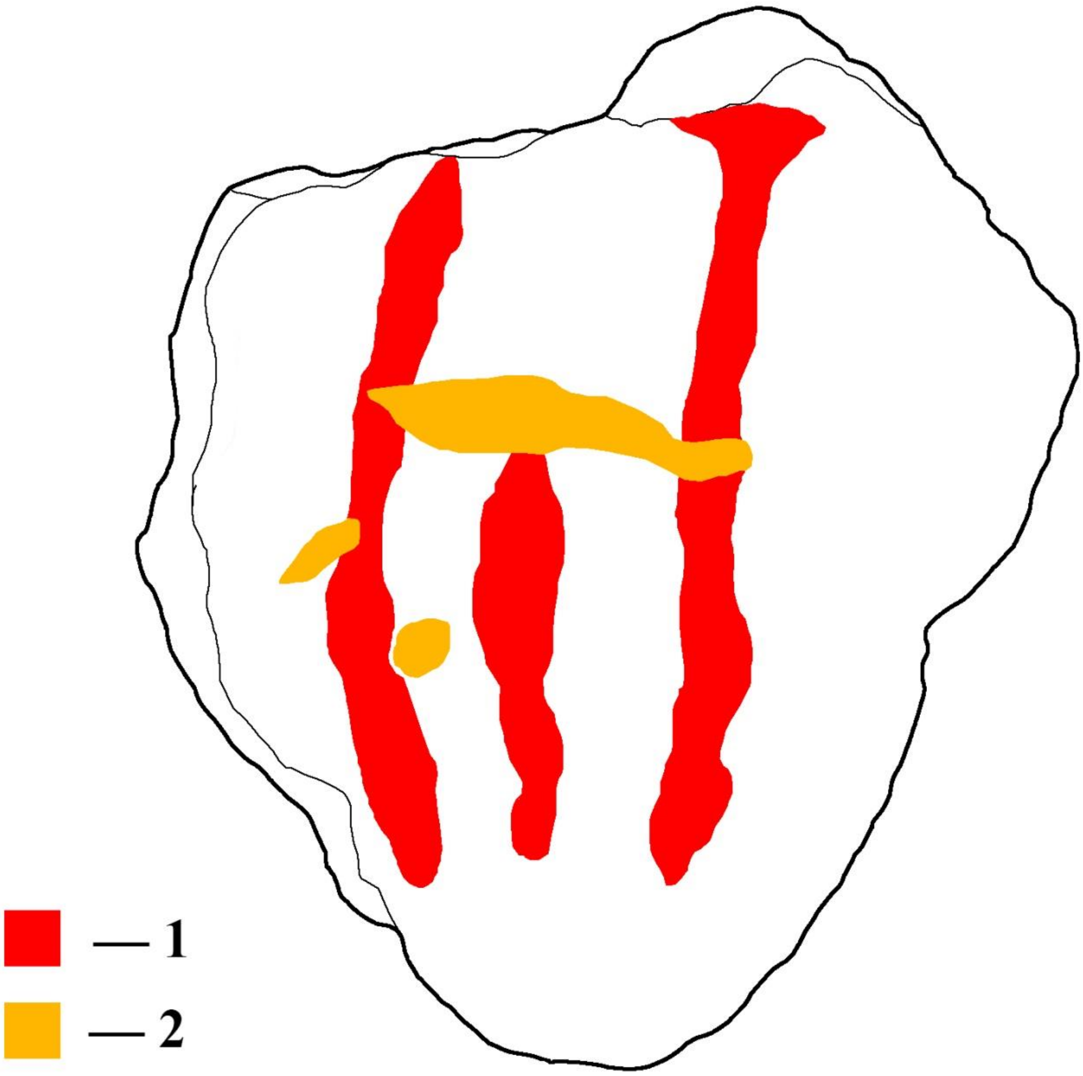
Specimen's ID	N12(A87)
Image front	
Image left	
Image back	

Image right	
Image top	
Image bottom	
Length, cm	19.7
Width, cm	17.6
Thickness, cm	3.42
Date of discovery	1987
Finder	I. Aliev, G. Aslanov
Location	Bendyustyu site, Apsheron penninsula
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	The human figure is depicted in full growth. Near the assumed “shoulder,” the stone block is broken (possibly intentionally). The image is schematic; the stomach is crossed with the belt line. Lines are shallow and scratched. Heights — 14 cm, width — 6—7 cm.

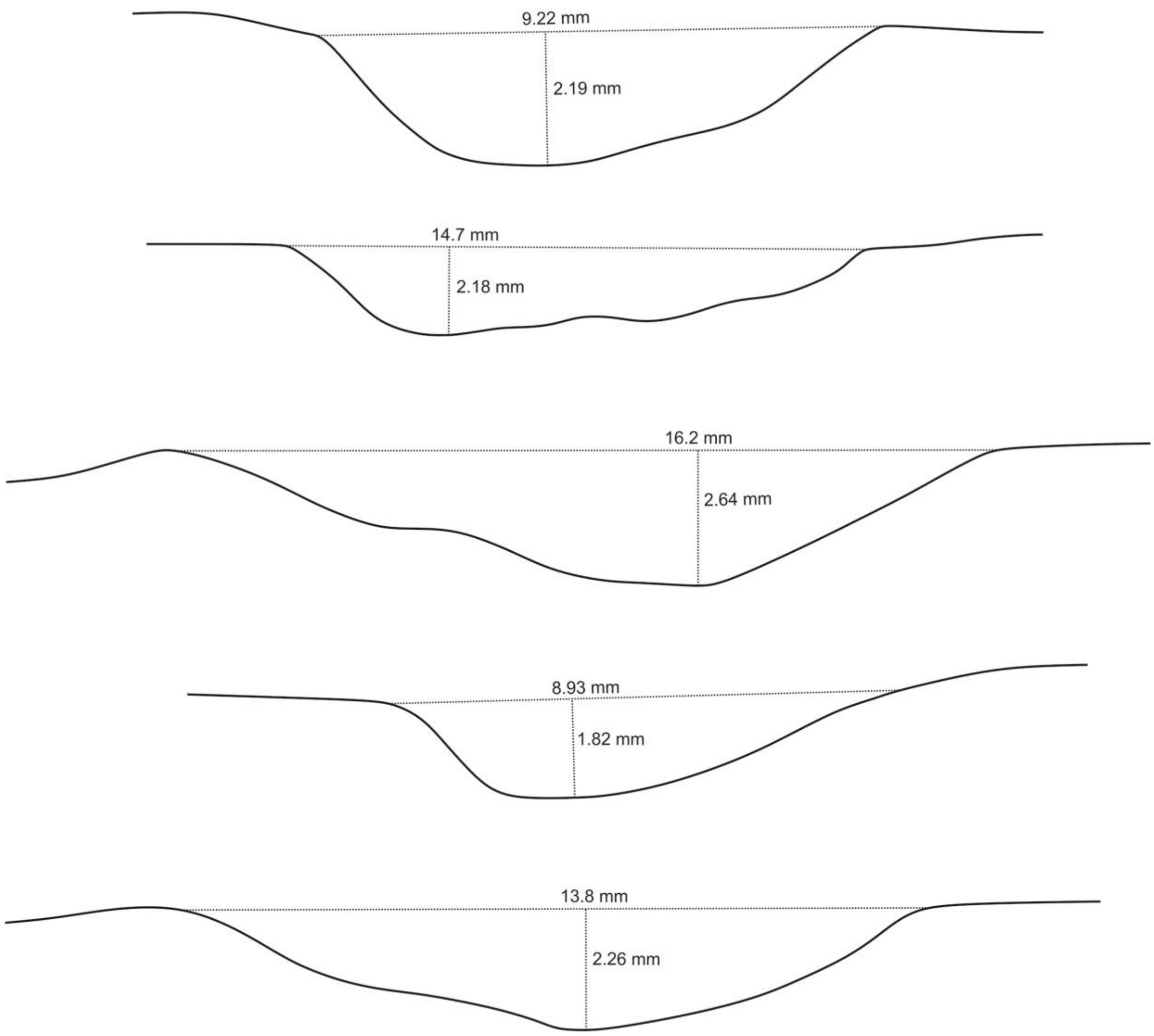
Description source	Report of Apsheron squad of Baku-Apsheron archaeological expedition in 1987 (June 10 — July 10): 13
Note	The block has been described only in the field report from the 1987 field season. The measurements provided in the field report are not correct. The front side of a stone has been polished to create a flat shape before engraving. The assumption of Aslanov and Aliev that the belt line has been added after a vertical one proved to be correct. The sequence is well-defined due to the softness of the limestone. The primary engraving method is multiple scratches that cause the appearance of a curvilinear and irregular profile. The left vertical line is featured with two short scratched or pecked lines.

Technological drawing front

Drawing sequence front



Cross-section card

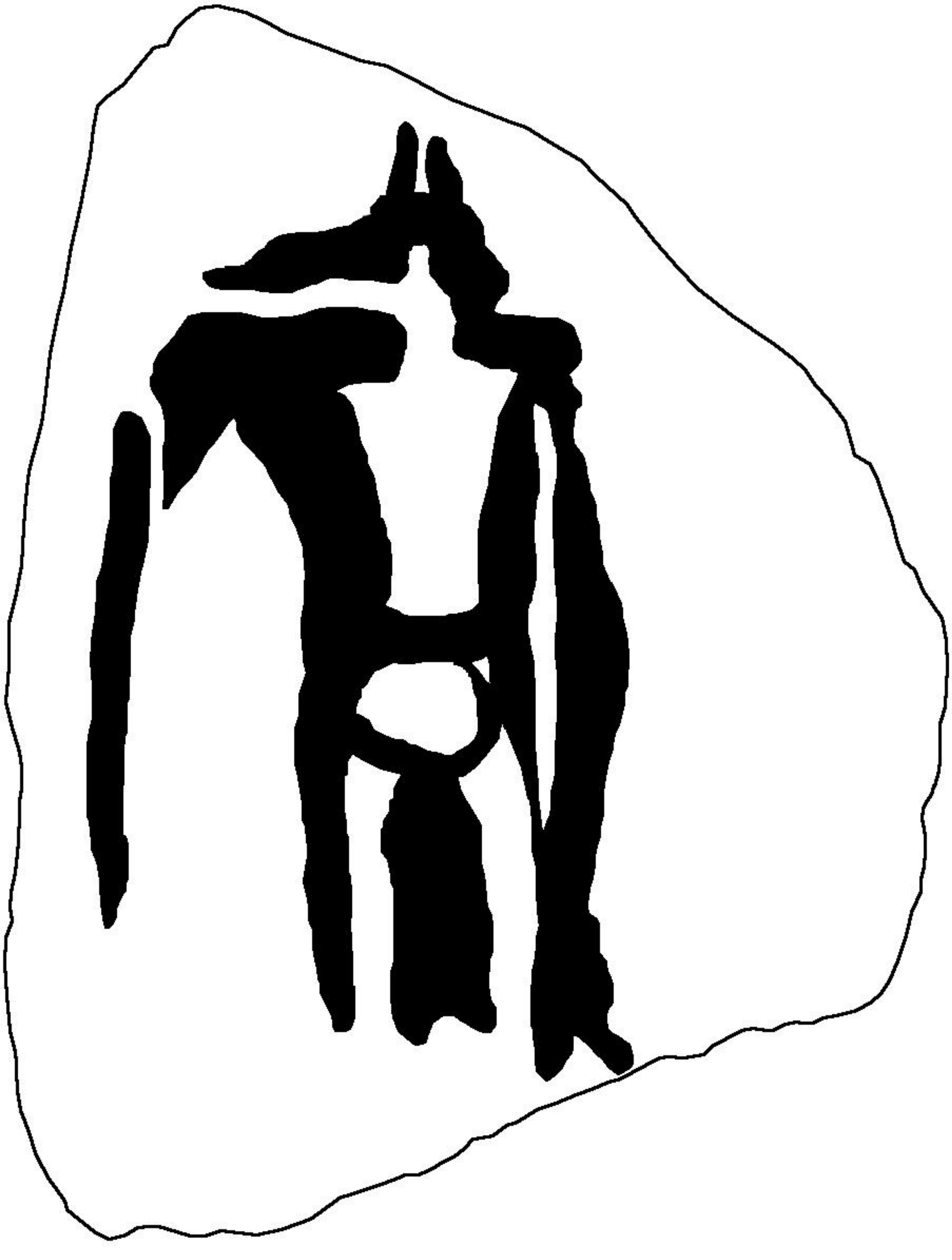


Specimen’s ID	N14(A87)
Image front	
Image left	
Image back	

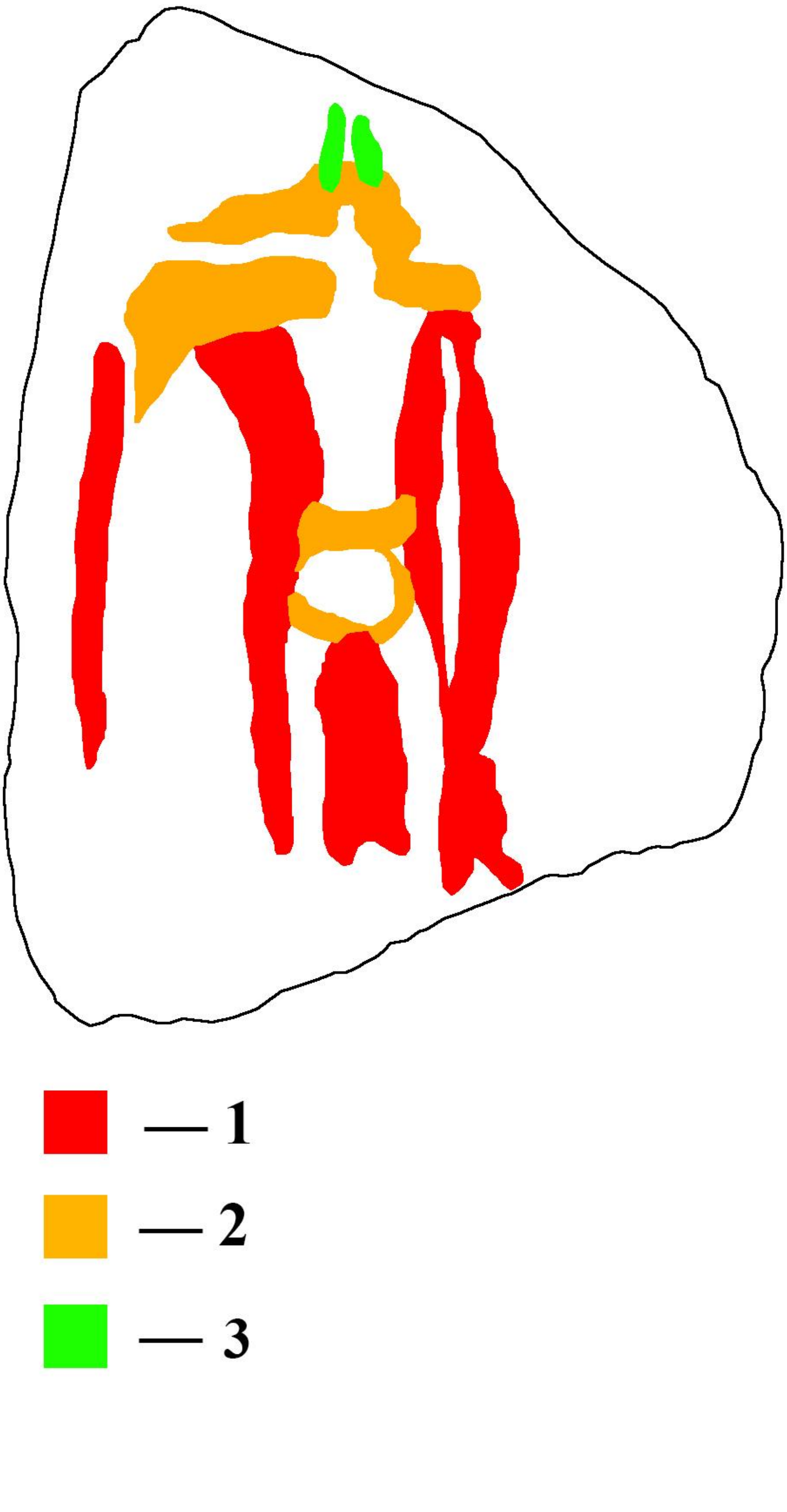
Image right	
Image top	
Image bottom	
Length, cm	20.4
Width, cm	14.9
Thickness, cm	5.62
Date of discovery	1987
Finder	I. Aliev, G. Aslanov
Location	Bendyustyu site, Apsheron penninsula
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	A woman is depicted in full growth. Lines are pecked and deepened. A head is in a shape of a prolonged trapeze. The curved line connects the head and the legs (probably resembles a hair). The left hand is near the hip; the legs are apart. Shoulders and hips are slightly emphasized. The stomach is featured with the belt above a small circular bump. Heights — 15 cm, width — 5—6 cm.
Description source	Report of Apsheron squad of Baku-Apsheron archaeological expedition in 1987 (June 10 — July 10): 13—14

Note	The block has been described only in the field report from the 1987 field season. The measurements provided in the field report are not correct. The front side of a stone has been slightly polished to create a flat shape before engraving. The engraving is a “positive” relief of a human figure in a horizontal hat, which used to be considered in relation to Sumerian impacts on the region. The belt line has been engraved later than the body. A narrow protrusion under the belt forms a circular ledge. It has been considered a sex representation. The sequence is well-defined due to the softness of limestone though almost non-informative. The primary engraving method is scratching with multiple scratches that cause the appearance of curvilinear and irregular cross-sections.

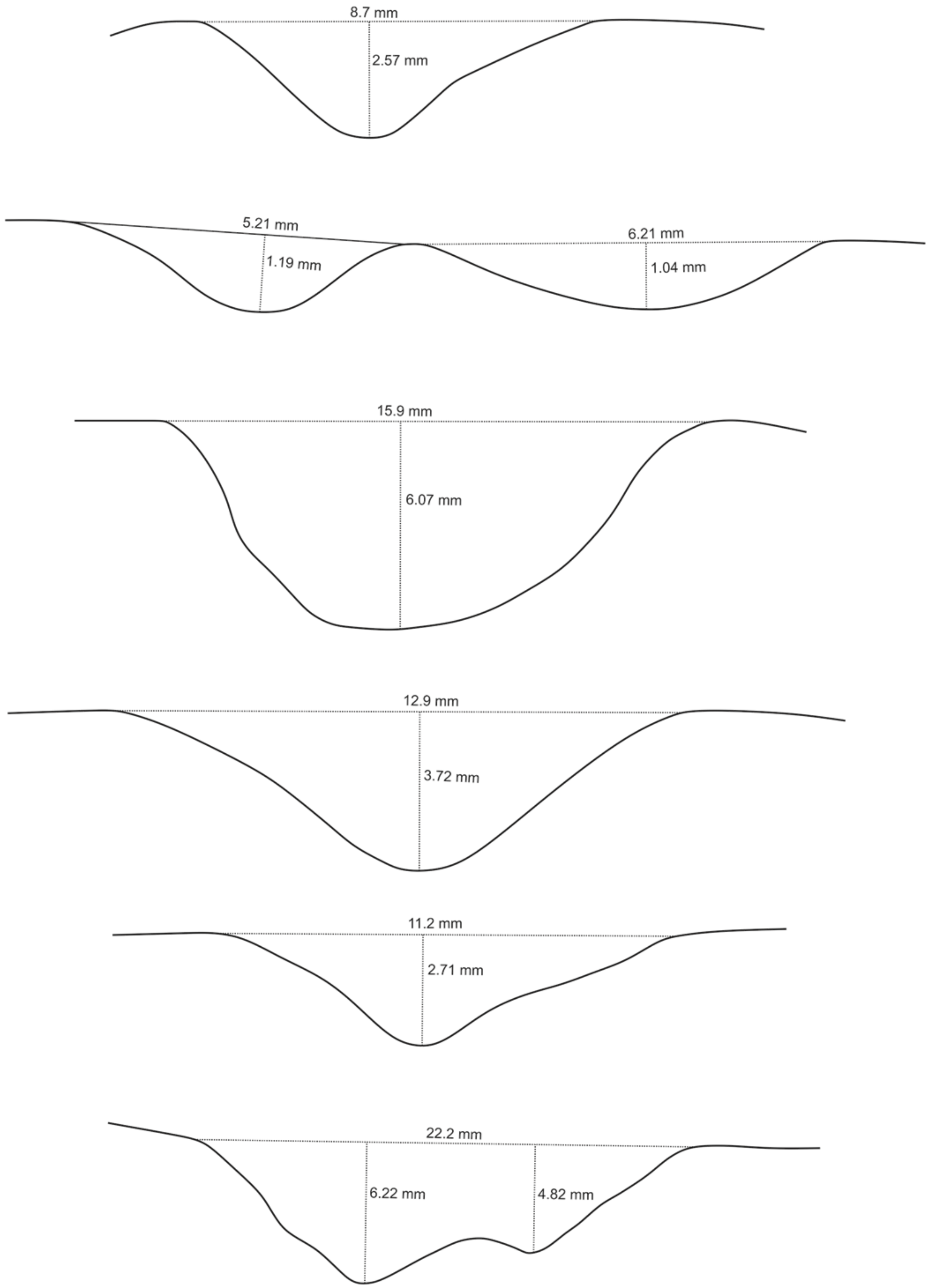
Technological drawing front



Drawing sequence front



Cross-section card

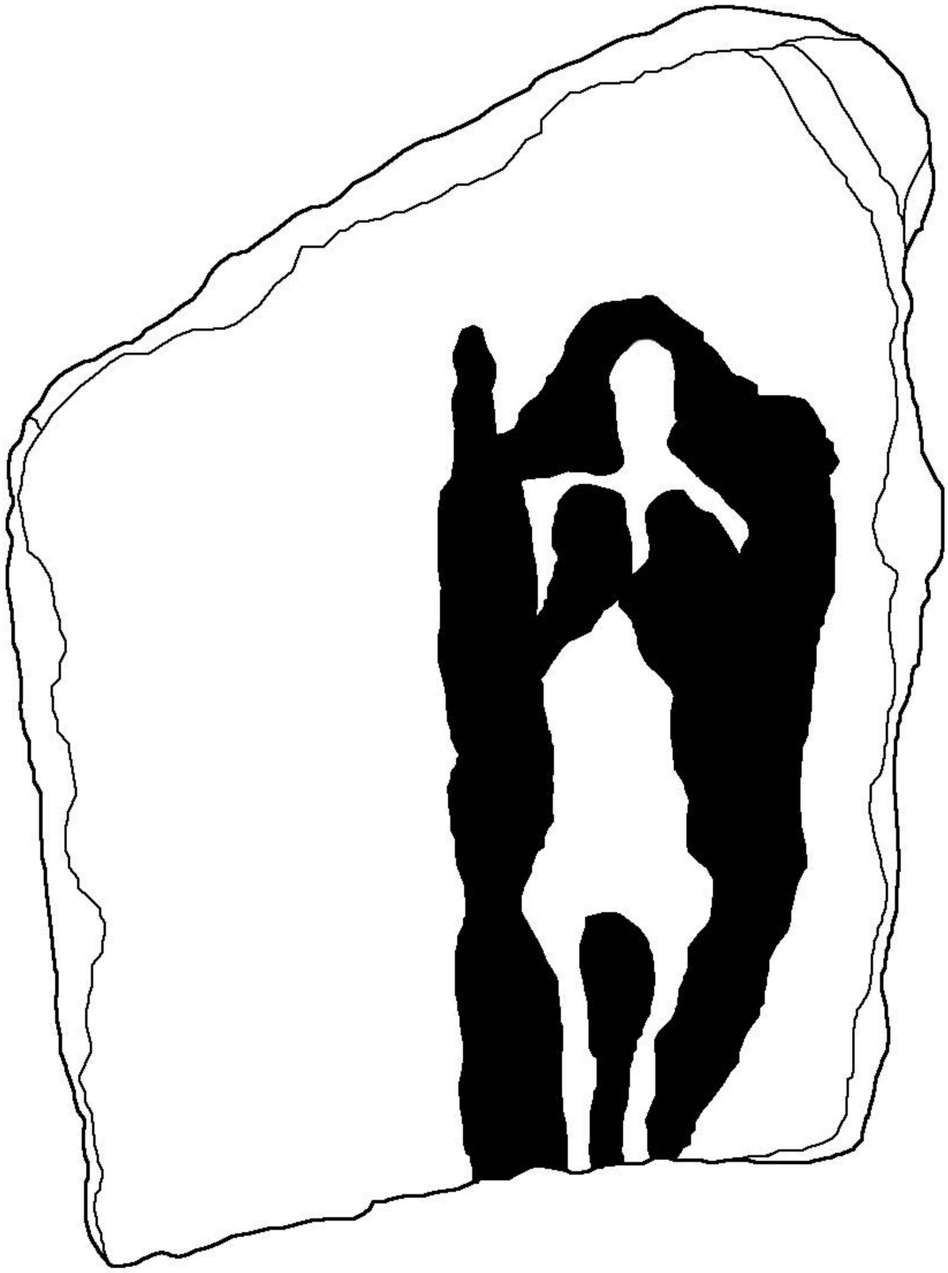


Specimen's ID	N11(A87)
Image front	
Image left	
Image back	

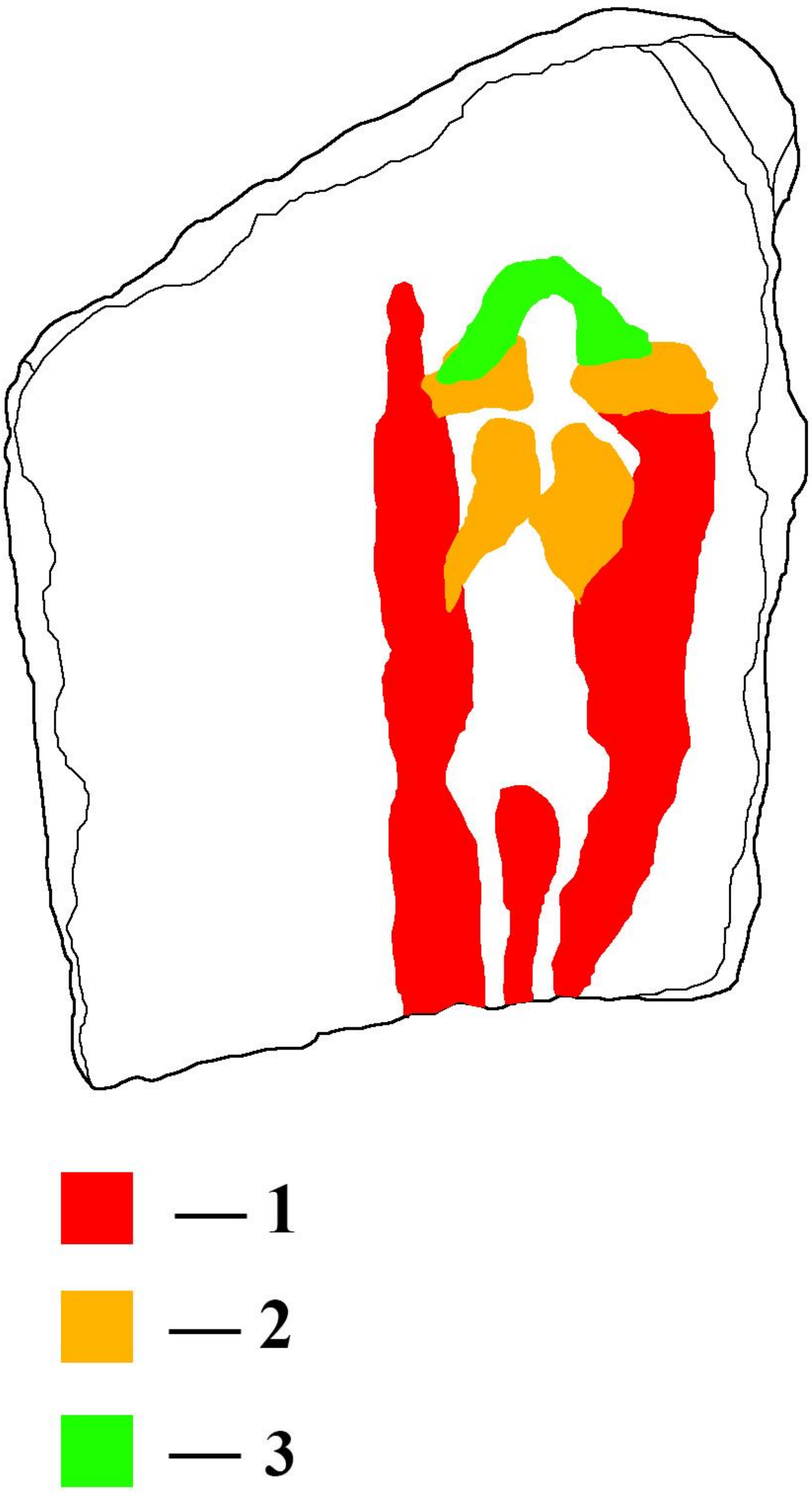
Image right	
Image top	
Image bottom	
Length, cm	24.8
Width, cm	15.4
Thickness, cm	5.92
Date of discovery	1987
Finder	I. Aliev, G. Aslanov
Location	Bendyustyu site, Apsheron penninsula
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	The human figure is depicted in full growth. Lines are pecked, irregular. The head is fully depicted, hands are crossed on the chest, and shoulders are wider to the top. The waist is narrowed, the hips are highlighted, and the legs are compressed. Heights — 14—15 cm, width — 4—5 cm.

Description source	Report of Apsheron squad of Baku-Apsheron archaeological expedition in 1987 (June 10 — July 10): 13
Note	The block has been described only in the field report from the 1987 field season. The measurements provided in the field report are not correct. The front side of a stone has been polished to create a flat shape before engraving. The engraving is a “positive” relief of a figure. It is probably female due to the shape of the hips. The hands are curved on its breast and represented with engraved areas. The engravings indicate the use of the mixed technique — scratching, featured with pecking. However, this assumption requires additional traceological experiments to be proven. The surface analysis allows the reconstruction of the artistic strategies of the object creator. The long vertical lines that contour the body were made first (scratched and polished). Further, the shoulders were shaped with pecking, and the head was shaped in mixed technique. The long line between the figure’s legs and the image of hands was probably created by pecking.

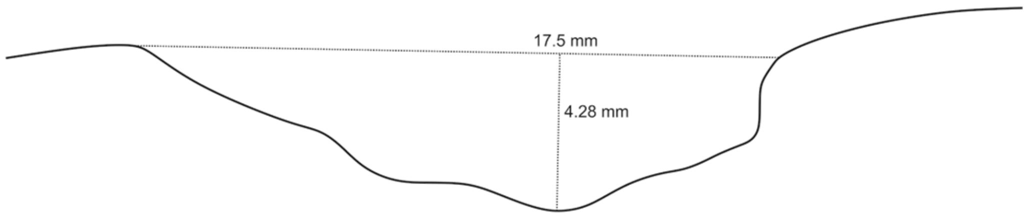
Technological drawing front

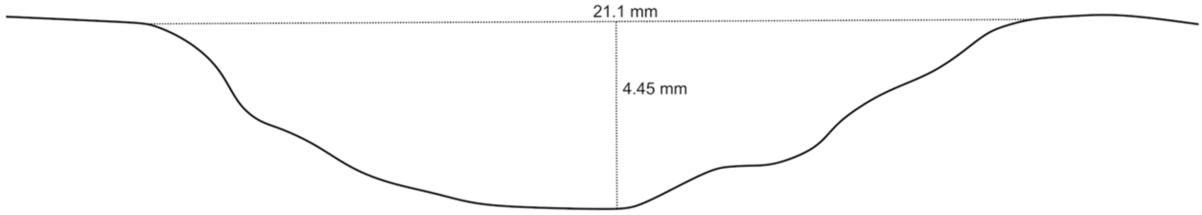


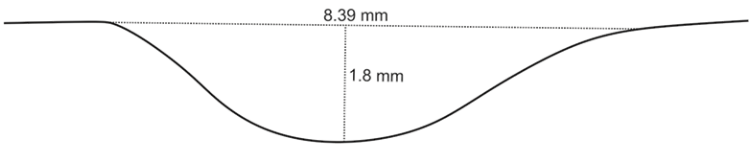
Drawing sequence

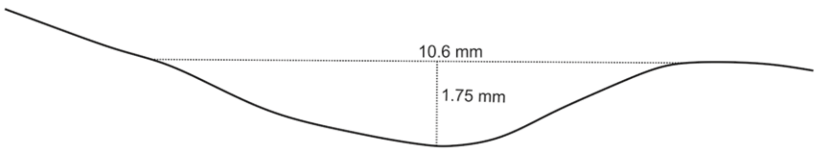


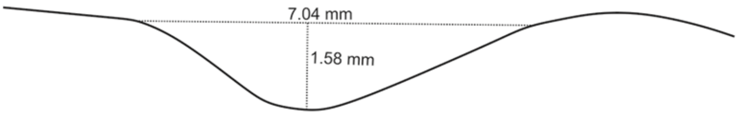
Cross-section card

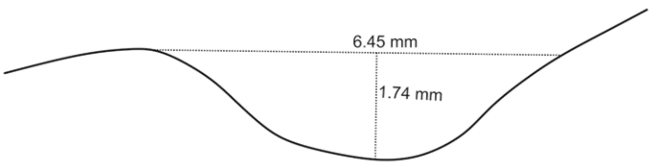












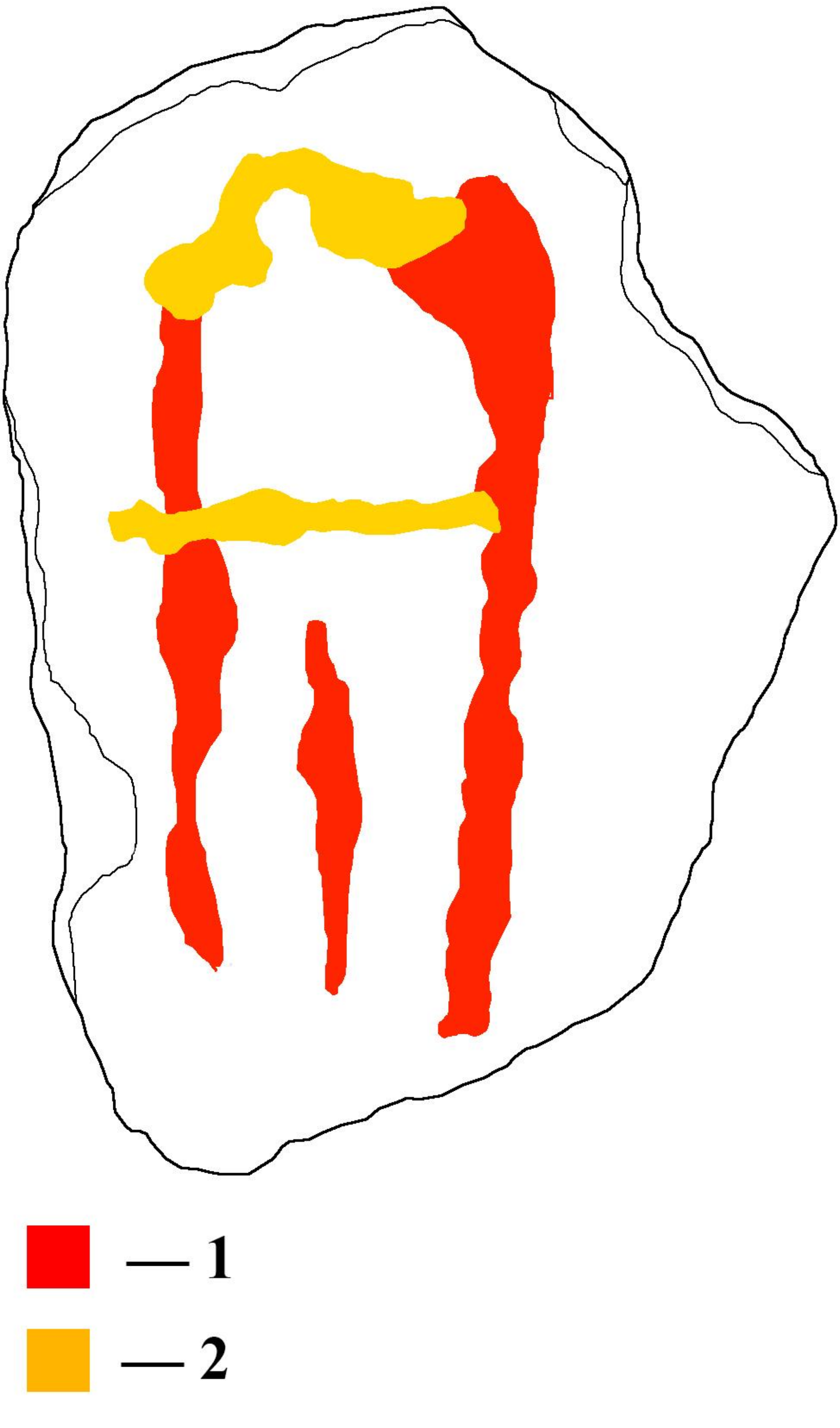
Specimen's ID	N15(A87)
Image front	
Image left	
Image back	

Image right	
Image top	
Image bottom	
Length, cm	19.7
Width, cm	12.4
Thickness, cm	4.25
Date of discovery	1987
Finder	I. Aliev, G. Aslanov
Location	Bendyustyu site, Apsheron penninsula
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	The human figure is depicted in full growth. The image is schematic; lines are shallow and smooth. The Head is depicted as a small semi-circle. A line near the stomach resembles a belt. Legs are apart, and shoulders are widened and slightly raised. Heights — 14—15 cm, width — 5—6 cm.
Description source	Report of Apsheron squad of Baku-Apsheron archaeological expedition in 1987 (June 10 — July 10): 14

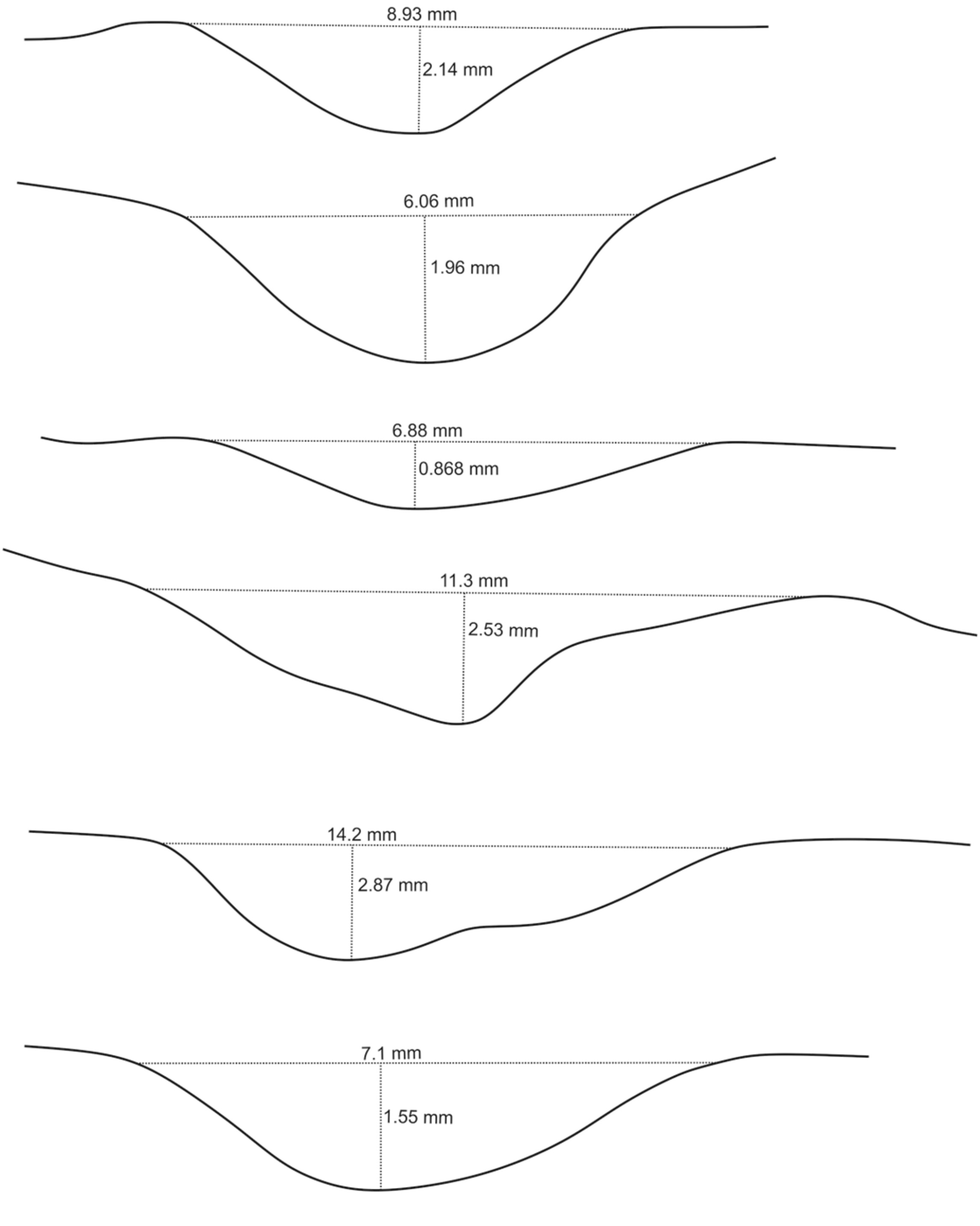
Note	The block has been described only in the field report from the 1987 field season. The measurements provided in the field report are not correct. The front side of a stone has been slightly polished to create a flat shape before engraving. However, the surface is hardly damaged, especially in the lower part of the block. The engraved lines are irregular in shape, have different widths and lengths, and have complicated cross-sections. Some parts of the image indicate the use of a mixed technique — pecking after scratching. The assumption of Aslanov and Aliev that the belt line has been added after a vertical one seems correct. The sequence is unclear as the lines were heavily pecked after the scratching. However, the legs, head, and belt are well-defined.

Technological drawing front

Drawing sequence front



Cross-section card

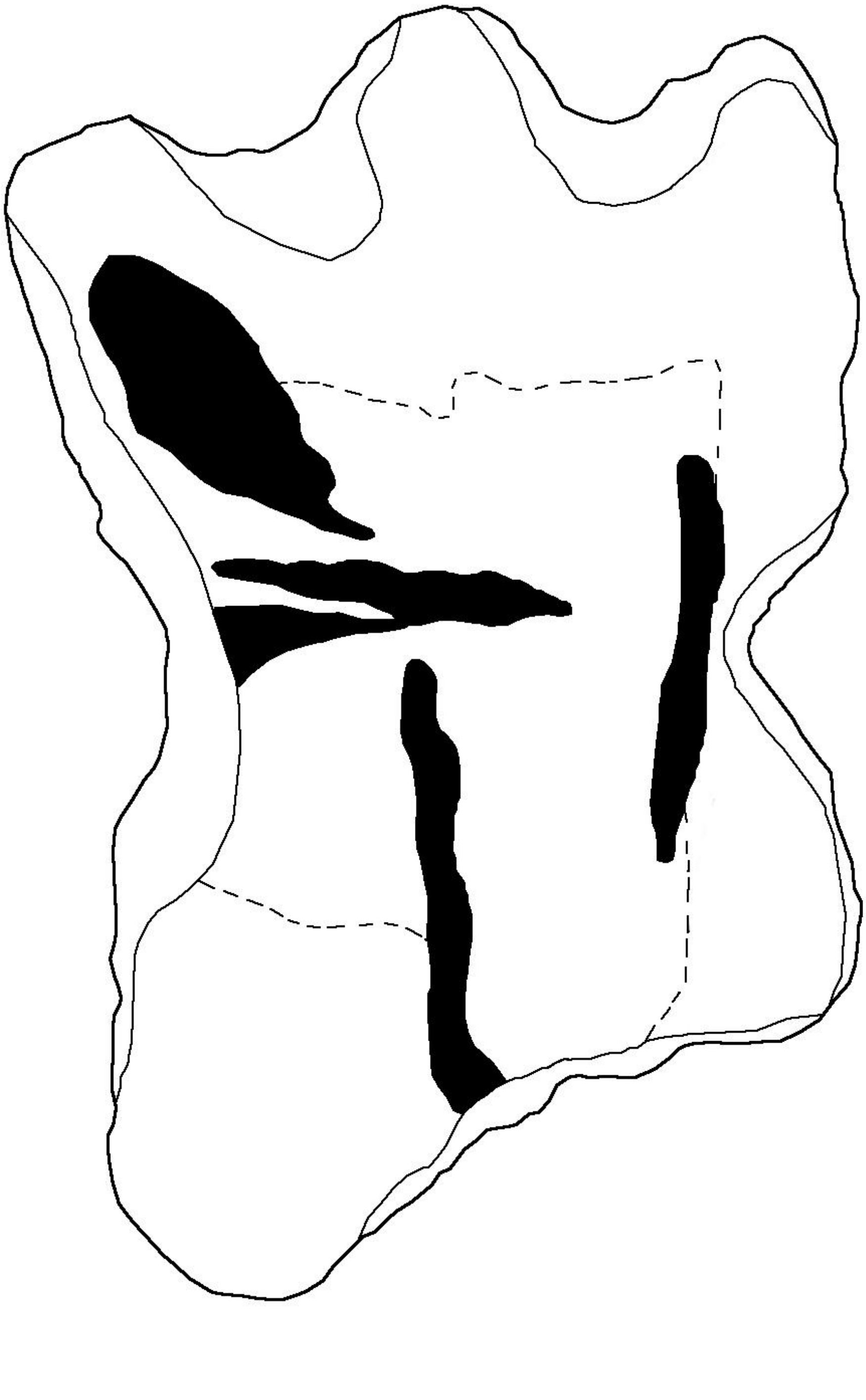


Specimen's ID	N13(A87)
Image front	
Image left	
Image back	

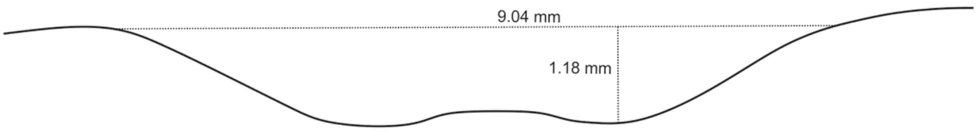
Image right	
Image top	
Image bottom	
Length, cm	13.6
Width, cm	8.5
Thickness, cm	2.6
Date of discovery	1987
Finder	I. Aliev, G. Aslanov
Location	Bendyustyu site, Apsheron penninsula
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	Sculptured figurine. The head is emphasized; hands are crossed on the chest. The elbows are slightly raised and also emphasized. The waist is narrowed, legs are shortened (one is broken off). Heights — 14 cm; width — 6—8.5 cm.
Description source	Report of Apsheron squad of Baku-Apsheron archaeological expedition in 1987 (June 10 — July 10): 13

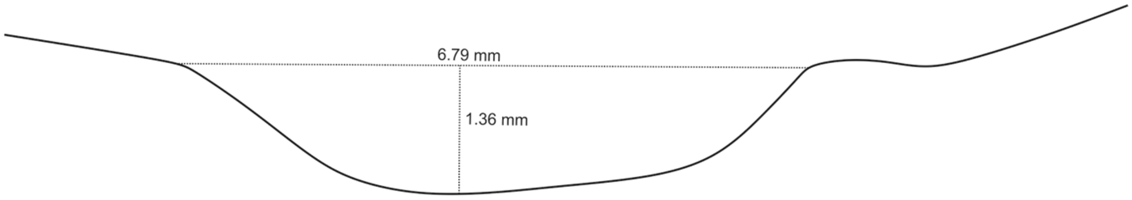
Note	The figure has been described only in the field report from the 1987 field season. The measurements provided in the field report are approximately correct. The stone represents an anthropomorphic figurine with a narrow waist, possibly emphasized by the engraved line, raised hands, stressed head, and shortened legs. A central part of the front side of a figure is deepened. It contains several irregular lines and has probably been pecked to contour the figurine. Aslanov and Aliev claim that one leg is broken off, possibly true. Engravings are barely visible, outnumbered, and irregular; the shape is mostly processed through pecking. Some areas, especially on the front side, may have been polished.

Technological drawing front



Cross-section card



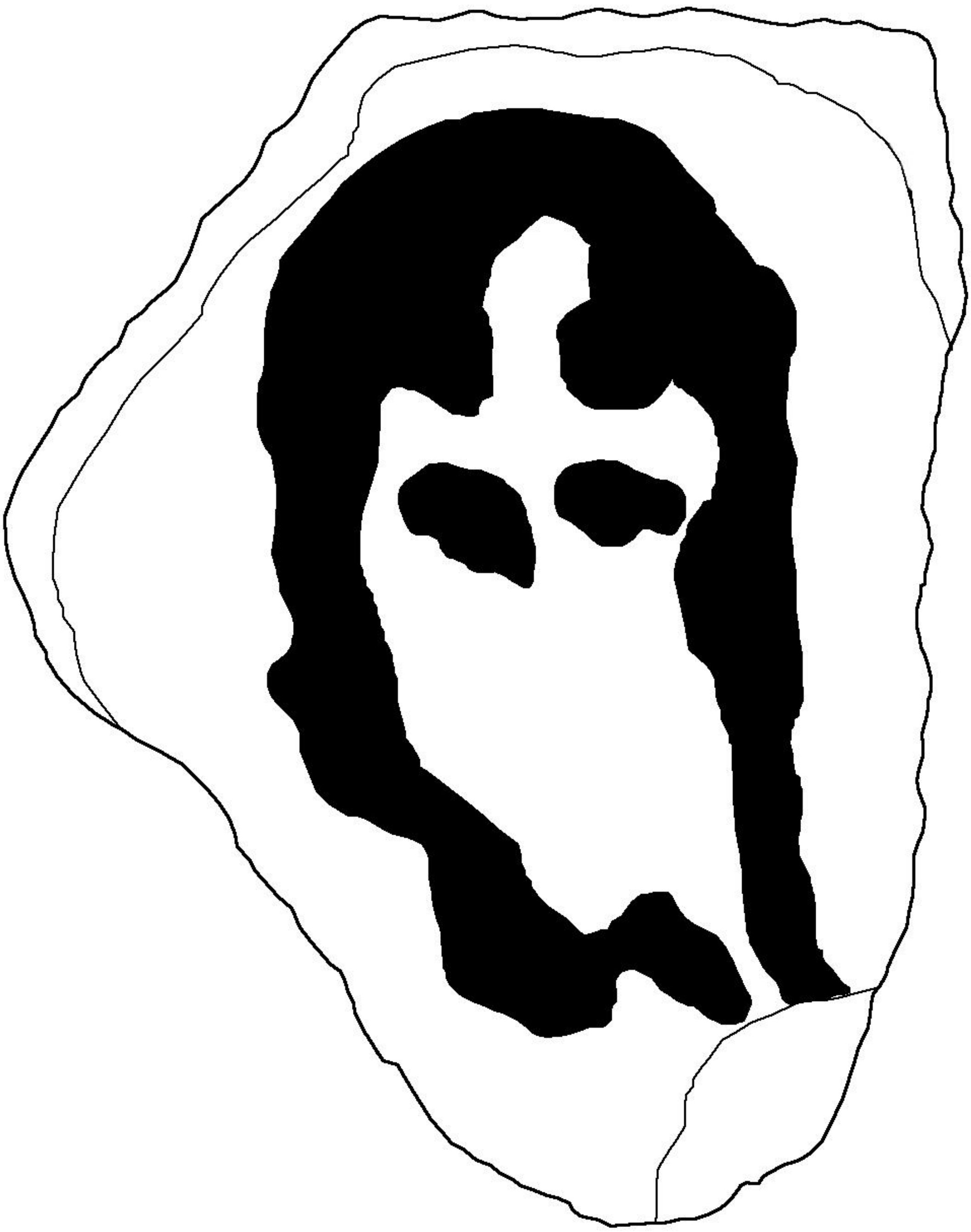


Specimen's ID	N15(A87)-2
Image front	
Image left	
Image back	

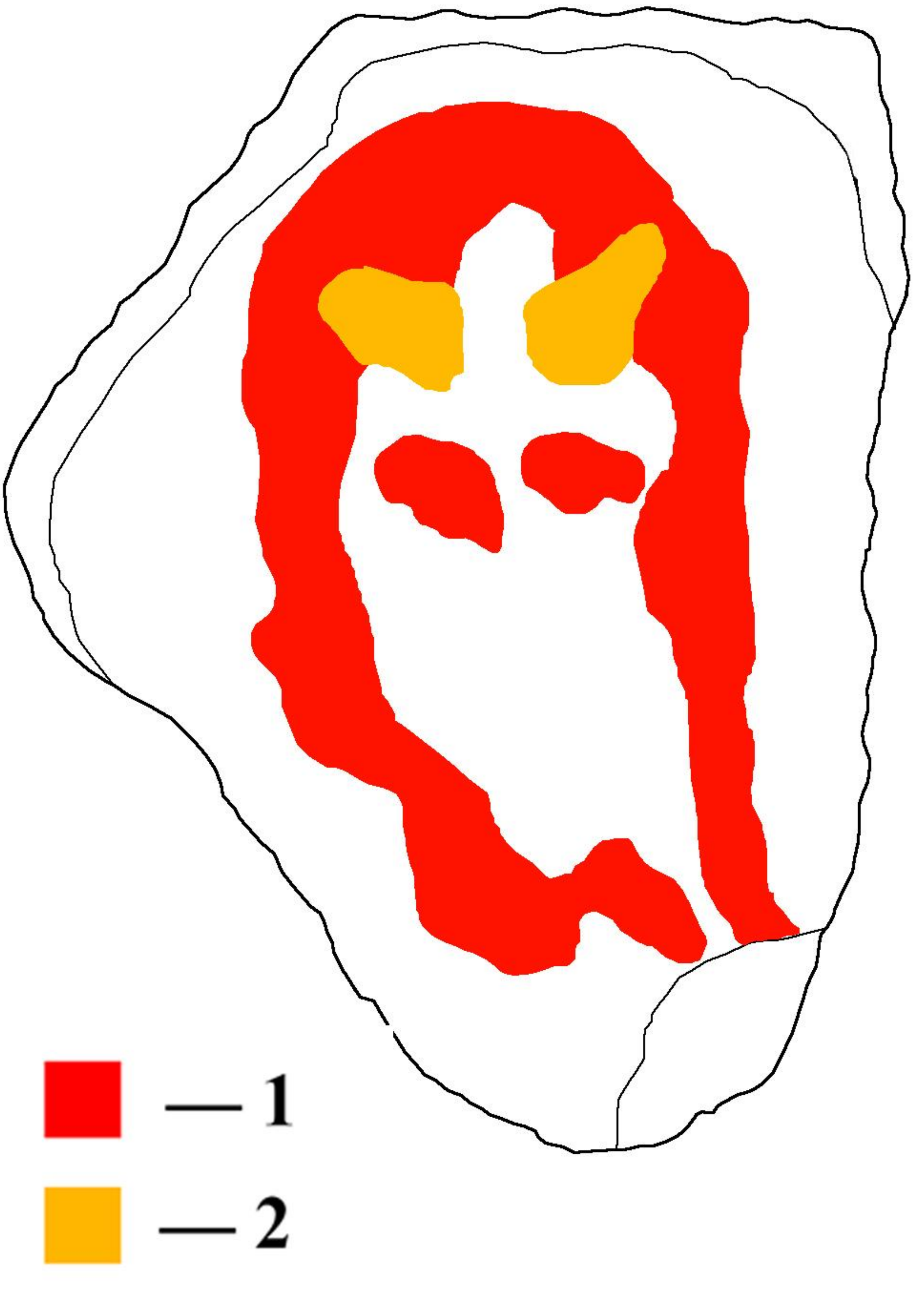
Image right	
Image top	
Image bottom	
Length, cm	12.2
Width, cm	9.26
Thickness, cm	3.35
Date of discovery	1987
Finder	I. Aliev, G. Aslanov
Location	Bendyustyu site, Apsheron penninsula
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	Stylized image of a human being. The head is emphasized. The chest is featured with two marks. Legs are shortened. Heights — 8—8.5 cm, width — 4—4.5 cm.
Description source	Report of Apsheron squad of Baku-Apsheron archaeological expedition in 1987 (June 10 — July 10): 14

Note	The block has been described only in the field report from the 1987 field season. The measurements provided in the field report are not correct. All stone sides have been polished to create six flat or sub-flat surfaces. The front side was manufactured to create a “positive” image of an anthropomorphous figure. The engraving is done with pecking or (less probably) a mixed technique. The figure’s arms are bent. They are marked by deepened areas on the anthropomorph’s breast. Its shoulders are contoured with two areas after the whole silhouette was carved. The wide pecked line that contours the head is shallow, while the silhouette around the body is comparatively deeper. Legs are depictured schematically.

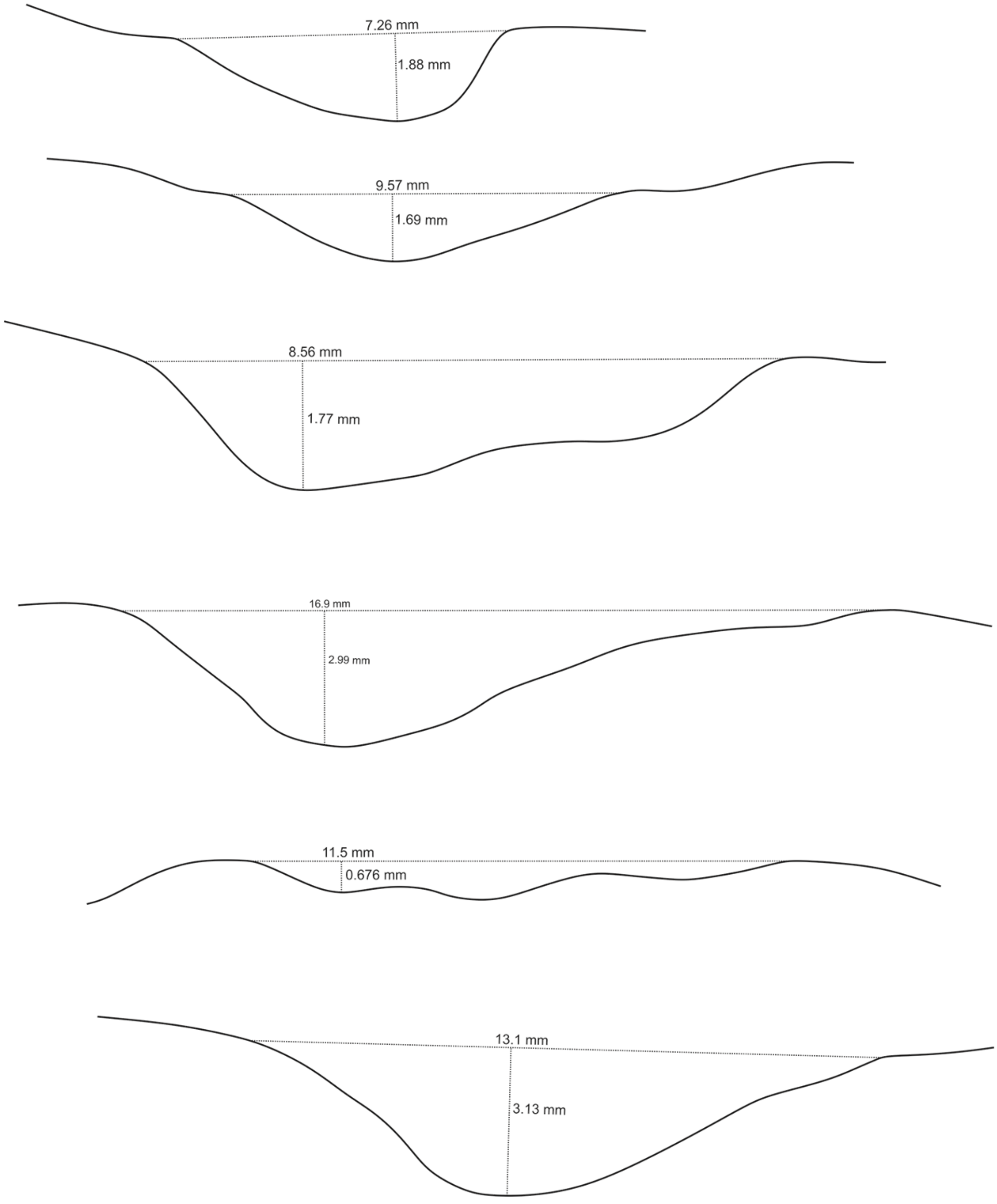
Technological drawing front



Drawing sequence front

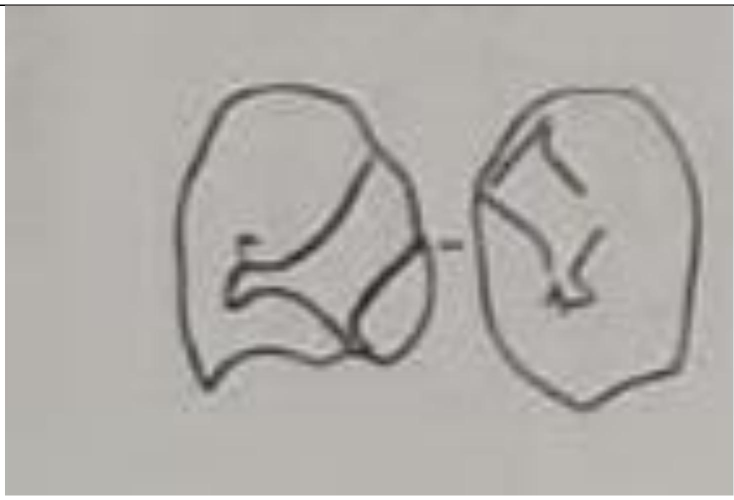


Cross-section card

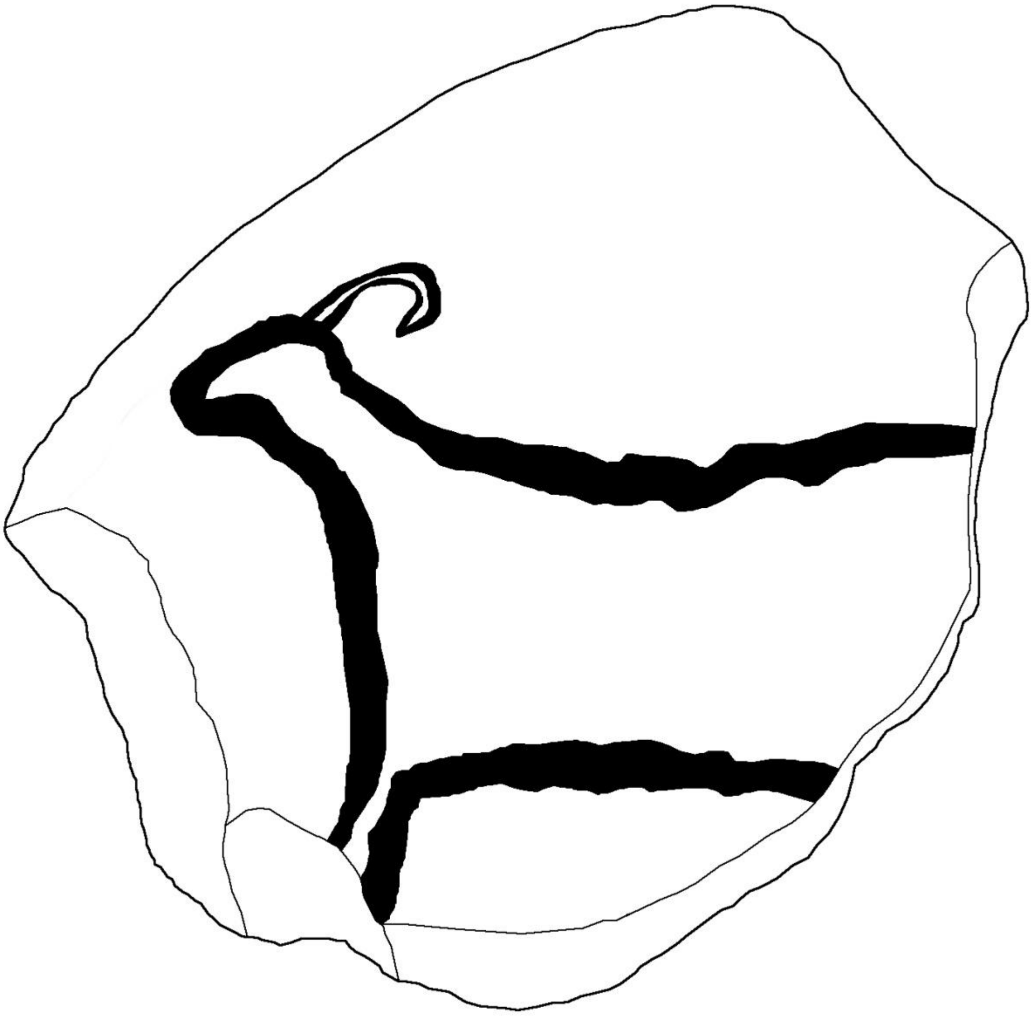


Specimen's ID	Kurgan No. 3, 1969 [Inv. 4]
Image front	
Image left	
Image back	

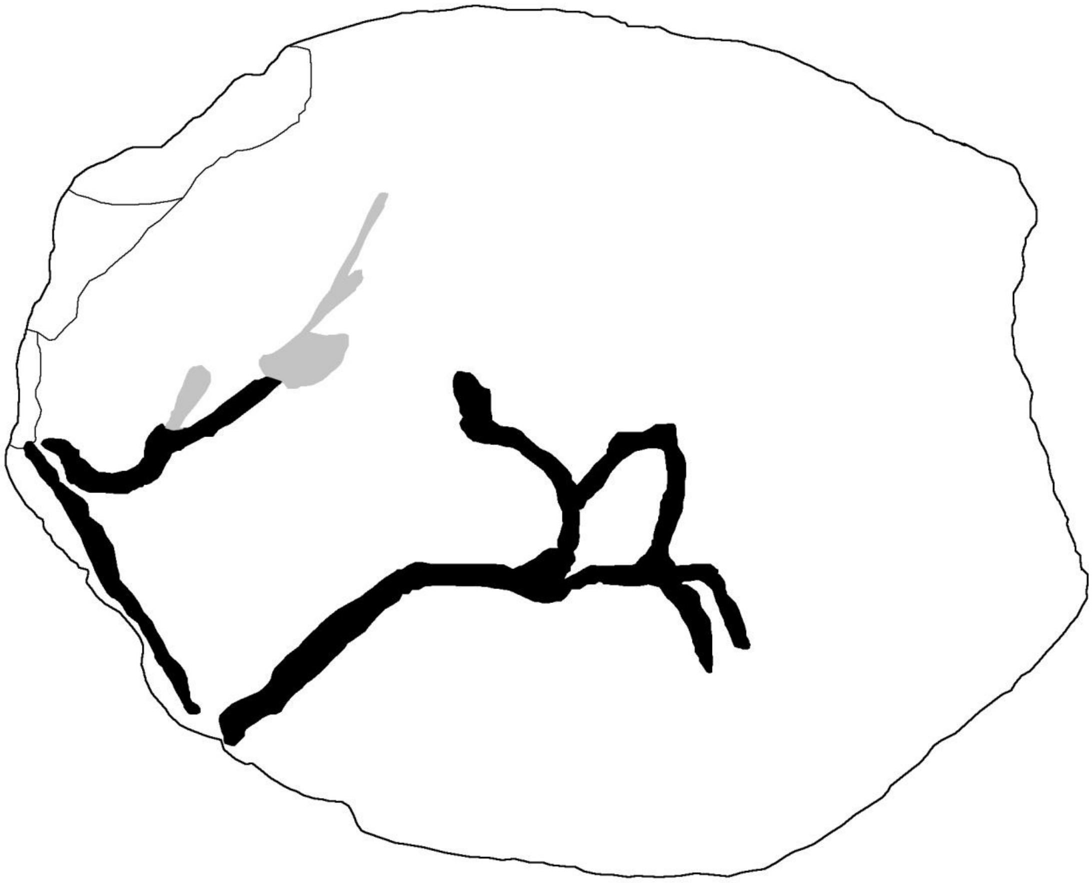
Image right	
Image top	
Image bottom	
Length, cm	31.4
Width, cm	23.1
Thickness, cm	6.85
Date of discovery	1969
Finder	F. Muradova

Location	Burial Mound 3, Boyukdash, Gobustan
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	A stone with zoomorphic images on both sides.
Description source	Muradova 2003: 47—54
Description 2	The stone is found together with 11 other stones in the burial mound No. 3 in Boyukdash. The Mound belongs to the Stone Box type. The burial belongs to the complex of Bronze Age burial mounds of Boyukdash. It was 1.1 m high and contained a cromlech with a diameter of 11 m.
Description 2 source	Muradova 2011: 145—146
Drawing	
Drawing source	Muradova 2003: 53, fig. 2
Note	The block has been described only in the field report from the 1969 field season and in Muradova 2011, though no detailed description of engravings is available. Both the front and back sides are polished. A stone is most probably broken after being engraved. Flat surfaces are featured with the engraving of a goat. The engraving on the front side is partial, with small horns and front legs. The lines are wide and shallow. The cross-sections are smoothened, so the whole surface seems to be degraded. The technology, most probably, is polishing after pecking. The engravings were filled with white chalk upon discovery. The back side is featured with a smaller image. The front legs are absent, possibly due to the degradation of the surface. The engravings are deeper, possibly pecked and scratched (additional microscopic investigation is needed). A lot of natural destructions on the back side of the block. The sequence needs to be clarified.

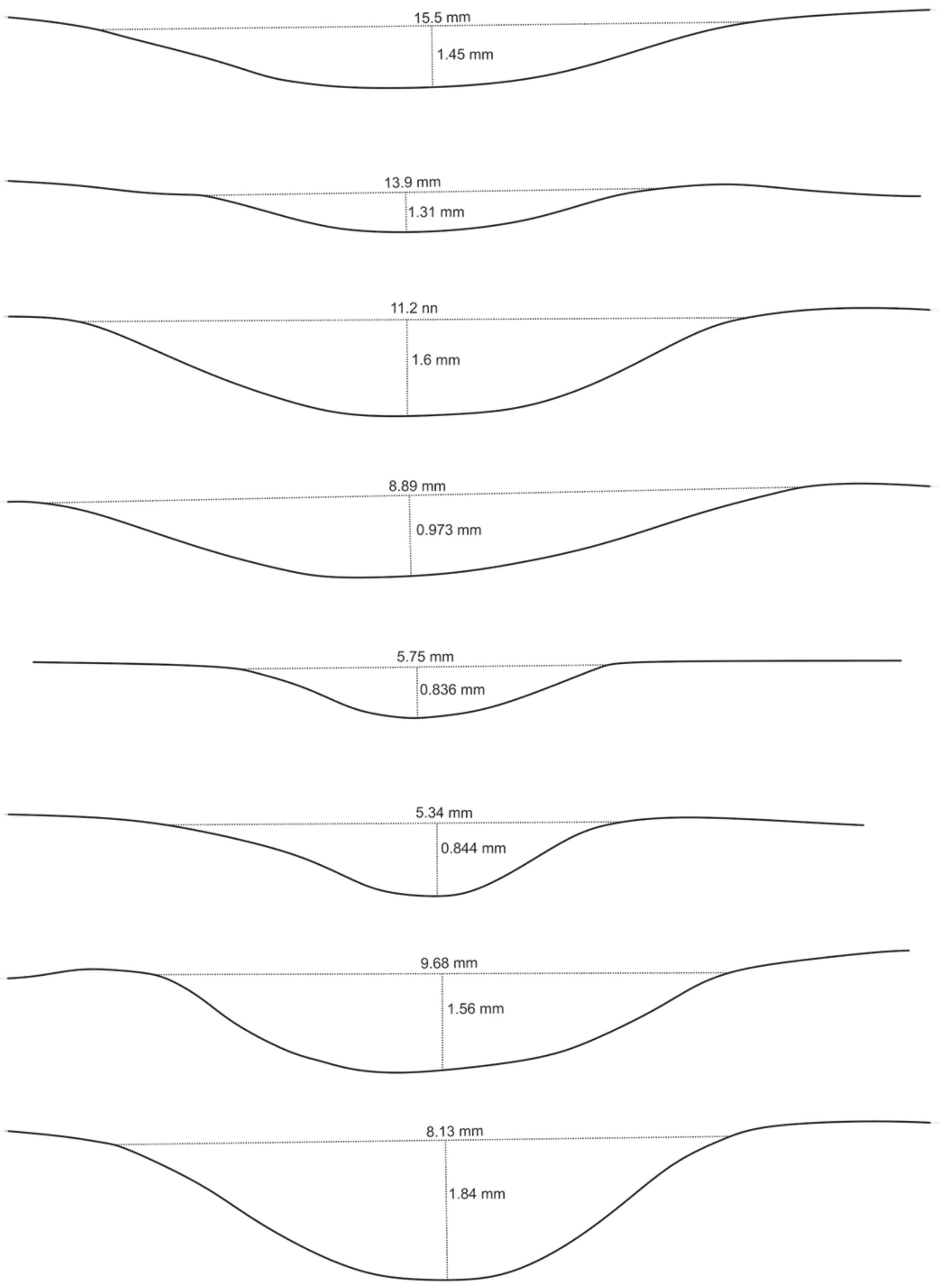
Technological drawing front



Technological drawing back



Cross-section card



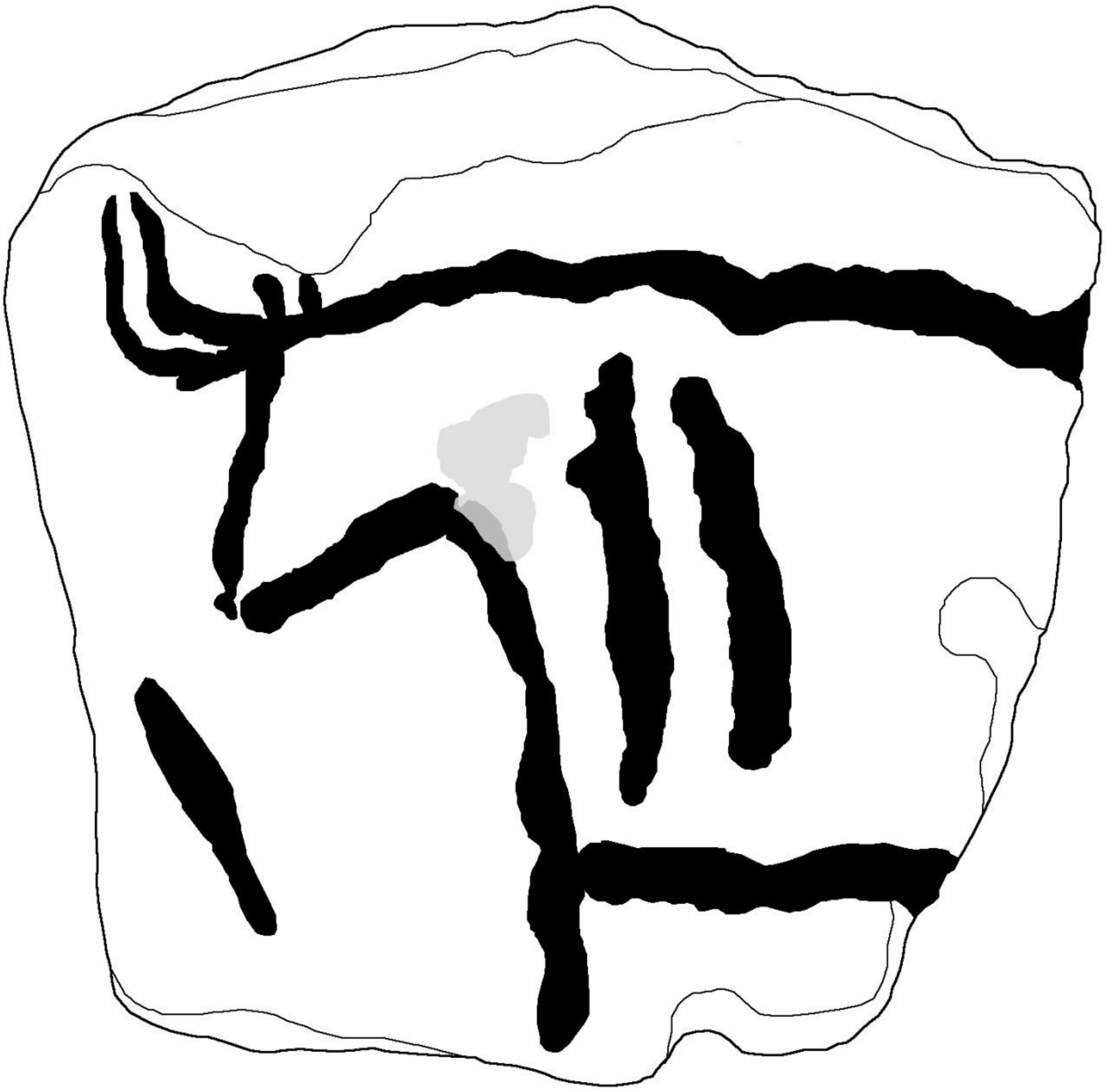
Specimen’s ID	F / N 588 [Inv. 3116]
Image front	
Image left	
Image back	

Image right	
Image top	
Image bottom	
Length, cm	22.2
Width, cm	21.8
Thickness, cm	5.4
Date of discovery	1971
Finder	C.N. Rüstəmov, F.M. Muradova
Location	Kichikdash mountain, Firuz 1 site
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	Subrectangular stone, a small piece of limestone. Its length is 21—23 cm. The thickness is 5—6 cm. One side of the stone contains the front part of an auroch, and another one — is a schematic image of a man. The auroch's horns are parallel; they are reaching forward, which creates a curve to reach up. Two small ears are located near the horns. The convex neck shape is typical of the archaic images of aurochs. The

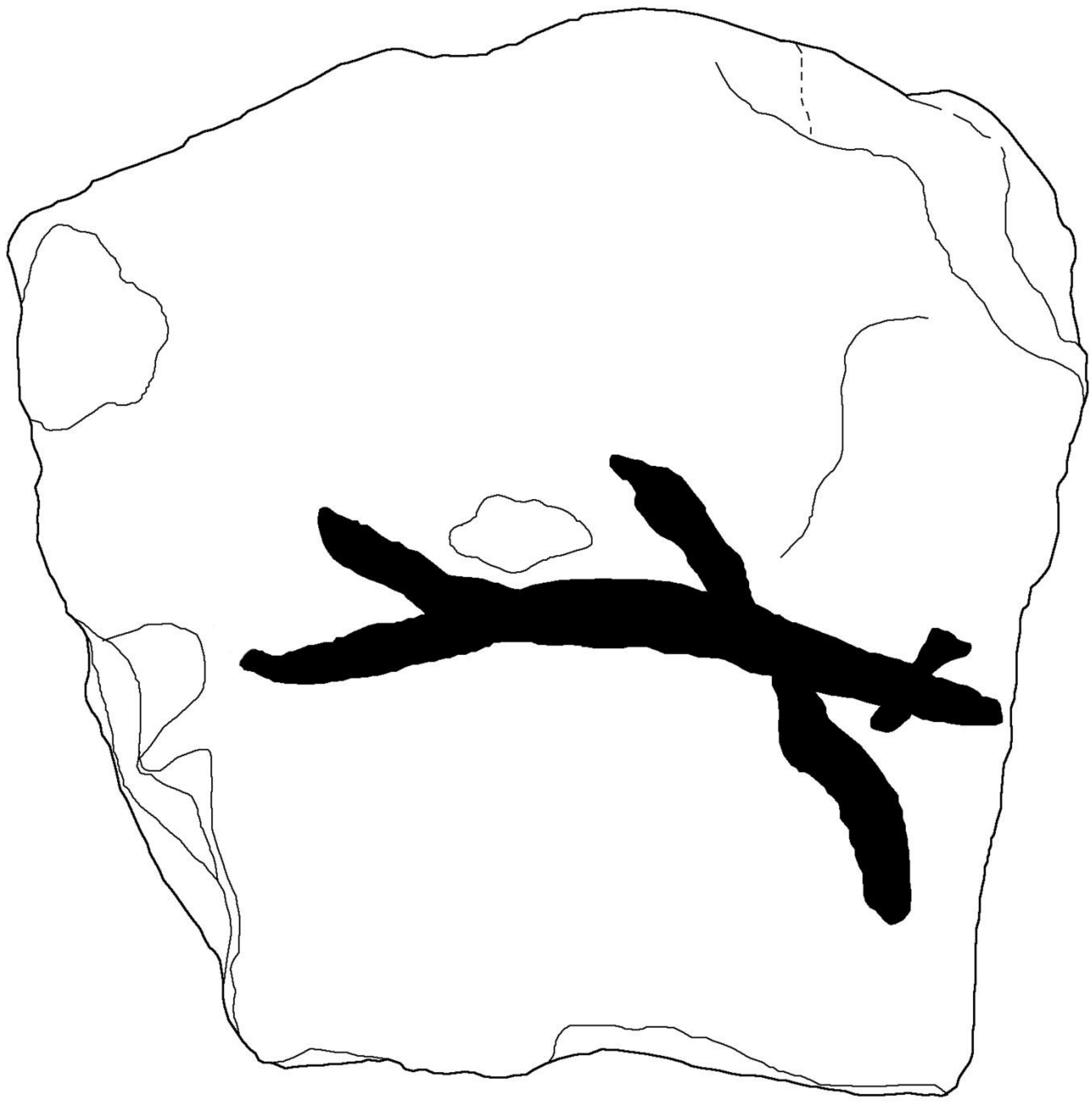
	head is realistic and proportional to the body. One of the front legs is not depicted; another is a prolongation of the creature’s chest. A back side of an animal is lost as the stone is broken. The front side contains two parallel vertical lines. The highs of an auroch are 17 cm, and the length is 20 cm. The schematic image of a human being on the other side of a stone is perpendicular to the aurochs image. The right leg might be considered broken. The head is marked with a short line on the top part of the man’s body. A diagonal line is engraved from right top to left down near the pre-supposed shoulder. It is probably damaged according to its condition. Most probably, this line depicts a bow. The total height of the picture is 18 cm. The images might be considered Neolithic because the stone was used during the Bronze Age as a usual piece of limestone for fence construction.
Description source	Rüstəmov & Muradova 2008: 105—106
Drawing	
Drawing source	Rüstəmov & Muradova 2008: 193, fig. 50
Site description	“Firuz” camp was found in the middle part of the eastern foothills of Kichikdash mountain, away from the railway line. Archaeological excavations were conducted there in 1970 and 1971. The site is attributed to two time laps — the transition from the Mesolithic to the Neolithic and the Early Bronze Age. In the eastern part of the covered area in the “Firuz 1” camp, the Mesolithic layer (20—30 cm thick) starts right below the Bronze Age one. The Bronze Age assemblage is spread across the area, covering not only the places nearby the limestone slabs. The lower layer (the Mesolithic one) lies right on the limestone floor of the shelter. It is presented with a thin layer of mainly stone materials.

	The excavation of the “Firuz 1” camp revealed the remains of hearths, almost 9,000 archaeological materials, and collective graves (11 burials featured with burial goods), including four places from the Meso—Neolithic layer. Fishing tools, the fact that the camp is on the coast of sea level (currently the distance between the camp and the sea is less than 1 km), the presence of ancient boat images on the rock cover walls, and the drawing of boat images on small stones discovered from the cultural layer reaffirms that the “Firuz 1” inhabitants were mainly occupied with fishing.
Site description source	Azərbaycan arxeologiyası. I c. Bakı: Şərq-Qərb, 2008: 381—387
Note	The stone has been found on the site of Firuz I and published in Azerbaijanian several times. It was attributed to the Meso / Neolithic time lap according to the general attribution of the site (Azərbaycan arxeologiyası 2008). The measurements provided in the publications are approximately correct. However, no accurate hi-res drawings have been presented till now. The front part of the block is slightly polished and depicts an aurochs. His buttocks, tail, and back legs are most probably broken off. The technology of engraving creation is most probably pecking or mixed (pecking and multiple scratching). The engravings have very rough and irregular contours; the cross-sections are of different shapes with irregular bottoms. Some parts are deeper; others (like horns) remain shallow. The back part of the block is rough. It contains an image of an anthropomorphic being depicted perpendicularly to the aurochs from the front side. A lengthy diagonal line represents the hands. Diagonal carving also presents the head, though the latter is very shallow and remains almost invisible. This figure is created by pecking. The body line is deep, while the head and hands are shallow. The engraving cross-sections are wide and shallow. Their bottom is irregular and bumpy. The white pigment was added during the 20th-century investigation and conservation procedures.

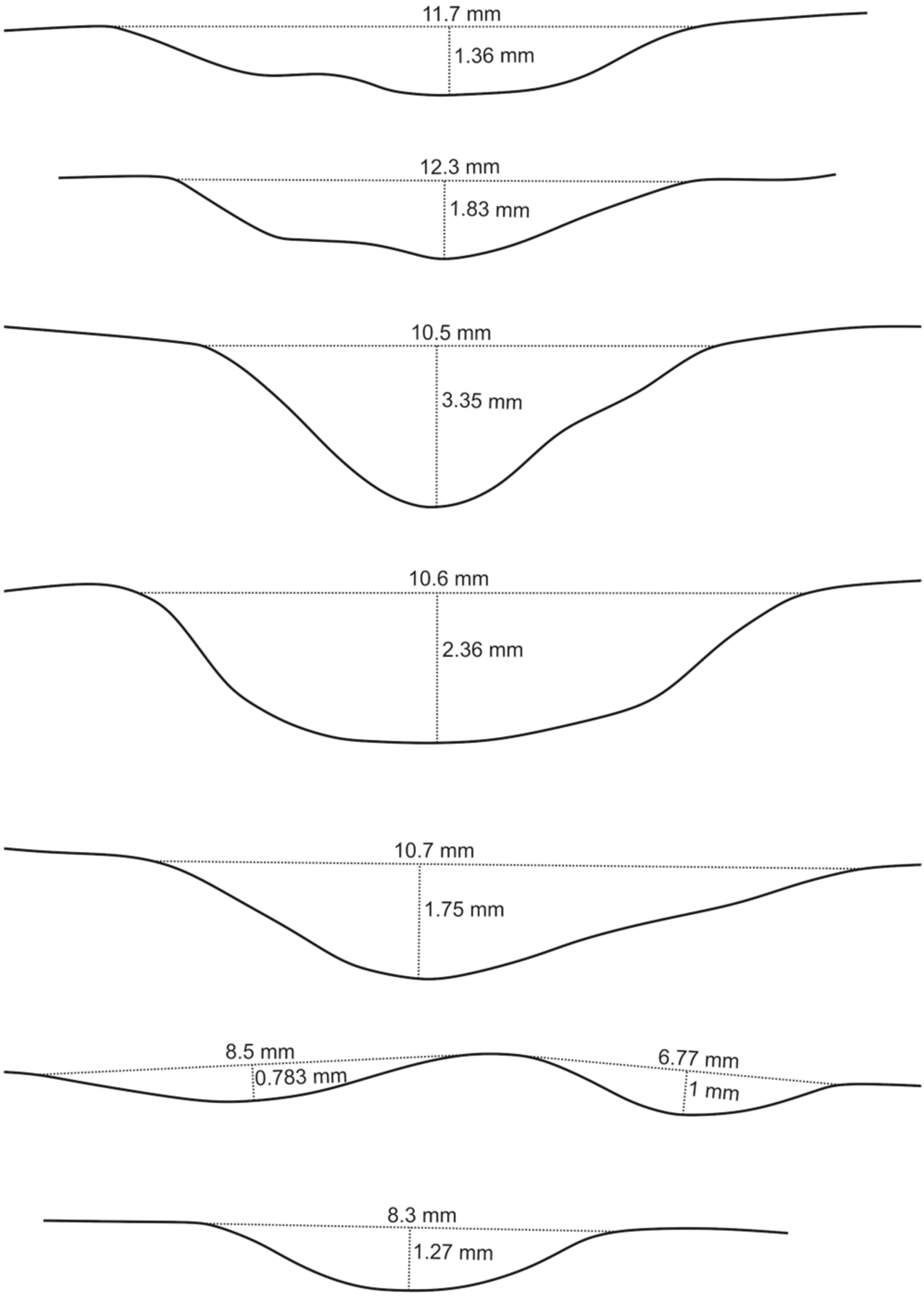
Technological drawing front



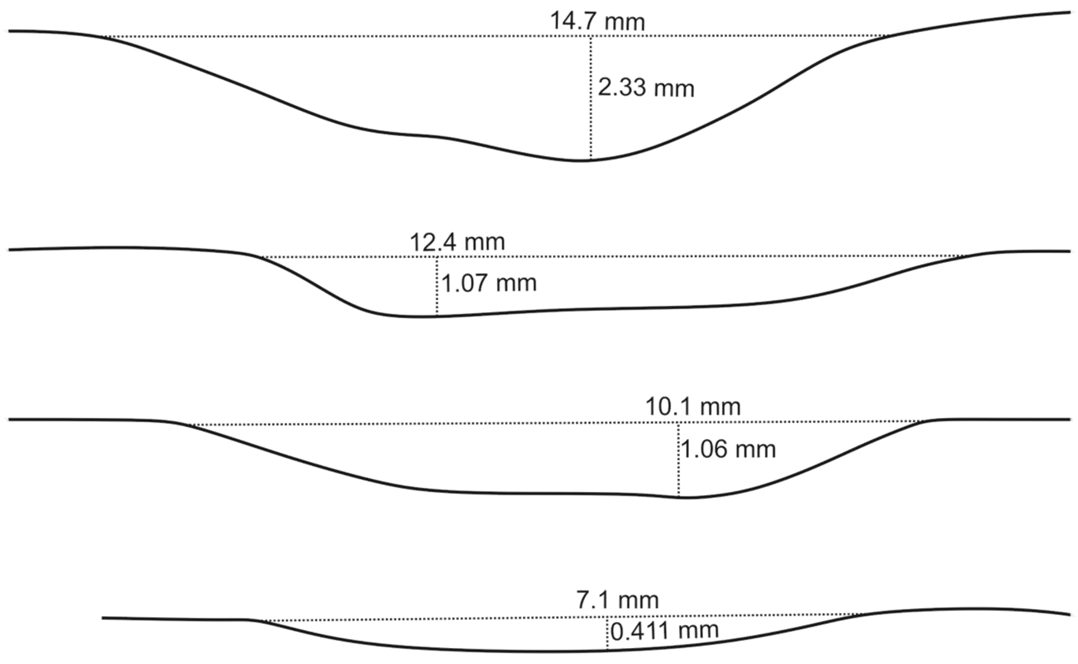
Technological drawing back



Cross-section card front



Cross-section card back

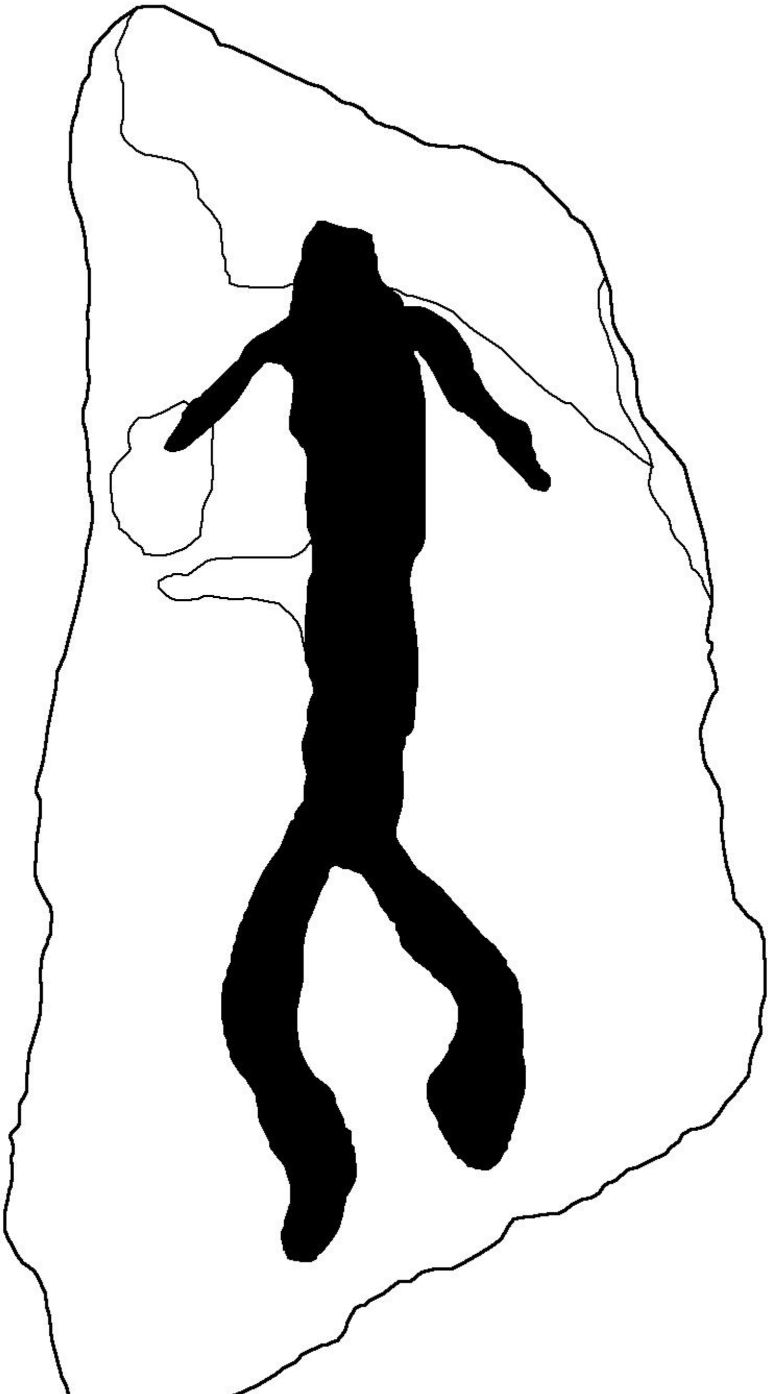


Specimen's ID	F / N 1270 [Inv. 1587]
Image front	
Image left	
Image back	

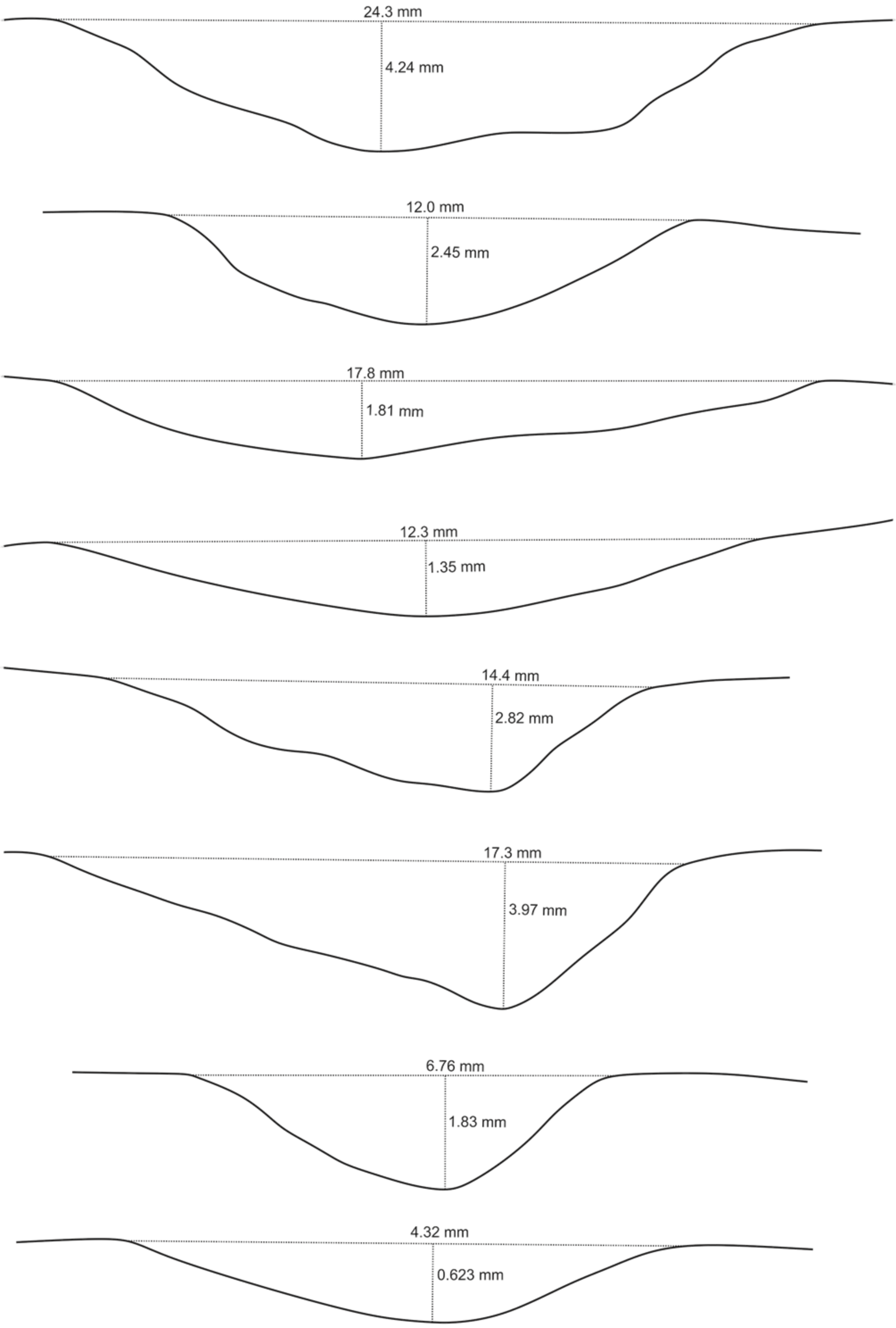
Image right	
Image top	
Image bottom	
Length, cm	29.8
Width, cm	13.5
Thickness, cm	5.56
Date of discovery	1975
Finder	C.N. Rüstəmov, F.M. Muradova
Location	Boyukdash Mountain, Kenize shelter
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	Unpublished
Site description	“Keniza” camp. 40—50 m southeast of “Ana zaga” in the area of Beyukdash Mountain. The deposition and redeposition of the limestone rocks formed areas suitable for sheltering the region’s ancient

	population. In 1974, 1975, and 1976, archaeological excavations were carried out in the camp on an area of approximately 300 sq.m. Significant material culture remains of mainly Mesolithic and partially Neolithic periods were revealed. Neolithic burials were also discovered here. The total number of materials obtained from archaeological excavations from the “Keniza” camp is more than 20,000. The main findings of the Mesolithic period of the “Keniza” camp include triangular, small-sized sharp points, segmented, trapezoidal, triangular tools, micro-gashes, scrapers made of blade-like plates, etc. Tools include chiseled chisel-type tools, small bits made from blade-like plates, drills, chisels, arrowheads, and tools with a special beak-like protrusion on the tip. Female figures made of limestone from the Mesolithic period found in the “Keniza” camp (Rustamov 1986) are of particular scientific importance.
Site description source	Azərbaycan arxeologiyası. I c. Bakı: Şərq-Qərb, 2008: 353—358
Note	A piece of limestone has never been published. It is reported to be found in Kenize shelter and preliminary attributed to the Mesolithic. The engraving contains an anthropomorphic image. The block of irregular shape with the polished front side contains an engraving of an anthropomorphic figure. It represents the use of different engraving techniques. The body is represented with a wide pecked line. Hands and legs were probably added later. Hands are made by scratching. The area above the figure's shoulders broke off. Therefore the head is not presented. Most probably, the legs are polished after pecking (maybe after scratching). They are curved in a specific rounded shape that is indicative of the Mesolithic of the region. Due to the mixed technique, the sequence remains unclear. The white pigment was added by the archaeologists of the 20th century during their study.

Technological drawing front



Cross-section card



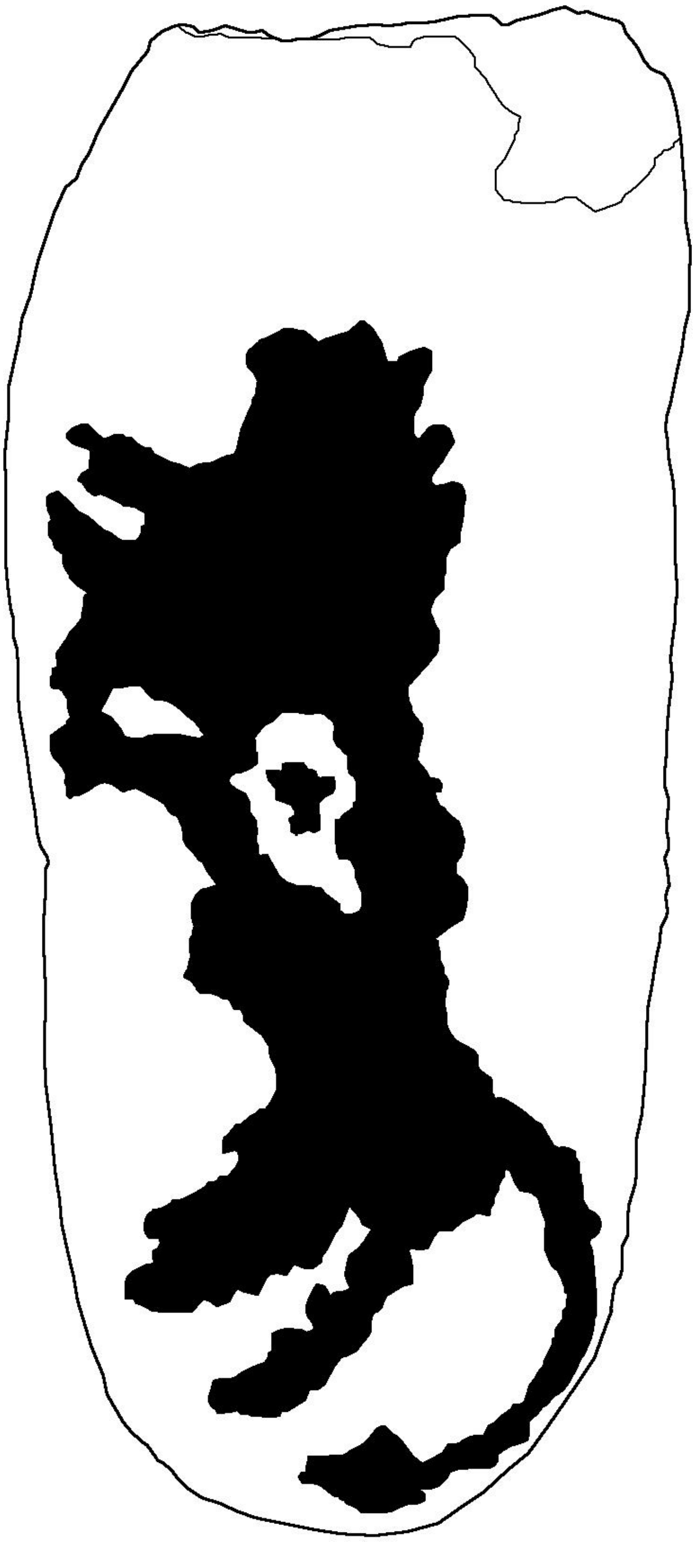
Specimen’s ID	F / N 2236 [Inv. 2049]
Image front	
Image left	
Image back	

Image right	
Image top	
Image bottom	
Length, cm	44.5
Width, cm	18.1
Thickness, cm	13.3
Date of discovery	1976
Finder	C.N. Rüstəmov, F.M. Muradova
Location	Boyukdash Mountain, Kenize shelter
Current location	Gobustan National Historic and Artistic Preserve, Qobustan

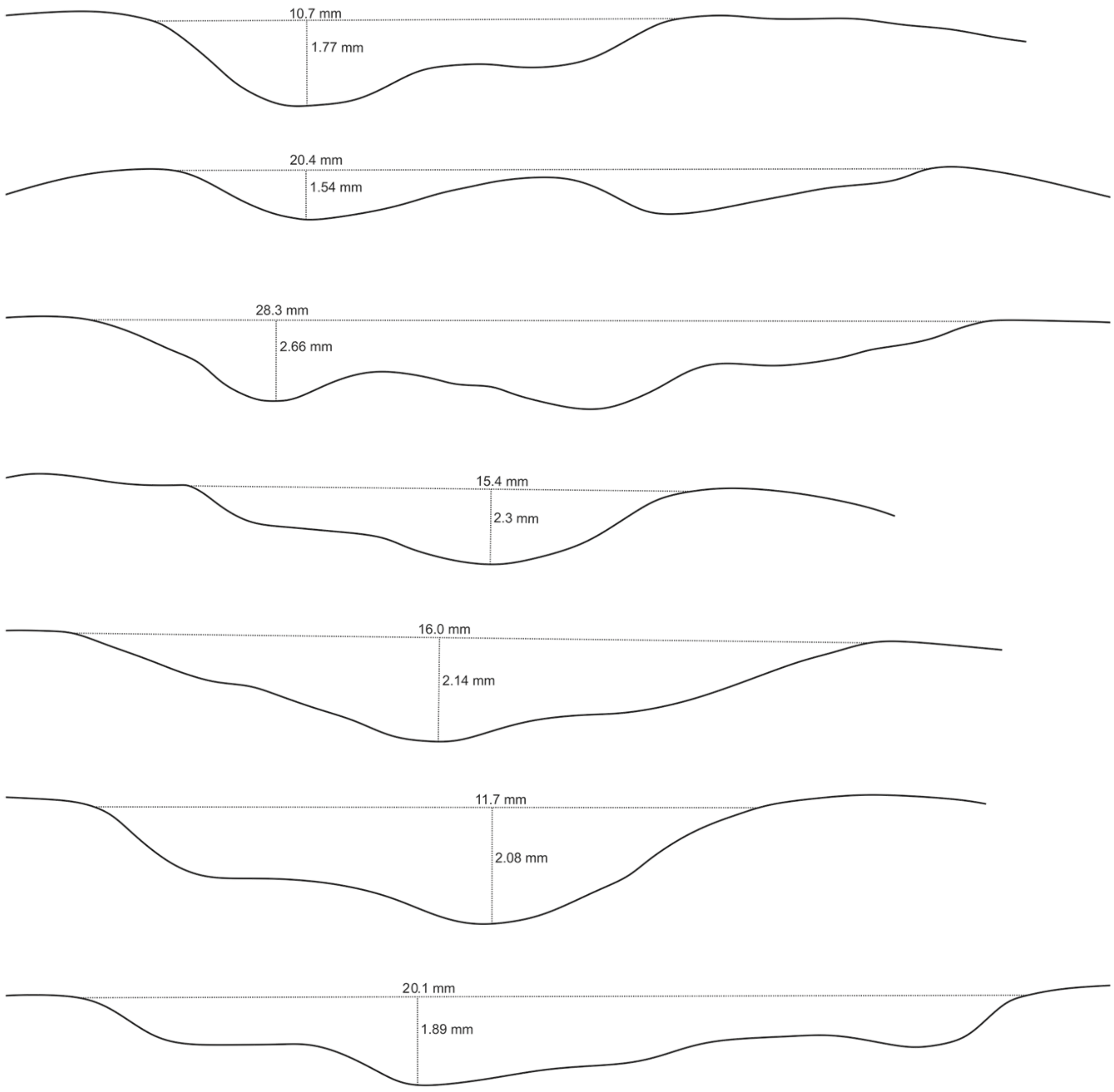
Description	The block was revealed at a depth of 3.8—4.2 m, with a number of sharp edges (similar to “typical Solutre sharp edges from Western France”) and a cylindrical nucleus. It is a typical Late Paleolithic sample. Stone with an image of a lion. A similar image in the rock art of Gobustan can be dated to the same period.
Description source	Farajova 2009: 143
Image	
Image source	Farajova 2009, fig. 101:6, 368
Site description	“Keniza” camp. 40—50 m southeast of “Ana zaga” in the area of Beyukdash Mountain. The deposition and redeposition of the limestone rocks formed areas suitable for sheltering the region’s ancient population. In 1974, 1975, and 1976, archaeological excavations were carried out in the camp on an area of approximately 300 sq.m. Significant material culture remains of mainly Mesolithic and partially Neolithic periods were revealed. Neolithic burials were also discovered here. The total number of materials obtained from archaeological excavations from the “Keniza” camp is more than 20,000. The main findings of the Mesolithic period of the “Keniza” camp include triangular, small-sized sharp points, segmented, trapezoidal, triangular tools, micro-gashes, scrapers made of blade-like plates, etc. Tools include chiseled chisel-type tools, small bits made from blade-like plates, drills, chisels, arrowheads, and tools with a special beak-like protrusion on the tip. Female figures made of limestone from the Mesolithic period found in the “Keniza” camp (Rustamov 1986) are of particular scientific importance.
Site description source	Azərbaycan arxeologiyası. I c. Bakı: Şərq-Qərb, 2008: 353—358

Note	A piece of limestone with a zoomorphic image can be interpreted as an image of a lion. The block has a smooth shape and contains several shell imprints. The left part probably broke off in prehistory. The engraving in the front part represents a zoomorphic figure of a complex shape interpreted as a lion, most probably due to the tuft on its tail and the body configuration, and attributed to the Upper Paleolithic. The head is schematic. The depiction of the front and back legs is complex and done with numerous lines. The figure is pecked in limestone. The lines are wide and shallow; the bottom is irregular and rough. The narrowest parts of a figure are 1—1.1 cm wide lines representing the legs and tail. The body is up to 6.5 cm wide. Some small areas inside the silhouette are not pecked.

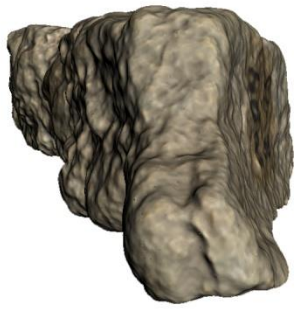
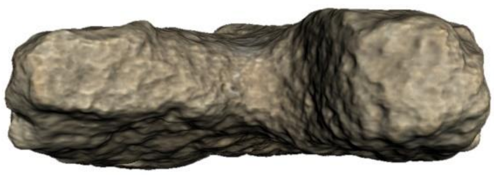
Technological drawing front

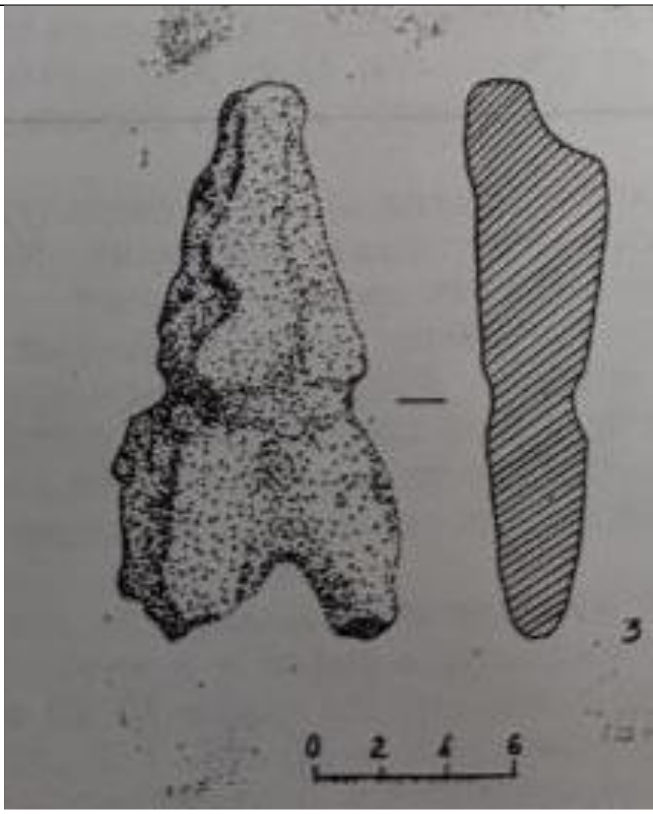


Cross-section card



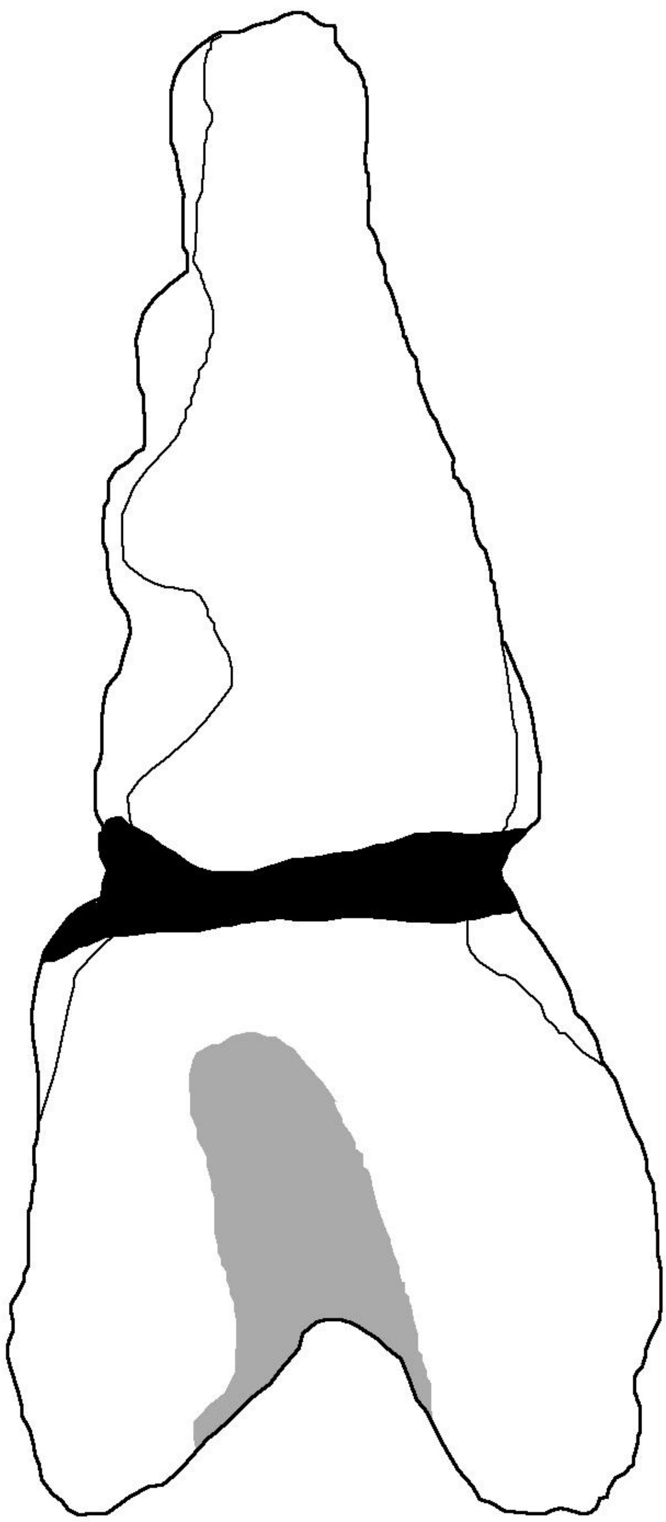
Specimen's ID	N 1094 [Inv. 1478]
Image front	
Image left	
Image back	

Image right	
Image top	
Image bottom	
Length, cm	16.6
Width, cm	6.62
Thickness, cm	3.45
Date of discovery	1975
Finder	C.N. Rüstəmov, F.M. Muradova
Location	Boyukdash Mountain, Kenize shelter
Current location	Gobustan National Historic and Artistic Preserve, Qobustan

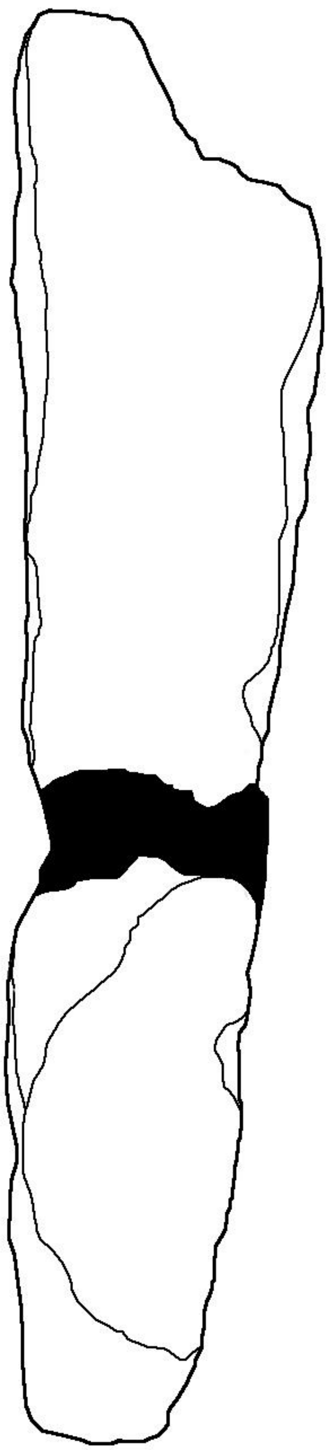
Description	An anthropomorphic figure is made on a long and flat piece of limestone. It has a subtriangular shape with a sharper upper part. The basement of this triangle includes a big recess (2—3 cm deep). This recess creates a shape similar to the figurine’s two short legs. A waist features a 1—1.5 cm wide notch that contours the stone’s middle part. The total height of a figure is 17 cm. The width of the widest part is 7 cm; the width of the shoulder is 3.7 cm. The upper part is narrow and represents a head with a height of 2.0 cm, width of 1.7 cm, and thickness of 1.8 cm. It is found in the Mesolithic layer, in the northern part of the shelter’s central room, at a depth of 1.9 cm. Apart from the notch on the figure’s waist and the legs, shaped with recess, a figure’s surface is not featured with other manufactured parts. However, its general appearance resembles a female figure. The figurine’s profile is similar to the female’s profile from stones No, 128 and 58b on the upper terrace of Boyukdash mountain.
Description source	Rüstəmov 1986: 92—96
Image	
Image source	Rüstəmov 1986: 93, fig. 1
Site description	“Keniza” camp. 40—50 m southeast of “Ana zaga” in the area of Beyukdash Mountain. The deposition and redeposition of the limestone rocks formed areas suitable for sheltering the region’s ancient

	population. In 1974, 1975, and 1976, archaeological excavations were carried out in the camp on an area of approximately 300 sq.m. Significant material culture remains of mainly Mesolithic and partially Neolithic periods were revealed. Neolithic burials were also discovered here. The total number of materials obtained from archaeological excavations from the “Keniza” camp is more than 20,000. The main findings of the Mesolithic period of the “Keniza” camp include triangular, small-sized sharp points, segmented, trapezoidal, triangular tools, micro-gashes, scrapers made of blade-like plates, etc. Tools include chiseled chisel-type tools, small bits made from blade-like plates, drills, chisels, arrowheads, and tools with a special beak-like protrusion on the tip. Female figures made of limestone from the Mesolithic period found in the “Keniza” camp (Rustamov 1986) are of particular scientific importance.
Site description source	Azərbaycan arxeologiyası. I c. Bakı: Şərq-Qərb, 2008: 353—358
Note	The limestone block of subtriangular shape has been processed to represent a figure that has been interpreted as a female image. Its head is very schematic and represented by a small narrow upper part of the block. The shapes are rough and barely processed, though the short legs are emphasized together with the comparatively massive hips. The space between them is narrowed and polished. The waist is represented by a deep line that belts the whole figure. It was most probably done by scratching or scratching together with pecking. The processed part has quite an irregular bottom in their cross sections except for the profile parts of the belt (these cross-sections are deep and have rounded bottoms). The description given by Rüstəmov (1986: 92—96) and the metrics he provides are comparatively accurate, though the figure differs from the other female figurines found in the area of Beyukdash mountain.

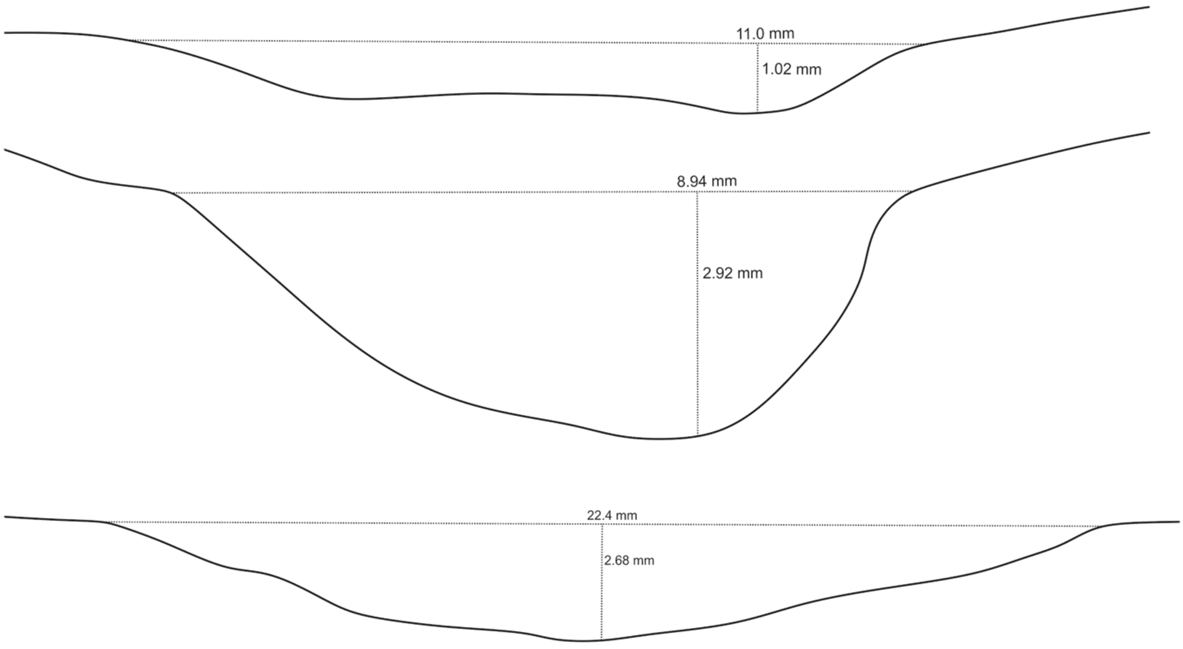
Technological drawing front



Technological drawing right



Cross-section card

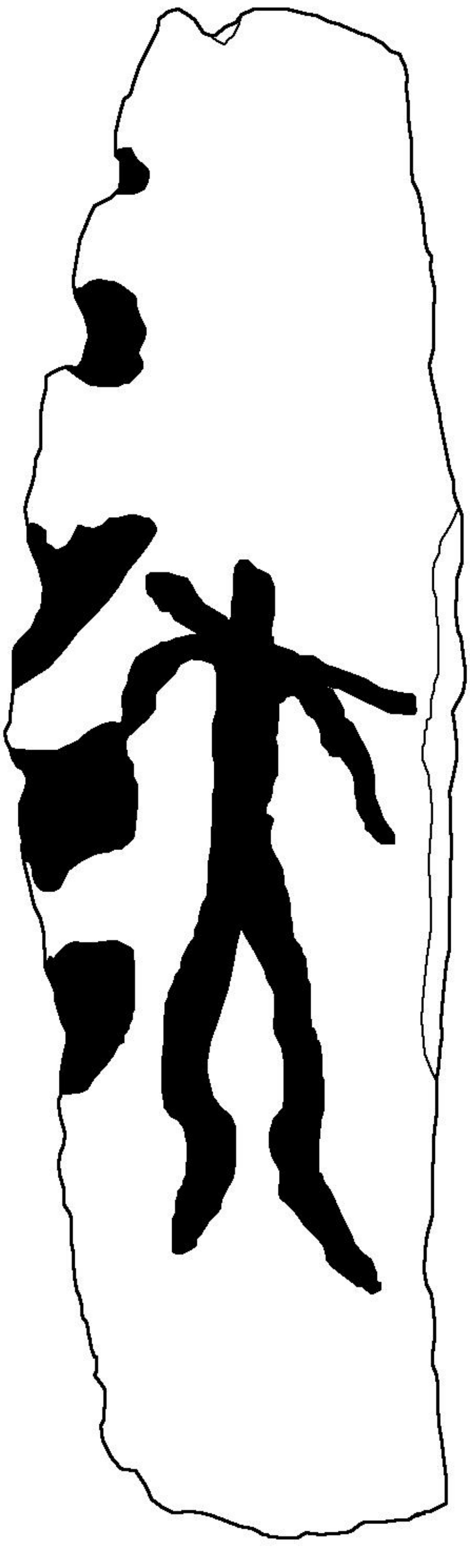


Specimen's ID	Unnumbered (No. 7 in survey record, given by SR)
Image front	
Image left	
Image back	

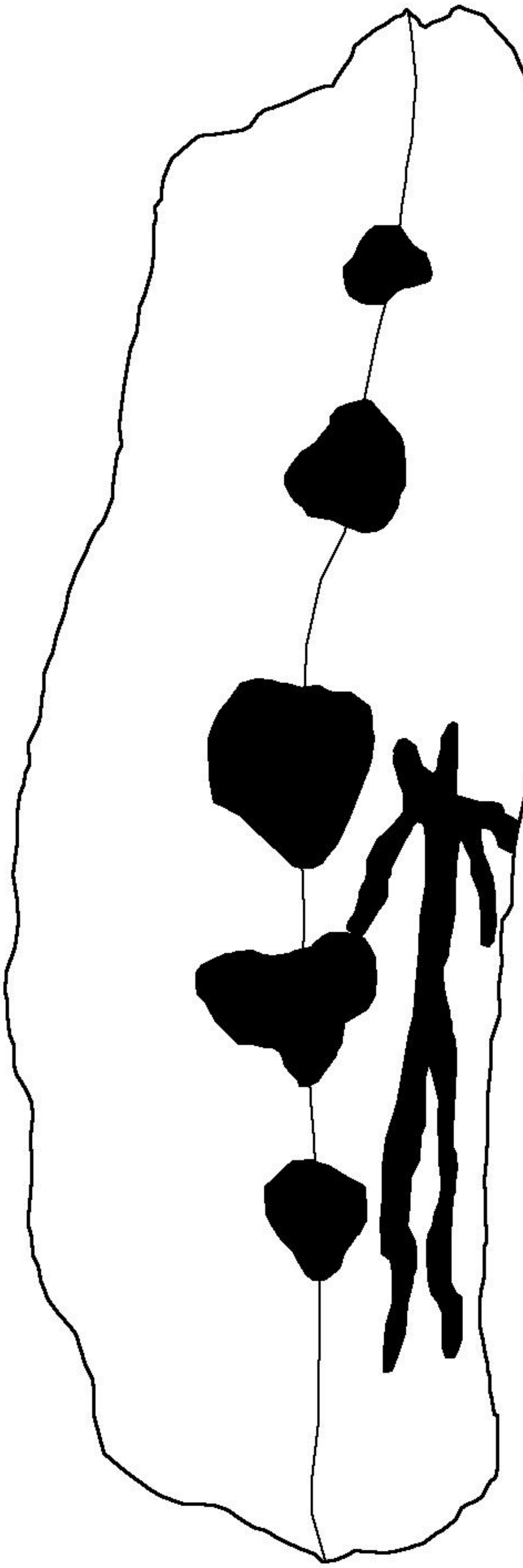
Image right	
Image top	
Image bottom	
Length, cm	31.4
Width, cm	8.83
Thickness, cm	11.7
Date of discovery	Unknown
Finder	Unknown
Location	Unknown
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	—
Description source	—
Note	The block is found in the storage of the Gobustan National Historic and Artistic preserve. Probably decontextualized in the second half of the 20th century. The white pigment was added to the engraving after the decontextualization procedures. His provenance, origin, and archaeological context are unknown. However, it

	represents a set of exciting petroglyphs and is a shining example of Gobustan rock art images. The front part of the large (more than 30 cm long) limestone block is featured an anthropomorphic figure. It contains a body, represented by the long and wide line, and two legs curved in a semi-circular shape typical for female figurines of the Stone Age of the region. Four narrow lines are located near the figure's shoulders. The head is not represented. Other lines may represent extremities (hands) and breasts or be interpreted differently. Most probably, the lines were pecked (legs and body) or scratched ("hands" and "breast") and then polished to smooth the carvings' bottom. The relative chronology of the process remains unclear, though the body line seems to be polished after the extremities' creation (it is more profound and smoother than other lines of the figure). However, it is reasonable to assume that this is the first line that was pecked. Additional experiments are needed before the technological conclusion. The block's edges (left-front edge and right-back edge in particular) are featured with five and four engravings, respectively. Those are deep, wide, and rough. They might indicate the possible functional use of the block. Most probably, these marks were made by scratching. Their bottoms are round or subrectangular, while the walls and cross sections are irregular.

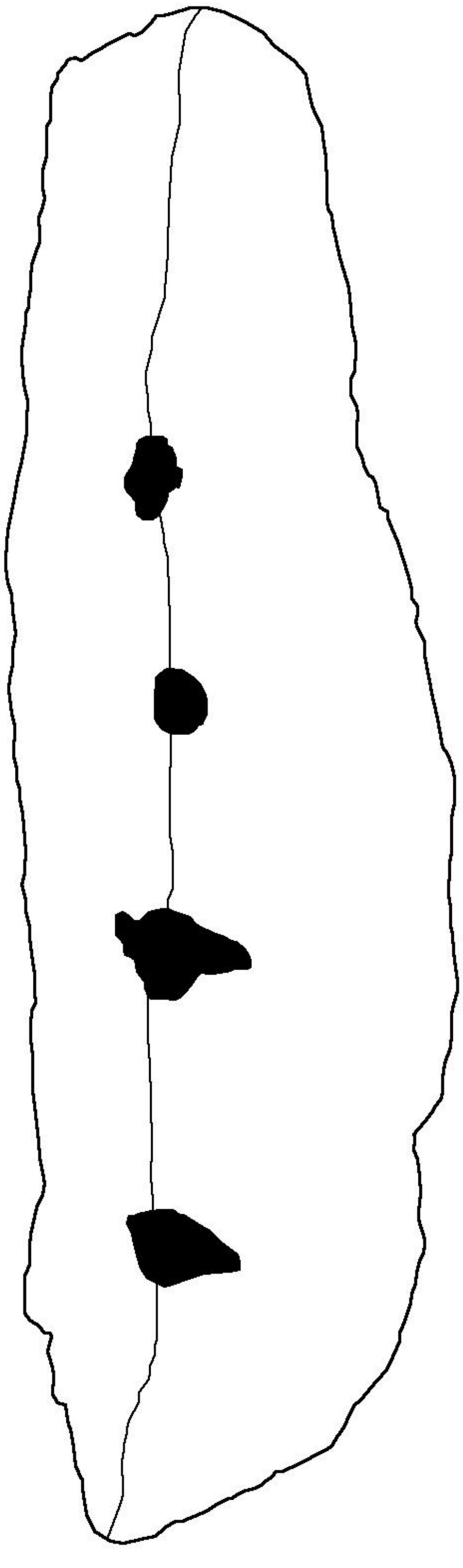
Technological drawing front



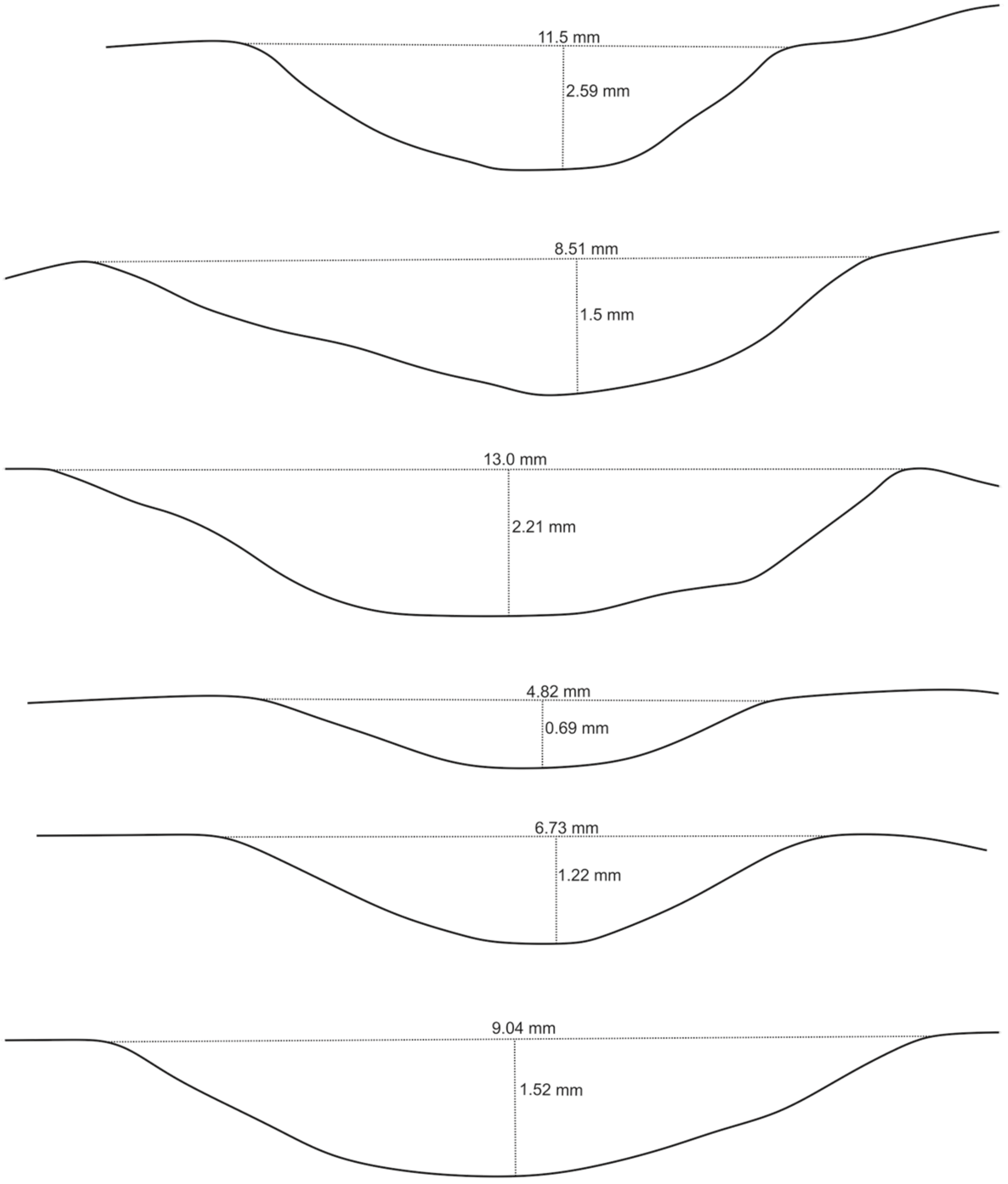
Technological drawing left-front edge



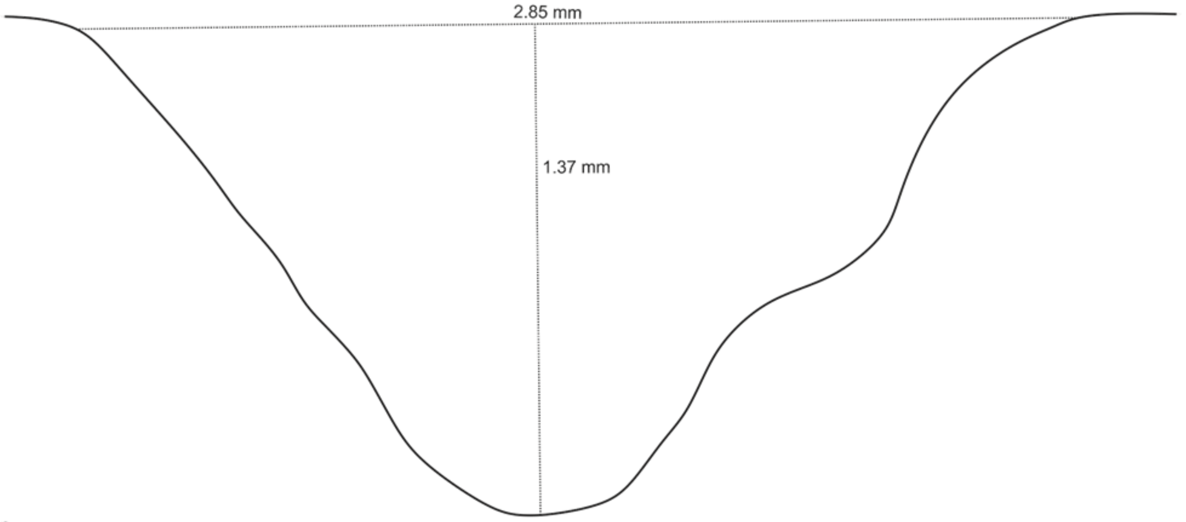
Technological drawing right-back edge

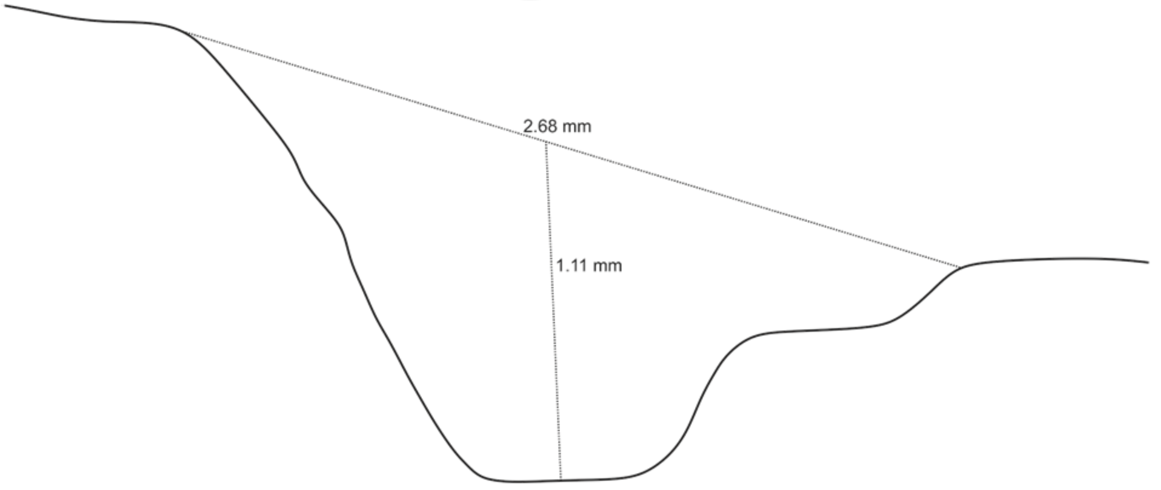


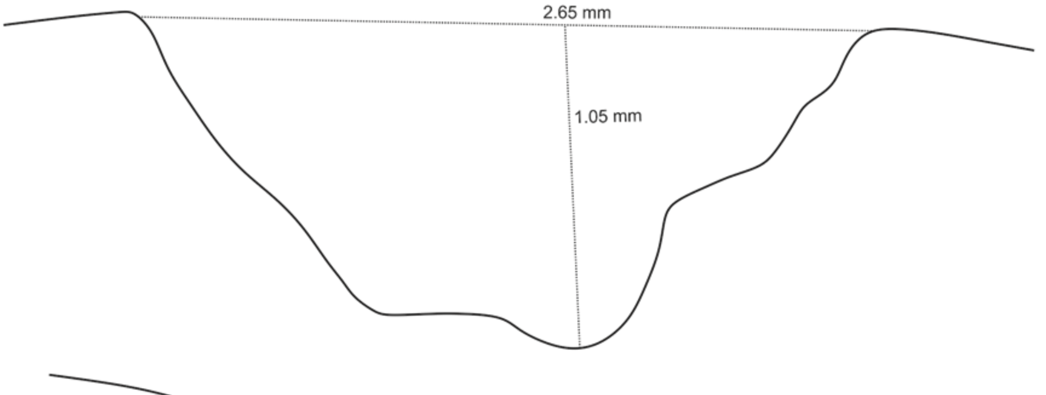
Cross-section card, anthropomorphic figure

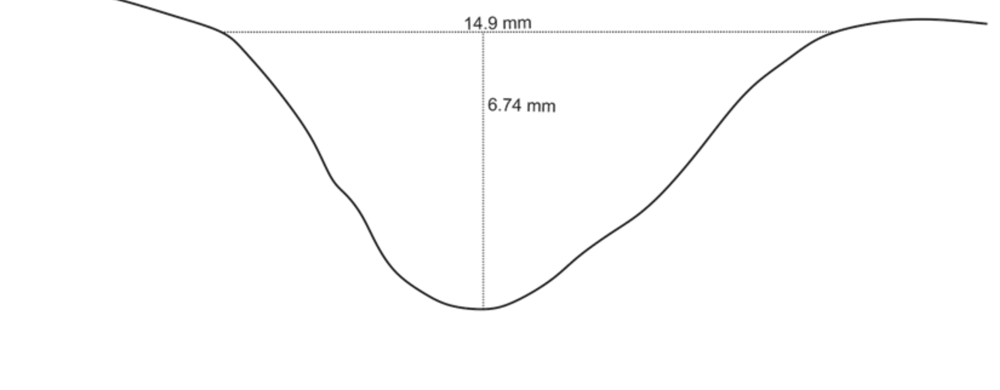


Cross-section card, edges







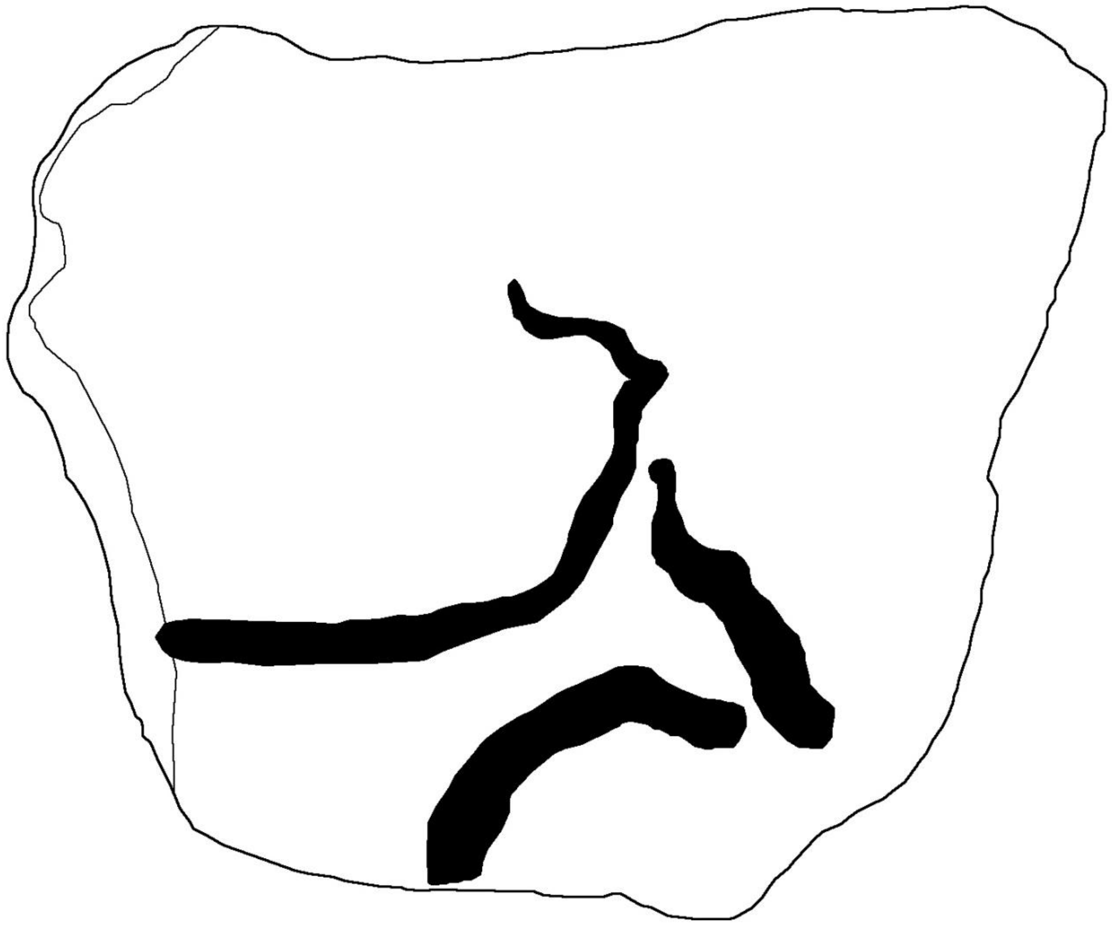


Specimen's ID	F / N 205 [Inv. 3116]
Image front	
Image left	
Image back	

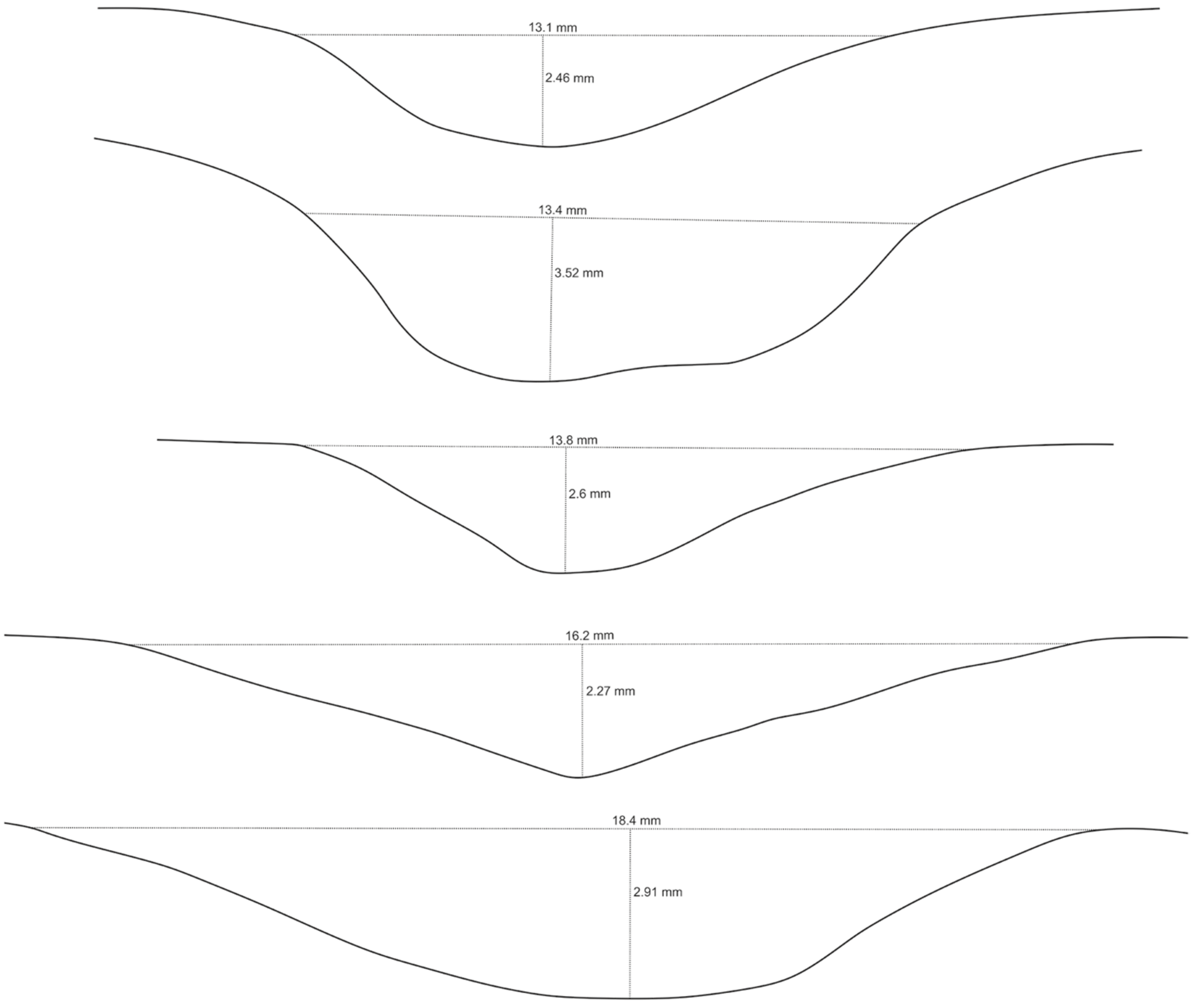
Image right	
Image top	
Image bottom	
Length, cm	28.1
Width, cm	21.9
Thickness, cm	6.11
Date of discovery	1973
Finder	C.N. Rüstəmov, F.M. Muradova
Location	Kichikdash mountain, Firuz 2 site
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	The stone contains an engraved partial image of a goat. The color of the block is reddish due to the influence of fire.
Description source	Rüstəmov & Muradova 2008: 73—76
Site description	“Firuz” camp was found in the middle part of the eastern foothills of Kichikdash mountain, away from the railway line. Archaeological excavations were conducted there in 1970 and 1971. The site is attributed to two time laps — the transition from the Mesolithic to the Neolithic and the Early Bronze Age.

	Firuz 2 site is located 385 m southwest of the Firuz 1 camp. It was discovered on the western side of the engraved stone No. 19. It is suitable for a habitation enclosure between stone no. 19 and stone No. 97. In 1972 and 1973, archaeological excavations were carried out in the camp on approximately 70 square meters. As a result of the excavation, a 5—25 cm thick Mesolithic cultural layer was recorded near stone No. 19. This cultural layer was separated from the cultural layer recorded above it by a 5, 10, and sometimes 15 cm thick sterile layer. Hearth remains were found in 4 places from the bottom layer. As in all Stone Age camps in Gobustan, the materials found in the “Firuz-2” camp were made of flint and limestone. In the lower part of the 4 m vertical surface of stone No. 19, almost 50 ancient drawings were found. The cultural layer partially covered these. Engravings depict tattooed men and women, boats, bulls, etc. The lower stratum of the camp is attributed to the Late Mesolithic — Early Neolithic period based on the similarity of the stone assemblage to the “Firuz 1” and “Ana zaga” shelters.
Site description source	Azərbaycan arxeologiyası. I c. Bakı: Şərq-Qərb, 2008: 381—382, 387—388
Note	The stone was reported during the publication of the Firuz 2 site. It lacks the proper drawing and description. The large block of limestone contains an engraving on its front part. Though Rüstəmov and Muradova considered the reddish color a consequence of fire contact, there is no other proof for that version. Four lines are scratched inside the stone surface. The main ones are wide and deep. They are not forming any clear superimpositions but form a figure that might be considered a representation of a goat's head. It is unclear whether the stone was broken before or after the engraving. However, the first version seems to be more probable. The line that has been considered a representation of the antlers (filled with white pigment together with others) seems to be a modified natural relief of the stone.

Technological drawing front



Cross-section card



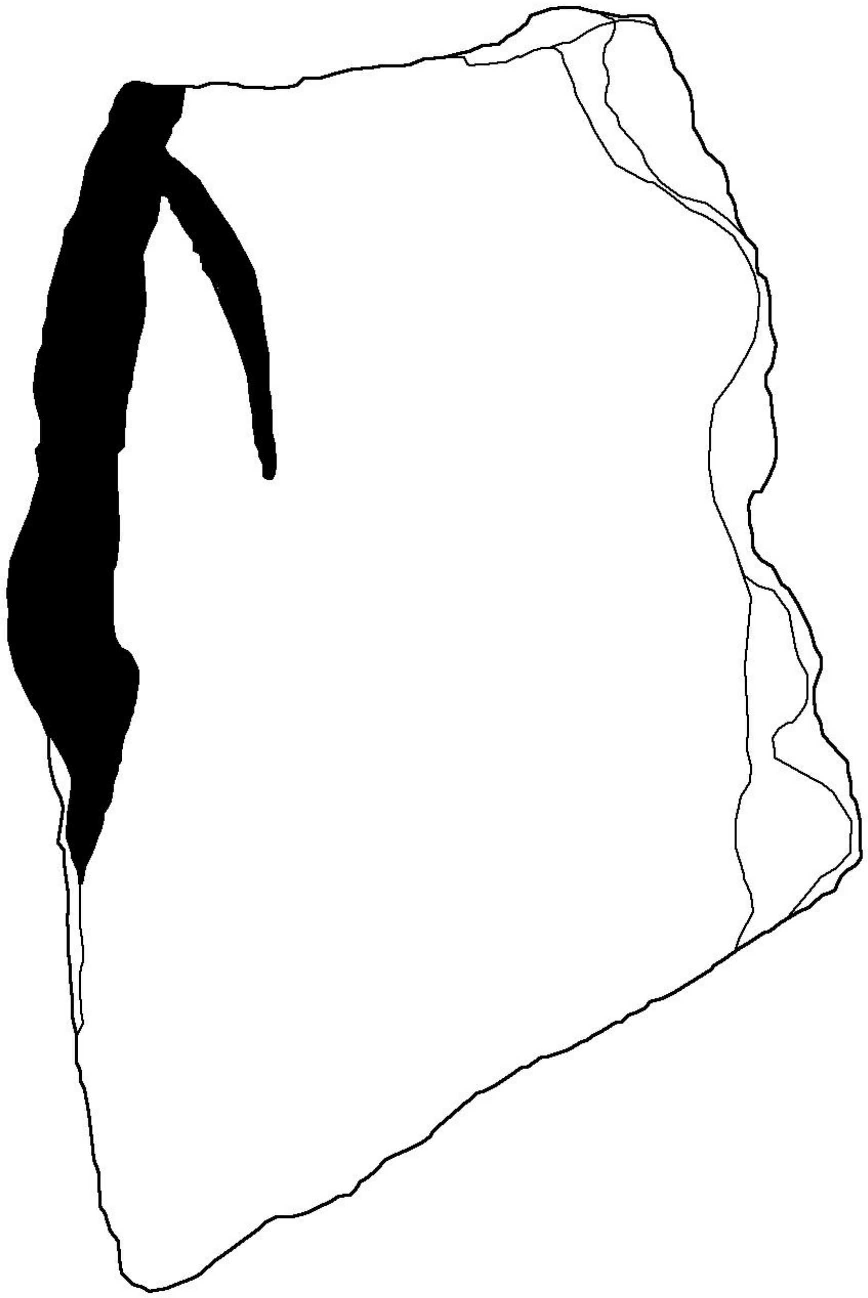
Specimen's ID	F / N 1068
Image front	
Image left	
Image back	

Image right	
Image top	
Image bottom	
Length, cm	31.7
Width, cm	19
Thickness, cm	4.13
Date of discovery	1966
Finder	C.N. Rüstəmov, F.M. Muradova
Location	Boyukdash Mountain, V shelter (Ana Zaga)
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	Unpublished
Site description	“Ana Zaga” camp contains the Stone Age cultural layers discovered mainly in the middle part of the camp, at the southern bottom of rock No. 30, which forms its northern wall, in the area excavated in 1965

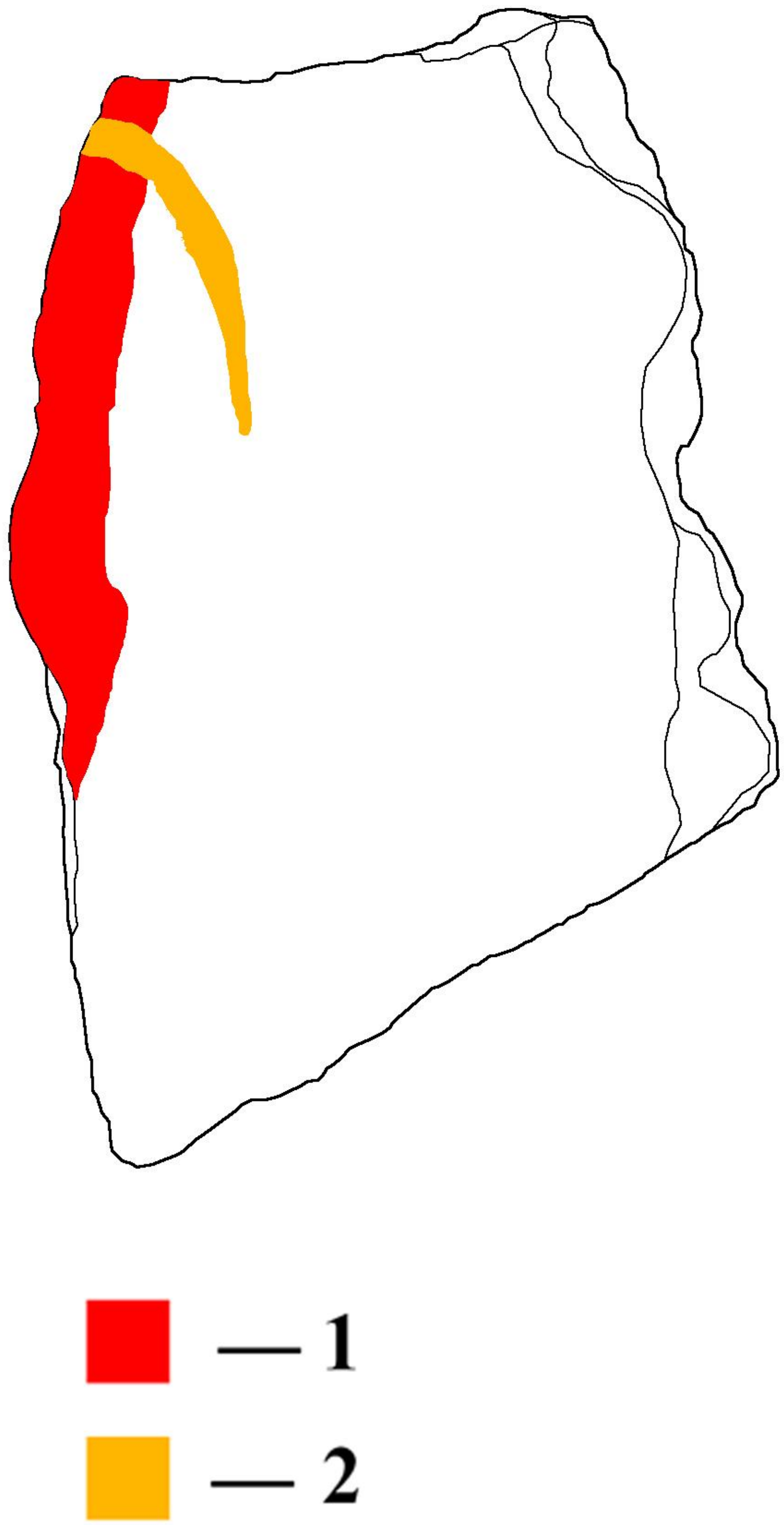
	and 1966. The lower layer of Ana Zaga stoneware belongs to the transition from the Upper Paleolithic to the Mesolithic and the first phase of the Mesolithic. In contrast, the middle layer mainly belongs to the transition period from the Mesolithic to the Neolithic. The absence of a sterile layer between the lower and middle layers is due to the absence of a time break between them. The difference between the lithological composition and color of the strata is probably due to natural climate change. This is confirmed by the complementarity of the primary archaeological assemblage of the layer — stone tools and faunal remains. Due to the similarity of the materials of the lower and middle layers of “Ana Zaga” and the scarcity of samples, which are a definite indicator of the period difference, most of the artifacts related to the Neolithic of the camp are included in the Mesolithic complex. Archaeological excavations conducted in “Ana Zaga” have shown a residence from the end of the Upper Paleolithic to the beginning of the Mesolithic period and in all subsequent historical stages. More than two thousand materials obtained by archaeological excavations in “Ana Zaga” consist of flint, river stone, and a small number of tools made of bone and other materials, as well as found for other purposes. [The portable engraved rocks are of particular interest.] It should be noted that the materials of both layers of the camp do not differ much in terms of typology and quantity. Based on the flint assemblage, the lower layer of Ana Zaga is attributed to the end of the Upper Paleolithic — the beginning of the Mesolithic. The middle layer is attributed to the end of the Mesolithic — pre-pottery Neolithic period. More than 600 flint cores (mostly 1.5—3.0 cm in height; rarely 5 cm) were found in “Ana zaga.”
Site description source	Azərbaycan arxeologiyası. I c. Bakı: Şərq-Qərb, 2008: 347—350
Note	A piece of limestone has never been published. It is reported to be found in Ana Zaga camp and preliminary attributed to the Mesolithic. A flat subrectangular sandstone block is the part of a bigger one that has broken off in the past. The engravings on the front side were created before the failure. The remained part represents a part of an anthropomorphic figure — part of the body, left hand, and the part of the left leg. The body is introduced with a wide and deep pecked vertical line and was created first.

	Then left hand was scratched. They are superimposing the body. The horizontal line that is a prolongation of a hand superimposes a body line. It was scratched together with the left-hand line. After decontextualization in 1966, the engravings were filled with white pigment. Though the site and general context of the stone are known, the details remain unclear.

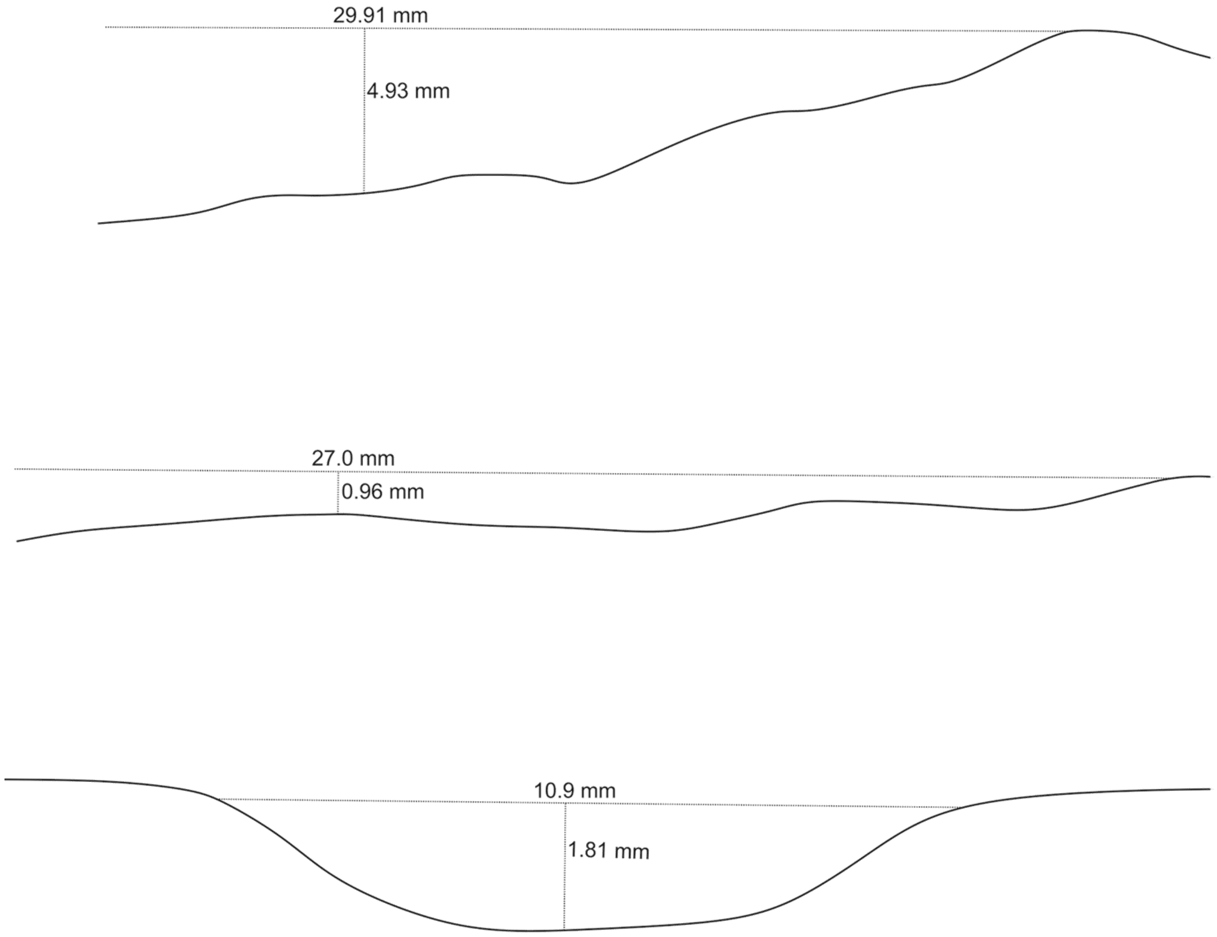
Technological drawing front



Drawing sequence front



Cross-section card

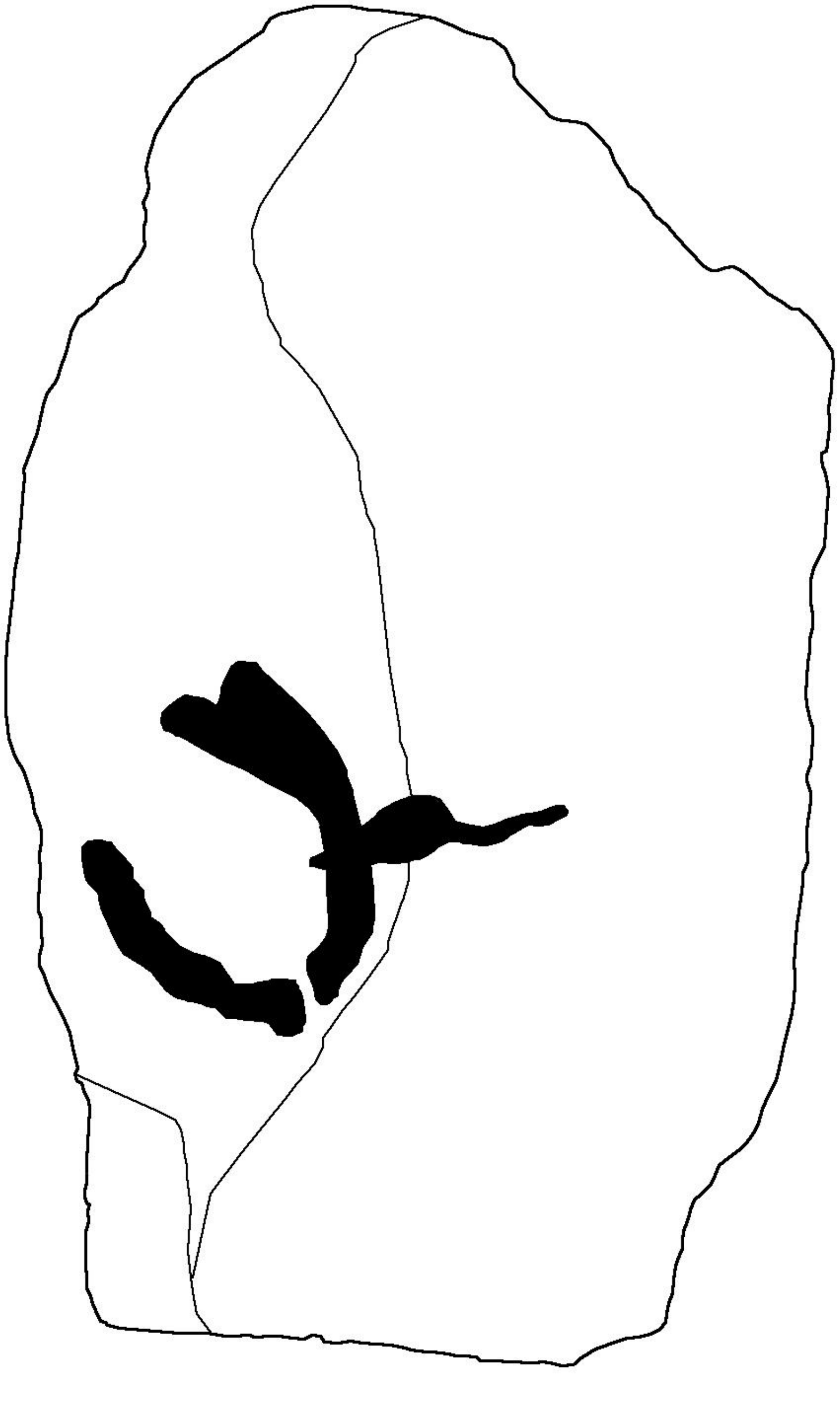


Specimen’s ID	F / N 1803 [Inv. 1813]
Image front	
Image left	
Image back	

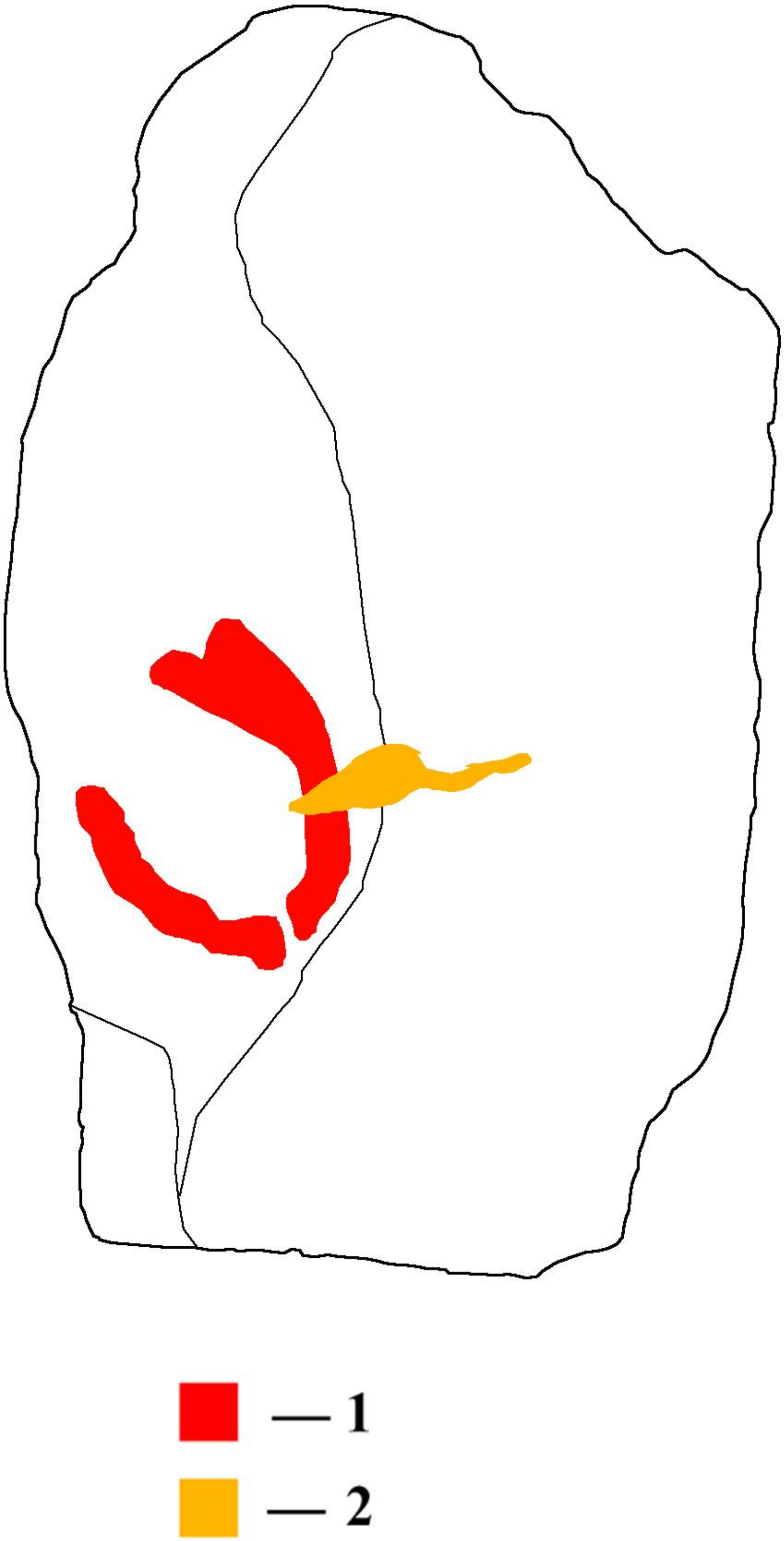
Image right	
Image top	
Image bottom	
Length, cm	35.7
Width, cm	22.9
Thickness, cm	8.14
Date of discovery	1975
Finder	C.N. Rüstəmov, F.M. Muradova
Location	Boyukdash Mountain, Kenize shelter
Current location	Gobustan National Historic and Artistic Preserve, Qobustan
Description	Unpublished
Site description	“Keniza” camp. 40—50 m southeast of “Ana zaga” in the area of Beyukdash Mountain. The deposition and redeposition of the limestone rocks formed areas suitable for sheltering the region’s ancient population. In 1974, 1975, and 1976, archaeological excavations were carried out in the camp on an area of approximately 300 sq.m. Significant material culture remains of mainly Mesolithic and partially Neolithic periods

	were revealed. Neolithic burials were also discovered here. The total number of materials obtained from archaeological excavations from the “Keniza” camp is more than 20,000. The main findings of the Mesolithic period of the “Keniza” camp include triangular, small-sized sharp points, segmented, trapezoidal, triangular tools, micro-gashes, scrapers made of blade-like plates, etc. Tools include chiseled chisel-type tools, small bits made from blade-like plates, drills, chisels, arrowheads, and tools with a special beak-like protrusion on the tip. Female figures made of limestone from the Mesolithic period found in the “Keniza” camp (Rustamov 1986) are of particular scientific importance.
Site description source	Azərbaycan arxeologiyası. I c. Bakı: Şərq-Qərb, 2008: 353—358
Note	A piece of limestone has never been published. It is reported to be found in Kenize shelter and preliminary attributed to the Mesolithic. Though the general archaeological context of the find is revealed, the details remain unknown. After decontextualization, engravings on the front part of the stone were covered with white pigment. A big limestone block of bifacial shape was probably slightly damaged during the excavation and storage. It contains three linear engravings on its convex front side. Two of them create a semi-circular shape, while the third one (added later) superimposes the longest engraving. These lines were scratched into the stone surface. The cross-sections are comparatively regular, with rounded bottoms, except for the widest one, which is slightly irregular. The image is schematic.

Technological drawing front



Drawing sequence front



Cross-section card