

# The Upper Paleolithic rock art of Ukraine between here and nowhere

Simon Radchenko<sup>a,\*</sup>, Dmytro Kiosak<sup>b,c</sup>

<sup>a</sup> Department of Historical Sciences, University of Turin, Italy

<sup>b</sup> Department of Asian and North African Studies, Ca' Foscari University of Venice, Italy

<sup>c</sup> Odesa I.I. Mechnikov National University, Ukraine

## ARTICLE INFO

### Keywords:

Upper paleolithic  
Composite beings  
Photogrammetry  
Rock art  
Kamyana mohyla  
Ukraine

## ABSTRACT

The complex of Kamyana Mohyla is the westernmost rock art location of the Eurasian Steppe and the largest accumulation of cave art sites in the Eastern Europe. So far it has been believed that the complex contains the Upper Paleolithic cave art images as well as portable art collection that resemble the instances of Upper Paleolithic worldview. Though this belief lacked the support of archaeological context and chronological attribution it remained neither proved nor disputed. However, the application of digital photogrammetric tools allowed to perform the sub-millimeter surface modeling of the rock art objects and to re-examine and reconsider the engravings that were previously attributed to Pleistocene. The modeling results presented in this article revealed the complete absence of figurative images for the collection of portable art specimens and the dubious character of those for the cave art one. Therefore, the whole collection should be reconsidered, studied and attributed according to the state of the art and contemporary archaeological record in the region. This contribution attempts to think over the possible Upper Paleolithic origin of the motifs from Kamyana Mohyla in the light of new data and proposes three hypotheses towards the understanding of the rock art assemblage from one of the caves in the complex.

## 1. Introduction

Despite scholars have made a giant step forward in chronological attribution of rock art objects, we still do not have a reliable tool to directly determine the age of petroglyphs. However, numerous constantly-emerging novel approaches are pushing rock art researchers to reconsider the established hypotheses in the chronological and cultural attribution of the sites worldwide. They apply innovative techniques and additional research efforts in order to test and re-evaluate previous interpretation of rock art sites to confirm or invalidate them. However, in some cases an outdated hypothesis might stuck halfway through formulation to rejection. This is the exact case of Kamyana Mohyla, the largest rock art complex in Ukraine.

Despite its European location, this complex is quite unique in its history, outlook, geological structure and the appearance of rock art objects. V. Danilenko, who provided the long-term rock art research on the site, described the carvings from the caves referring to the concepts of style and figurativeness of rock art objects (1986: 51–57) attributing them to Upper Paleolithic. However, both concepts appear to be misleading as the dating evidence. Since V. Danilenko had died before

the publication of his research and there was no sapid discussion, the hypothesis on Pleistocene origin of some Kamyana Mohyla rock art instances is to be evaluated or properly 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 et al., 1999).

Such state is not healthy or good for historical discipline and should be reconsidered, re-examined and resolved if possible. Therefore, the aim of this article is to test the old hypothesis using new data and novel approaches. Furthermore, we may endeavor to communicate the rock art of Kamyana Mohyla in a relevant way that is not obsessed with misleading concepts and traps of the past. To do this we overview the archaeological and rock art materials in the region. Then apply digital tools to examine the most iconic rock art objects from Kamyana Mohyla that were considered to belong to Upper Paleolithic and test Danilenko's arguments regarding their cultural and chronological attribution. Finally, we indicate the new state that would resolve the ambivalent and schizophrenic nature of 'Upper Paleolithic' Kamyana Mohyla rock art

\* Corresponding author.

E-mail address: [simon.radchenko@unito.it](mailto:simon.radchenko@unito.it) (S. Radchenko).

<https://doi.org/10.1016/j.quaint.2022.09.008>

Received 20 May 2022; Received in revised form 5 August 2022; Accepted 22 September 2022

Available online 8 October 2022

1040-6182/© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

and propose a set of new hypotheses to be tested in the future.

## 2. Materials

### 2.1. The Kamyana Mohyla rock art complex and its surroundings

The rock art complex of Kamyana Mohyla is located at the western border of Eurasian Steppe Belt (Fig. 1). It originated approximately 14 million years ago, when the monadnock of soft sandstone concreted at the bottom of Sarmatian Sea (Radchenko et al., 2020: 167). Later the monolith broke into numerous sandstone slabs of different size that formed a recognizable hill in Ukrainian steppes (Fig. 2) near the banks of Molochnaya River. The hollow space between the blocks formed caves that were used by ancient inhabitants of the region to produce rock art engravings throughout the millennia, while the sand, the density of sandstone and desert varnish on the slabs helped to preserve the incisions. Though the caves have never been inhabited and do not contain rich assemblages (apart from a few exceptions), most of them contained cave art or portable rock art specimens that includes engravings sometimes covered with red ochre. 68 rock art locations were discovered so far within the hill and its surroundings. Some engravings are exposed to the sun outside of the caves; others are under the blocks or covered with sand.

So-called “Bull’s cave” (cave No. 9) and “Wizard’s cave” supposedly contain the Upper Paleolithic rock art motifs (No. 52). The entrance to the former is on the Northwestern slope of the hill, while the latter occupies its Southeastern part. (Fig. 2).

The complex of Kamyana Mohyla was recognized as a unique rock art location at the end of 19th century by N.I. Veselovskiy (1893). Though in his report to the Emperor’s Archaeological Committee he

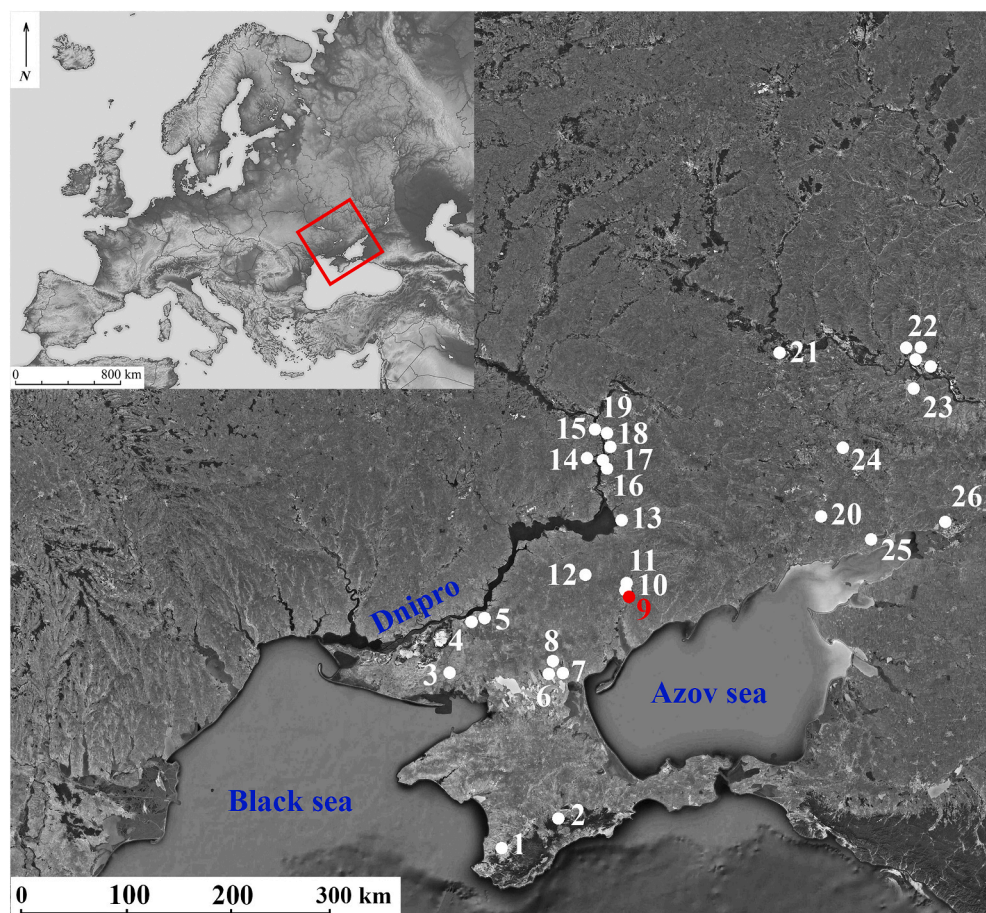
emphasized the great relevance and importance of this location, Russian government did not made any effort to investigate the site. Later in 1910s Veselovskiy examined the hill again and found the Bull’s cave. Numerous archaeological studies and research projects performed there in 20th century have led to the discovery of many other caves, such as cave No. 52, first entered during 1973 field season.

The interpretation of Kamyana Mohyla rock art is complicated due to the absence of any other datable material on the panels or in the filling of the caves, the absence of archaeological context of the rock art specimens and the abstract and schematic imaging for most of the caves. However, the recent advances in digital photogrammetry have already confirmed its efficiency for particular objects of the complex (Radchenko and Nykonenko, 2019; Radchenko et al., 2020) and are a promising and informative source of information even for such a complex dataset.

The archaeological study of the region proceeded simultaneously to the rock art research process. Though it was mainly focused on the Mesolithic (Kotova et al., 2018; Kiosak et al., 2022), Neolithic (Danilenko, 1969; Kotova et al., 2017) and Bronze Age (Makhortykh et al., 2020) sites, some efforts were made to search for the Upper Paleolithic locations in the Kamyana Mohyla surroundings.

### 2.2. Upper Paleolithic sites of the region

The Azov Sea region was settled since the Early Paleolithic (Praslov, 1968; Stepanchuk et al., 2010). The intensive Neanderthal settlement of the adjacent Donetsk ridge and Dnieper Rapids poured out onto the lowlands of the modern-day Azov Sea (Chabai, 2007). However, the best represented period of the Stone Age here is the Upper Paleolithic, especially its later part after the Last Glacial Maximum (Kitagawa et al.,



**Fig. 1.** 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 — Kash-taeva balka; 13 — Lysa Hora; 14 — Kant-cerka 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).



Fig. 2. Aerial view of Kamyana Mohyla (after Radchenko, 2022, Fig. 2). 1 — entrance to the Bull's cave; 2 — entrance to the Wizard's cave.

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).

In the immediate vicinity of the Kamyana Mohyla there are several Upper Paleolithic sites attested: Kashtaeva Balka, Novopavlivka, Sekiz.

Only Kashtaeva Balka was published in sufficient detail (Mykhailov, 1987). “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, engraved tools etc. The non-geometric microlithic assemblage includes points of “gravettian outlook” (Mykhailov, 1987: 51) (according to Dmytro Kiosak, the “gravettian outlook” in Mykhailov’s publication mean typical backed points), oblique truncations and points with arched back as well as a single double truncation on a blade resembling a trapezoid. The site has 23 pieces of sandstone, “which is known in the North Azov region only at the Kamyana Mohyla hill” (Mykhailov, 1987: 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: high percentage of double burins and double end-scrapers, constant presence of Federmesser type curved backed points and 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).

The excavations at Novopavlivka (41 m<sup>2</sup>) yielded 81 flint implements and several sandstone blocks that originate 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.).

The excavations at Sekiz I (96 m<sup>2</sup>) yielded 398 lithic artefacts (Mykhailov, 1992). They can be attributed only provisionally so far since only a single point (Olenkovskiy, 1992: 57–58) has been reported from this collection.

Nowadays it is evident that the critical assessment of these sites as “destroyed and redeposited” (Mykhailov, 1982: 91; Olenkovskiy, 1992: 57) was a bit unreasonable. It was based partially on their low topographic position in the floodplain of Molochna river, thus on the geomorphological forms of supposed Holocene age (Olenkovskiy, 1992: 57). However, recently a so called pro-terrace of the Late Glacial age was

detected near the small rivers flowing into the Black Sea and described. It contained some Upper Paleolithic sites (Chepalyga and Kiosak, 2014). It would be reasonable to assume that these terraces also exist near the rivers flowing into Azov Sea so tracing them would provide a stratigraphic basis for the preservation of the Upper Paleolithic cultural layers.

The North Azov group of Epigravettian sites is studied relatively well. Some sites underwent systematic excavations: Fedorivka (Krotova, 2019), Solone Ozero I, Ia, IX, IXa (Olenkovskiy, 2010).

The set of radiocarbon dates is sparse for these sites (Olenkovskiy, 2010). The dates were obtained in late 1990s — early 2000s by a conventional analysis of animal bone samples in Kyiv radiocarbon facility (see Table 1). 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 reported in Table 1 can be younger than their “real ages”.

The dates were calibrated in OxCal 4.4.4 (Bronk Ramsey and Lee, 2013) with the calibration curve IntCal20 (Reimer et al., 2020). The results are somewhat contradictory. There are two sets of dates: older encompass 18730–17462 calBP (2σ), while younger cluster is around 16498–14962 calBP (2σ).

The ups-and-downs of calibration curve add up uncertainty to the actual age of North Azov Culture sites (Fig. 3, see also Biagi et al., 2014). On the typological grounds Kashtaeva Balka was attributed to the older

Table 1  
Radiocarbon dates for Epigravettian sites of North Azov Sea region.

No	Site	Lab N	Age, BP	+/-	Material	Reference
1	Fedorivka, I2	Ki-10354	15200	110	Animal bone	Krotova (2019)
2	Fedorivka, I1	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)

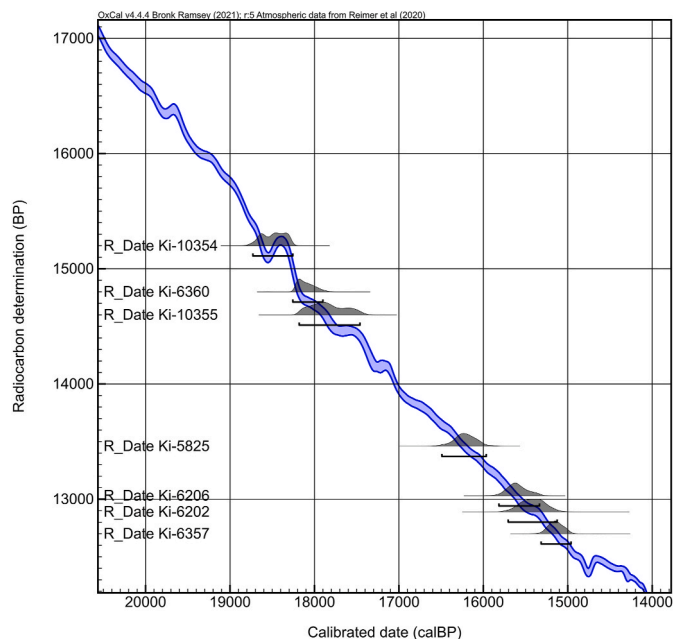


Fig. 3. Radiocarbon dates for the Upper Paleolithic sites of North Meotic region (after Olenkovskiy, 2010; Krotova, 2019).

phase of this cultural aspect and compared to the site of Fedorivka with two XIX—XVIII mill. calBP radiocarbon dates. So we can suppose that the Upper Paleolithic people were in the close vicinity to the Kamyana Mohyla hill during GS2-1b (Rasmussen et al., 2014) and quite probably later.

This statement is additionally supported by separate finds from the Chervona Hora (the ridge above Kamyana Mohyla (Danilenko, 1986: 135)) as well as some deeply-patinated chipped stone artefacts with rounded edges found during the excavations of the Kamyana Mohyla 1 site, Mesolithic and para-Neolithic sequence situated between the Chervona Hora and the hill of Kamyana Mohyla (Kotova et al., 2017; Kiosak et al., 2022). Usually, it is interpreted they moved down the Chervona Hora by slope processes. Some could be manuports due to the Mesolithic and para-Neolithic dwellers of the site. A two-platformed prismatic core for wide and short irregular blades (Kotova et al., 2017, Fig. 11:1) is a good example. It comes from a layer of para-Neolithic Surskyi culture and finds few counterparts in its technological context, while resembling similar cores from Kashtaeva Balka (Mykhailov, 1987, Fig. 1:9) and other Epigravettian sites of the region (Olenkovskiy, 2010, Fig. 3:28; 7:1 etc.). It can belong to Epigravettian, however this cannot be stated with certainty due to the lack of relevant stratigraphic context.

### 2.3. Upper Paleolithic art of Kamyana Mohyla?

All the archaeological materials found within the Kamyana Mohyla surroundings and considered Upper Paleolithic were taken into account by Ukrainian rock art scholars to provide the archaeological context to the rock art motifs of Kamyana Mohyla. The discovery of Pleistocene assemblages within the site surroundings used to be a supportive argument to verify the possible Paleolithic Age of some Kamyana Mohyla petroglyphs. Indeed, these assemblages within the site surroundings do not mean the Pleistocene attribution of a particular engraving *per se*. If there are none though, this attribution is very questionable.

The discovery of Upper Paleolithic sites in the region was awaited ever since the first hypotheses on the images of Pleistocene fauna.

#### 2.3.1. The Bull's cave

The so-called 'Bull's cave' primal complex was discovered in 1918 and was considered by V. Danilenko as an Upper Paleolithic one. It

contains figurative images of different creatures produced by polishing and incising the ceiling of the cave. Danilenko regards them as Paleolithic by two criteria: 1) the Pleistocene fauna on the image; 2) the "clearly Paleolithic style of their appearance" (Danilenko, 1986: 53). The researcher considers this chronologic and stylistic group to be the oldest in Kamyana Mohyla and describes it as 'characterized by the realistic images from the "Mammoth cave" [the way he named the "Bull's cave"] protruded into the sandstone surface on the large area and then painter. This includes the "bulls' in defense" scene, singular engravings found by B. Gladilin and a "row of animals" placed along a cornice' (Danilenko, 1986: 56). This interpretation was a matter of long discussion since the discovery of the images. Since the 'mammoth' image was the only instance of Pleistocene fauna depiction in the cave, it played a key role in the chronological attribution of the motifs in general. While 'mammoth' version was supported by M. Rudynskiy (1952), other authors interpreted the carving as a bull (Zemlyakov, 1939; Gladilin, 1969). Later these versions were compromised by B. Mykhailov who suggested that the silhouette presents a mythical "Rain Bull" (Mykhailov, 2005: 118–119) — a creature with a trunk and bull's silhouette. These researchers attributed the image (and thus the whole asset of rock carvings in the cave) to the Eneolithic—Bronze Age. The discussion ended after the digital photogrammetric study of the animal depictions from the cave and their comparison with the Eneolithic images from Central Asia (Radchenko and Nykonenok, 2019) (Fig. 4:1, 2). The images of bulls and the 'mammoth' one were reexamined, new traces were produced; they have numerous analogies in the Eneolithic of Central Asia. The hypothesis of their Late Eneolithic origin was also supported by the recent study of similar engravings in Late Eneolithic burial nearby (Daragan et al., 2021). These recent advances have proven the idea of Upper Paleolithic art in the Bull's cave wrong and induced the reexamination of other complex that was interpreted by V. Danilenko as depicting the Pleistocene fauna.

#### 2.3.2. The Wizard's cave

V. Danilenko also provided archaeological excavations and rock art survey of Kamyana Mohyla and its surroundings during 1947, 1951–1956, 1973 and 1974. In 1973 he discovered two more caves — the cave of Churingas and the Wizard's cave. While the former was not featured by cave art objects and contained only portable ones that were considered as Mesolithic depictions of a fish (Radchenko, 2022), the latter has been attributed to the Upper Paleolithic due to the motifs that were considered by V. Danilenko as Upper Paleolithic ones: "the wizard, mammoth, a few anthropomorphic dancers featured with the horns and slightly spoiled image of cervidae were discovered. All these images are pictured in a "shallow engraving" technique and remain barely noticeable in the dark. The cave was called "the Wizard's cave" according to the first image that was found there. The discovery of an asset of Upper Paleolithic images of a special style caused the necessity of a trip to Kyiv to request additional resources (Danilenko, 1986: 75–76) (Fig. 4: 3–6). The data in V. Danilenko's book contains a schematic drawing of the rock art motifs from the cave that were never checked due to the limited access to the cave.

During 1973 and 1974 Danilenko also found 88 portable engraved stones that represent the collection of mobiliary art specimens from the Wizard's cave. He named them 'churingas' by coincidence, since the shape of the portable stones resembled Australian churingas (1986: 118). The word itself means an object that is "hidden" (tju) but also "thing, which is personal to me" (runga) (Strehlow, 1947: 85–86). However, in Ukrainian case the use of Australian word is just traditional and does not reflect neither physical nor functional parameters of portable objects. Danilenko analyzes some of them and provides the semantic interpretation of the engravings on their surface (Danilenko, 1986: 94–118). According to his interpretations, these stones are the clear representation of Upper Paleolithic worldview that includes the Pleistocene fauna of the region, female figures and domestic and mythological scenes (Fig. 5).



**Fig. 4.** Engravings from the Bull's cave (1, 2) and the Wizard's cave (3–6) from Kamyana Mohyla. 1 — An image of so-called 'Rain Bull' that V. Danilenko considered to be a mammoth (after Radchenko and Nykonenko, 2019: 59, Fig. 11); 2 — an image of 'row of animals' (after Radchenko and Nykonenko, 2019: 57, Fig. 8); 3 — drawing of the 'Wizard' (after Danilenko, 1986: 137, Fig. 91); 4 — killed mammoth and the anthropomorphic figures surrounding him (after Danilenko, 1986: 76, Fig. 27:2); 5 — an image of a cervidae (after Danilenko, 1986: 77, Fig. 28:2); 6 — composition of a "Great goddess" and a cave lion, the first group from Scynia (Danilenko, 1986:90, Fig. 41).

In order to make his results and drawings more visible, Danilenko used a method of direct painting of engravings with pastel coal right on the stone surface. His methodology of rock art recording consisted of "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 drawing 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). The photo fixation was impossible, according to the scholar, due to the lack of proper electric lighting systems. Therefore, V. Danilenko interpreted the parietal art depictions using his own drawings while the portable ones were analyzed later in the laboratory of the Institute of Archaeology of National Academy of Sciences of Ukraine.

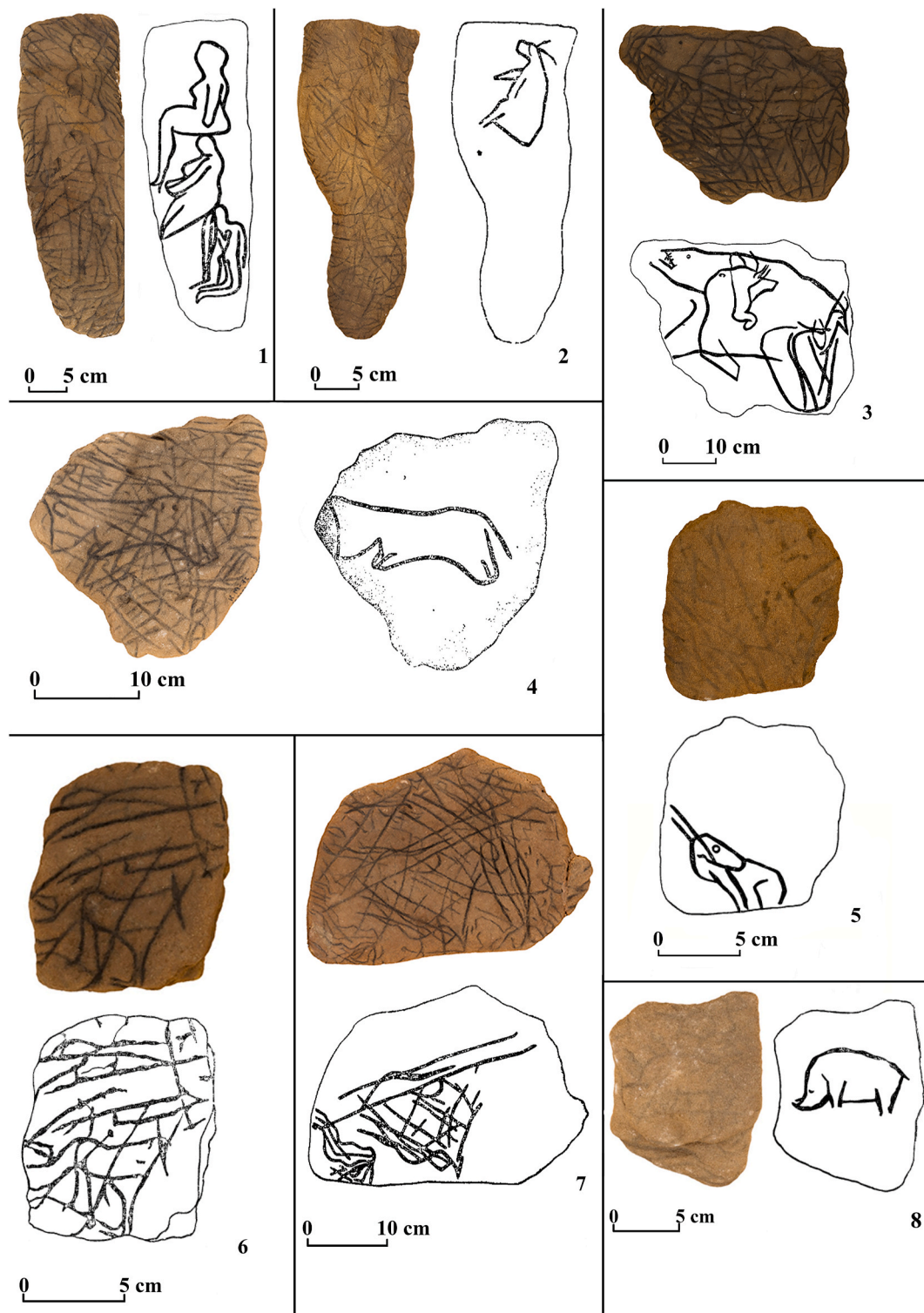
Following the same methodology, he covered the portable rock art specimens with the pastel coal to make the engravings visible during the photo fixation in the laboratory. On one hand, such method does a lot of damage to the engraved image and prevents the correct understanding of the motifs. On the other hand, the pastel coal drawings that remained on the surface of portable stones and cave ceilings give an opportunity to follow Danilenko's consideration and understand the origin of his ideas.

To sum up, there were 4 main statements to prove the existence of Upper Paleolithic rock art on Kamyana Mohyla and in the Wizard's cave in particular: 1) there are archaeological sites that belong to the Upper Paleolithic within the Kamyana Mohyla surroundings; 2) The image of a

mammoth from the 'Bull's cave' is a clear naturalistic depiction of Pleistocene fauna and thus a representation of an Upper Paleolithic motif; 3) portable rock art specimens feature instances of Upper Paleolithic worldview — images of a woman, rhinoceros, mammoths, wizards etc. (Figs. 4 and 6); 4) the ceiling of the Wizard's cave contains numerous depictions of clearly Upper Paleolithic images made in unique and recognizable style.

Unlike the interpretation of depictions from the Bull's cave, those from the Wizard's cave were never criticized or evaluated in a separate research. Though B. Mykhailov states that "the efforts of V. Danilenko and B. Mykhailov played an important role in the proof of the Upper Paleolithic petroglyphs [on Kamyana Mohyla]" and "... the ceilings and cornices with the depictions of Pleistocene fauna were discovered as well as numerous portable blocks with semantically equal images" (2005: 102), he used the drawings provided by V. Danilenko and did not consider them critically.

However, the misinterpretation of the images from the Bull's cave deconstructs one of the four statements and deprives Kamyana Mohyla of the whole set of 'naturalistic images of the Pleistocene fauna' in one go. Moreover, it has revealed that the possible interest of Ukrainian rock art scholars in discovery of the Paleolithic art might have affected their interpretations of Kamyana Mohyla site. Therefore, it is reasonable to reexamine the objects from the Wizard's cave to confront the hypotheses made by V. Danilenko with new data and current state of the art. This is relevant both for the collection of portable art specimens from the



**Fig. 5.** Churingas from Kamyana Mohyla. Photos (by S. Radchenko) and drawings made by V. Danilenko. 1 — No. 245, three women (after Danilenko, 1986: 128, Fig. 88); 2 — No. 247, the image of a bull (after Danilenko, 1986: 126, Fig. 84); 3 — No. 283, mammoth, cave bear and rhinoceros (after Danilenko, 1986: 107, Fig. 60); 4 — No. 302, the image of a wolf (after Danilenko, 1986: 101, Fig. 54); 5 — No. 338, an antelope (after Danilenko, 1986: 98, Fig. 49); 6 — No. KM74—1, a bull and partially depicted cave lion (after Danilenko, 1986: 95, Fig. 45); 7 — No. KM74—2, a river, human being and a hut (after Danilenko, 1986: 114, Fig. 68); 8 — No. 307, rhinoceros (after Danilenko, 1986: 98, Fig. 50).

Wizard's cave that are in the storage of the Institute of Archaeology of NAS of Ukraine in Kyiv and parietal art motifs on the ceiling of the cave. The latter, however, is barely accessible due to the recent destruction in the cave and considerable amount of sand that fills most part of the space inside.

The only parietal art motif that remains observable and accessible for 3D modeling in the Wizard's cave is the eponymous image of so-called 'Wizard', discovered and interpreted by V. Danilenko in 1973 (Fig. 4:3). It is located close to the cave entrance, where the ceiling height is almost 70 cm. Therefore the observation of the image and its

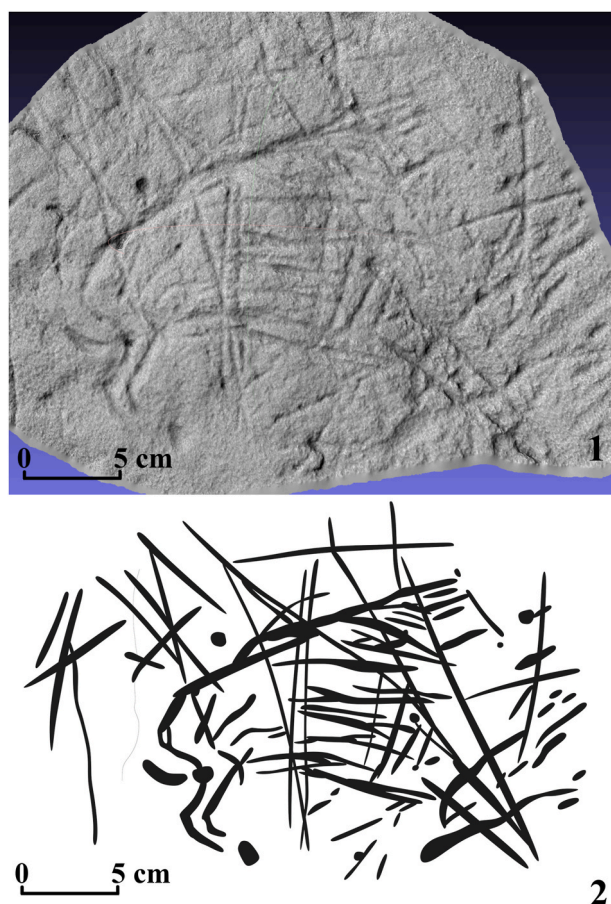


Fig. 6. An engraving of the Wizard. 1 — reconstructed mesh; 2 — drawing (made by SR).

photogrammetric assessment is possible despite the lack of natural light and the need to crawl inside the cave. Following the interpretative drawing made with pastel coal and copied to his book, Danilenko states:

‘The complex consists of at least three components: totally anthropomorphic symbol of a Wizard; an animal with the tail where the tail is also the Wizard’s attribute; zoomorphic frame that surrounds the Wizard. The latter is the least clear phenomenon. Search for the analogies in the fauna did not lead us to the solution of this issue. A snout of a creature if examined carefully seems to be not that of an hoofed animal due to its sharp shape similar to a beak. It is possible that the zoomorphic background of the Wizard is introduced by a bird ... It is worth noticing that the motif of a shaman embodied in a bird is the ancient and common one that was probably shared by human beings across the world during the Paleolithic Age’ (Danilenko, 1986: 136–137).

The validation of these V. Danilenko’s hypotheses requires a complex and accurate reexamination of the objects’ surface. The comparison between the new data and the existent drawings and pastel coal paintings on the sandstone surface will clarify the relevance of semantic interpretations. Moreover, the accurate digital tracing will contribute to the required digital preservation and representation of a motif.

### 3. Methods

The most pressing needs for the rock art recording and rock art research can be summarized as visibility, abstraction, accuracy and objectivity (Rondini, 2018: 260). In addition, the particular tools must be applied to the given rock art objects taking into account their location and limited access to the engravings.

Application of these concepts to the particular case of Kamyana

Mohyla justifies the image-based 3D-modeling as the most relevant and accessible solution for rock art research there. To begin with, the reconstructed shape of rock panels and portable rock art specimens gives more visibility than the direct observation and single image, i.e. it clearly presents what is depicted and where (Porter et al., 2016; Likhachev, 2018). These methods, applied to the rock carvings of Kamyana Mohyla, have already resulted in the discovery of new petroglyphs and reconsideration of the known ones (Radchenko and Nykonko, 2019).

Abstraction serves the need of seeing the engraved figures apart from distracting elements (Rondini, 2018: 260). Applying it to the Ukrainian art this means the possibility to avoid the confusing impact of V. Danilenko’s paintings on the current analysis by examining surface rather than color.

Finally, accuracy and objectivity refer to the level of correspondence between the model, visual data and reality. Though the digital photogrammetric solutions have shown their great efficiency for the rock art recording all around the world (Tosello and Villaverde, 2014; Méléard et al., 2016; Wang et al., 2019; Radchenko et al., 2020), the assessment of accuracy often requires special solutions for the particular case.

The data acquisition process in the Wizard’s cave is also affected by the limited space in the cave and impossibility to safely provide any additional excavation works. Therefore, images were collected from the same distance and comprise the Wizard’s engraving and the small area around it including the photogrammetric plastic card for the assessment of metric parameters (see Table 2). The images with automatically estimated quality below 0.5 were excluded from the processing.

Unlike the cave art object, the portable ones were photographed to perform the image-based 3D-modeling in the laboratory. The data acquisition involved the use of metallic calibration board, designed and calibrated on a submillimeter level specially for the study of portable rock art objects from Kamyana Mohyla. The metallic board allows to have the accuracy of 3D-model reference of less than 0.7 mm and to provide the detailed analysis of the mobiliary art specimens. The coordinate field is made by the computer numerical control machine equipped with laser. The error of coordinate line placement does not exceed 100 µm according to the laser interferometer check. Taking into account the results of metrological tests, the reference error might be reduced to 0.5 mm. The total size of the field, which is 19 × 19 cm, allows referencing every stone in the Kamyana Mohyla portable art collection to the conventional rectangular coordinate system and acquiring the metric data from the model measuring and examination. In total 50 portable art specimens attributed to Upper Paleolithic were modeled and examined.

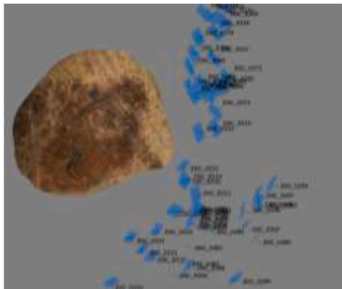

The data for each specimen were acquired in five acquisition scenes:

- 1) Top view, horizontal rotation of the object and the coordinate field (for the future referencing);
- 2) Down view, horizontal rotation of the object without the coordinate field
- 3) Left view, vertical rotation of the object;
- 4) Right view, vertical rotation of the object
- 5) Additional imaging of the stone facets if required.

The scenes were referenced and reconstructed in Agisoft Metashape v. 1.5. The reconstruction of the shape of portable objects required the masking of the image background. In order to align and 3D-reconstruct the shape of portable stones the masks were applied differently for different acquisition scenes. On the first acquisition scene the stone and calibration field were considered during the alignment; only the stone object without additional objects was considered on the rest of acquisition scenes. After the alignment and dense point cloud reconstruction, the scene was manually cleaned from noisy points and meshed into a model (Fig. 6: 1).

The models were used to extract the cross-sections of engravings from Agisoft Metashape and for metric assessment of their parameters —

**Table 2**  
Data acquisition and processing parameters.

Parameter	Wizard's engraving	Portable objects
Reconstructed scene		
Camera	NIKON D3300	Canon EOS 5DS R
Aperture	3.5	16
Exposure, s	1/60	1/5
Focal distance, mm	18	50
Image size, pixels	4000 × 6000	5792 × 8688
Number of images (average)	54	113
Number of polygons	8 000 000	8000 000
Estimated size of a polygon, μm	30	50
Control points error, mm (max)	0.461	0.497
Control points error, mm (min)		0.107
Control points error, mm (average)		0.316
Check points error, mm (max)	0.742	0.483
Check points error, mm (min)		0.171
Check points error, mm (average)		0.372

after the small part of the model containing cross-section is separated, it is transformed into 2D orthophoto, measured and vectorized to provide objectivity and accuracy during the analysis of engraving and consider the technological differences of different incisions.

To provide the further examination, models were exported into Meshlab v. 2016.12. *Ambient occlusion* and *Radiance Scaling* shaders were applied to increase the visibility of the engravings. Moreover, the artificial virtual light manipulation provided an additional tool for the examination of 3D models. The latter is comparable to RTI-technology applied to 3D models (Porter et al., 2016; Graff, 2018). Applied to the models of portable specimens, these filters increase visibility of the incisions including those with depth below 0.15 mm. Finally, the drawings were created from the digital orthophotos, taking into account the results of artificial light application.

These methodological efforts provide the sufficient level of accuracy and visibility and allow to re-examine the previous assumptions made by V. Danilenko. When compared to his drawings and pastel painting of rock art objects, they reveal the relevance and accuracy of the established 'Upper Paleolithic' interpretations.

#### 4. Results

In order to test both semantic interpretations and chronological attribution of the rock art objects from the Wizard's cave provided by V. Danilenko the image-based 3D modeling has been performed. This allows to accurately examine the surface of the rock and revise the current understanding according to the new data.

##### 4.1. The portable art objects from the Wizard's cave

The accurate and precise surface examination of all 50 portable rock art specimens revealed the misleading pattern of their interpretation applied by V. Danilenko. His pastel coal pictograms on the surface of the ancient stones do not correspond to the real location of the engravings. Vice versa, he painted the surface of the stones regardless of which particular parts of the stone are engraved. All investigated objects share the same trend: while some of engravings are covered with pastel coal, others are not; there are also many painted lines that were drawn not on

the engravings. Consequently, the drawings that V. Danilenko created from these paintings and used during the interpretation of the engravings do not correspond to what is really engraved (Figs. 7 and 8). From the 50 3D-modeled specimens there is not a single one that shows different pattern. Moreover, any figurative engravings like woman or animal depictions etc. are absent on the surface of the objects. Therefore, the whole set of interpretations, provided by V. Danilenko regarding the portable art specimens from the Wizard's cave is irrelevant as the interpreted pictures are not equal to what is actually engraved. The stones are covered mostly with reticulated or linear ornamentation, sometimes containing small cupmarks.

This non-figurative ornamentation, however, is a trace of artificial processing of the stone surface. The flat surface of the objects is covered with shallow and wide lines and perforated cupmarks. They were processed by human beings and thus might be considered as a collection of portable rock art instances.

The sandstone of Kamyana Mohyla is too dense and hard for animals to scratch accidentally or even intentionally. The main component of the Kamyana Mohyla sandstone is quartz. Its Mohs hardness is mostly equal to 7, while the assumed hardness of keratin-based animal claws (similarly to human fingernail) does not exceed 2.5–3 (Ivanov 1990). Even if we assume that the animals could scratch out the sandstone grains from the slabs (that would be really uncomfortable to perform with the small blocks of irregular shape), this would create the irregular and curved edge of the engraving, which is not the case for the engravings on Kamyana Mohyla stones. 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, that is evident from cross-sections of the incisions and the shape of cupmarks.

To conclude, the collection of portable art objects from the Wizard's cave represents an asset of stones with non-figurative ornamentation. They do not contain any kind of depictions that might be considered as Upper Paleolithic.

##### 4.2. The 'wizard' motif on an eponymous cave ceiling

Since the examination of the portable art specimens had shown the systematic error in rock art recording and interpretation procedure, the



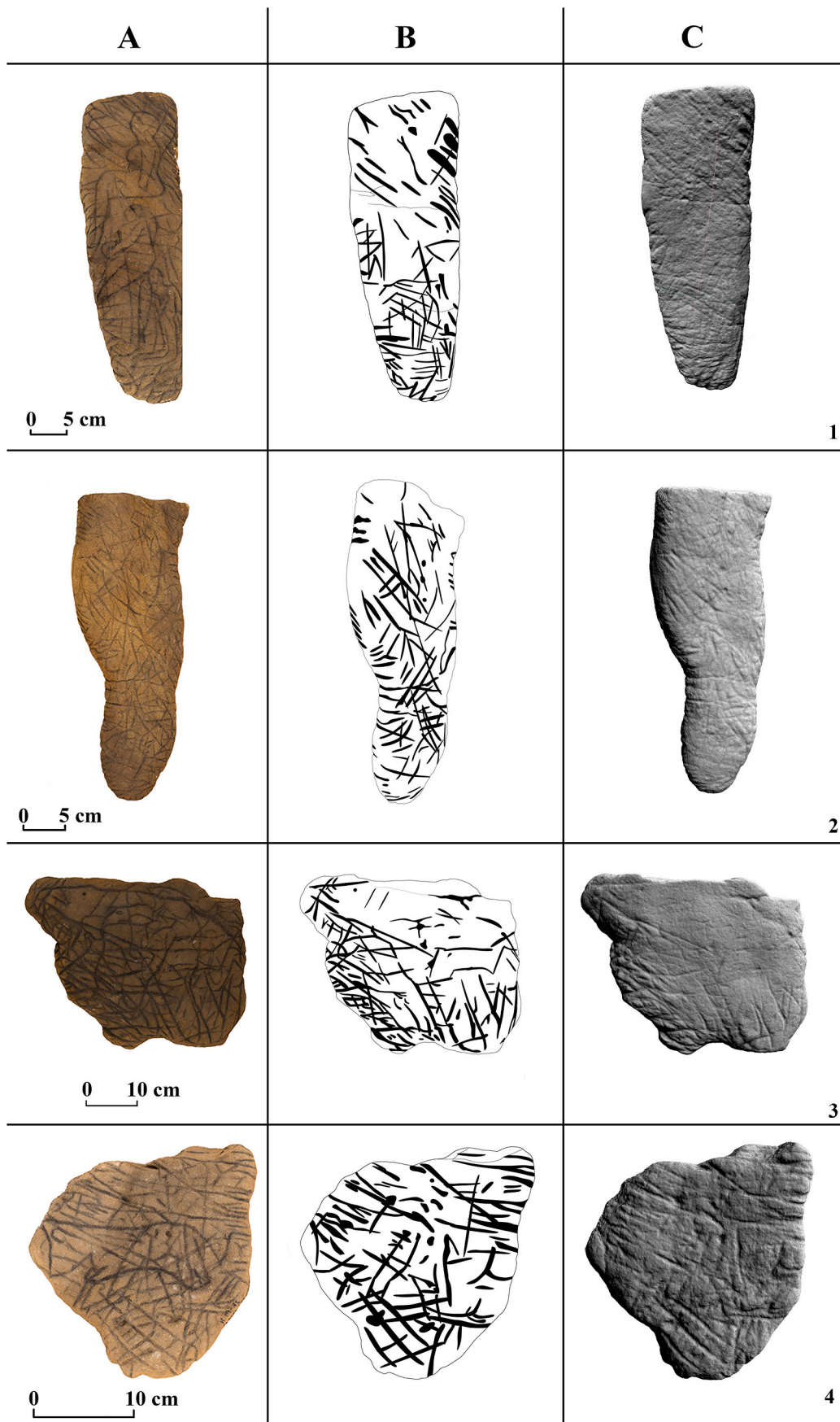
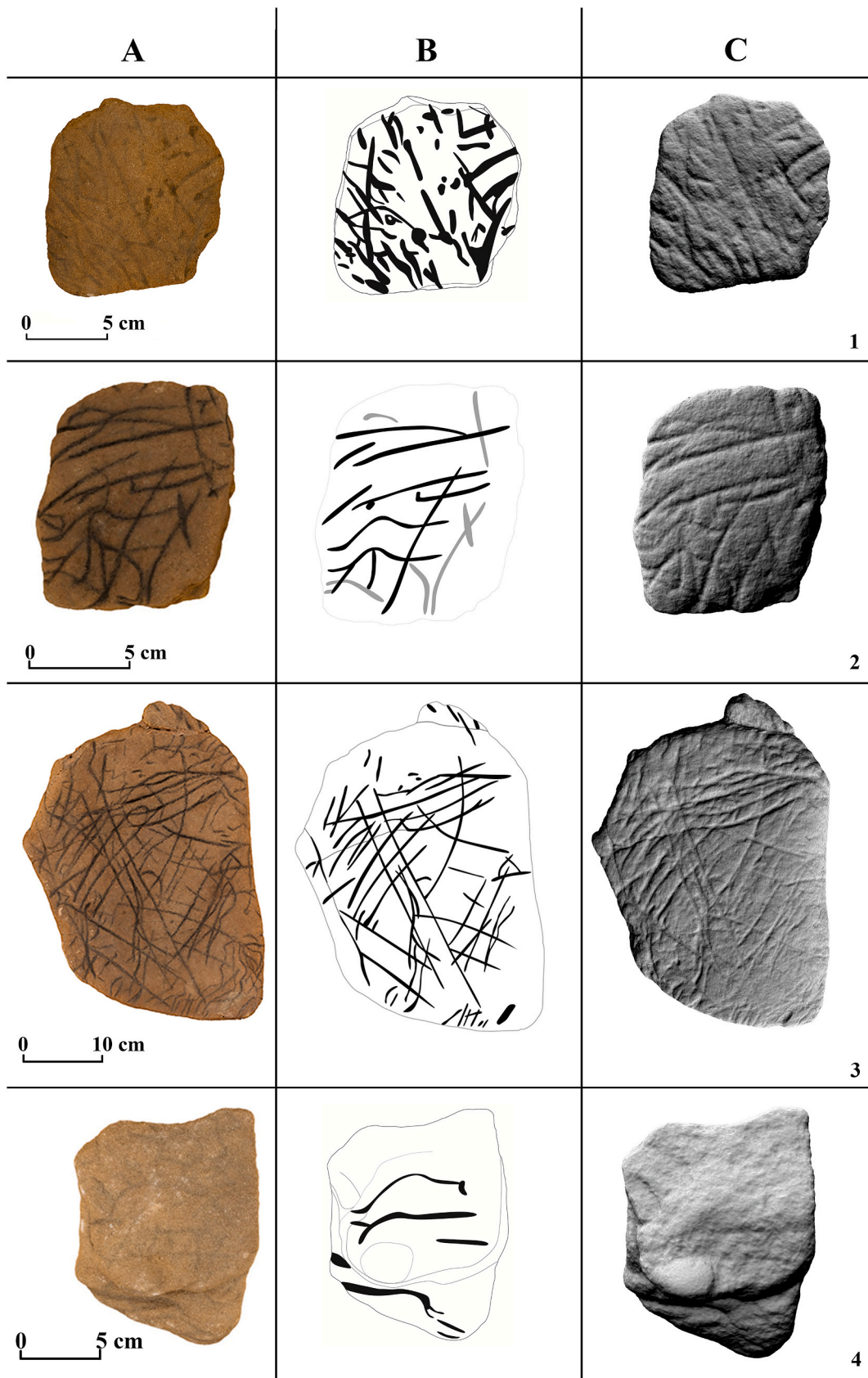


Fig. 7. Churingas from Kamyana Mohyla. A — Photos; B — Drawings, made by S. Radchenko after examining 3D-models; C — 3D-mesh. 1 — No. 245; 2 — No. 247; 3 — No. 283; 4 — No. 302.



**Fig. 8.** 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.

relevance of interpretation of the parietal art motifs from the Wizard's cave also needs to be verified. Unfortunately, excavation and exploration of the cave appears to be dangerous and requires additional financial and institutional support. Among all the engravings in the cave only the eponymous one is available for the digitization and check. Fortunately, it presents the example of what V. Danilenko considered as 'common Upper Paleolithic motif' of a wizard or a shaman that turns into a creature by wearing its skin (Danilenko, 1986: 137–139). Scholar distinguished (and pictured with black pigment) the silhouette of a human being, inscribed into the larger silhouette of an animal or a bird.

The digital examination of the picture revealed the pattern, identical to the pattern of portable stones. The cave ceiling contains engravings made by human beings. The reticulated ornamentation contains chaotically placed linear incisions. The latter have different sizes and shapes and are different by their cross-sections (Fig. 9). However, the placing of a black pigment, used by V. Danilenko, does not necessarily correspond to the engravings in sandstone surface. Comparing to the drawing provided by V. Danilenko (see Fig. 4:3), the real image of a human being lacks head and the part of torso. Two zigzag lines, which were considered creature's legs, are presented as well as the line, which was thought to be a creature's tail (though its shape changed). The shape of 'snout' or 'beak' is also different from what was drawn in 1973. These differences between the real image and what was interpreted by V. Danilenko make his interpretation dubious, especially taking into account that he did not support his assumptions by any parallels with known rock art sites, while all his supportive arguments appeared to be misleading or insufficient.

Therefore, none of depictions that are accessible for examination represent an example of clearly 'Upper Paleolithic' motif. Moreover, the drawings and interpretations of 51 out of 51 examined objects do not correspond to what is engraved on the sandstone surface.

## 5. Discussion

The results of 3D modeling and investigating the surfaces of the models bring up the need to reevaluate the assumptions that were made regarding the Upper Paleolithic rock art of Kamyana Mohyla — both portable and parietal art objects. This implies testing all four arguments listed by V. Danilenko in his book, where the Upper Paleolithic complexes were first published.

### 5.1. Re-evaluation of the arguments for Upper Paleolithic origin of the art objects

1) *The Upper Paleolithic origin of rock art motifs from the Bull's cave and the Wizard's cave is supported by the archaeological data within the Kamyana Mohyla surroundings.* For the decades since this assumption was made by V. Danilenko the conceptual development of the discipline led to the more profound understanding of the known sites. They now may be reconsidered as not redeposited but located on Late Glacial pro-terraces. Moreover, they were preliminarily attributed to Epigravettian technocomplex and local North Azov culture and the particular period of time (16780–15512 calBCE). These archaeological evidences prove the hypothesis of the intense inhabitation of the Kamyana Mohyla surroundings during Upper Paleolithic to be correct.

However, there are no direct links between the rock art of Kamyana Mohyla and these sites. Moreover, the art objects from both caves are deprived of any archaeological context and their relation to the particular inhabitants of the region is still questionable. To sum up, now we have more evidence of the presence of Upper Paleolithic human beings near Kamyana Mohyla than we had 50 years ago, but their relation to the rock art of the region is still not proved.

2) *The engravings in the Bull's cave depict the Pleistocene fauna.* The Holocene attribution of the depictions from the cave No. 9 is now supported by Eneolithic archaeological assemblage in the cave, photogrammetric study of the surface of the engravings (Radchenko and Nykonenko, 2019) and stylistically and technologically similar images both in the region and in broader Central Asian rock art context. Therefore the hypothesis of the Upper Paleolithic origin of the engravings from the Bull's cave seems to be refuted.

3) *The portable art objects from the Wizard's cave contain images of Pleistocene fauna and Upper Paleolithic worldview.* The analysis of 3D models performed during the research showed that portable objects do not contain any depiction of Pleistocene fauna or any motif that can be arguably attributed to Upper Paleolithic. Therefore, they cannot present any evidence to support neither their own Upper Paleolithic origin nor Upper Paleolithic origin of the images on the Wizard's cave ceilings. However, they are a unique collection of engraved sandstone blocks with anthropogenic engravings that share the cultural and chronological context that is not defined yet.

4) *The images on the Wizard's cave ceiling are an example of typical Upper Paleolithic motifs and Pleistocene fauna.* Similarly to the portable rock

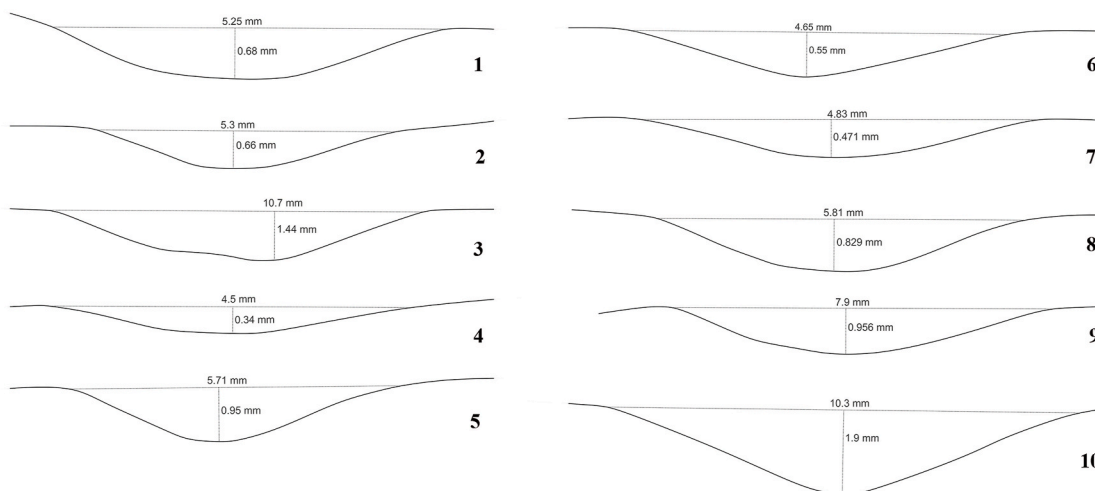


Fig. 9. The cross-sections of incisions that constitute the Wizard's engraving. The measurements below the calculated accuracy of 3D-model (0.5 mm) remain inexact.

art objects, the examined parietal ones do not represent what V. Danilenko thought. There is no clear depiction of a zoomorph, human being or therianthrope creature. Therefore, this interpretation cannot support the hypothesis of the Upper Paleolithic rock art existence on Kamyana Mohyla without sufficient reconsideration.

Taking into account the inconsistency of all four statements, we conclude that there is no reliable evidence that Kamyana Mohyla complex contains the instances of Pleistocene rock art. None of the examined objects might be considered Upper Paleolithic for sure.

On the other hand, the presence of Upper Paleolithic sites within the Kamyana Mohyla surroundings and the appearance of the petroglyphs allow to formulate new hypothesis on portable stones attribution and three more on the possible interpretation of the Wizard image. Though these hypotheses outline the possible connection of the engravings to the Upper Paleolithic, they are not privileged among other possible answers regarding the chronology of Kamyana Mohyla rock art. These particular ones are considered here in detail simultaneously due to their coherence with the existent tradition of the rock art research on Kamyana Mohyla and their inner consistency despite the obvious lack of archaeological reasoning to consider any hypothesis as a solid one. No doubts, the formulation of other assumptions and the discussion on the chronological attribution of Kamyana Mohyla rock art depictions are required before any solid answers will be found. Therefore, we will consider the hypotheses here as assumptions to be tested in future, when more data on the archaeological and rock art contexts of the site will be discovered.

## 5.2. Hypothesizing the examined motifs

The up-to-date hypothesis on how the portable rock art collection from the Wizard's cave is related to Upper Paleolithic derives from the chronological and technological attribution of the known archaeological assemblages from the region and recent advances in the structuring of the artistic representations both in European and Ukrainian Upper Paleolithic. Though it lacks the direct evidences and clear parallels, some assumptions might be made.

### 5.2.1. Portable rock art collection from the Wizard's cave

The important consideration for any hypothesizing on the portable art of Kamyana Mohyla is that it is different from known European and Eastern collections and lacks clear analogies and thus should be considered as a separate phenomenon — at least so far. This is also the case for the Upper Paleolithic archaeological sites of the region that used to be considered different and separate from those in Central Europe (Olenkowski, 2000). It is therefore should be taken into account that Ukrainian case is unique and requires special concepts and approaches to be developed. On the other hand, particular similarities are noticeable and leave space for hypothesizing.

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 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) and Foz do Medal introduce numerous examples of different Paleolithic rock art traditions. The largest of them, Parpalló, consists both 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 and de Marco, 2008) Europe. However, the portable stones from Kamyana Mohyla have the biggest 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 Upper Paleolithic imaginary, including anthropomorphic forms (Bosinski, 1991; Fuentes, 2016), animals (Güth, 2012; Bosinski and Bosinski, 2009), abstract and geometric motifs (Sieveking, 1987a) and sometimes even environmental depictions (García-Diez and Vaquero, 2015).

Though the plaquettes are mostly found in France, Spain and Germany, their geography varies from Portugal in the west (de Figueiredo et al., 2014) to Romania in the east (Cărciumaru and Nițu, 2018; Anghelinu et al., 2020). Single finds of comparable age are sometimes present in Eastern Ukraine (Gorelik and Tarasenko, 1993: 28–34; Gorelik, 2001: 208–209; Vetrov, 2007).

As most of these collections (not all of them) are featured with archaeological context, their functions and life cycle can be considered or suggested. The former included use in hearth constructions (Tosello, 2003; Fritz and Tosello, 2011), as a pavement (Bahn and Vertut, 1988; Arias and Ontañon, 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 (de Figueiredo et al., 2014).

The portable stones from the Wizard's cave of Kamyana Mohyla share a number of characteristic features to be mentioned for their technological description and contextualization. First, the shapes of the objects from the Wizard's cave were slightly processed before engraving. All stones from the collection are covered with desert varnish. Moreover, the portable stones from Kamyana Mohyla lack any kind of archaeological context; we are forced to consider them *per se*.

Second, the stones from the Wizard's cave are the representation of how human beings interacted with their environment. Similar to the Western European stones, those from Kamyana Mohyla might have also been re-engraved after the fragmentation. A clear illustrative instance is the block No. KM74—2, that broke in two pieces that were left in the Wizard's cave. The smaller one, however, was engraved after the fragmentation.

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 for 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 include 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 meander, zigzags etc. (Iakovleva, 2010). If this is taken into account, the portable rock art from Kamyana Mohyla remains alone other Ukrainian archaeological objects of this kind, though it shares some common features with the portable art of Western Europe. Under no circumstances they might be persuasively attributed to Upper Paleolithic without direct archaeological or chronological proofs. Such attribution, however, is possible due to the relevant features of Magdalenian objects and known archaeological context of the region. This should be taken into account in the future research.

### 5.2.2. Parietal art motif

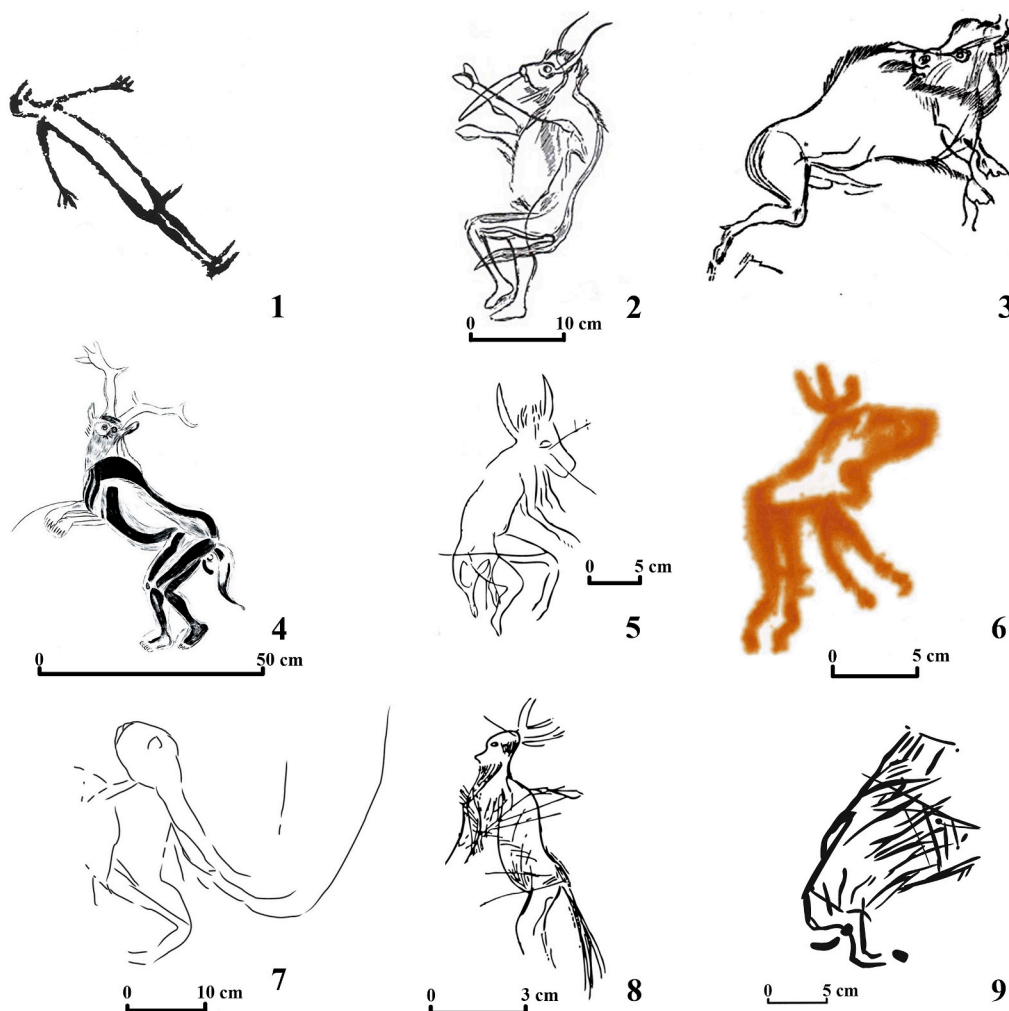
Unlike portable objects, the image of so-called Wizard on the ceiling of the cave reveals more space for interpretation or attribution. This is due to the peculiar shape of the curved lines that were considered by V. Danilenko as buttocks and legs of a human being. Though the initial idea of a man's silhouette inscribed into the larger contour of an animal appeared to be wrong and does not correspond to the real surface of the object, the particular part of the ceiling in the cave remains covered with linear engravings. Moreover, the scene still might be considered meaningful and thus can possibly be interpreted. Though this assumption is quite daring *per se*, such possibility should not be ignored. Similar to the portable stones, the Wizard petroglyph does not have any direct references in Central European Upper Paleolithic art, though it might be considered in the frame of particular motifs and traditions, modified according to the details of particular complex, its geological and technological features.

**5.2.2.1. Hypothesis 1.** The most simple and modest solution to the understanding of an image would be to consider it as non-figurative — a set of chaotic and sometimes almost parallel lines. Such solution does not leave any space for further interpretation and attribution since non-figurative imaging, linear and reticulated ornamentation might be attributed to any time and space. It is typical for many different stone

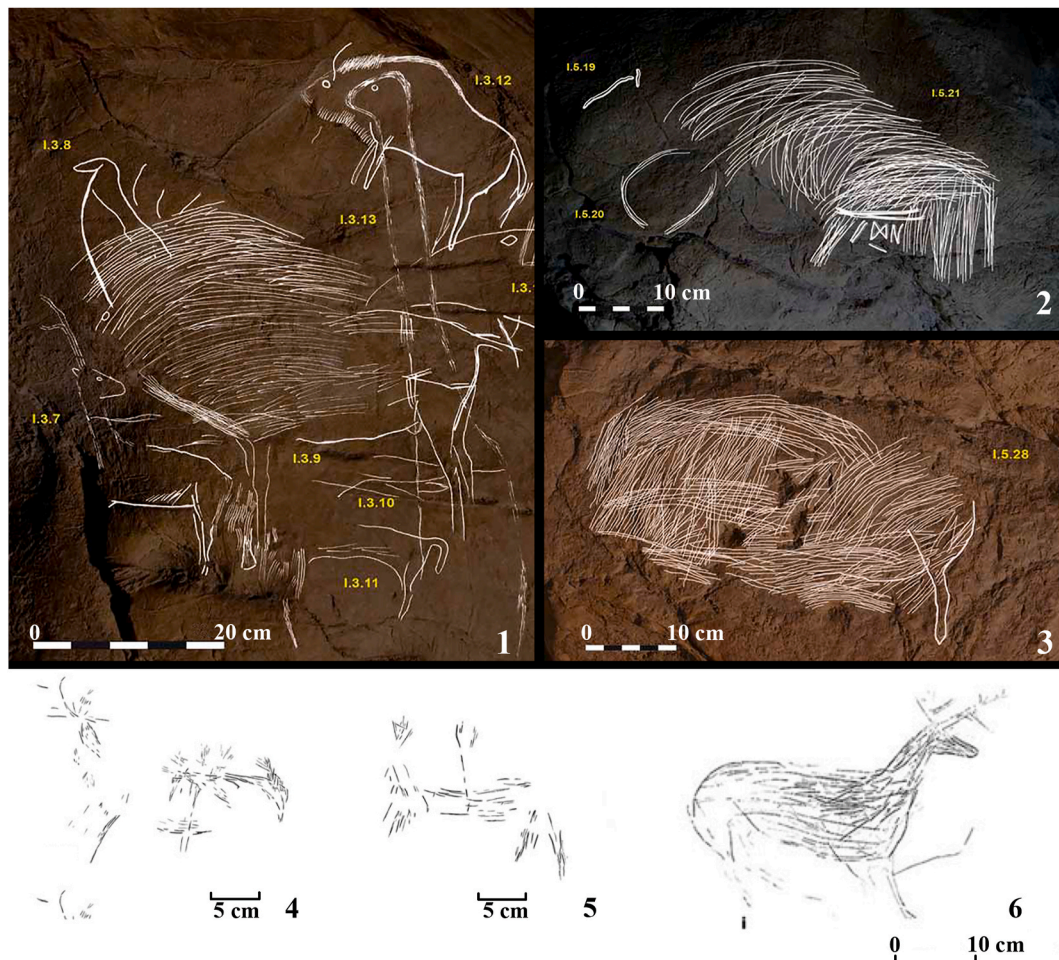
panels of Kamyana Mohyla, including those considered (not tested or proved) Paleolithic (Mykhailov, 2005: 203, Fig. 10), Mesolithic (Mykhailov, 2005: 200, Fig. 6), Bronze Age (Mykhailov, 2005: 204, Fig. 12) and Iron Age (Mykhailov, 2005: 216, Fig. 30). The non-figurative parietal art depictions are well known from the Upper Paleolithic of Southern (e.g. Servidio et al., 2021; Sigari et al., 2021) and Western Europe (e.g. Lerma et al., 2006; Ruiz-Redondo, 2014; Moralez and Straus, 2015; Riley, 2017; White et al., 2019; Ruiz et al., 2022) and assumed to be presented in Ukrainian Carpathians (Chernysh, 1959).

Being the most strict and reliable interpretation, it neither confirms nor disproves the Upper Paleolithic origin of the Wizard engraving, which still remains questionable. The 'non-figurative' hypothesis seems to be solid also since it corresponds to the understanding of portable rock art objects and does not need semantic meaning of a petroglyph. This is, however, a less fruitful assumption that is followed by two more daring but more informative versions.

**5.2.2.2. Hypothesis 2.** The second way of the petroglyph interpretation is to follow the initial V. Danilenko's assumption that the image depicts a therianthrope figure. The scholar considered it to be 'wizard or shaman' with bent knees that is inscribed into the silhouette of a large unknown creature. Such composition supposedly depicts a human being in the process of metamorphosis (Danilenko, 1986: 136–138). Danilenko



**Fig. 10.** The images of composite beings from Central European Upper Paleolithic. 1 — man with bird head from Lascaux (after Lommel, 1966); 2–4 therianthrope creatures from Les Trois-Freres (after Bégouën, 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 Archanbeau and Archanbeau, 1991); 8 — portable art of Espelugues (after Capitan et al., 1924); 9 — The Wizard from Kamyana Mohyla (drawing by Simon Radchenko).



**Fig. 11.** Magdalenian and Epimagdalenian animal depictions from Cantabria, Spain. 1–3 — bison, Altxerri complex; 4–5 — cervidae, Cañada de Marco; 6 — cervidae, Parelada IV. 1 — after Ruiz-Redondo (2014): 66, Figs. 6–4; 2 — after Ruiz-Redondo (2014): 71, Figs. 6–7; 3 — after Ruiz-Redondo (2014): 74, Figs. 6–9; 4–5 — after Ruiz et al., (2022): 17, Fig. 16; 6 — after Viñas and Sarriá, 2010: 79, Fig. 2.

assumed that the creature might be a bird due to its sharp beak and pointed out that bird images are popular in European Upper Paleolithic and represent one of the main cosmological myths (Marshac, 1970).

The appearance of the Wizard from Kamyana Mohyla, however, differs from known bird depictions from Central and Western Europe (see Sigari et al., 2021). In fact, it lacks all attributes that might support this interpretation. The known therianthroic bird-like figures (including the most iconic and well-known from Lascaux cave (see Fig. 10: 1)) have nothing in common with the image from Kamyana Mohyla.

Though this assumption was based on the wrong drawing while in reality there are no torso and head of a human being (i.e. the shaman), the therianthroic hypothesis might be considered in a slightly different light — a human being turning into a bison. The double zigzag on the left part of the engraving, supposedly bent legs of a creature, is proved to be correctly depicted after photogrammetric study.

The concept of “composite body as a representation of human body plus non-human elements, generally taken from the animal” (Fuentes et al., 2017: 240) is well known from European Magdalenian in Dordogne and around Les Trois Freres during the latest phase of the Magdalenian (Fuentes, 2013). These creatures usually turn into bison (Fig. 10: 2–6) and have animal upper body while the legs remain human. The legs are often bent in a shape similar to zigzag. Such images had multiple interpretations as the depictions of sorcerers, horned gods (Breuil, 1952; Bégouën, 2014) or shamans in trance (Clottes and Lewis-Williams, 1996).

Taking this into account, the interpretation of the ‘shaman’ from Kamyana Mohyla as a human being with bent knees who wears the bison’s skin (featured with furs) is possible and links the figure to the brightest examples of Magdalenian composite figures depictions. Once again, such interpretation attributes the image to Upper Paleolithic, which is in general convergence with archaeological assemblage within Kamyana Mohyla surroundings and the hypothesis on the attribution of portable art specimens.

However, lack of clearly visible head, horns and the upper part of bison body depictions leave this interpretation questionable and hypothetical rather than provides any kind of final conclusion.

**5.2.2.3. Hypothesis 3.** The third and last hypothesis on possible interpretation of the engraving derives from the absence of clearly distinguishable human silhouette on the ceiling of the cave. However, in order to assume that the petroglyph represents any figurative image it is required to hypothesize its possible meaning in the light of new data. Excluding the ‘human’ component from the interpretation of the engraving, we can suggest that the image is animalistic depiction.

Taking this concept as a starting point, one can consider zigzags as a representation of the creature’s bent legs and buttocks, while the upper horizontal line depicts the back of an animal. Chaotic and subparallel lines on the right part of the figure represent a massive creature covered with furs. Such bison depictions were found among the Magdalenian art of Cantabria, Spain (see Fig. 11: 1–3), namely Altxerri complex (Ruiz-Redondo, 2014: 74) although their contours are clearer than those of the

studied figure.

However, the shape of supposed buttock of the creature does not correspond to that of Magdalenian bison depictions — its round shape together with bent legs are rather typical to therianthropes (see Fig. 10) or cervidae. The schematized depictions of the latter also appear in Late Magdalenian rock art of Spain (see Fig. 11: 4–6), namely Cañada de Marco (Ruiz et al., 2022: 17) and Parellada IV (Viñas and Sarriá, 2010: 79) and might be featured with the depicted furs. The assumption that the engraving from Kamyana Mohyla depicts a cervidae, however, is not satisfying because of its massive front part and abstract, almost non-figurative, appearance.

Some patterns of some Magdalenian animal depictions might be relevant for the engraving from Ukraine, but none of them can be used systematically and in full scale as some patterns correspond to the particular components of engraved creature in particular and specific way. Though interpretation of the petroglyph from Kamyana Mohyla as an animalistic depiction of a bison or a cervidae would contribute to its Upper Paleolithic attribution, it remains as hypothetical as two others are.

## 6. Conclusion

The reported analysis was carried out with the application of image based 3D-modeling of rock art objects with submillimeter accuracy. It supported the analysis with detailed models of 50 portable rock art specimens out of 88 reported so far and an accurate model and drawing of a petroglyph from the only rock art location in Ukraine that used to be considered Upper Paleolithic. This engraving used to be eponymous to the cave and a crucial proof of the Pleistocene origin of the whole complex. However, the examination of the analyzed asset revealed mostly non-figurative anthropogenic alterations of natural surfaces and objects. In general, the figurativeness of the discussed engravings was largely overestimated by almost every scholar that ever worked with the collection. In the absence of well-dated archaeological context this observation undermines the possibility to attribute depictions to some chronological or cultural group on the basis of their semantic interpretation. In fact, every considered depiction of Pleistocene fauna or anthropomorphic figure appeared to be a set of misinterpreted incisions. Thus, the Paleolithic age of some rock art from Kamyana Mohyla remains highly questionable. Moreover, since all four statements that supported the Paleolithic attribution of the rock art from the Wizard's cave of Kamyana Mohyla were invalidated, this attribution fails to be persuasive in general. The archaeological contexts are distant and indirect and cannot be considered as reliable evidence, while the stylistic-symbolic ones are not supportive due to the lack of indicative motifs or reliable analogies. Before additional evidences are found we should consider this attribution misleading and incorrect, or at least highly hypothetical.

However, on the way of morphological comparisons the portable art specimens may be considered as resembling Magdalenian plaquettes. In turn, the interpretation of the parietal art object cannot be made with sufficient level of certainty. This leads to the formulation of several hypotheses: either the object presents a set of non-figurative incisions (which is the only solid case that can be formulated so far) or, when considered as figurative one, a therianthropic or a zoomorphic image. The features of its appearance, however, bring us back to the set of analogies from Magdalenian objects.

To sum up, there is no certain evidence *pro* or *contra* the Upper Paleolithic origin of parietal and portable art objects from the Wizard's cave. Complicated by the absence of archaeological context and dating tools, the attribution or interpretation of engravings from the Wizard's cave seems to be secondary issue. Though archaeological assemblage within the surroundings of the site and the reminiscences to European Upper Paleolithic objects leave space for hypothesizing, the clear and final solutions on that score are yet to come. Meanwhile, the accurate description and multivariate consideration of what rock art objects

really are is a prominent way of getting closer to the correct understanding of a complex. So far, the validity of used methods is proved, a set of hypotheses formulated and the direction of further research is outlined. Both the results of digital analysis and the hypotheses that originated from them present Kamyana Mohyla as an important rock art location that shouldn't be ignored during the discussions on the pre-History of Eastern Europe.

## Author contributions

SR provided the photogrammetric study of rock art objects and the analysis of both portable and parietal objects, all the figures except Figs. 1 and 3 and text for parts 1, 2.1, 2.3, 3, 4, 5. DK analyzed the sites of the region and performed data calibration, created Figs. 1 and 3, wrote paragraph 2.2 and contributed to discussing, editing and structuring the whole text.

## Data availability

All raw data supporting the conclusions of this article can be obtained upon request from the corresponding author.

## Funding

The research was supported by H2020-MSCA-COFUND, G.A. nr. 754511 — “PhD Technology Driven Sciences: Technologies for Cultural Heritage (T4C)” — second call and the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 891737.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- Anghelinu, M., Nița, L., Cordos, C., 2020. Contrasting approaches to lithic assemblages: a view from no man's land. *Cercetari Arheologice* XXVII, 33–44.
- Archambeau, M., Archambeau, C., 1991. Les figurations humaines de la grotte des Combarelles. *Gall. Prehist.* 33, 53–81.
- Arias, P., 2009. Rites in the dark? An evaluation of the current evidence for ritual areas at Magdalenian cave sites. *World Archaeol.* 41 (1), 262–294.
- Arias, P., Ontañón, R., 2013. Cantabrian portable art in its context: an approach to the study of Palaeolithic graphic expression in northern Spain. In: Pastoors, A., Auffermann, B. (Eds.), *Pleistocene Foragers on the Iberian Peninsula: Their Culture and Environment. Festschrift in Honour of Gerd-Christian Weniger for His Sixtieth Birthday*. Neanderthal Museum, pp. 261–282.
- Bahn, P.G., Vertut, J., 1988. *Images of the Ice Age*. Leicester: Windward.
- Bégouën, R., et al., 2014. In: Bégouën, Robert, Clottes, Jean, Feruglio, Valérie, Pastoors, Andreas, Lacombe, Sébastien, Hansen, Jörg, Berke, Hubert, Lumley, Henry de, et al. (Eds.), *La caverne des Trois-Frères : anthologie d'un exceptionnel sanctuaire préhistorique*. Association Louis Bégouën.
- Biagi, P., Khlopachev, G.A., Kiosak, D., 2014. The radiocarbon chronology of Shan-Koba rockshelter, a late paleolithic and mesolithic sequence in the Crimean mountains. *DIADORA* 28, 7–20.
- Bosinski, G., 1982. *Die Kunst der Eiszeit in Deutschland und der Schweiz. Katalog vor- und frühgeschichtlicher Altertümer des Römisch-Germanischen Zentralmuseum Bonn*, p. 20. Bonn: Habelt.
- Bosinski, G., 1991. The representation of female figures in the rhineland magdalenian. *Proc. Prehist. Soc.* 57 (1), 51–64.
- Bosinski, G., Bosinski, H., 2009. Seals from the magdalenian site of gönnersdorf (rhineland, Germany). In: Bahn, P. (Ed.), *An Enquiring Mind: Studies in Honour of Alexander Marshack*, pp. 39–50. Oxbow.
- Breuil, H., 1952. Four hundred centuries of cave art. *Montignac, Dordogne: Centre d'Études et de Documentation Préhistoriques*.
- Bronk Ramsey, C., Lee, S., 2013. Recent and planned development of the program OxCal. *Radiocarbon* 55 (2/3), 720–730.
- Capitan, L., Breuil, H., Peyrony, D., 1924. *Les Combarelles Aux Eyzies, Dordogne*. Paris: Masson.
- Cărciumaru, M., Nițu, E.-C., 2018. Symbolic behaviour and art in the territory of Romania from the middle palaeolithic to the mesolithic (55,000–7,500 B.P.). Editura cetatea de Scaun. <https://doi.org/10.1186/s13063-018-2457-2>.

- Chabai, V., 2007. The middle paleolithic and early upper paleolithic in the northern Black Sea region, in: the Black Sea flood question: changes in coastline. Climate, and Human Settlement 279–296. [https://doi.org/10.1007/978-1-4020-5302-3\\_11](https://doi.org/10.1007/978-1-4020-5302-3_11).
- Chepalyna, A., Kiosak, D., 2014. 'Little known stone age sites and traces of the extreme inundations epoch in Budzhak'. *Stratum Plus* 1, 59–66.
- Chernysh, O.P., 1959. New Prehistoric Art Site. Materials on the Archaeology of Carpathians and Volyn, vol. 2. Academy of Sciences of USSR Publishing, Kyiv, pp. 40–53.
- Clottes, J., Lewis-Williams, D., 1996. Les chamanes de la préhistoire : transe et magie dans les grottes ornées. *Arts rupestres*, Paris.
- Danilenko, V., 1969. Neolit Ukrainy: Glavy Drevnejshej Istorii Jugo-Vostochnoj Evropy. Naukova dumka, Kyiv.
- Danilenko, V., 1986. Kamyana Mohyla (Kyiv).
- Daragan, M., Polin, S., Svoyski, Yu., 2021. Chronological sequence of megalithic burial complexes of the Eneolithic in the Velikaya Aleksandrova burial mound. *Proceedings in Archaeology and History of Ancient and Medieval Black Sea Region* 13, 13–98. <https://doi.org/10.53737/2713-2021.2021.49.36.001>.
- de Figueiredo, S.S., Nobre, L., Gaspar, R., Carrondo, J., Cristo Ropero, A., Ferreira, J., 2014. Foz do medal terrace—an open-air settlement with paleolithic portable Art. *International Newsletter on Rock Art* 68, 12–20.
- Fuentes, O., 2013. The depiction of the individual in prehistory. *Human representation in Magdalenian societies*. *Antiquity* 87 (228), 985–1000.
- Fuentes, O., 2016. The social dimension of human depiction in Magdalenian rock art (16,500 cal. BP—12,000 cal. BP): the case of the Roc-aux-Sorciers rock-shelter. *Quat. Int.* 430 (A), 97–113.
- Fuentes, O., Lucas, C., Robert, E., 2017. An approach to Palaeolithic networks: the question of symbolic territories and their interpretation through Magdalenian art. *Quat. Int.* 503 (B), 233–247. <https://doi.org/10.1016/j.quaint.2017.12.017>.
- Fritz, C., Tosello, G., 2011. Exceptional evidence for palaeolithic art in the paris basin: the engraved pebble from Étioilles (Essonne). *Bull. Soc. Prehist. Fr.* 108 (1), 27–46.
- García-Díez, M., Vaquero, M., 2015. Looking at the camp: paleolithic depiction of a hunter-gatherer campsite. *PLoS One* 10 (12), e0143002.
- Gaussens, J., 1964. La grotte ornée de Gabillou (Dordogne). *Institut de Préhistoire de Bordeaux*, Bordeaux.
- Gladilin, V., 1969. Die Felsbinder der Kamennaya Mogila in der Ukraine. *Jahrbuch für prähistorische und ethnografische Kunst* 22, 82–92.
- Gorelik, A.F., Tarasenko, N.I., 1993. Female image on the retoucher from the late paleolithic site of Rogalik VIIIa on siverskiy donets river. *Ancient cultures of Azov Sea Region* 1, 28–34.
- Gorelik, A., 2001. Rogaliksko-Peredelskoye local region site complex. *Problems of the final paleolithic of South-eastern Ukraine*. Institute of Archaeology of NAS of Ukraine, Kyiv-Luhansk.
- Gorelik, A., 2005. On the characteristics of the final Palaeolithic mobiliary art of the South-Eastern Ukraine: certain aspects of the investigations of the Rogaliksko-peredelskoye regional site complex. *Archaeologisches Korrespondenzblatt* 35 (3), 283–300.
- Graff, C., Piquette, K., De Bruyck, R.L.L., Kelany, A., 2018. Comparing the use of R.T.I. (Reflectance transforming Imagery) and photogrammetry in wadi abu subeira (assuan, Egypt): what technology for which context?. In: 20th International Rock Art Congress IFRAO 2018, vol. 130 Book of abstracts. Darfo Boario Terme, Italy.
- Güth, A., 2012. Using 3D scanning in the investigation of Upper Palaeolithic engravings: first results of a pilot study. *J. Archaeol. Sci.* 39, 3105–3114. <https://doi.org/10.1016/j.jas.2012.04.029>.
- Higham, T.F.G., Jacobi, R.M., Ramsey, C.B., 2006. AMS radiocarbon dating of ancient bone using ultrafiltration. *Radiocarbon* 48 (2), 179–195. <https://doi.org/10.1017/S0033822200066388>.
- Iakovleva, L., 2009. The Mezian art in Eastern Europe. *Chronological, cultural and spiritual context*. *L'anthropologie* 113 (5), 691–752.
- Iakovleva, L., 2010. Upper paleolithic. In: Skrypnik, H. (Ed.), *History of Decorative Art of Ukraine*, Vol. 1. From Ancient Times to Late Medieval Age. M. Rylskiy Institute of art history, folklore and ethnology, Kyiv, pp. 25–56.
- Ivanov, I., 1990. *Slovar' spravochnik Po Liteynomy Proizvodstvu*. Mashynostroyeniye, Moscow.
- Kiosak, D., Kotova, N., Radchenko, S., de Capitani, A., Gobet, E., Makhortkyh, S., Dzhos, V., 2022. Chipped stone assemblage of the layer B of the Kamyana Mohyla 1 site (South-Eastern Ukraine) and the issue of kukrek in the North meotic steppe region. *Open Archaeol.* 8 (1), 85–113. [10.1515/opar-2022-0226](https://doi.org/10.1515/opar-2022-0226).
- Kitagawa, K., Julien, M.-A., Krotova, O., Bessudnov, A., Sablin, M., Kiosak, D., Patou-Mathis, M., 2018. Glacial and postglacial adaptations of hunter-gatherers: investigating the late Upper Paleolithic and Mesolithic subsistence strategies in the southern steppe of Eastern Europe. *Quat. Int.* 465, 192–209.
- Kotova, N., et al. Kotova, N., Tuboltsev, O., Kiosak, D., Spitsyna, L., Makhortkyh, S., Tinner, W., Nielsen, E.H., Dzhos, V., 2017. Preliminary results of excavations at the multiflayer Kamyana Mohyla 1 site (2011–2012). In: Makhortkyh, S., de Capitani, A. (Eds.), *Archaeology and Palaeoecology of the Ukrainian Steppe*. IA NAS of Ukraine, Kyiv, pp. 28–50.
- Kotova, N., Kiosak, D., Radchenko, S., Spitsyna, L., et al., 2018. Microscopic examination of Mesolithic serpent-like sculptured stones from southern Ukraine. *Antiquity* 92 (366), E2. <https://doi.org/10.15184/aqy.2018.249>.
- Krotova, O., 2019. Upper Paleolithic Hunters of the North Pontic Region. Institute of Archaeology, Kyiv.
- Leonova, N.B., 2015. Kamennobalskaya culture — one of the reference complexes of the upper paleolithic of North Black Sea region. In: Khlopachev, G.A. (Ed.), *Ancient Cultures of Eastern Europe: Reference Sites and Complexes in the Context of Modern Archaeological Studies*, vol. 4. IIMK RAN, Saint-Petersburg, pp. 150–161.
- Lerma, J.L., Villaverde, V., Garcia, A., Cardona, J., 2006. Close range photogrammetry and enhanced recording of palaeolithic rock art. *IAPRS XXXVI* (5), 147–154.
- Likhachev, V., 2018. Rock carvings of Kanozero: new methods of documentation and the new findings. In: 20th International Rock Art Congress IFRAO 2018. Book of abstracts, Darfo Boario Terme, Italy, p. 38.
- Lommel, A., 1966. *Prehistoric and Primitive Man*. McGraw-Hill Book Company, New York and Toronto.
- Lorblanchet, M., 2010. *Art pariétal. Grottes ornées du Quercy (Rouergue: Rodez)*.
- Lwoff, S., 1941. La Marche, commune de Lussac-les-Châteaux (Vienne). In: Péricard, L., Lwoff, S. (Eds.), *Gravures à représentations d'humains du Magdalénien III*, *Bulletin de la Société Préhistorique Française*, XXXVIII/8.
- Makhortkyh, S., Kotova, N., Dzhos, V., Radchenko, S., 2020. New burial and ritual assemblages of Early Bronze Age located near the complex of Kamyana Mohyla. *Archaeology and Early History of Ukraine* 37 (4), 226–239. <https://doi.org/10.37445/adiu.2020.04.18>.
- Marshac, A., 1970. Notation dans les gravures gu Paleolithique superieur. *Publications de l'Institut de Préhistoire de l'Université de Bordeaux* 8.
- Méland, N., 2008. *Pierres gravées de La Marche à Lussac-les-Châteaux (Vienne)*. Techniques, technologie et interprétations. Gall. Prehist. 50.
- Méland, N., 2010. L'étude microtopographique et la visualisation 3D dans l'analyse de gravures préhistoriques — L'exemple des pierres gravées de La Marche. *Situ*. <https://doi.org/10.4000/insitu.6837>.
- Méland, N., Boust, C., Cogne, G., Maigret, A., 2016. Comparison of imaging techniques used in the microanalysis of Paleolithic mobiliary art. *J. Archaeol. Sci.: Report* 10, 903–909. <https://doi.org/10.1016/j.jasrep.2016.05.038>.
- Moralez, M.R.G., Straus, L.G., 2015. Magdalenian-age graphic activity associated with the El Mirón Cave human burial. *J. Archaeol. Sci.* 60, 125–133.
- Mussi, M., de Marco, A., 2008. A Gönnersdorf-style engraving in the parietal art of Grotta Romanelli (Apulia, southern Italy). *Mitteilungen der Gesellschaft für Urgeschichte* 17, 97–104.
- Mykhailov, B.D., 1982. Late paleolithic site on the Molochna river. *Arheologia* 32, 90–93.
- Mykhailov, B.D., 1987. The first pod Upper Paleolithic site in the North Pontic region. *Arheologia* 59, 47–52.
- Mykhailov, B.D., 1992. Late paleolithic site by Kamyana Mohyla. In: Olenkovskiy, M. (Ed.), *Late Paleolithic Sites in the Centre of North Pontic Region*, pp. 31–36. Kherson: Pre-print.
- Mykhailov, B.D., 2005. *Petroglyphs of Kamyana Mohyla: Semantics, Chronology and Interpretation*. Kyiv.
- Naudinot, N., Bourdier, C., Laforge, M., Paris, C., Bellot-Gurlet, L., et al., 2018. Correction: divergence in the evolution of Paleolithic symbolic and technological systems: the shining bull and engraved tablets of Rocher de l'Impératrice. *PLoS One* 13 (9), e0204464. <https://doi.org/10.1371/journal.pone.0204464>.
- Needham, A., Wisher, I., Langley, A., Amy, M., Little, A., 2022. Art by firelight? Using experimental and digital techniques to explore Magdalenian engraved plaquette used at Montastruc (France). *PLoS One* 17 (4), e0266146. <https://doi.org/10.1371/journal.pone.0266146>.
- Olenkovskiy, M., 1992. Sites of paleolithic. *Archaeological map of the Lower Dnieper region*. Kherson: Pre-print.
- Olenkovskiy, M., 2001. On origin and development of North Azov late paleolithic culture. *Stratum Plus* 1, 283–292.
- Olenkowski, N.P., 2000. Central European Epi-gravettian and eastern gravettian cultures of the Ukraine. *Stratum plus* 1, 368–377.
- Olenkovskiy, M., 2010. The eastern Epigravettian in the North Azov region (Ukraine). *Atti della Società per la Preistoria e Protostoria della Regione Friuli Venezia-Giulia XVII*, 7–26.
- Paillet, P., Man-Estier, E., 2014. De nouvelles découvertes d'art mobilier laborien dans le Nord du Périgord. In: Langlais, M., Naudinot, N., Peresani, M. (Eds.), *Les groupes culturels de la transition Pléistocène-Holocène entre Atlantique et Adriatique*. Société Préhistorique Française, Paris, pp. 129–154.
- Pinhasi, R., et al., 2011. Revised age of late Neanderthal occupation and the end of the Middle Paleolithic in the northern Caucasus. *Proc. Natl. Acad. Sci. U.S.A.* 108 (21), 8611–8616. <https://doi.org/10.1073/pnas.1018938108>.
- Pinhasi, R., et al., 2012. New chronology for the Middle Palaeolithic of the southern Caucasus suggests early demise of Neanderthals in this region. *J. Hum. Evol.* 63 (6), 770–780. <https://doi.org/10.1016/j.jhevol.2012.08.004>.
- Plonka, T., Kowalski, K., 2017. Symbolic artefacts in the late palaeolithic and the early mesolithic in northern and central Europe. In: Plonka, T., Kowalski, K. (Eds.), *Rusinowo. The Symbolic Culture of Foragers in the Late Palaeolithic and the Early Mesolithic*. University of Wrocław, Wrocław.
- Porter, S.T., Huber, N., Hoyer, C., Floss, H., 2016. Portable and low-cost solutions to the imaging of Paleolithic art objects: a comparison of photogrammetry and reflectance transformation imaging. *J. Archaeol. Sci.: Report* 10, 859–863.
- Praslov, N.D., 1968. *Rannii Paleolit Severo-Vostochnogo Priazovia i Nizhnego Dona*. Nauka, Leningrad.
- Radchenko, S., Nykonenko, D., 2019. Western edge of steppe rock art. *Expression* 24, 49–62.
- Radchenko, S., Nykonenko, D., Kotova, N., Tuboltsev, O., Kiosak, D., Volkov, A., 2020. A complex rock art object in Ukrainian Steppe. *Rock Art Research* 37 (2), 167–183.
- Radchenko, S., 2022. Rediscovered mesolithic rock art collection from Kamyana Mohyla complex in eastern Ukraine. *Open Archaeol.* 8 (1). XX–XX. [10.1515/opar-2022-0226](https://doi.org/10.1515/opar-2022-0226).
- Rasmussen, S.O., et al., 2014. A stratigraphic framework for abrupt climatic changes during the Last Glacial period based on three synchronized Greenland ice-core records: refining and extending the INTIMATE event stratigraphy. *Dating, Synthesis, and Interpretation of Palaeoclimatic Records and Model-data Integration: Advances of the*



- INTIMATE project*(*INTEgration of Ice core, Marine and TERrestrial records*. COST Action ES0907)106 14–28. <https://doi.org/10.1016/j.quascirev.2014.09.007>.
- Reimer, P.J., et al., 2020. The IntCal20 northern hemisphere radiocarbon age calibration curve (0–55 cal kBP). *Radiocarbon* 62 (4), 725–757. <https://doi.org/10.1017/rdc.2020.41>.
- Riley, D., 2017. *The Caves of Cantabria: Non-figurative Cave Art in Northern Spain*. Unpublished thesis. Memorial University of Newfoundland.
- Roldán García, C., Villaverde Bonilla, V., Ródenas Marín, I., Murcia Mascarós, S., 2016. A unique collection of palaeolithic painted portable Art: characterization of red and Yellow pigments from the Parpalló cave (Spain). *PLoS One* 11 (10), e0163565. <https://doi.org/10.1371/journal.pone.0163565>.
- Rondini, P., 2018. Digital Rocks. An integrated approach to rock art recording: the case study of Ossimo-Pat (Valle Camonica), monolith 23. *Archeologia e Calcolatori* 29, 259–278. <https://doi.org/10.19282/ac.29.2018.21>.
- Roussot, A., 1987. Art mobilier et art pariétal du Périgord et de la Gironde: comparaisons stylistiques. In: Clottes, J. (Ed.), *L'art des objets au Paléolithique, 1, l'art mobilier et son contexte*, colloque international de Foix-le-Mas-d'Azil. Ministère de la Culture, Paris, pp. 189–205.
- Rudynskyi, M.Ya., 1952. Kamennaia mogila. *Kratkiie soobshcheniia Instituta arkheologii AN Ukrainy* 1, 21–31.
- Ruiz, J., Royo-Lasarte, J., Royo-Guillén, J., Rivero, O., 2022. Filling the void: rock-art continuity over the pleistocene–holocene boundary in eastern Iberia. *Camb. Archaeol. J.* 1–27. <https://doi.org/10.1017/S0959774322000105>.
- Ruiz-Redondo, A., 2014. Entre el Cantábrico y los Pirineos: El conjunto de Altxerri en el contexto de la actividad gráfica magdalenense. *Nadir Ediciones*, Santander.
- Servidio, D., Sigari, D., Larocca, F., 2021. Nuove evidenze di arte rupestre. In: Calabria. In: Carrera, F.M.P., Cremonesi, R.G., Tosatti, A.M. (Eds.), *L'arte rupestre nella penisola e nelle isole italiane: rapporti tra rocce incise e dipinte, simboli, aree montane e viabilità: Rock art in the Italian peninsula and islands: issues about the relation between engraved and painted rocks, symbols, mountain areas and paths*. *Archaeopress*, Oxford, pp. 254–270. <https://doi.org/10.2307/j.ctv1zcm00t.14>.
- Sieveking, A., 1987a. Engraved Magdalenian Plaquettes: a regional and stylistic analysis of stone, bone and antler plaquettes from Upper Palaeolithic sites. In: *France and Cantabrig Spain*. *Br. Archaeol. Rep. Int. Ser.* 369.
- Sieveking, A., 1987b. *A Catalogue of Palaeolithic Art in the British Museum*. *British Museum Publications*.
- Sigari, D., Mazzini, I., Conti, J., Forti, L., Lembo, G., Mecozzi, B., Mutillo, B., Sardella, R., 2021. Birds and bovinds: new parietal engravings at the romanelli cave, apulia. *Antiquity* 95 (384), 1387–1404. <https://doi.org/10.15184/aqy.2021.128>.
- Smyntyna, O.V., 1999. *Ancient History of Ukraine*. P. 1: *Epoch of Anthroposociogenesis and Early Prehistoric Society*. *Hermes*.
- Stanko, V.N., Berezanska, S.S., Gladilin, V.M., Gladkykh, M.I., Otroschenko, V.V., 1997. *Ancient history of Ukraine*. In: *Primitive Society*, vol. 1. *Naukova Dumka*, Kyiv.
- Stanko, V.N., Gladkykh, M.I., Segeda, S.P., 1999. *The History of Prehistoric Society*. *Lybid*, Kyiv.
- Stepanchuk, V., et al., 2010. The lower palaeolithic of Ukraine: current evidence, oldest human Expansions. In: *Eurasia: Favouring and Limiting Factors*, 223–224, pp. 131–142. <https://doi.org/10.1016/j.quaint.2009.12.006>.
- Strehlow, T.G.H., 1947. *Aranda Traditions*. Melbourne.
- Steuri, N., Siebke, I., Furtwängler, A., Szidat, S., Krause, J., Lösch, S., Hafner, A., 2019. Multiple radiocarbon dating of human remains: clarifying the chronology and sequences of burials in the late neolithic dolmen of oberbipp (Switzerland). *Radiocarbon* 61 (6), 1697–1709. <https://doi.org/10.1017/RDC.2019.96>.
- Soares de Figueiredo, S., Botica, N., Bueno Ramirez, P., Tsoupra, A., Mirão, J., 2020. Analysis of portable rock art from Foz do Medal (Northwest Iberia): Magdalenian images of horses and aurochs. *Comptes Rendus Palevol* 4, 63–77. <https://doi.org/10.5852/cr-palevol2020v19a4>.
- Tosello, G., 2003. *Pierres Gravées de Périgord Magdalénien: Art, Symboles, Territoires*. *CNRS Editions*.
- Tosello, G., Villaverde, V., 2014. Portable Art recording methods. In: Smith, C. (Ed.), *Encyclopedia of Global Archaeology*. Springer, New York, pp. 6027–6037.
- Veselovskiy, N.I., 1893. Excavation of the tavrisheskaya guberniya. *Archaeological Commission reports for 1890*, 3–4.
- Vetrov, V., 2007. The late paleolithic art of the steppes in the northern black seaside and the Sea of Azov side. In: *XXII Valcamonica Symposium*, pp. 515–522.
- Villaverde, V., 1994. *Arte paleolítico de la Cova del Parpalló. Estudio de la colección de plaquetas y cantos con grabados y pinturas*. In: *Diputación Provincial de Valencia*, vol. 2.
- Viñas, R., Sarriá, E., 2010. Documentació dels nous conjunts d'art rupestre del Priorat (Tarragona). *Tribuna d'Arqueologia* 2009–2010 53–84.
- Wang, S., Wang, Y., Hu, Q., Li, J., Ai, M., 2019. Unmanned aerial vehicle and structure-from-motion photogrammetry for three-dimensional documentation and digital rubbing of the Zuo River Valley rock paintings. *Archaeol. Prospect.* 26 (3), 265–279. <https://doi.org/10.1002/arp.1739>.
- White, R., Bosinski, G., Bourrillon, R., Clottes, J., Conkey, M.W., Rodriguez, S.C., Cortés-Sánchez, M., Rasilla Vives, M., Delluc, B., Delluc, G., Feruglio, V., Floss, H., Foucher, P., Fritz, C., Fuentes, O., Garate, D., González Gómez, J., González-Morales, M.R., González-Pumariaga Solís, M., Groenen, M., Jaubert, J., Aránzazu Martínez-Aguirre, M., Medina Alcaide, M.-A., Abadia, O.M., Peredo, R.O., Paillet-Man-Estier, E., Paillet, P., Petrogiani, S., Pigeaud, R., Pinçon, G., Plassard, F., Ripoll López, S., Vilá, O.R., Robert, E., Ruiz-Redondo, A., Ruiz López, J.F., San Juan-Foucher, C., Sanchidrián Torti, J.L., Sauvet, G., Simón-Vallejo, M.D., Tosello, G., Utrilla, P., Vialou, D., Willis, M.D., 2019. Still no archaeological evidence that Neanderthals created Iberian cave art. *J. Hum. Evol.* 144, 1–7. <https://doi.org/10.1016/j.jhevol.2019.102640>.
- Zaliznyak, L.L., 2005. *Final palaeolithic and mesolithic of continental Ukraine. Cultural division and periodization*. *Kyiv: Shljah*.
- Zemlyakov, B., 1939. About the mammoth image from the “Mammoth grotto” of Kamyana Mohyla near Melitopol. *Short reports on the lectures and fieldworks of the Institute of History of Material Culture* 2, 33–36.