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On the Methodology of Studying Palimpsests in Rock Art: The Case of the Shalabolino Rock Art Site, Krasnoyarsk Territory

This article addresses the main problems in assessing the stratigraphy of superimpositions in rock art. When a petroglyph is overlain by one or several others, this may provide important chronological information not only about single images but also about entire stylistic traditions. Existing methods used for evaluating the relative chronology of the parts of petroglyphic palimpsests are discussed, and a new approach is proposed, combining high-resolution three-dimensional visualization at the macro level with traceological analysis. The article focuses on the characteristics of the pecked surface in the area outside the palimpsest and that of the overlap zone. The comparison of these parts makes it possible to reveal the traceologically informative features in the palimpsest areas, indicating the sequence of superimposed petroglyphs. This approach is illustrated by the analysis of one of the palimpsests at the Shalabolino rock art site in the Krasnoyarsk Territory. Images representing various stylistic traditions are stratigraphically associated in a complex way. The sequence of three main figures (the bear, bull, and elk) in this multilayered composition has been reconstructed. The results of the analysis cannot be used as an argument for attributing these petroglyphs to vastly different chronological periods. Rather, they provide new information relevant to the debate over the age of the Angara and Minusinsk petroglyphic styles in the Minusinsk Basin.

Keywords: *Rock art, petroglyphs, palimpsest, traceology, 3D, photogrammetry, Shalabolino rock art site, Krasnoyarsk Territory.*

Introduction

In rock art studies, palimpsests are one of the most sophisticated research objects, since the same intensity of desert varnish on superimposing representations complicates establishing the sequence of their creation. Meanwhile, the analysis of some palimpsests makes it possible to clarify the relative chronology of not only individual images belonging to various pictorial traditions, but also of entire cultural and chronological layers. Researchers have repeatedly encountered such

situations when a detailed study provided qualitatively new information about the age of representations with typical features of a specific style (Podolsky, 1973: 269–270, fig. 4; Kubarev, 1988: 141–142; 2013: 24; Molodin, Cheremisin, 2002; Novozhenov, 2002: 27, 36, 37; Sovetova, 2005: 18–20, figs. 4, 5; Molodin, Efremova, 2010: 166; Kovaleva, 2011: 31; Devlet E.G., Devlet M.A., Pakhunov, 2016: 523, 527). In some cases, on the contrary, it was possible to establish that the petroglyphs made by various authors belonged to a single stylistic tradition (Molodin, Efremova, 2010:

167–168; Miklashevich, 2012: 182). Sometimes, there was a tendency to deliberately superimpose some images on other representations in semantically integral compositions (Craig, 2009: 284–285). All these observations give grounds for further interpretations, and this is why it is so important to establish with confidence the sequence of the petroglyphs that constitute the palimpsests. Sometimes, multilayered compositions make it possible to detect even such subtle nuances as changing ideological or religious views within genetically related or completely different visual traditions (Nash, 2012; Geneste, 2017: 35).

The study of palimpsests has been given a prominent role in the literature. In the 1970s, A.D. Stolyar and Y.A. Savvateev proposed the method of "topographic layout", which involved identifying the sequence of creating the petroglyphs and filling free space on the surfaces (Stolyar, Savvateev, 1976; Stolyar, 1977: 25–34, 34–36). These scholars proceeded from the assumption that the largest images were created first, but this idea was later not confirmed (Lobanova, 2007). In his study of palimpsests appearing among the Karakol materials, V.D. Kubarev paid attention to the orientation of the images relative to each other and to the position of the slabs *in situ* (1988: 94). This argument was one of the most important points for establishing the reuse of slabs with petroglyphs, which turned out to be placed upside down in the burials. Both approaches to analyzing multilayered compositions in rock art can be described as indirect, since the arguments focused not so much on the intersection of images, but on the context of discovering the palimpsests. Unfortunately, not in all cases is it possible to rely solely on this aspect.

Sometimes, scholars have considered the depth of petroglyph pecking as the main criterion of stratigraphic analysis. According to this logic, the subsequent image should be deeper than the preceding image. This is not entirely true, since the rock crust within which pecking is usually done, has certain limitations in thickness. Therefore, after the crust was pecked to the main substrate, further processing in this area becomes very difficult. Experiments have shown that it is impossible to make the next petroglyph deeper in the intersection area if pecking of the initial image completely broke the fragile surface layer.

Quite often, the literature only makes mention of palimpsests, according to which it is not possible to get an idea of the criteria for analysis and arguments in favor of the authors' point of view on stratigraphy in each particular case. This usually results from a different purpose of the majority of publications (cataloging, summarizing works, etc.) (Lobanova, 2014: 33). There are very few specialized studies dedicated to specific instances of palimpsests, which reasonably substantiate their stratigraphic sequence (Lobanova, 2007: 129). Sometimes, the sequence of rock art images is established by the eye. Even if it is the eye of a specialist with many years of experience, one cannot ignore different perceptions of petroglyphs given changes in lighting, as well as the fundamental subjectivity of human perception.

Specialists have achieved tremendous results in studying the most complex palimpsests at the famous site of Fariseu (valley of the Côa River, Portugal) thanks to the use of an integrated research approach, which involved geomorphological analysis of surfaces with petroglyphs taking into account chronological dynamics, and correlation of figurative elements with variability of the rocky surface resulting from peeling (Aubry, Santos, Luis, 2014). This allowed scholars to establish the sequence of the multilayered composition, and assign various groups of petroglyphs to different periods of the Late Paleolithic (Ibid.: Fig. 5).

Y.A. Sher pointed to the possibility of refining the data on palimpsests by studying the density of desert varnish and specific features of tool marks (1980: 172–173). In some cases, it is easy to see that the degree of patination on various petroglyphs that constitute multilayered compositions is not the same. Thus, at the site of Baga-Oygur I (the Mongolian Altai), the stylized representation of a goat is superimposed on a group of two mammoth-like zoomorphic figures facing each other (Cheremisin et al., 2018: Fig. 4). The conclusion that the goat image was created much later is based on the much lesser degree of its varnishing as compared to the paired figures. However, desert varnish is caused by many factors, and in the cases when its intensity is approximately the same for all elements of a multilayered composition, it is almost impossible to distinguish between earlier and later petroglyphs.

Sher's idea of comparing the traces of tool marks in the areas of intersecting images (1980: 172–173) seems very promising. In addition, modern equipment and methods of recording have significantly expanded the opportunities for their research and comparison. This article proposes a way to study palimpsests on the basis of trace analysis of such marks and non-contact recording using 3D visualization with the photogrammetry technique.

Research methods and equipment

The proposed approach to the study of multilayered compositions is based on the analysis of the pecked surface in the areas of intersection between representations, and comparison of the trace features in such zones with the most typical pecked areas of each petroglyph of the palimpsest. This fairly simple principle makes it possible to identify the main features of each image, and establish which of them prevail in the intersection area. The presence of features specific for the pecking of one

image, and absence of the features of the other image in the intersection area indicates that the former was superimposed on the latter.

This approach is based on classical principles of trace analysis of petroglyphs made in the pecking technique (Girya, Devlet E.G., 2010, 2012). Three-dimensional high-resolution visualization at the macro level serves as an auxiliary tool for objectifying observations made during the traceological study. Pecking traces were reconstructed using cloud photogrammetry. For obtaining high-precision 3D models (over one million points per 3–5 cm^2), a full-matrix Nikon D750 camera with an AF-S MICRO Nikkor 62 mm macro lens and a ring flash providing uniform maximum illumination of the item, was used.

Pecking features in plan view were analyzed using a portable microscope with 20× magnification (Nikon 11470 NS). For obtaining data on pecking features in profile view, 3D models of zones relevant in terms of their trace evidence, were analyzed. For analyzing metric parameters of indentations in plan and profile view, as well as the morphological features of pecking traces (based on 3D models), various analytical tools, such as MeshLab, Blender, and Geomagic Studio, were used.

A Nikon D750 camera with various lenses (AF-S Nikkor 14-24 mm, AF-S MICRO Nikkor 105 mm, AF-S MICRO Nikkor 62 mm) was used for recording rock images at various scales (from the general view of the surface to details of the petroglyphs of 1 cm or less in size). Macro photography was carried out using a Canon EOS D1000 camera with a Canon EF-S 60 mm f/2.8 Macro USM lens with macro extension tube, tripod, and macro rails.

For summarizing the data obtained, the palimpsest was drawn (in the field) using a microscope (Nikon NS 111470, 20×), which captured the topography of the traces forming the images. Later, this drawing was corrected and supplemented on the basis of orthophotography from the 3D model of the surface. Such documentation has made it possible to obtain not only the stratigraphy of individual areas with relevant trace evidence, but to represent the entire picture.

Palimpsest analysis

For testing the proposed approach, one of the most interesting palimpsests was chosen. It includes three stylistically very expressive images (Fig. 1), and is located on plane No. 22 of section 4 (Uchetnaya karta…, 2010: Pl. 128, *1*, 129, *1*) (or on stone No. 14 after (Pyatkin, Martynov, 1985: 30, fig. 29)) of the Shalabolino rock art site, located in the Kuraginsky District of the Krasnoyarsk Territory, 0.6 km southeast of the village of Ilyinka, on the right bank of the Tuba River (tributary of the Yenisei), opposite the village of Tes (Vyatkina, 1949; Pyatkin, Martynov, 1985; Uchetnaya karta…, 2010: 2, pl. 1–2). Strictly speaking, this palimpsest consists of eight pecked petroglyphs. However, only three images (the bear, bull, and elk) have intersection points (Fig. 1, 2). The remaining petroglyphs are peripheral, since each of them contacts only one of these three.

This multilayered composition has been repeatedly copied by contact and contact-free methods, has been
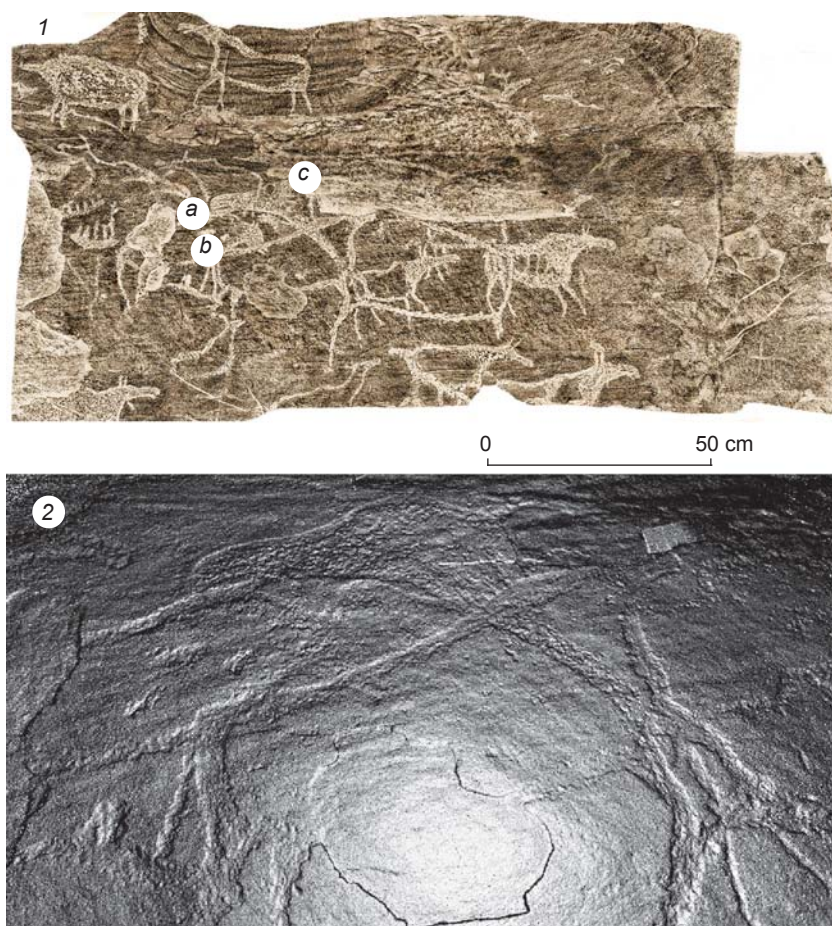

Fig. 1. Surface with the palimpsest.
1 – copy of rock images on mica-coated paper (Collection of the Museum of Archaeology, Ethnography, and Ecology of Siberia at the Kemerovo State University, No. 38/14; author V.F. Kapelko); *2* – fragment of the 3D model of the surface with the palimpsest.
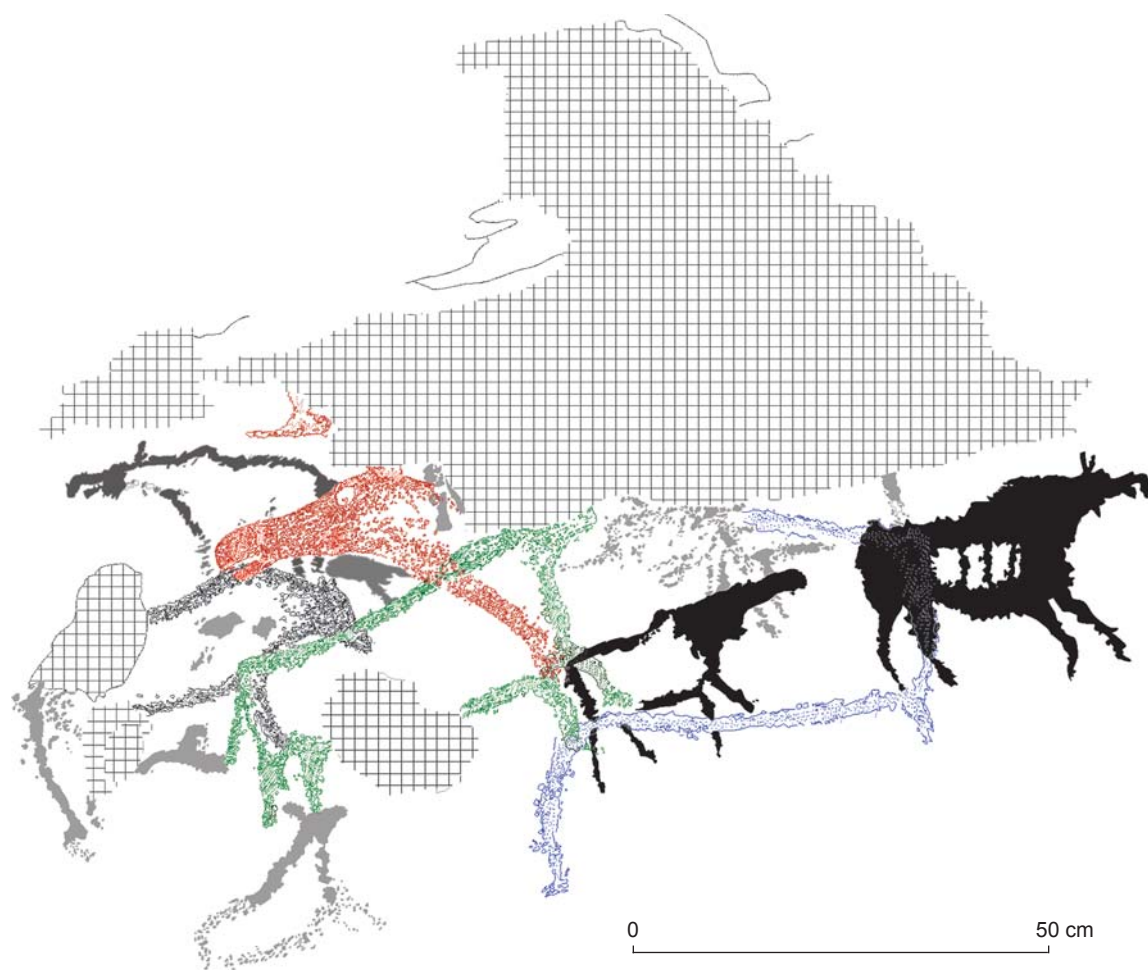*a* – representation of the bear, *b* – bull, *c* – elk.

Fig. 2. Tracing of the palimpsest made with a microscope (20× magnification) and supplemented by orthophotography from the 3D model of the surface.

studied by various scholars, and has been described in the literature (Pyatkin, Martynov, 1985: 160, pl. 14, *8*; 178, pl. 32, *3*). B.N. Pyatkin and A.I. Martynov described the following stratigraphic sequence of this palimpsest, "…part of the muzzle and its front legs [the bear's – *L.Z.*] overlap the image of the bull, made in outline, with the head to the right" (Ibid.: 31). However, it can be seen on the drawing (Ibid.: 178, pl. 32, *3*) that the image of the bull overlaps the remaining images, and rather the image of the bear is the earliest.

The surface with our multilayered composition is located more than 2 m above the level of the present ground surface. Therefore, for studying the palimpsest during the field seasons of 2017 and 2018, special scaffolding was made and dismantled each time after completion of the work, in order to restrict tourists' access. This unique composition is in a deplorable state of preservation: upon tapping, peeling of the rock crust is observed virtually over the entire plane. Extensive losses of rock crust are also visible, including losses on

the palimpsest, which include the end of the bear's torso, belly, and partly the head of the bull, horns and partly the back of the elk (Fig. 2).

Traceological analysis of petroglyphs on the palimpsest has shown the following results. The image of the bear can be divided into dense superficial (head contour), and deeper (torso contour) pecking areas, and more sparse (filling of the head) pecking areas (Fig. 3, *1*). The first area is distinguished by very shallow traces of small depth, very rarely legible; the outer contour is very even, but some traces of dents are visible, since the surface was not polished (Fig. 3, *a*, *b*). There was light direct pecking in the filling area, and indirect pecking along the contour. It is not possible to establish the material of the tool because of the pecking density. In the second area, the pecking is less dense, becoming sharply more prominent around the center of the head. The dents are fairly legible, deeper, approximately of the same sizes in plan, from sub-triangular and sub-round to wavy shapes. Chains of tightly adjacent dents are visible (Fig. 3, *c*). The lines are

quite wide (in some areas, over 1 cm); along the contour, there are many traces protruding beyond it. This makes it possible to conclude that pecking was done directly with a stone tool. Stylistically, this image looks quite uniform, so it is doubtful that the bear's head and torso could have been made at different times. Different pecking in these two areas could have resulted from the use of different techniques rather than different tools.

The image of the bull (Fig. 4, *1*) reveals a fairly homogeneous pecking, with marks typical of a stone tool, including pronounced traces of oblong shape with torn jagged edges (Fig. 4, *b*, *c*). In some areas (for example, the hind legs and tail), the dents are especially large; they have rough outlines, sub-triangular shapes or shapes similar to sub-triangular in plan (Fig. 4, *d*). The lines are very wide; sometimes they consist of two parallel pecked lines (the back and hump). Their boundaries are in most cases irregular; many individual dents protrude beyond them, especially along the internal contour. Despite greater density, pecking is deeper as compared to the image of the bear. Apparently, the figure of the bull was made in the technique of direct pecking with a stone tool. Traces of polishing (linear smoothness) over the pecked relief are very pronounced on the back of the animal (Fig. 4, *a*). Because of this, some features of the pecking are illegible, although the traces of the pecking are still clearly visible on the periphery. The contour of the lower lip and outer contour of the hump and beginning of the bull's back are absolutely even. Polishing must have been intended precisely for smoothing the boundaries of pecking.

The representation of the elk was made in a distinctive technological manner (Fig. 5). Relief along the contour of the muzzle was heavily evened up owing to high pecking density; there were no dents protruding beyond the contour (Fig. 5, *g*). The treatment of the horns is identical to the execution manner of the head and eye (Fig. 5, *c*, *d*). The external boundary of pecking looks very clear, and this is why the traces are not always very legible. The inner filling is more sparse, especially in the area of the neck (Fig. 5, *a*, *b*). This makes it possible to reconstruct the strategy behind the execution of the representation: dents of indirect pecking were made in parallel rows along the contour, especially the external contour, because the traces are arranged in even chains virtually without deviations; they are of equal size and approximately the same offset (Fig. 5, *a*, *b*, *g*). Almost every dent is legible. Along the internal contour, they are located less evenly (Fig. 5, *a*). This was possibly how the artist outlined the future boundaries of denser pecking. The outlines of the image were first indicated by wide lines made with
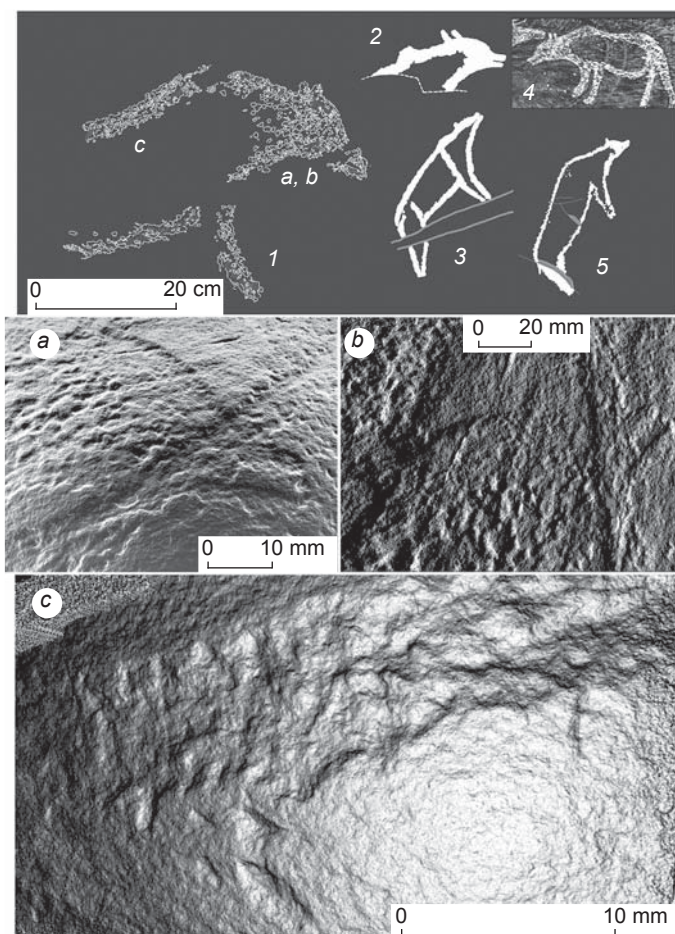

Fig. 3. Bear representation.
1 – tracing of the image and fragments of the 3D model: *a*, *b* – the bear's head, *c* – back; *2–5* – parallels: *2*, *4* – Shalabolino; *3* – Tepsey I; *5* – Oglakhty VI (after (Zotkina, Miklashevich, 2016)).

indirect pecking and then treated with direct pecking. The shapes of dents in the area of sparse filling range from oblong and sub-triangular to sub-circular and sub-square (Fig. 5). In the area of the muzzle they are larger than in the area of the neck. Very distinctive torn and wavy edges of pecking dents and amorphous contours occur (Fig. 5, *c*, *d*, *g*). The inconsistent features indicate the use of a stone tool possibly rejuvenated several times, or even different tools.

Such distinctive dents do not extend beyond the neck. The contours that can be considered to represent the body of the elk are very different from the head and neck in terms of techniques and trace features. The dents are very large, of stable shape in almost all areas, very deep (much deeper than those which form the image of the head and neck), rounded or teardrop-shaped, with smooth edges (see Fig. 5, *e*, *f*), which indicates the possible use of a massive metal tool. At the same time, a large number of dents protrude beyond the outline of pecking making the outline not smooth, which is completely unlike the
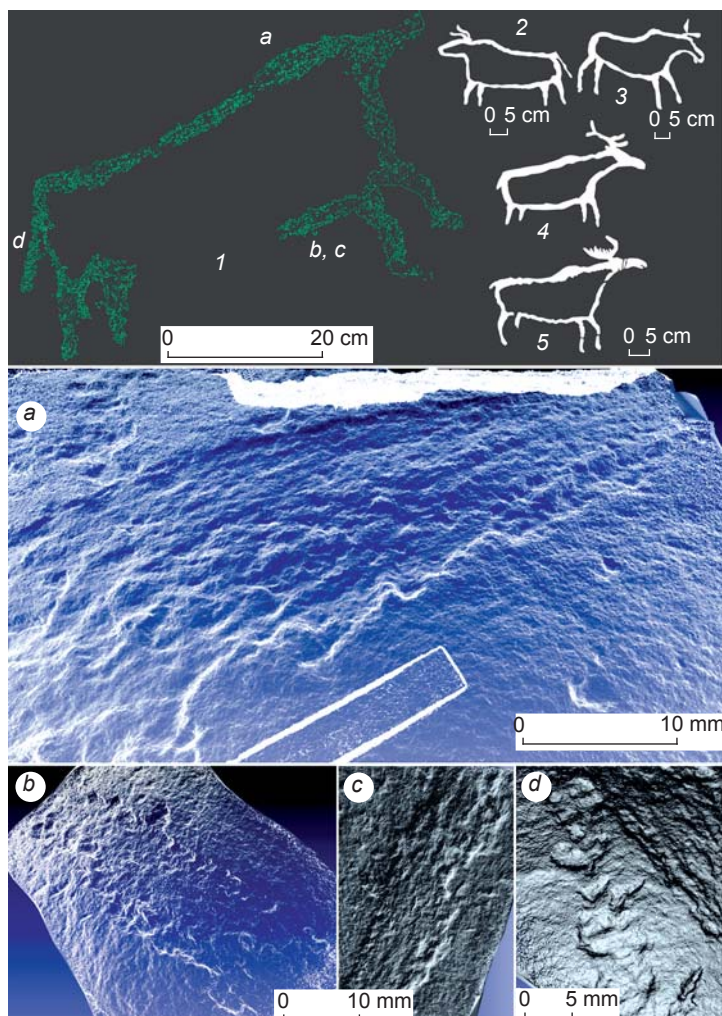
Fig. 4. Bull representation.
1 – tracing of the image and fragments of the 3D model: *a* – back and hump of the bull, *b*, *c* – belly, *d* – tail; *2–5* – parallels, Shalabolino rock art site (after (Pyatkin, Martynov, 1985)).

the intersections of the petroglyphs of the palimpsest. Five intersection points were selected: the front paw of the bear and rump of the bull (Fig. 6, *a*, *b*); the muzzle of the bear and back of the bull (Fig. 3, *a*, *b*); the hump of the bear and muzzle of the elk (Fig. 6, *c*, *d*); the back of the bull and neck of the elk (Fig. 6, *e*, *f*); and the beginning of the bull's front legs and end of the elk's neck (Fig. 6, *g*, *h*).

It is difficult to analyze the first area (the front paw of the bear and rump of the bull) because of great similarity in trace features belonging to both images. Nevertheless, the 3D model clearly shows that small traces and dense filling, which are more typical of the pecking on the bull's rump rather than on the bear's front paw, can be found in the intersection zone (see Fig. 6, *a*, *b*). In the second area (the muzzle of the bear and back of the bull), the following features were observed. As mentioned above, the depth of pecking on the representation of bear was generally smaller than in the lines forming the bull's figure. In the area of intersection, the pecking was deeper as compared to the image of the bear. The line of the back of the bull was polished, and at the intersection, linear smoothing of the pecking relief is observed, which is oriented perpendicular to the bear's muzzle and parallel to the contour of the bull's back (see Fig. 3, *a*, *b*). Thus, these two zones indicate that the image of the bear was earlier.

Clear boundaries of the pecked surface are visible in the next area (the hump of the bear and muzzle of the elk). Dense pecking that forms the lips of the elk is located within the line of the bear's hump and is deeper than the surrounding relief. The nature of traces in the intersection zone (leveled relief and small overlapping dents) is absolutely identical to that on the entire surface inside the contour of the elk's muzzle. Sparser pecking with legible traces of a stone tool, forming the bear's hump in this case acts as a "background" (see Fig. 6, *c*, *d*). Thus, the representation of the elk, like that of the bull, is later than the figure of the bear.

In the fourth area (the back of the bull and the beginning of the elk's neck), the following features have been observed. At the upper boundary of the line of the back, where the relief was leveled by polishing, an accumulation of traces typical of the representation of the elk have been found; these traces were not smoothed (see Fig. 6, *e*, *f*). Even assuming that abrasive treatment was a later addition, pecking dents relating to the figure of the elk still cover the relief smoothed by polishing. This means that the image of bull was created before

previous area. Traces are legible only in the area of the front leg; lines of the torso are heavily damaged by peeling; the features of dents can be observed only along the contours of pecking, and the lines inside look like deep, weathered grooves. Nevertheless, it is obvious that the nature of pecking over the entire body is the same as in the area of the front leg.

Judging by the pronounced differences, it can be assumed that initially the image of the elk was partially done, and the contours of its body were added later. This is suggested by much rougher marks, generally less careful pecking, and completely different style. It is unlikely that the torso was created earlier, with the image of the elk's head added to it.

It can be seen from the above descriptions that the technological aspects of all three images are different, sometimes even within the same figure. Such diversity suggests that specific features could be established at

the image of elk. The area of intersection between the front legs and sparse pecking at the end of the elk's neck show no traces of polishing; several expressive individual dents are observed, which are deeper and more rounded in profile view than the traces of dense pecking that form the outline of the bull (see Fig. 6, *g, h*).

The analysis has shown that the image of the bear was superimposed on the image of the bull, and they were created earlier than the image of the elk, whose torso was an even later addition.

Discussion

Stylistic attribution of the constituent images plays a crucial role in the analysis of palimpsests similar to the one described above. Even the proof of a certain stratigraphic sequence is not the endpoint in the establishment of chronology. In the composition under discussion, consisting of three figures, the representation of the bear shows the most distinctive stylistic features (see Fig. 3, *1*), including a head with small ears and elongated muzzle, an oblong body in a certain position, and a specific position of the front paws. Such features are typical of the Minusinsk style (Podolsky, 1973) (see Fig. 3, *2–5*). This stylistic tradition does not have any exact chronological framework. Some scholars attribute it to the Afanasievo period (Esin, 2010), others to the Neolithic. Even the possibility of its earlier dating cannot be excluded (Sher, 1980: 190). However, most scholars agree to a relatively early age of this style, closer to the Neolithic (Sovetova, Miklashevich, 1999: 47–74).

The image of the bull (see Fig. 4, *1*) also reveals very specific features: with a generally static posture of the animal, its legs are shown in perspective, in a special manner typical of the Angara style and the transitional forms between the Angara and Minusinsk traditions (Podolsky, 1973: 271, fig. 6). The image is oriented to the right, slightly upward and diagonally (Fig. 4, *2–5*). The head of the bull is preserved only partially, which does not make it possible to fully analyze the style. The presence of polishing, which overlaps pecking, is a fairly common feature of the Angara-style petroglyphs. However, owing to the significant expanding of the body of sources, the ideas about the boundaries of the Angara and Minusinsk stylistic traditions have become ambiguous in recent years. Our image of the bull can be considered a transitional form. Notably, this issue requires further special study.
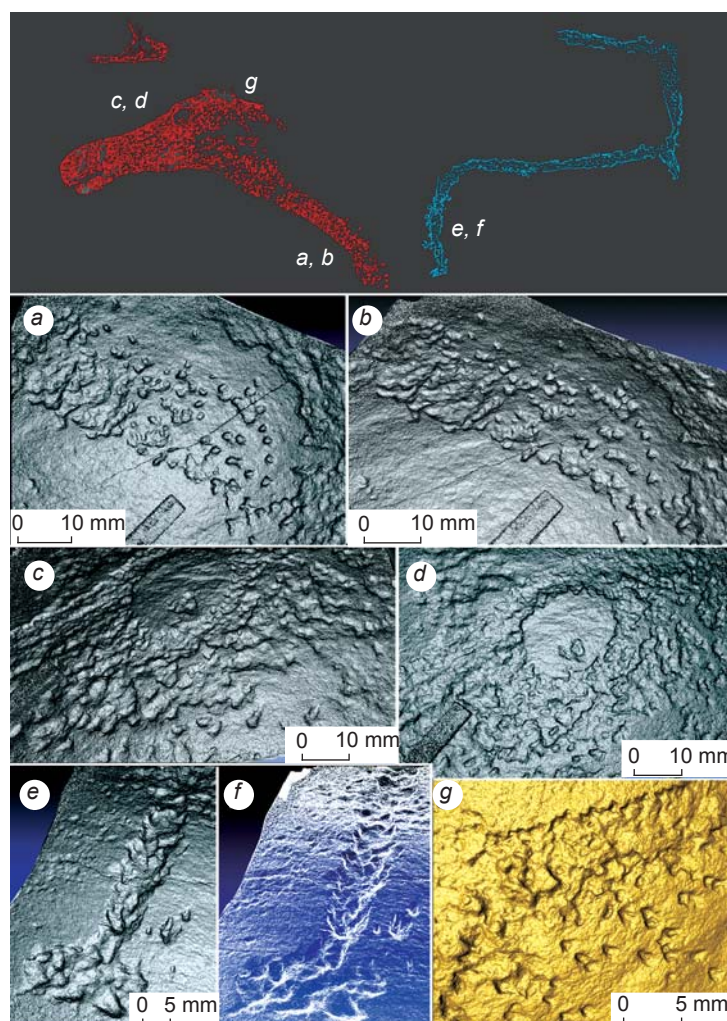

Fig. 5. Tracing of the elk representation (head and torso separately) and fragments of the 3D model.
a, b – neck; *c, d* – eye; *e, f* – front leg; *g* – outline of the muzzle.

The image of the elk in our multilayered composition deserves special attention. From the preserved fragment of the horn, it can be assumed that precisely this animal was represented (see Fig. 5, *1*). This petroglyph has a number of stylistic features typical of the Angara tradition (Okladnikov, 1966; Podolsky, 1973: 269; Ponomareva, 2016). Thus, the details of the head (lips, highlighted by the counter-relief of the eye) are typical of this style (Fig. 7). The combination of methods for producing the contour and coarser and parser filling creates the effect of "low relief" (Okladnikov, 1966: 112–113), which is also typical of the Angara representations of elk. However, the torso and legs belonging to this figure not only show completely different technological features, but also stylistically differ from the head and neck. Indeed, the Angara style is distinguished by its dynamics; the legs are usually rendered in perspective, and the torso looks more lean (Fig. 7). In our case, the figure is in static posture; two legs are shown, and not four; the
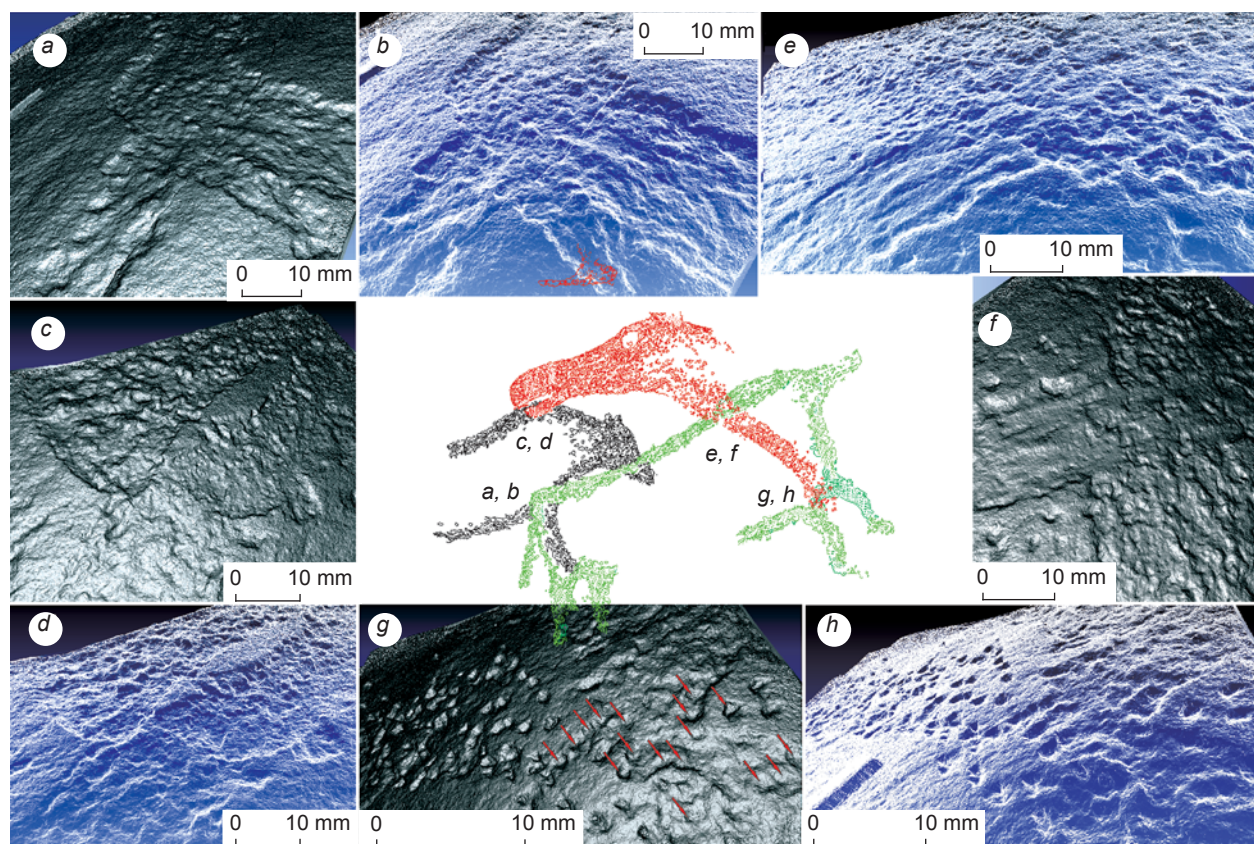
Fig. 6. Tracing of the multilayered composition of three images and fragments of the 3D model (areas of intersection between the images):
a, b – intersection between the bear's belly and front paw, and the bull's rump; *c, d* – intersection between the bear's back and elk's muzzle; *e, f* – intersection between the polished line of the bull's back and elk's neck; *g, h* – intersection of the base of the bull's front legs and end of the elk's neck.
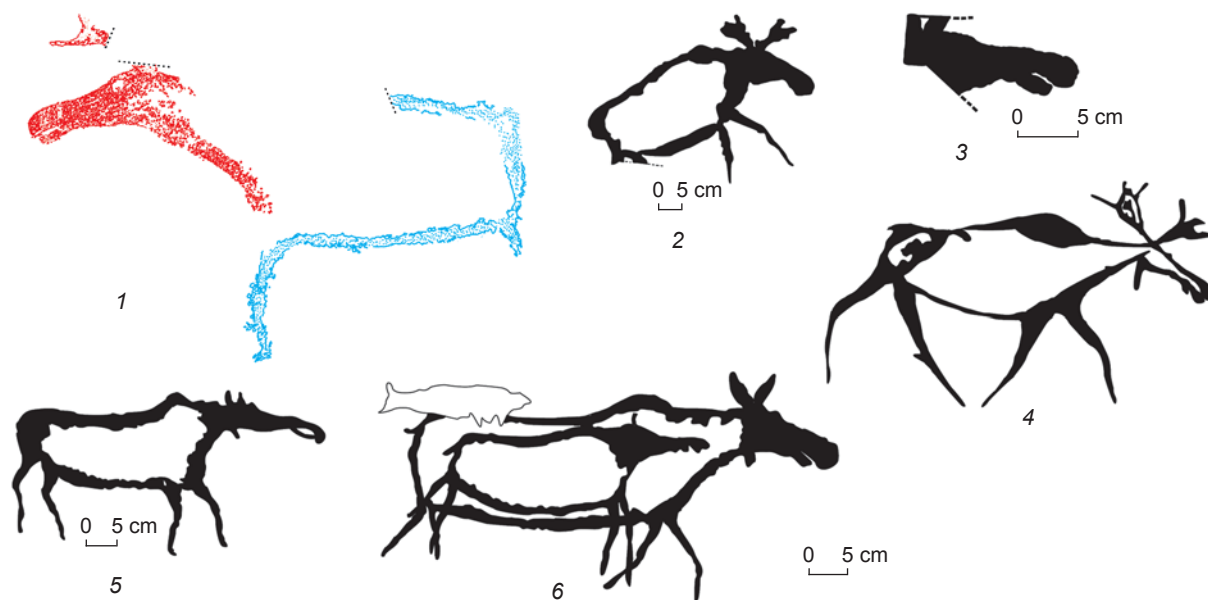

Fig. 7. Elk representation.
1 – tracing of the image; *2–6* – parallels, Shalabolino rock art site (after (Pyatkin, Martynov, 1985)).

body is quite bulky. Thus, these two elements (head-neck and torso-legs), which at first glance seem to belong to a single image, are either asynchronical, or were definitely made by different people.

Conclusions

Comparison of the data obtained from the traceological analysis of the palimpsest and its stylistic parallels suggests the following chronology of this multilayered composition. The very first image was the representation of the bear, which belongs to the Minusinsk style, presumably of the Neolithic. Further, it was covered over by the figure of the bull, which could have occurred in the same period or several millennia later, since the image can be attributed to both Minusinsk and Angara traditions, that is, probably, to the final Neolithic or the Early Bronze Age. The endpoint in the stratigraphy of this palimpsest was the figure of the elk (head, neck, and horn), made in the Angara style. It is curious that the image of the elk in completely canonical Angara style covers the transitional Angara-Minusinsk image of the bull. This can serve as an additional argument in favor of the hypothesis about the coexistence of these traditions on the territory of the Minusinsk Depression.

It has been established that all three petroglyphs were made with stone tools, although the techniques, intensity, and depth of pecking are different. In addition, the last image was complemented later, and obviously not by its original author, as evidenced not only by its stylistic, but also technological features shown by the outline of the body of the animal.

Since the complex palimpsest under study includes several more images, which require special research, the question of its stratigraphy should not be considered settled. This is the task of further research and the subject of future discussions.

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