

Pigments on Upper Palaeolithic mobile art. Spectral analysis of figurines from Mal'ta culture (Siberia)

Pigmente auf jungpaläolithischer mobiler Kunst. Spektralanalyse von Statuetten der Mal'ta Kultur (Sibirien)

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ABSTRACT - The use of paints by Palaeolithic hunter-gatherers in culture and practice has a diverse context. We analysed available materials in the Mal'ta-Buret' collections and revealed the wide use of various colours dated to the initial stage of the Late Glacial Maximum in Siberia. The results proposed for discussion concern the identification of the unique use of colourful components for decorating ivory figurines and the analysis of pigment traces in samples of the cultural layer of the Palaeolithic settlements. Results are presented from microscopic and spectral analysis of Siberian prehistoric mobile art containing traces of colouring materials found in the museum collections of the Mal'ta and Buret' sites (1928-1958 Mal'ta excavation by M. Gerasimov and 1936 Buret' excavation by A. Okladnikov). Our microscopic examination of the complete collection of figurines and objects of personal ornamentation revealed traces of spectra of red, blue/light blue and green colours in the collections of the State Historical Museum, the State Hermitage, and the Irkutsk Regional Art Museum. All samples were subjected to spectral analysis with varying degrees of accuracy, as a result of which complex compositions of pigments were prepared. In addition colouring samples of spots of the Mal'ta cultural layer sediments were investigated.

Preliminary analysis of the pigments was carried out using a Bruker M1 Mistral spectrometer, SEM-EDX by Bruker Quantax 70 and Hitachi TM3000, and IR-Furje spectroscopy. It seems as if the painting of the objects appears as part of the technological process of manufacturing the figurines. It is also possible that the figurines were carried in bags (containers), together with various pigments, so that the traces of coloring were only preserved in recessed areas of the product surfaces.

ZUSAMMENFASSUNG - Die Verwendung von Farben durch paläolithische Jäger und Sammler in Kultur und Alltag hat einen vielfältigen Kontext. Wir analysieren die verfügbaren Materialien in den Mal'ta-Buret'-Sammlungen und zeigen die breite Verwendung verschiedener Farben, die auf das Anfangsstadium des Late Glacial Maximum in Sibirien zurückgehen. Die zur Diskussion gestellten Ergebnisse betreffen die Identifizierung der einzigartigen Verwendung von farbigen Komponenten zur Verzierung von Elfenbeinfiguren und die Analyse von Pigmentspuren in Proben der Kulturschicht der paläolithischen Siedlungen. Es werden die Ergebnisse der mikroskopischen und spektralen Analyse sibirischer prähistorischer mobiler Kunst, auf denen Farbspuren zu erkennen, sind vorgestellt. Die untersuchten Funde stammen aus den Sammlungen der Fundstätten Mal'ta und Buret' (1928-1958 Mal'ta-Grabung von M. Gerasimov und 1936 Buret'-Grabung von A. Okladnikov). Unsere mikroskopische Untersuchung der gesamten Sammlung von Figurinen und Gegenständen der persönlichen Ornamentik im Staatlichen Historischen Museum, in der Staatlichen Eremitage und im Irkutsker Regionalen Kunstmuseum ergab Spuren von Spektren roter, blauer/hellblauer und grüner Farben. Alle Proben wurden mit unterschiedlicher Genauigkeit einer Spektralanalyse unterzogen, in deren Ergebnis komplexe Zusammensetzungen von Pigmenten hergestellt wurden. Darüber hinaus wurden Farbproben von Flecken der Mal'ta-Kulturschichtsedimente untersucht. Die vorläufige Analyse der Pigmente wurde mit einem Bruker M1 Mistral-Spektrometer, SEM-EDX von Bruker Quantax 70 und Hitachi TM3000 und IR-Furje-Spektroskopie durchgeführt. Es scheint, als ob die Bemalung der Objekte als Teil des technologischen Prozesses zur Herstellung der Figuren anzusehen ist. Es ist auch möglich, dass die Figuren in Beuteln (Behältern) zusammen mit verschiedenen Pigmenten transportiert wurden, so dass die Farbspuren nur in vertieften Bereichen der Produktoberflächen erhalten geblieben sind.

KEYWORDS - Upper Palaeolithic, anthropomorphic figurines, ivory, decoration, pigment, Siberia
Jungpaläolithikum, anthropomorphe Figuren, Elfenbein, Dekoration, Pigment, Sibirien

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Introduction

Mal'ta is a multi-layered archaeological site in Baikal's Siberia (Fig. 1) with cultural deposits belonging to the chronological range from 43 000-41 000 to 12 000 BP (Medvedev 2001; Lipnina 2012). The main collection of finds was obtained during the excavations under the leadership of M. Gerasimov from 1928 to 1958 (Gerasimov 1958), before the current excavations directed by G. I. Medvedev and E. A. Lipnina, which focused on the problem of dating, microstratigraphy and cultural differentiation of the assemblages. According to the investigations of Gerasimov, the classical Mal'ta layer contained a Gravettian-like lithic industry, about 13 000 stone and ivory objects (anthropomorphic and zoomorphic sculptures, personal ornaments) and 15 dwelling structures dated from 23 000 to 19 000 BP (Gerasimov 1958; Lipnina 2012; Lbova 2014; Lbova et al. 2017; Derevianko et al. 1998). This corresponds to the lithological sedimentation of layers 8 and 9 in the initial stage of the Last Glacial Maximum of the modern section of the current excavations by Medvedev (Kuzmin et al. 2011; Lipnina 2012). In addition to the anthropomorphic figurines, the Mal'ta collection contained over eight hundred ivory and bone artefacts including zoomorphic sculptures, numerous pendants, objects with ornamental decoration, ivory and stone bracelets, perforated disks, beads, an ivory plaque engraved with the representation of a mammoth and nail-like pins in the same archaeological context.

The Buret' site (as the "double" of Mal'ta) is 12 km north of Mal'ta and was discovered in the village Lower Buret', on the river Angara, in sediments of the second floodplain terrace, 18-20 m high. From 1936 to 1940 the site was excavated under the leadership of A.P. Okladnikov. The general stratigraphic situation at Buret' is analogous to Mal'ta (more specifically, lithological layers 8 and 9 of the current excavations), but in a different geomorphological situation (Okladnikov 1960; Derevianko et al. 1998). The Buret' collection contains about 500 items of stone and bone artefacts. Four dwellings of various configurations were excavated with a unique reinforcement by reindeer antlers, pillars made of mammoth femurs, and wall fastenings made of limestone blocks and rhino skulls. The stone inventory is close in technological characteristics to the Mal'ta complex, and consists of a few artefacts: points, scrapers on blades, scrapers, incisors, prismatic cores and blades, including those with retouching, choppers (quartzite and Cambrian flint). Anthropomorphic and ornithomorphic sculptures as well as objects of personal ornaments (pendants, piercings, beads, discs with holes) are well known (Okladnikov 1960; Larichev 1972).

Both complexes have a number of similar features in the production of stone and bone tools, as well as stylistically homogeneous anthropomorphic and ornithomorphic figurines, and form a specific archaeological culture (Mal'ta-Buret'). Mal'ta and Buret' were defined as short-term hunting camps of the same

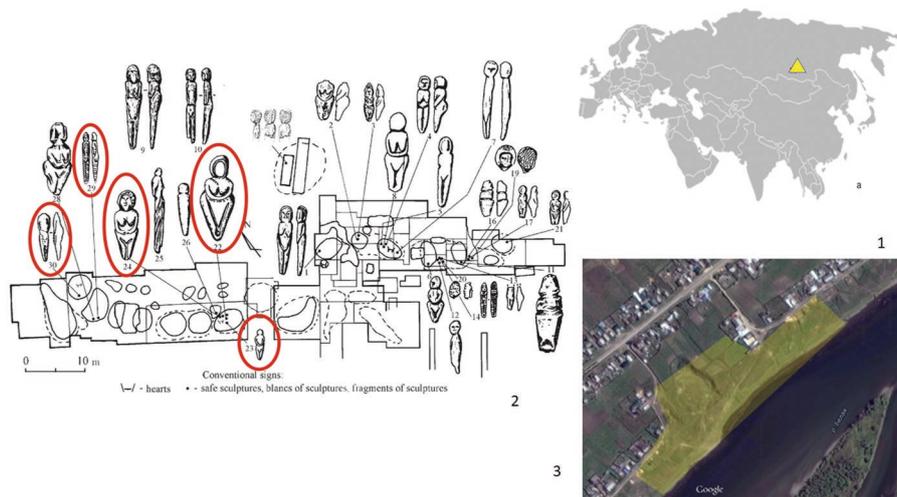


Fig. 1. Mal'ta site: (1) location of Mal'ta- site in Eurasia, (2) excavation by M. Gerasimov (west part of excavation with reconstruction of plan by G. Medvedev (2001) and figurines with pigment marked), (3) location of the archaeological site.

Abb. 1. Mal'ta: (1) Lage von Mal'ta in Eurasien, (2) Ausgrabung durch M. Gerasimov (der westliche Bereich der Ausgrabung mit einer Rekonstruktion des Plans von G. Medvedev (2001) und Statuetten mit Pigmenten), (3) archäologisches Fundareal.

culture, or even the same human groups (Gerasimov 1958; Okladnikov 1960; Derevianko et al. 1998).

During the excavations from 1934 to 1958, Gerasimov noted spots of red, blue, green, white, and violet colours in the evident structures of the cultural layer with dwellings (Gerasimov 1958). Unfortunately, most of the field documents of the 1930-50s are lost, and no other evidence on the spatial vicinity of sculpture findings to these structures have been found. In the past, spots of ochre on separate ivory objects were noted by Praslov (1992) and Filippov (2004).

Figure 1 shows the result of the attempt to place the painted objects on the plan by Medvedev (2001) (Fig. 1: 2). It becomes apparent with the help of a microscope that all objects on which paint was discovered are concentrated in an unusual structure. The layout of the structure is complex and elongated. According to Medvedev and Gerasimov, however, these are the traces of a single construction located in the western part of the excavation zone (Medvedev 2001; Lipnina 2012; Lbova & Volkov 2017). In this paper the results from both Mal'ta and Buret' are presented to provide a more complete picture and comprehensive understanding of the creativity and technological capabilities of the Palaeolithic population of the Baikal region. Moreover, in the collections of the state museums (such as Kunstkamera, the State Historical Museum, and the State Hermitage) we could find parts of the cultural layer from Gerasimov's excavations with objects painted in different colours as well as small ochre pieces.

Methods

Detailed morphological, techno-typological and microscopic analyses were carried out on the largest part of the collection, which is now kept in the State Hermitage Museum (SHM) and Museum of Anthropology and Ethnography (MAE) in St. Petersburg, and in the State Historical Museum in Moscow (Mal'ta). Buret's part of the collection is stored at the State Historical Museum and at the Regional Art Museum (IRAM) in Irkutsk. Experiments were also carried out. In the international practice of examining pigments, several techniques are applied to the study of pigments or pigment-containing materials (e.g. Popelka-Filcoff et al. 2008; Zipkin et al. 2015). This include non-destructive X-ray diffraction (XRD), X-ray fluorescence (XRF), FT-IR spectroscopy, Raman spectroscopy (Raman scattering of monochromatic light) or Raman spectrometry, SEM-EDX-based spectrometry, X-ray induced proton radiation (PIXE), inductively coupled plasma mass spectrometry (ICP-MS), and instrumental neutron activation analysis (INAA). A number of specific questions are to be examined: the establishment of sources of mineral raw materials, the differentiation of pigments into natural and artificial pigments, the identification of organic

components. Further detailed research was carried out by scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDX). This is the best known and most widely used of the surface analysis methods, and we use this method to determine the qualitative and quantitative properties of the pigments.

Our microscopic examination and identification of traces using low and high power Altami microscopes with digital camera revealed the presence of ornamental decoration and pigments on the surface of the sculptures. Preliminary analysis of the pigments was carried out using a Bruker M1 Mistral spectrometer (State Historical Museum, Moscow). The sensitivity of the spectrometer makes it possible to detect elements up to 0.01 wt. %. In addition to these detectors, digital pulse processing and optimised geometry of the system ensure the best efficiency and speed of the X-ray analysis, and accuracy of its results. The most interesting discovery in this study of the Malta's collection was the identification of pigments of scarlet colour (vermillion), as well as green and blue (dark blue) colours on the surface of some sculptures by using the BRUKER M1 Mistral spectrometer with collimator setting of 0.4 mm (time of analysis 180 sec) (Lbova & Volkov 2017).

In complex or controversial cases, a part of the samples of coloured sediments from the archaeological layer was examined by means of crystal-optical analysis and microstructure sampling in polarised light in order to determine the homogeneity or heterogeneity of the sample structure. This is an important aspect for the determination of the natural components (hematite, goethite), or the definition of an artificial composition with possible impurities. The crystal-optical method shows that all the components were obviously rubbed into a relatively homogeneous mass. Unfortunately, no adequate technical equipment is available to determine the organic components in the paints.

Materials, Results and Discussion

The identification of scenes decorating Palaeolithic anthropomorphic sculptures from the Mal'ta culture allow us to agree that human representation was a way to represent the natural patterns of human behaviour. The choice of attributes was a reflection of specific cultural, environmental and historical conditions behind certain traditions of material culture during the Ice Age (Abramova 1966; Delporte 1979; Lipnina 2012; Soffer et al. 2000). Pigments (usually red ochre) are documented in the decoration of sculptures and elements of cultural layers among the Upper Palaeolithic materials such as Willendorf, Dolni Vestonice, Kostenki and other sites (e.g. Lázníčková-Galetová et al. 2016; Praslov 1992; Yansina et al. 2017).

More than 50 items of ivory figurines are present in the Mal'ta collection. Figurines with traces of

pigment include five anthropomorphic and one ornithomorphic sculptures (Fig. 1: 2). At this point we have some analytical results of pigment composition provided by the available equipment of the State Historical Museum (SHM). The following descriptions of the respective figures are taken from the website Art of Mal'ta, an information system of Mal'ta culture mobile art (Artemiris 2019a).

1. The figure of a "teenage girl" (N 1822/629 SHM) appears to be dressed in a one-piece garment with hood that covers the entire body and head (Artemiris 2019b). This is an elongated thin figurine. The surface of the statuette is covered with thin horizontal lines. The figurine shows on the front and the back depictions of triangles that imitate the pubis and the tail (significantly lower than the pubis). Shaping was made with a lithic artefact. On the surface some traces of the work with a burin are visible. The other traces are covered with polishing. Decoration was made with a cutting tool (Abramova 1962: 47; Lbova et al. 2017). The presence of scarlet pigment has been detected in the area under the tail, on the right thigh and on the right arm (Fig. 2: 2a & 2b).
2. Figure of an "adult woman" with massive lower part (N 1820/208 SHM) (Artemiris 2019c). The

head is covered with deep ornamentation in the form of serpentine lines. This object is a full-figured round sculpture of the classic type with ornamental decoration. The ornament is in the neck area and probably represents a special structure, perhaps a hairdo. Gerasimov considered the line from neck to chest as an element of a hairdo (braid). The chest is convex and symmetrical. The arms are complexly bound and folded on the tummy under the chest. On the tummy is a row of nine indentations. On the shoulders we can see some parallel lines (probably, shoulder bracelets) (Abramova 1962: 46). On the head, in the parietal part, there is a platform which is purposely flattened. A characteristic feature is the depiction of straps (or maybe locks of hair) and marks of the girdle in the upper abdomen. The head is decorated with different types of ornamentation. Green pigment on the head was observed at the part ornamented by wavy lines. Scarlet colour also appears on the head; spots of pink colour is marked at the base of the head (Lbova et al. 2017).

3. Figure of an "adult woman" (N 1820/209 SHM) (Artemiris 2019d). It is a full-figured round sculpture of the classic type with ornamental

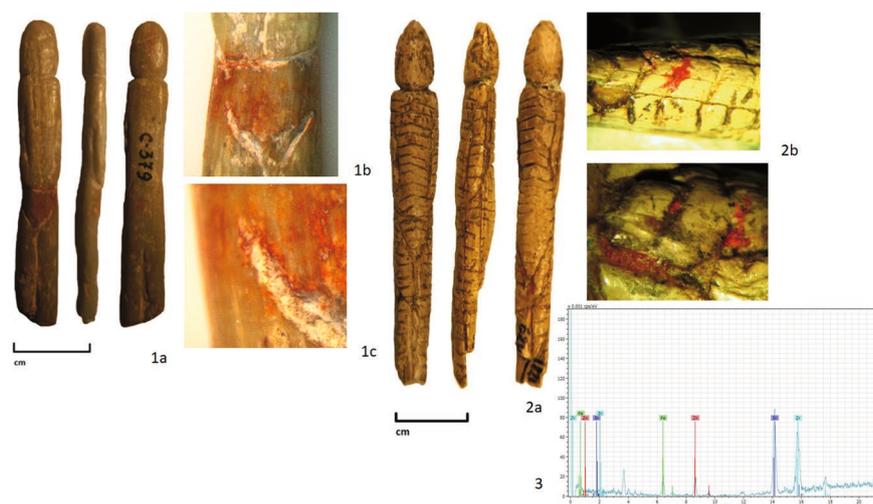


Fig. 2. Figurines of girls ("teenagers") with traces of red paint. (1) Buret' site: (1a) depiction in three projections, (1b) macro photography of the central part of the sculpture with a magnification of 7 increase, (1c) macro photography of the stained area with a magnification of 25 increase. (2) Mal'ta site: (1a) depiction in three projections, (1b & 1c) - macro photography of the stained area with a magnification of 25 increase. (3) Spectrum of red pigment.

Abb. 2. Mädchenstatuetten („Jugendliche“) mit Resten roter Färbung. (1) Buret: (1a) drei Ansichten der Statuette, (1b) vergrößerte Aufnahme (7x) des mittleren Bereichs der Statuette, (1c) makroskopische Aufnahme der gefärbten Stelle (25x). (2) Mal'ta: (1a) drei Ansichten der Statuette, (1b & 1c) makroskopische Aufnahme der gefärbten Stelle (25x). (3) Spektrum des roten Pigments.

- decoration. The head is large and disproportionate in relation to the body. The face is profiled; the eyes, high nose, and a massive chin are well modelled. Massive 'bracelets' are depicted on the arms of the figurine. Distinct spiral ornamentation is present on the head (Abramova 1962: 46). There are some traces of the work with a burin on the face, chest and shoulders. The contours of the legs and the hands are made with cutting tool. Hair and spiral-shaped hairdo were made with a burin and a borer (lines and "cupulas"). The face area is divided from hairline with cutting tool. The mouth and the eyes are made with cutting tool, but nostrils are made with a burin. There are some cutting marks on the face. Traces of dark-blue pigment were found in the recesses (cavities) of the ornamentation on the head, in the area of the spirally decorated hair (Lbova et al. 2017).
4. The sculpture of a "young male" (N 1822/625, SHM) is an elongated figurine with a presumed phallus (Artemiris 2019e). Shallow lines outline the details of the body. A thin flattened statuette of medium size, hands are folded on the stomach, the front part is rather elongated and narrow. The knees and buttocks are well highlighted. The head is broken off (Lbova et al. 2017). The surface of the figurine is made with a knife and a burin; details (hands, calves, legs, popliteal cavities) are marked with a knife. The shoulders and torso from the clavicle are contoured by a burin, while the burin also divided the feet and corrected the zones separating the arms from the torso.
- Traces of the incisor's work were recorded on the chest and back. It is likely that during the shaping of the item only the knife was used, which performed various functions. In the front of the figure, traces of a blue pigment were found in the area of the right arm, right knee, leg, as well as in the groin area (Fig. 3: 1a & 1b).
5. The form of a "teenage" (N 1822/206, SHM) is a short figurine, with a large round head (Artemiris 2019f). The decorations of the figure are rough, without any particular details. It is a small statuette, probably of a child. The head is large and ornamented. The face is flattened. The arms are along the body and end with a triangle. The womb area looks like a triangle (Abramova 1962: 47). There are traces of green paint on the entire surface. In addition, there are some traces of blue paint on the tummy. Traces of green pigments are observed on the reverse side of the object in the area of the cross lines separating the legs and under the knees.
 6. Ornithomorphic figurine of a "flying bird" (N 5412-409, MAE) (Artemiris 2019g). The figure is small with a rounded massive body, an elongated neck and an oval head. The wings of the bird are short and rounded. There is a hole in the area of the legs and the tail. It should be noted that only on this figure did the use-wear analysis show traces of suspension (unpublished use-wear analysis by P. Volkov). Traces of pigment in the form of a brown-red small spot are noted among the black dendrites on the body.

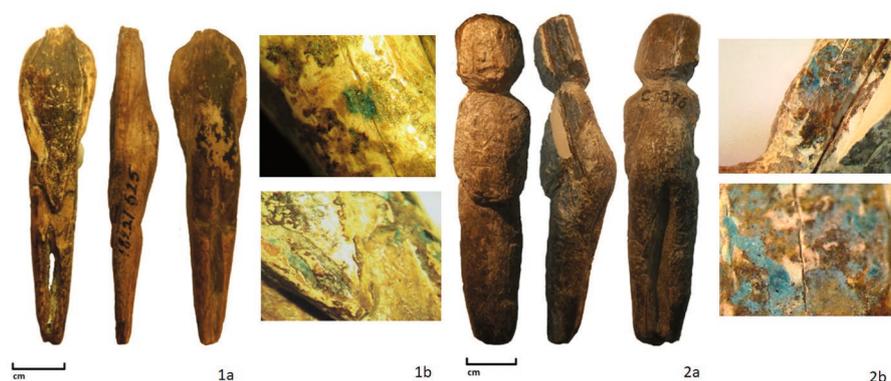


Fig. 3. Figurines with blue painting. (1) Mal'ta site: (1a) Figurine of a young man in three projections, (1b) traces of blue paint on the surface with an increase of 25 times. (2) Buret' site: (2a) Figurine of an adult woman in three projections, (2b) traces of blue paint on the surface with an increase of 25 times.

Abb. 3. Figuren mit blauer Bemalung. (1) Mal'ta: (1a) Figur eines jungen Mannes in drei Projektionen, (1b) Spuren von blauer Farbe auf der Oberfläche mit Vergrößerung (25x). (2) Buret-Site: (2a) Figur einer erwachsenen Frau in drei Projektionen, (2b) Spuren von blauer Farbe auf der Oberfläche mit Vergrößerung (25x).

The Buret' collection comprises six figures. Figurines with traces of pigment include three anthropomorphic and one ornithomorphic sculptures.

1. This figure of a young girl (C 379, IRAM) with elongated body proportions, a characteristic of adolescents, was made from a small serpentine pebble (Artemiris 2019h). Head, shoulders, body and legs are depicted. Traces of a knife are observed when forming the contour of the head. A burin was used to decorate the details of the face (left eye) and the contour of the head, as well as to shape the contour of the arms and legs and the area of the bosom. Diagonal traces of a scraper are found on the back of the head and on the legs in the buttocks area. The artist paid special attention to the bottom zone, carved with great care. An additional emphasis on this area is also placed in the form of red colouring (Fig. 2: 1a-1c).
2. Anthropomorphic figure of an adult woman on an elongated blank (C-376, IRAM) (Artemiris 2019i). The profile shows the characteristic bending of the figure for an adult woman, typical of Mal'ta sculpture. The head, middle part, legs and arms are well marked. The head is round, spherical in shape, the back of the head is flattened, and the surface of the dentin is partially preserved. The head is separated from the body by a noticeable indentation in the neck area. Face details are missing. The contours of the hands are made distinctly from the back. Hands are folded on the stomach. The contour of the legs is profiled at the back with a relatively deep channel. The contour of the bosom is weakly expressed in the form of an elongated triangle, dropped almost below the knees. Separate lines on the left leg are observed. A light thin line outlines a small chest - W-shaped. On the chest, there is a small hole, made intentionally. On the left shoulder is probably the depiction of a bracelet. In the area of the right shoulder joint, there are traces of bright blue paint on the left side in the area of the arms and hips. The sculpture is not finished completely, and as in Mal'ta collection, there are no details and body ornamentation (Fig. 3: 2a & 2b).
3. Elongated thin blank with a slight scribble in the area of the legs (C 380, IRAM). Traces of a knife are observed over the entire surface and at both ends of the object; traces of the use of a scraper are present in the upper part of the blank. The figure is not finished. The overall outline of the raw piece is preserved. Traces of green paint are noted on all surfaces of the object.
4. Ornithomorphic sculpture of a flying bird (C 378, IRAM) (Artemiris 2019j). The head is

rhombic with smoothed soft forms; the wings are oval and small. The neck is elongated, the body is slightly convex, and the abdomen is flattened. Legs are not cut, but outlined. A small hole is located in the lower part of the figure, made by a stone perforator, one-sided drilling. On the tail area it bears marked spots of green paint.

It should be noted that some traces of ochre and bright red pigments were also found on the blanks of anthropomorphic and ornithomorphic sculptures stored at the State Hermitage, on the internal parts of a bracelet made from torbanite (a lacustrine type of oil shale), on stone beads as well as on long ivory pieces that might have been used for fastening the hair or for the nose.

Red paint on the objects reveals the proximity to the samples of violet sand and a piece of ochre. The composition of the paint on the sculptures noted the presence of lead, strontium and zirconium. Traces of red, pink, purple, rose and scarlet pigments have been found on the surface of three figurines. These marks are concentrated in the abdomen area, on the legs and at the base of the head. The composition of the scarlet pigment includes iron, strontium, zinc, and zirconium. These elements give a special brightness to the paint, which can be identified precisely as bright pink, scarlet, and not red. Most likely ground hematite was used for such a paint and mixed with a clay mineral, rich in zirconium, of local origin (Fig. 2: 3).

Green pigment was identified in three cases. The coloured spots are located on the head and in the area of the knees of the presumed teenage figurine. The composition of green pigment is identical to the blue pigment, with the addition of chromium. Dark-blue and light-blue pigments were found on three anthropomorphic sculptures. The traces of this pigment appear in the abdomen area and on the head, as well as in the cavities of the hair, on the legs, and bag. The composition of the blue/dark-blue pigment shows the predominance of strontium, calcium, iron, zinc, and bromine. In both cases, copper, chrome, and bromine would give colour to blue and green pigment. The Palaeolithic Mal'ta museum collection includes pieces of native copper, which makes it possible to explain the presence of blue and green pigments in the composition of the Mal'ta culture collection even more confidentially. A general analysis of copper-bearing samples shows up to 96 % of the presence of copper in the sample and a rich palette of other metals (silver, lead, arsenic, bismuth). Copper samples in the composition of the cultural layer of the Palaeolithic era can cause numerous questions. However, it should be noted that the Southern Baikal region has a rich natural polymetallic base. Probably these bright green samples attracted attention and were taken to the camps as manuports.

The second part of the present investigation is devoted to the analysis of different materials of

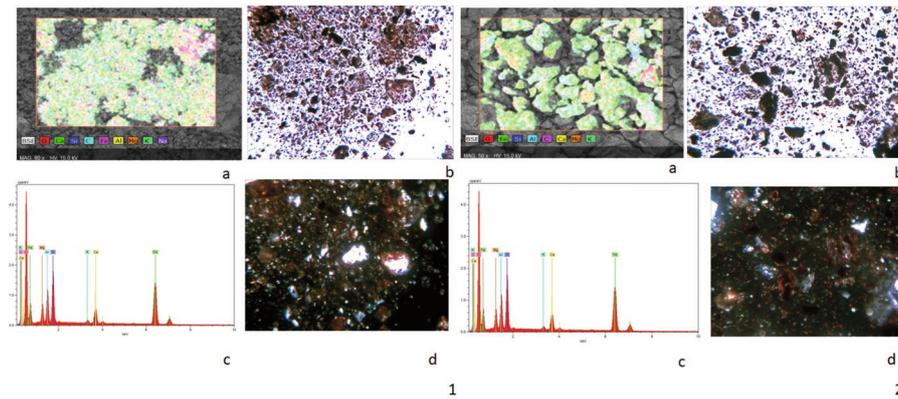


Fig. 4. Results of the analysis of the pieces of ochre (1), and different colors of the samples of violet pigment-containing sediments (2): (a) microstructure of the samples by SEM-EDX analysis, (b) microstructure of the samples by crystal optical photo, (c) graph of quantitative characteristics of elements, (d) microstructure of the samples photo by polarised light.

Abb. 4. Ergebnisse der Analyse der Ocherstücke (1) und die verschiedenen Farben der Proben mit pigmenthaltigem Sediment (2): (a) Mikrostruktur der Probe anhand der SEM-EDX Analyse, (b) Mikrostruktur der Proben durch optisches Kristallfoto, (c) Diagramm der quantitativen Merkmale der Elemente, (d) Mikrostruktur des Probenfotos durch polarisiertes Licht.

coloured sediments, powdered homogeneous finely divided samples, pieces of "ochre" (Fig. 5), and copper-bearing rocks from the archaeological layer that were collected by Gerasimov during the excavation process.

A comparative analysis of the relative proportions of the elements in the powders showed that all samples were identified as mixtures containing red ochre (colourful clays), quartz and calcite (Fig. 4: 1d & 2d). The variation of the composition, a piece of ochre and a powder-like sample of reddish-yellow colour were practically identical (Fig. 5). The main component, iron, is distinguished by a group of samples of grey

and reddish-yellow colour similar in composition (6-9 %). Violet powder and ochre demonstrate a distant relationship to the Fe component (30 and 15 %). Iron in a sample of purple colour reaches a maximum in the collection as a whole and is a powdered cherry hematite in which calcite and quartz are also present in a finely dispersed form. All the samples showed a very close uniformity in the composition of the elements forming up to 5 % additives (aluminium and siliceous clays, magnesium, used for greater colour density, and an obvious organic component (carbon, potassium, and sodium) (Fig. 4).

Element	Gray sand	Violet sand	Red-yellow sand	"Ocher"
Oxygen	50.54129397	40.00746591	50.72237	45.88212
Iron	9.395430927	30.69825353	6.811389	15.14017
Silicon	17.7231767	8.74743858	12.15038	6.853152
Aluminium	5.694251782	5.907912786	4.456948	2.707674
Magnesium	2.380049623	4.020253778	2.111894	1.397975
Calcium	12.49088707	4.383010649	13.92125	19.84944
Carbon	-	5.581844675	8.014108	7.063638
Potassium	1.774909929	0.653820093	1.08064	0.608207
Sodium	-	-	0.731026	0.49762

Fig. 5. Mal'ta site. The elemental composition of color samples components from the cultural layer (in %). Iron is a significant component of the spectra. As artificial additives, the presence of calcium, aluminum, silicon, magnesium are important. As well as calcium, potassium, carbon and sodium are marked as probable indicators of organic additives. Oxygen is not a determining component for spectra.

Abb. 5. Mal'ta. Die Elementzusammensetzung von Bestandteilen der Farbproben aus der Kulturschicht (in %). Eisen ist ein wesentlicher Bestandteil der Spektren. Als künstliche Zusätze sind das Vorhandensein von Kalzium, Aluminium, Silizium und Magnesium wichtig. Neben Kalzium werden auch Kalium, Kohlenstoff und Natrium als wahrscheinliche Indikatoren für organische Zusätze angesehen. Sauerstoff ist kein bestimmender Bestandteil der Spektren.

Conclusion

Pigments appearing on some early Upper Palaeolithic objects from Siberia, dated to the initial stage of the Late Glacial Maximum, were subject of this study. Multi-elemental composition of these pigments was also obtained using SEM-EDX analysis, which showed differences in the use of various natural and human-made ingredients in the territories of Southern Siberia (Kara-Bom, Malaya Syya, Khotyk, Kamenka, Ust'Kova) (Lbova et al. 2018; Lbova 2020; Volkov et al. 2018) and Russian Plain (Yanshina et al. 2017). The tradition of using various colours in the Palaeolithic is proven. It is interesting that in the complexes of the Initial and Early Upper Palaeolithic, raw materials (such as colourful clay, hematite, goethite, azurite, and malachite) for obtaining paints not only of the red spectrum were used, but also of blue, and green, black and yellow.

Mal'ta-Buret' tradition with applying pigments on some objects (figurines, personal ornaments), the traces of which have been identified in this study, is one of the most interesting facts of the additional decoration of the anthropomorphic sculptures. The Mal'ta culture collections revealed pigments of red, pink, green, blue, violet, grey, and white colours, which are present and represented in samples of the cultural layer (coloured sand), as "ochre", and as paint on the surface of the ivory sculptures. Personal adornments show traces of red pigment. Painted samples of the layer (coloured sand) and ochre samples show analogy combinations on additives combination of the main chemical elements with elemental composition of the paint of red, pink and scarlet colour, marked on the sculpture.

On one side, decoration of the objects of mobile art in the Mal'ta cultural collections can be considered as follows: A canon of stable technology, including the typical elements of the ornamental decoration and their combinations, and specific areas of ornamentation (Lbova & Volkov 2016; Lbova et al. 2017). On the other side, not in all cases, we can be sure that the traces of pigments resulted from intentional painting of the figurines (excluding the "teenage" girls). It is also possible that the figurines were carried in bags together with various pigments or coloured sand, thus preserving the traces of colouring only in recessed areas of the relief of the surfaces. Traces of pigments on other objects (bracelets, hairpins, beads) indicate the active use of red ochre as pigments at the Mal'ta site for colouring the human body and possible clothes.

One of the main principles of symbolic communication is that any individual person is always social, i.e. the personality cannot be formed outside society. According to the symbolic concept of communication, the behaviour of an individual is determined by three variables: the structure of the personality, the role of the reference group, and the symbol "recognition"

(Soffer et al. 2000; Abramova 1966). From our understanding, the Mal'ta-Buret' figurines constitute the element of social communication. The realistic nature of their artistic style defines the comprehension of meanings and symbols for the members of Palaeolithic society. The newly added knowledge and the collection of a comprehensive database can be used successfully for studying materials from similar Upper Palaeolithic sites in Northern Eurasia.

ACKNOWLEDGMENTS: The author would like to express deep gratitude to N. Khaikunova and other employees of the State Historical Museum (Moscow), A. Gryzlova in Irkutsk Regional Art Museum (Irkutsk), and T. Rostyazhenko, J. Gubar (Novosibirsk) and V. Kireeva, researcher of laboratory Art-Consulting (Moscow) for providing the opportunity to work with the collections and samples of cultural level, technical support. I express my deep gratitude to Isabell Schmidt and anonymous reviewers for effective discussions on the research topic and assistance in preparing this publication. The author also thanks the administration of Novosibirsk State University and Institute of Archaeology and Ethnography, Siberian Branch of RAS, who supported the archaeological research of the LIA ARTEMIR. We are very grateful to the Russian National Foundation for funding this study (project No. 18-78-10079) and for the opportunity to create and develop an information system dedicated to the Art of the Mal'ta culture of the Upper Palaeolithic. Generally, the Mal'ta-Buret' collection can be considered as a full-fledged archaeological source for the study and individual issues. Most of the collection can be seen on the Novosibirsk State University (Artemiris 2019a).

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