An Experiment in Studying the Felt Carpet from Noyon uul by the Method of Polypolarization

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The elite burials in the Noyon uul (Noyon-ula) mountains of northern Mongolia are among the best known archaeological monuments of the Xiongnu (the Asiatic Huns). The cemeteries located there were the object of work by the Mongolo-Tibetan Expedition of P. K. Kozlov in 1924-1925, when, under the supervision of S. A. Kondrat'ev (in the case of barrow no. 12/24, of S. A. Teploukhov) more than 2000 varied objects were exhumed, above all silk and wool fabrics, felt carpets and prestige gold and silver ornaments (*Kratkie otchety* 1925; Trever 1932; Umehara 1960; Rudenko 1962). The main collection of the finds, which date to the first century CE (Miniaev and Elikhina 2009) today are preserved in the Oriental Section of the State Hermitage Museum (Elikhina 2007; 2007a).

Various materials from the Noyon uul collection have undergone both technical and stylistic analysis (Voskresenskii and Tikhonov 1932; Lubo-Lesnichenko 1991, 1994; Miniaev 1981). In the first instance this involved the silk and wool fabrics and the felt carpets, which almost immediately after the discovery underwent chemical analysis in the Laboratory of Archaeological Technology of GAIMK (now IIMK RAN, the Institute for the History of Material Culture of the Russian Academy of Sciences). Particular attention in this was devoted to the felt carpet No. 14568 (Hermitage Inventory No. MR-2300) from barrow no. 6. It underwent chemical, microchemical and histological anayses; its coloring was studied, as were the techniques of its embroidery, etc. (Voskresenskii and Kononov 1932). In order to determine the species of animal from which the wool was obtained for making the felt, the wool fabrics and threads and samples of the wool of camels, wild and domesticated caprids, sheep, goats and oxen were examined. However, as the report noted, "in spite of the wide spectrum of comparative materials and detailed analysis, it was impossible to obtain data which would support a definite conclusion." The researchers themselves recognized that their several possible suppositions were paradoxical: the material of the carpet, they believed, was similar to the wool of the Sudanese sheep, which had been adapted in China in ancient times; or the high quality wool of this animal hand been imported from Egypt; or in Han Dynasty times a breed of sheep was raised which later disappeared; or this was the wild sheep of Mongolia subsequently wiped out by hunting (Voskresenskii and Kononov 1932, p. 81).

In recent years V. I. Kulikov and E. Iu. Mednikova of the Laboratory of Archaeological Technology of IIMK RAN have developed the method of polypolarization, applied there in a Image Recognition System (STZ), and used it to determine the specific nature of samples of wool, down, hair, plant fibers and other biological and archaeological objects (Kulikov et al. 2010).[1] The polypolarization method was so named because of the large quantity of polarized objects and their corresponding images.

The basic idea of the proposed method is to obtain qualitatively new information from the studied object by creating a new kind of electron optics system, in which a secondary Lambert-source of illumination operates allowing one to remove the background illumination of the studied sample (in classical microscopy that background illumination is always present and must be estimated due to optical aberration). In order to improve the quality of the images obtained, an apodizing filter developed specially for this system was introduced, making possible the even illumination of the sample. An important benefit of this method for archaeology is the small size of samples needed, which then barely alters the form and structure of the object under study.

The given method of polypolarization was used to study samples from fragments of the felt carpet from barrow no. 6 in the Noyon uul cemetery (one of four felt carpets found in

Fig. 1. Felt carpet from Noyon uul barrow no. 6 (State Hermitage Museum Inv. no. MR-1958; KP GAIMK Nos. 14377 and 14378).

that barrow). Two fragments of the carpet laid under the coffin [Fig. 1] were found behind a column outside the exterior wall of the northern corridor (State Hermitage inventory no. MR-1958; KP GAIMK Nos. 14377 and 14378) and then were sewn together during restoration of the finds.

The table below specifies the fragments selected for this study, which were compared with standard samples of animal wool (the numeration of carpet samples is given according to the general inventory, which includes as well material from the other cemeteries).

The photographs of the standard and test samples done by the polypolarization method with magnification of 350x are shown in Fig. 2 below. The juxtaposition of the standard samples of wool from various animals (sheep, horse, camel) and the carpet samples led to the conclusion that camel wool was used in the manufacture of all the elements of the tested fragment of carpet no. MR-1958/1959. This conclusion is supported both by the fineness (the size of the cross-section of the individual thread) as well as by the characteristic configuration for camel wool of the middle part of the hair (the cortex), which is clearly evident from the visual analysis of the macrophotographs.

No.	Sample
06	Felt backing of carpet
07	Beige wool cloth, covering for backing of carpet with spiral ornament.
08	Brown wool cloth, covering backing of carpet in its center
09	Thread for the mount of the ornamental band
10	Felt of the "shield-shaped" appliqué
11	Felt of the tree appliqué
11a	Thread used to attach the tree appliqué
12a	Felt of the yak appliqué
12b	Mount for the yak appliqué
12c	Thread used to attach the yak appliqué
13	Felt of the cross-shaped appliqué
14	Cherry-colored thread for the embroidery of the spiral ornament
15	Beige thread for embroidery of the backing of the carpet

Camel hair, apparently, was used in the manufacture of other felt and wool objects found at Noyon uul. Evidence of this was obtained from preliminary polypolarization analysis of samples of fur from barrow 6 and fragments of a rug from Kondrat'ev's barrow.

Thus the perspectives for applying the polypolarization method in archaeology generally and for the study of samples of fabric in particular are quite evident. For the materials from Noyon uul the analysis of other samples of felt and fabrics both from barrow no. 6 and from other burials is a task for the future.

In this article the authors have not touched on the question of the means by which coloring was applied to the various components of the carpet. Such as task will require separate study. We note only that macrophotography in the reflected light of the twisted thread of the spiral ornament (which has a cherry color) confirms the suggestion by A. A. Voskresenskii and V. N. Kononov that "coloring had been applied to already manufactured cloth, not its yarn" (Voskresenskii and Kononov 1932, p. 94). We can also add that one should not exclude the possibility that the wool of a newborn camel was colored (before the hair stiffened), and also the possibility of coloring as a result of the thermal treatment of the yarn or the application of clayey minerals — aquaeous silicates with manganese and chromium, which always, when alloyed, color objects a deep red.

About the authors

V. E. Kulikov received his degree from the Leningrad Institute of Precise Mechanics and Optics and is the holder of several patents on apodization methods. **E. Iu. Mednikova**, a graduate of the Leningrad Technology Institute developed the method of polypolarization. **S. S. Miniaev**, a senior staff member of IIMK, is one of the most prominent specialists on the archaeology of the Xiongnu. He and **Iu. I. Elikhina**, who is Curator of the Tibetan, Mongolian and Khotanese Collections of the State Hermitage Museum, are preparing a catalogue of the Noyon uul collection.

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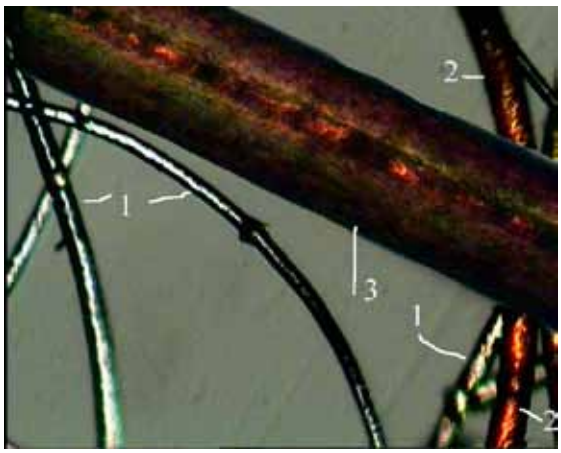
Note

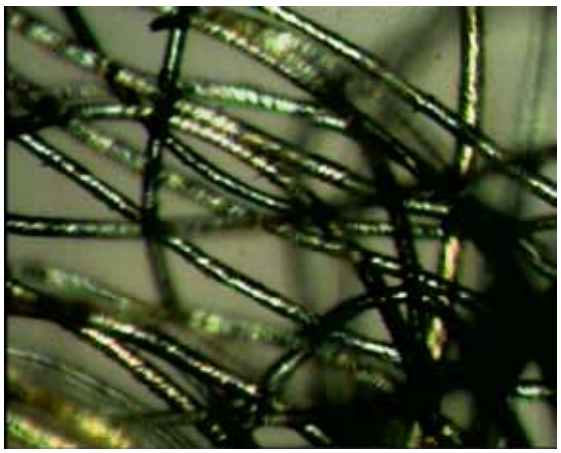
1. Using such a system of image recognition, a huge number of the most varied kinds of apparatus have been developed in the world, from navigation mechanisms of rockets and robotic sensing to the simple calculation of the available means of transport, security in the galleries of museums, etc. All of these entirely different systems have in common the function of recognizing an image (identification, composition, color, determination of its spectrographic profile, histograms, etc.).

Translated from Russian by Daniel C. Waugh

Fig. 2. Microphotographs of the samples.



Standard (control) sample: 1. camel; 2. sheep; 3. horse



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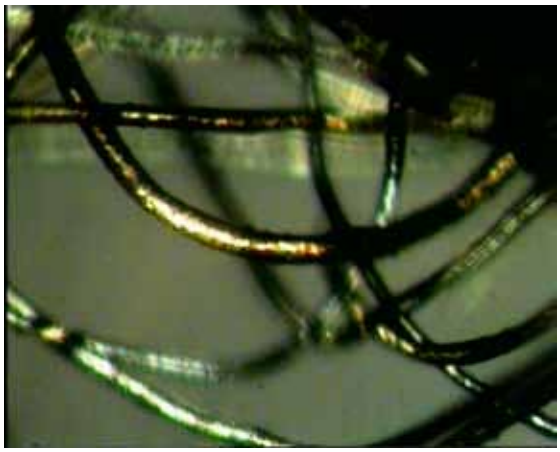

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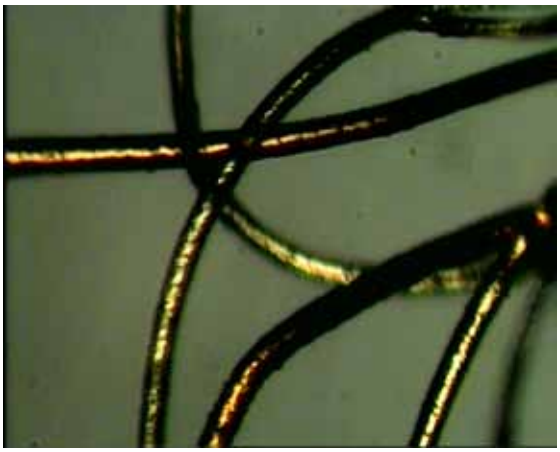

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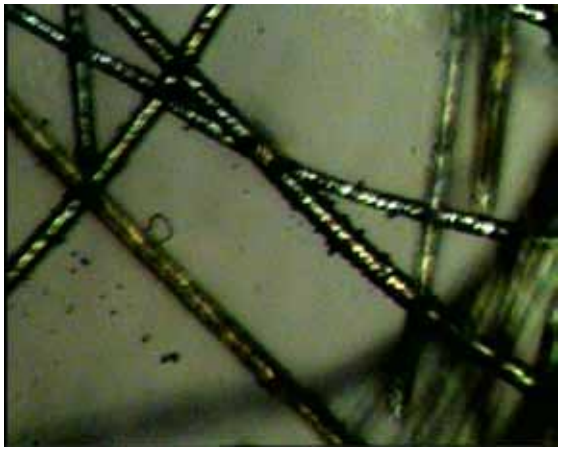

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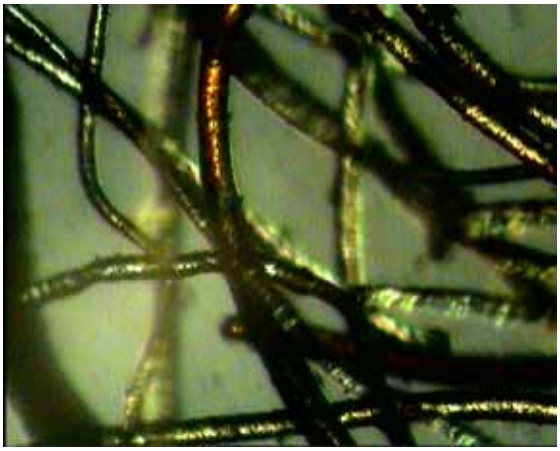

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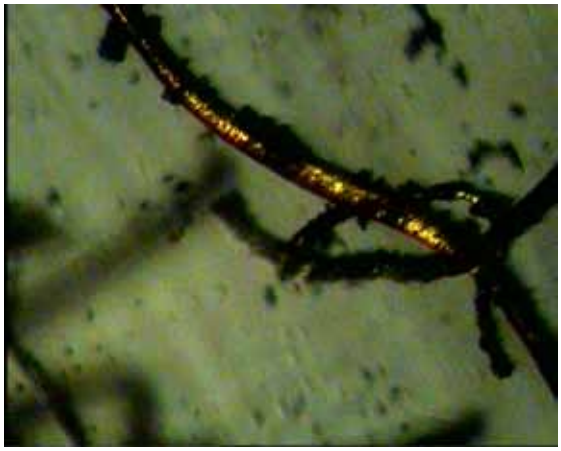
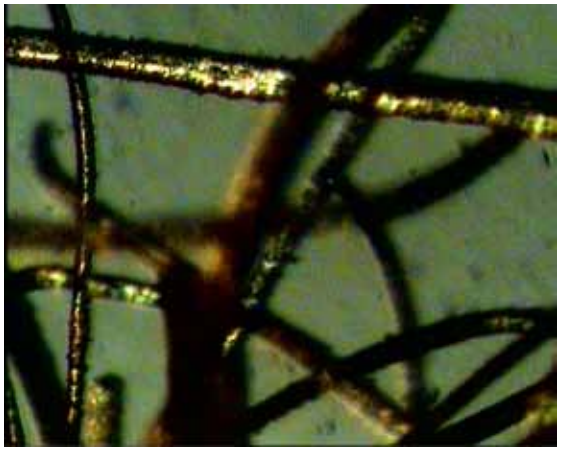


Sample no. 11

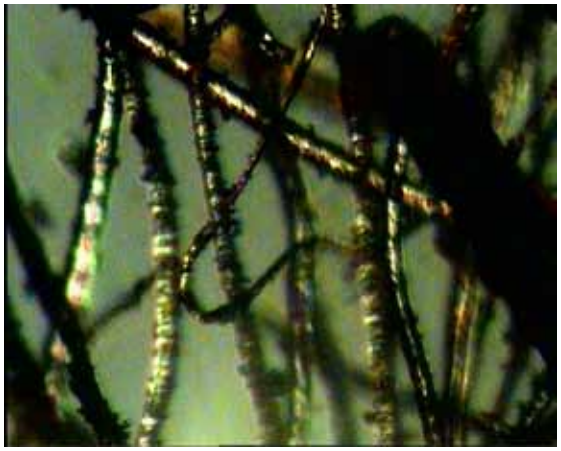
Sample no. 11a

Sample no. 12a



Sample no.12b

Sample no. 12c



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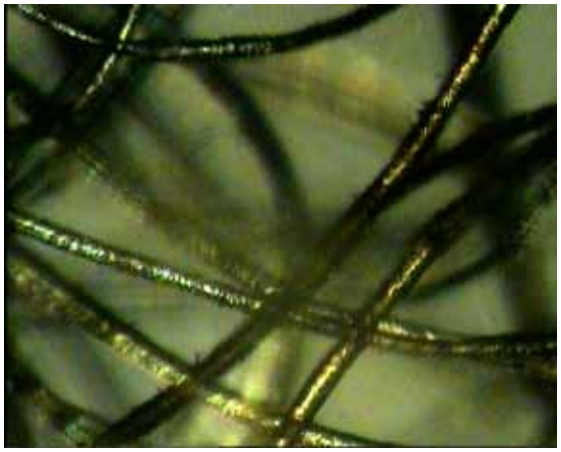
Sample no. 14



Sample no. 15