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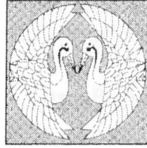
Front cover:

Portrait of the Georgian translators of “Kalila and Dimna”, king Vakhtang VI, and of the poet and scholar Saba Sulhan Orbeliani. Manuscript P 2 in the collection of the St. Petersburg Branch of the Institute of Oriental Studies, fol. 3a, 22.0×19.0 cm.

Back cover:

Illustration to the story “Disservice”, the same manuscript, fol. 97a, 19.0×22.5 cm.

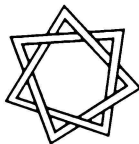
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CONSERVATION PROBLEMS

E. A. Mikolaychuk

SOME RESULTS OF AN ANALYSIS OF PAPER FROM KHARA KHOTO (TWELFTH — FOURTEENTH CENTURIES)

Paper was widely known and amply used in the Tangut state Xi Xia, which is confirmed by discoveries in Khara Khoto, where a number of articles were found with paper as their base or component.

Fibrous materials are used in paper production; most often vegetable fibre is employed, because the main component of such fibres is cellulose (pulp), a natural polymer of organic origin. It possesses several valuable properties which are essential in different papermaking processes. The cohesion forces between fibres in paper stock are determined mainly by the ability of cellulose to generate bonds. This allows one to produce sheets of paper without binder additives.

Papermaking originated in China in the first century A.D. While making paper the artisans could observe in practice the behaviour of fibrous materials at various stages of the process, as well as what properties the finished product displayed. Today we know that the paper-generation properties of vegetable raw materials depend on their chemical composition and the morphology of the fibres.

The chemical composition is basically determined by the content of cellulose in pulp and by the hemicellulose content. We do not consider here the chemical composition of raw wood materials, as they have been used since as late as the nineteenth century.

Different morphology of fibre suggests different types of paper produced. However, the relationship between the chemical composition of raw material, its morphology and the properties of paper as a finished product is a very complex one. Of great importance in this case is the production method selected.

The process of papermaking has steadily developed over the course of time. Nevertheless, very primitive technologies of papermaking, such as, for example, producing paper from mulberry bast, have been preserved and are still in use. The history of paper has recorded certain features of its emergence, both time-dependent and local. This is why it is important to indicate the technological factors of paper production, such as appearance, structure, thickness, fibre fineness, method of moulding, the type of the moulding screen, sizing agents, the method of sizing application, paper transparency and cloudiness, watermarks, dye, etc.

Being of organic nature, paper is naturally subject to considerable changes over time which are determined by

natural ageing processes of paper components, their reciprocity, and the conditions of paper production, use, and storage. As a rule, changes affect all the main properties of paper: physical, mechanical, chemical, optical, as well as colour.

Since fibres are the main component of paper, their identification is a major issue in research on paper. The morphology of fibres, however, may also be subject to destruction. Visually, this shows up in damage fibre: cracks, fractures, and ruptures may be observed. Eventually, this process may lead to the loss of specific features of fibre, or, on the contrary, to the appearance of features not inherent in the fibre in question. The result is that the destruction of the morphological structure seriously impedes the identification of fibre.

The current article aims at summarising the results of the study of twenty-eight samples of paper originating from Khara Khoto in the collections of the Hermitage and the St. Petersburg Branch of the Institute of Oriental Studies. Mostly it is paper of manuscripts, paper employed in producing crowns, banknotes, or paper used in manufacturing ladies' shoes. These types of paper employed vary in their appearance, representing thin, thick, soft, dense samples, with uniform or cloudy translucence. Some of them are dyed. The removal of sizing substances, which by now have become yellow, and of the products of decomposition of the lignocarbhydrate complex, makes it possible to lighten paper and restore its initial colour. As a rule, yellow paper becomes white, brown paper — beige, and dark blue paper — light blue. This reveals a clearer picture of the paper structure, and its screen lines show up. In the process of examining Khara Khoto samples of paper, multilayer types of paper have been revealed; for example, three beige layers and one azure layer, or two azure layers with a white layer between them are present.

Also, moulding screen lines have been found in twenty-two samples. They all were moulded on screens manufactured after the Chinese model, that is, using horse hair. The distribution of the screen lines is seven to eight per centimetre. All papers studied are starch sized over the surface. Some of them have a second sizing.

Ten samples of paper are made of mulberry bast, and nine of these are thin, sometimes nearly completely transparent, silky, light-coloured and strong paper of very high

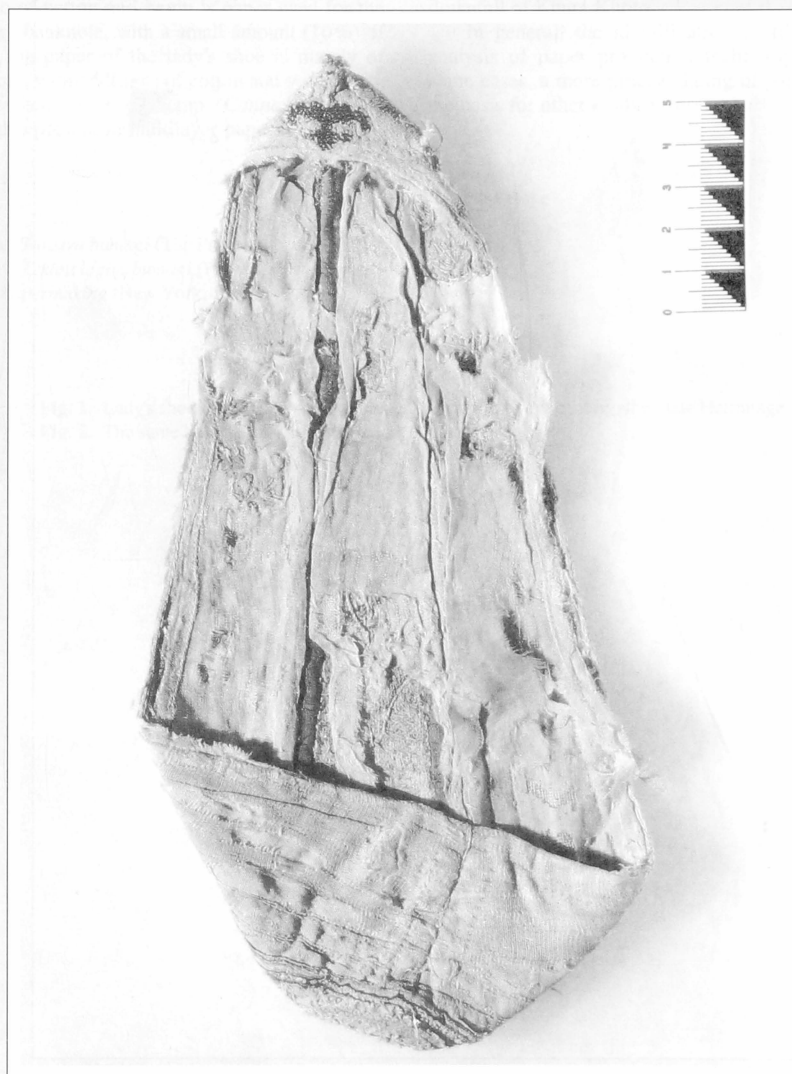


Fig. 2

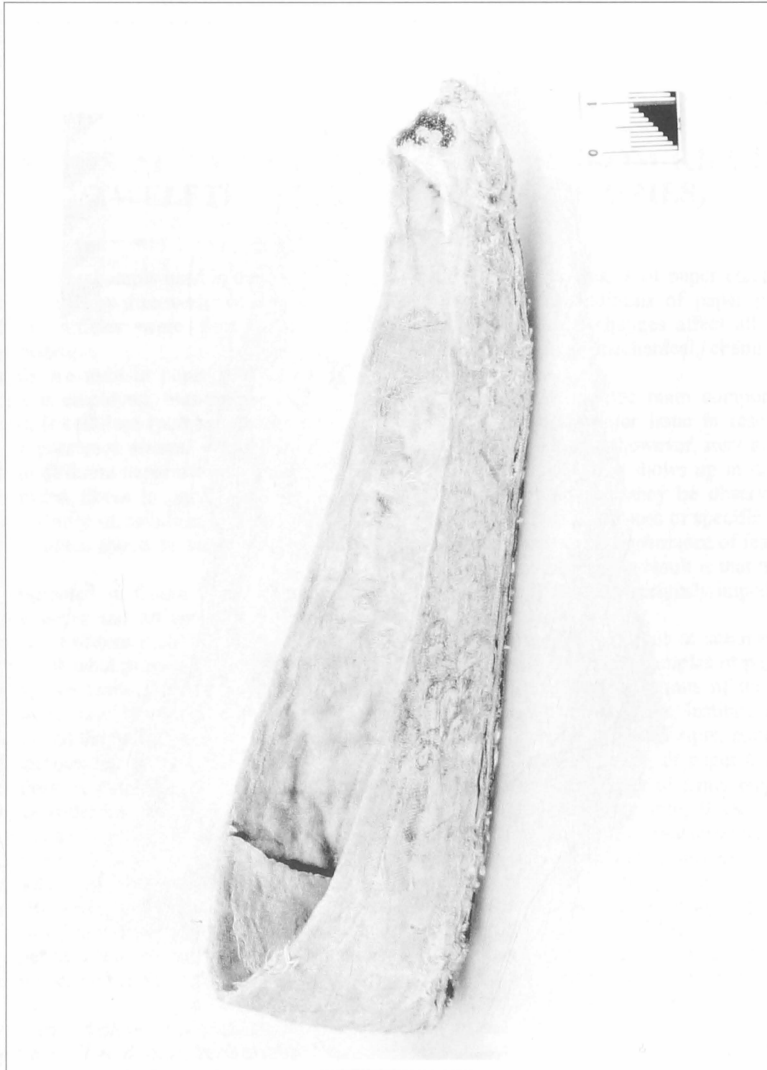


Fig. 2

quality. To make such paper, a soft inner layer of mulberry bast was used. One sample is denser, of a greyish colour and of lower quality. To produce such paper, a coarser outer layer of mulberry bast is used.

The paper in eight manuscripts from Khara Khoto is made of bamboo. Bamboo has been used in papermaking since the early twelfth century, and it was the material from which writing book, and mail grades of paper were made.

Four paper samples are produced from rag stock, while paper in two manuscripts is of cotton and hemp in various proportions. Also of cotton and hemp is paper used for the fourteenth-century banknote, with a small amount (10%) of wool fibre. The rag paper of the lady's shoe is mainly of hemp and silk fibre, with additions of cotton and wool.

Two samples are solely of hemp (*Cannabis sativa*). Hemp paper is also present in multilayer papers. The hemp

fibre structure provides a much denser and thicker paper than, for example, mulberry bast paper.

Two paper samples are of flax fibre. This type of paper has been identified in the composition of the crown, which also contains other kinds of fabric.

Finally, one sample is a mixture of hemp (80%) and rice straw (20%), while another consists solely of rice straw (rice straw in papermaking has been used since the fourteenth century). These materials had probably not yet gained firm positions in the production of paper by the downfall of Khara Khoto.

In general, the identification of fibre, as well as the analysis of paper production technology, can provide, in some cases, a more precise dating of paper or may serve as the basis for other kinds of research.

Reference literature

1. D. M. Fliate, *Svoïstva bumagi* (The Properties of Paper) (Moscow, 1976).
2. S. N. Ivanov, *Tekhnologiia bumagi* (Paper Technology) (Moscow, 1970).
3. D. Hunter, *Papermaking* (New York, 1956).

Illustrations

Fig. 1. Lady's shoe from Khara Khoto (before restoration), 14th century, the State Hermitage.

Fig. 2. The same lady's shoe after restoration.
