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Original article

Scientific methods for philological scholarship: Pigment and paper analyses in the field of manuscriptology

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ABSTRACT

In this paper, members of three research teams, namely the Turfan Project of the Berlin Brandenburg Academy of Sciences and Humanities, the Berlin-based research project on pigments in Central Asian paper manuscripts, and the Hamburg-based project on the history and typology of Central Asian paper manuscripts, present some of the results of their cooperation. The investigated manuscripts belong to the Berlin Turfan Collection. On the basis of different examples the contribution of scientific methods to philological scholarship within a multidisciplinary approach is demonstrated.

1. Research Aims

Our main goal is the inclusion of material analysis in manuscriptology. We want to encourage philologists working with manuscripts to enlist support from experts in material analysis. Physico-chemical examination is a means to try to gain more data about production, provenance, use, and re-use of manuscripts. Furthermore, the measurements should be able to show that two or more fragments belong to one and the same manuscript or not. More generally, the question can be raised if the different and opposing religious communities and their scriptoria along the Silk Road in Central Asia were using the same suppliers for inks and other items in some cases.

2. Introduction

Philologists study texts, or to be more precise: they study written texts.[1] Manuscripts, the traditional carriers of written texts, had been of interest to them mainly for their texts, until in the late 1980s, scholars from Western European medieval studies called for the "materiality" of texts to be taken into consideration and proposed, among other things, a "new philology" [1], a "material philology" [2] or even a "materialist philology" [3]. For more than two decades since then, much energy in literary and cultural studies have been spent on theoretical problems of the concept of materiality, but only little on research into the material of more than ten million manuscripts still extant in various parts of the world. Some philologists still seem to be reluctant to accept that their written texts ("witnesses") are parts of artefacts, which may be subjected to the same scientific methods of inquiry as other artefacts are in disciplines such as art history or archaeology, although material analysis is more and more accepted. It seems further problematic,

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[1] Oral texts came into play only in the first half of the 20th century when Lord and Parry took the Serbian guslars as a model to explain certain features of Homer's epics as derived from oral poetry.

as often librarians are the responsible persons to restrict access to objects and decide whether material analysis is accepted for certain objects or not.

3. The Turfan collection in the Berlin Brandenburg Academy of Sciences and Humanities

The Berlin Turfan Collection of 40,000 manuscripts and fragments of manuscripts is an impressive collection of religious material in the main and is an excellent source for the languages and religions along the Silk Road in Central Asia from ca. 300 through ca. 1400 CE. However, important information about the manuscripts and their places of production is usually lacking. This is due to the fragmentary character of many of them, such that we can point to the existence of books but very often we only have parts of these, in some cases only a single page (or part of it) and therefore cannot date the book as such.

This applies to the original date of the composition of the text or texts in the book and also to the time and place of the production of the manuscript containing it. The book cultures from the west, i.e. those of the Middle Iranian and Syrian speaking Manichaeans and Christians mainly used parchment; in Turfan and other places in the Tarim Basin, these books were now rewritten using paper. The originals of Buddhist books from India were written on palm leaves or birch bark; these too were copied on to paper, in this case often made to look like the formats of palm leaf manuscripts – pothi. From historical sources, we know some things about the arrival of these religions in the Turfan area and other places along the northern branch of the Silk Road in the Tarim Basin, but concrete information is scarce. In our attempts to reconstruct texts from short fragments, we would like to know more about the individual fragments. If they come from a single archaeological context, there exists at least a possibility that they once belonged to the same codicological unit.

The fragments of the Berlin Turfan Collection are sorted into groups on the basis of the languages and scripts together with a number. The signatures mentioned in this paper are U for Uighur, Ch/U for fragments with Chinese on one side, Uighur on the other, So for Sogdian, SHT for Sanskrit ("Sanskrithandschriften aus den Turfanfunden" – Sanskrit manuscripts from the Turfan finds).

4. Analysis

4.1. Materials and methods

The investigations were performed using different scientific techniques focussing on paper analysis and the investigation of writing materials – mainly of the black carbon inks and pigment-based coloured inks. The paper analysis included fibre identification, fibre distribution, and further technological features. The investigation of the inks was based on X-ray fluorescence analysis (XRF) and visible spectrophotometry (VIS).

4.2. Paper

The analysis of the paper started with the identification of the fibre using an Olympus BX51Transmitted-Reflected light microscope with BF/DF/DIC/PL with Olympus UC30 camera attached for photographic documentation. A varying magnification from ×50 up to ×600 with both plain and polarized light was applied. Fibres were first observed without any reagent and then treated with Herzberg or "C" stain [4]. Attention was paid to stain colouring, the morphology of the fibres, and of other cells and elements of pulp. Both the width and length of fibres were measured to support the identification in particular cases.

Further technological features of paper manuscripts were examined on a light box in order to identify the type of sieve used for making the paper. Depending on what type of material was attached to the frame in the papermaking process, we can observe a slight difference in texture and imprint of the sieve on the paper. The imprint of a textile sieve clearly differs from that made of bamboo (laid down in a regular pattern), reed, or other grasses (laid in an irregular pattern). This pattern, sealed in the structure of the paper, allows us to distinguish between handmade woven paper and handmade laid paper characterized by the particular number of laid lines in 3 cm. These can be categorized as: laid, regular where unequivocal clear evidence is present; laid, irregular where the pattern is not regular; and, finally, laid, patchy where the pattern can only be seen in patches of the paper but could not have been made by anything else.[2]

The next descriptor refers to the number of paper layers in a leaf. This number is closely related to the thickness of the paper sheet and to methods of book or scroll making. The usual thickness can vary from 0.01 up to 3.5 mm. Using a caliper or micrometer, one should measure the paper in at least five different places and give a span value.

The texture is usually described as, for e.g., smooth, rough, coarse, polished, highly sized. This is qualitative, but it can be an important indicator of the "natural recto", that is, the side of the paper that is smoother as a result of the manufacturing process and which is therefore most desirable for writing.

The distribution of the fibre is derived from papermaking technology. If visible the fibre distribution within a sheet was documented here–whether the fibres were poured into the floating mould and distributed by hand or scooped by the mould from a vat, and how quickly the drainage of the pulp took place. The construction of the mould and type of screen/sieve greatly influences the final product. The presence of uneven pulp thickenings distributed and visible within a sheet of paper, sometimes along the chain and laid lines, sometimes evenly along one edge, also contributes to the description of the type of raw material and the methods of its pulping.

4.3. Pigments and inks

The writing inks of the Turfan collection consist of black carbon inks and coloured pigment based inks. We found cinnabar (HgS) as the main red pigment and red lead (Pb_3O_4) as well as iron oxide (e.g. hematite Fe_2O_3) in a few examples. Azurite, lapis lazuli and indigo were used for blue colourations [5].

Carbon inks belong to the oldest writing materials used in Egypt, India or China for more than a millennium. They consist of carbon pigments that were mixed with a water-soluble binding media (e.g. gum Arabic or glue). The material was dried and pressed into small bars, available for immediate use [6]. In many cases, the smooth carbon material came from burnt oil.

Iron oxide minerals such as red ochre ($Fe_2O_3 \times H_2O$ + clay + silica), hematite (Fe_2O_3) or goethite (FeOOH) belong to the oldest pigments, they were used since prehistoric times. Due to the variety of colours of iron oxides, many prescriptions for the preparation of writing inks, book illumination, etc. exist and their use has been confirmed in manuscripts from Late Antiquity in Europe, Egypt, Mesopotamia and Asia [7]. The pigments were

[2] The laid type of mold/sieve is also sometimes characterized by the chain lines. These are the vertical lines from the screen on which the paper was manufactured. They are not very common in the fragmentary papers from Turfan since these are often not large enough to allow us to observe a compete sheet of paper. The sequence of measurements of the interval between two (or more) chain lines should be given where chain lines are clearly visible.