Reading papyrus as writing material

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Knowledge of materials and technical features is as integral to the restorer as knowledge of language is to Egyptologists. Museums and collections around the world hold thousands of ancient texts on papyrus that are read, translated, analysed and interpreted. Yet, we know very little about the ancient Egyptian writing material itself. So far, only one historiographical source is known: Pliny the Elder’s *Naturalis Historia*. An understanding of material technical details can be gained through observation during the conservation and restoration processes and through targeted investigations. Worldwide, there are few restorers, however, who specialise in the restoration of papyri. A long-standing and experienced colleague in this field is Bridget Leach.

Most papyrus restorers are trained paper conservators who gradually focused on papyrus during their study. The differences between paper and papyrus become immediately apparent during conservation work, i.e. the diversity of raw materials and their processing and the resulting diversity of structures and behavior that in turn requires different conservation and restoration treatments.

The condition of the papyrus is the starting point for choosing appropriate actions. Here, there must be a clear distinction between the material properties and their current state (see table 1), which has changed over the course of millennia. In order to assess the conservation status as accurately as possible, it is important to know the material technical characteristics.

In the course of decades of conservation and restoration, new details about papyrus production, structure and texture have continued to emerge. When restoration was begun in the 1980s with systematic and detailed material-specific documentation, it became clear that the material papyrus required a separate report protocol. An important part of this documentation is the material description (page 2 of the Berlin restoration report), that has been regularly updated and includes a number of significant features that are based on visual observations as well as measurable data.

So far, a first series of measurements reveals an increase in papyrus dimensions over time, which is especially evident in the sheet thickness and the width of the sheet joints. This increase indicates a younger age (see Krutzsch Forthcoming b, Chart 6) for the papyrus.

Details of the material

Pliny’s statements regarding papyrus production methods and production locations are gradually being confirmed by working with the material. Based on the results of tests to determine mineral content, production locations may be identified and papyri with unexplained provenance can be situated. It remains to be verified, however, whether such results refer to the location of the papyrus plant or the place where the writing material was produced.

1 The original German article was translated into English. A German abstract will be provided at the end of the article.

Front image: Berlin P 3165 @ Ägyptisches Museum und Papyrussammlung, Staatliche Museen zu Berlin, Photo: A. Paasch.
though the two were probably not far from one another.

The question of whether individual papyrus production centers existed, perhaps lasting for extended periods, is of interests. It seems almost certain that as Pliny tells us, certain qualities are a kind of ‘trademark’ for specific places or regions (Saitica from Sais and Taenaotica from Taenoeotis). Among these are areas with a long tradition of papyrus cultivation and others, where papyrus was only temporarily cultivated. It is unclear where and how Pliny received his information and whether his observation are applicable to later periods (for example, from the Greek period onwards), or also concern the earlier Pharaonic era.

The content of the texts on papyrus indicate that there is a relationship between text genre and the quality of the papyrus material chosen, which in turn relates to particular transport and trade routes of the raw material, i.e. the blank scrolls.

The papyrus structure shows distinctive fibre flows that reflect one of two production methods, the classical and the peeling method (Hendriks 1980, 121-136). This can be true for both fibre layers (i.e. recto and verso) or only one.

A closer look reveals individual fibres and fibre bundles in various strengths: fine, medium and coarse. Moreover, the fibre flow can be straight, wavy or oblique. The fibre types, their course and (measurable) density determine the sheet quality. The fibre count takes place on both fibre layers, per cm.

The measured papyrus thicknesses show that after 4000 years of use, a change occurs in the Greek period. The papyrus sheets becomes thicker and the structure denser. The higher density is probably owed to two factors. First, the writing instrument is now the pen, which is considerably stronger than the Egyptian soft rush. Second, the demand for writing materials increased because the circle of scribes expanded. This ‘mass production’ was accompanied by a decline in quality.

**Sheet and roll**

Pliny reports a link between papyrus quality, the production locations and the sheet widths. This certainly applies to the Greek period. But older papyri also show specific sheet widths in correspondence to sheet strengths (Möller 1927, 6-7; Helck 1974, 7-9; Krutzsch forthcoming b, overview 2). Both are easy to measure and an increase in sheet strength can be observed from the Old Kingdom through the Arab period (see Krutzsch Forthcoming-b, Chart 1).

Regarding the proportion of sheet dimensions used, exact statements cannot be made at present. Scribes not only cut off smaller or larger portions of the scroll as needed, but often cut complete scrolls along their height to a certain extent. This is visible by the curved upper and lower edges. Large-sized rolls such as the Papyrus Harris (with a height of c.41 cm) or the Book of the Dead of Ani (from 42 cm), however, probably display their original full height.

Some rolls stand out by their limited height of 7 - 10 cm (Berlin P 3158 and 3159; Berlin P 10495 and 10499). These were probably not specially cut into small sizes, but rather obtained from scraps or waste material. The same can be said for the predominantly narrow sheet formats (in both landscape and portrait orientation) of the numerous demotic letters, which were also written on waste pieces as M. Depauw has shown (Depauw 2006, 71-84).
Regarding papyrus sheet shapes, I have identified three different types distinguishable in two ways at the side edges:

1. The completion of the recto and verso layer on the two lateral edges (i.e. recto fibres protrude above the verso fibres, on one or both sides, or the fibres end concisely).
2. The edge profile (i.e. trimmed or not trimmed).

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Table 1: Comparison between natural features and current condition

The finishing of the sheet had a significant influence on the sheet join. Depending on the number of fibre layers at the edge of a sheet, a two-, three- or four-layer joining (types I-III) could be used (Krutzsch 2012, 101-108; Forthcoming b). These in turn, appear in three variations: basic, special and mixed form. Occasionally, a five-layer join can be seen, when a sheet from the end of a roll was added to a sheet with a two-layered edge. This type was mainly used for administrative documents that were merged into larger rolls for storage (for example, P 10461).

A word about two variations found at the ends of rolls. Either the last sheet has been in use (i.e. added with its verso to the recto of the previous sheet) or at least a small verso strip.
is glued on the recto and marks the end of the roll (similar to the selvedges in textiles).

Sheet joins differ in three ways (see Figs 1-2), described as follows: manufactured-, scribal- and office joins (Krutzsch 2012, 101-108). The distinction is based on the moment of joining the sheets, which also influences the sheet quality. Further characteristics and distinguishing criteria of sheet joins are the width, the sheet sequence and the precision of the join's execution.

Modern presentation or labeling of joins can take various forms (Graf 2008, 84-92; Osing 1998, plate 1-30A; Yardeni and Porten 1986, 43). I use an arrow from which two lines branch off. The line at the arrowhead is closed and shows the edge of the recto, which is the upper layer in the join. The second, dotted line marks the edge of the underlying (verso) sheet. The arrow indicates the direction of the sheet sequence (see Fig. 3).

The sheet joins are usually easy to recognize on a light box or with raking light as can be easily obtained with a torch. In this way, the sheet sequence can be established. In many cases the sheet joins are accompanied by residue at the edge of the sheet or stand out by their darker colour. The latter is caused by the penetration of the adhesive, especially in three-layer joining, since most of the top sheets consist of only a fibrous layer at the edge. Rarely, and almost exclusively either in two-layer joins or joins of very high quality (in terms of design) are sheet joins almost invisible or difficult to recognize (for example Berlin P 10463).

Writing process

Knowledge of inks and colours, especially in relation to their water solubility, is important for determining conservation and restoration treatment. Current studies of inks, their chemical composition, types of pigments, binders and other additives enable precise dating of the papyrus, and consequently of the manuscript. Some ingredients can also provide provenance information.

Just as the material structure with its fibre flow, especially the horizontal ones on the rectos, must occasionally have served as imaginary line indications so did the sheet widths and their joins determine the width of the columns. In most cases, the text does not take the joins into account and thus the measurements of the individual sheets, i.e. text is written over sheet joins. The ductus of the script gives an indication of the writing instrument used and can be helpful when dating a text (Rabin and Krutzsch 2015, 356-367).

The form of the texts

There is often a relationship between text genre and the writing material. The ancients not only selected their writing material - papyrus, parchment, textile, clay or limestone shard, wood or wax tablets, or in a later period, paper - they were also conscious of the quality of the particular material they chose to use. The nature and scope of the text also determined the format and type of manuscript that was selected (roll, folding or later codex). Specific guidelines were possibly followed for certain documents. Whether these guidelines were geographically and temporarily different requires further research. For example, a large number of documents survive on individual sheets, and from the 3rd and 4th century AD onwards books in codex form appear.

Quite a few single sheet documents have lateral edges with fringes. These mostly belong to
sheet type II, where the recto fibres extend beyond the verso fibres on the short edges. This state of preservation leads to two observations. First, that the verso fibres in the edge had not been cut away after the sheet was manufactured, but that a sheet with exceeding recto fibres was prepared.

Secondly, we have to ask where the scribe acquired such fringed sheets, taking into account that scholarly literature has always assumed that only complete scrolls were sold to the scribal community. It must have been possible to acquire single sheets, for example when they were of poorer quality and not suitable to add to a roll. This raises the question of whether the papyrus manufacturing and the scriptoria formed a unity, especially since the individual sheets have not been rolled but folded.

Here, too, a relationship between the text content and the specific type of folding can be observed (Krutzsch 2008, 71-83). This mainly concerns letters, documents and magical texts. The consistency with which the texts with magical content are folded into closed packages is particularly striking. The closing ensured that the magic inside could neither escape nor be disturbed from the outside (Krutzsch 2015, 1-74). As a result, texts can occasionally be identified by means of their outer form.

Earlier restorations of codices offered insight into their manufacturing technology and composition. Hugo Ibscher made numerous detailed observations when processing the so-called Berlin proverb codex (Ibscher 1958, XXI-XXVII). Among other things, he realized that the double sheets had been cut out of three complete rolls that were initially cut to half-height. For the codex sheets, also the shorter end pieces of the rolls were used; these narrow sheets could only be used as individual sheets and were evenly distributed in the monolayered codex block.

The inner double sheet of this codex also contained reinforcement in the form of a parchment strip. The Berlin Papyrus Collection holds Syrian texts on parchment (P 22364) that display a similar secondary use for the same kind of strips (Krutzsch 2013b, 269-275). Unfortunately, this technical detail that apart from papyri can be seen in early parchment codices, was often not preserved during modern restorations.

Restoration work on the Papyrus Berolinensis (P 8502) revealed two interesting material technical details. During the reconstruction of the original double sheets, it became clear that they had been cut from the roll and inserted into the codex. Whoever did this knew that the sheets must be narrower in width at the centre than the outer sheets, so they do not exceed the later block. This ply codex originally consisted of 35 double and 3 single sheets. The course of the recto fibres of the successive double sheets continues imperceptibly and shows no layers. That the sheets were not initially cut as a book-block is indicated by the sluicing out of the inner sheets during folding.

Another observation concerns the sheet sequence. This speaks for an early codex as an aesthetic moment was not (yet) considered. Depending on how the sheets were stored in the block after cutting, a smooth and homogeneous view of the pages either arises when rolling, or does not. The latter is the case for our codex P 8502, since recto and verso are always juxtaposed except for the inner double sheet (codex P 8502, p 76-77; see cross-sectional drawing of the stitch (Krutzsch 2013 a, Fig. 20e)).
Recycling and re-use

It is often assumed that papyrus was always expensive. The large number of palimpsest is therefore not surprising. Some papyri have been washed off and reused several times. The process of reuse accounts for the change in surface colour to a greyish black, a possible mark of apprentices manuscripts, commented upon by J. F. Quack as: “Da haben wir doch wieder einen Schüler ertappt” (Quack 2012).

A hieratic papyrus in the Suzuki collection in Tokyo (SK116-003) shows a particularly striking example of the possible effects of reuse. Repeated writing and washing, in this case on both sides, has not only led to discolouration but rendered the sheet soft and flexible.

Recycling was widely practiced by the ancient Egyptians, the best example perhaps being the painted coffins and mummy covers manufactured from several layers of papyri pressed together to obtain a cartonnage. When dissolved to recover the texts, interesting information regarding the production of the cartonnage was revealed (Ibscher 1908, 23f). It has been found, for example, that the texts of the cartonnage from Abusir el-Melek all originate in Alexandria (Salmenkivi 2008, 106-112). The reuse thus led to the preservation of manuscripts that would otherwise have been lost due to the humid climate of the Egyptian north coast.

Papyrus cartonnage is also used as reinforcement of the leather bindings of earlier codices. Earlier described Coptic codices (the Berlin proverb codex and Berlin P 8502) display such reinforcements in the covers. The binding of the Berlin Coptic Codex P 8502 contained a Greek Christian reference letter (Treu 1982, 53) that was stuck paste-down in the cover. These two sheets are catalogued as P 8508.

Occasionally one comes across a vessel seal consisting of folded papyri or papyrus plugs especially created for easy opening of the vessels. Lastly, we should mention relic-like objects (for example Berlin P 23034 und P 23035) usually consisting of painted or inscribed (with hieroglyphs) papyrus fragments mixed with pieces of textile and wound around flat wooden sticks. Such objects confirm accounts of magical practices in historiographic text sources (Preisendanz 1974, 26f).

Conclusion

The material-related study and conservation assessment conducted at the beginning of a restoration process will enable more elaborate comparisons between papyri with similar content. Similarities and differences in the material structure of papyri can provide indications regarding the place and time of fabrication. The Elephantine Papyri, for example, show a remarkably consistent state of preservation over millennia with very few structural changes (Krutzsch forthcoming a). From this, we can reconstruct ancient trade routes of the raw material. The near future will bring further investigations using μ-Roentgen fluorescence analysis, optical and electron microscopy as well as statistical methods for image analysis in collaboration with Ira Rabin (Rabin 2013, 124-142).

2 “We have yet caught another student”.

German abstract


Alle diese Kenntnisse können helfen, das Papyrusmaterial und die Texte zeitlich und / oder räumlich besser einordnen zu können.

Bibliography


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Pliny the Elder. Naturalis Historia XIII.
<table>
<thead>
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<th>Type</th>
<th>Type</th>
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<td>p 3005, detail</td>
<td>Berlin, p 3057, detail</td>
<td>Berlin Collection Papyri of the Examples</td>
</tr>
</tbody>
</table>

**Fig. 1: Types of sheet joins (p 3005, p 3057 and p 11652)**

- **Office Join**
  - Over the ink lines
  - Not so correct and to rolls:
  - Documents (sheets)
  - Join of single

- **Scribe Join**
  - Direction
  - Not all in the same writing process:
  - Before or during the join of sheets or rolls

- **Manufacture Join**
  - Direction
  - All in the same to a roll:
  - Even joins of the sheets
Fig. 2: Marking the sheet join indicating the sheet sequence.

Fig. 3: P 3005: Ägyptisches Museum und Papyrussammlung, Staatliche Museen zu Berlin, Photo: Sandra Steiß.
Fig. 4: P 3057: Ägyptisches Museum und Papyrussammlung, Staatliche Museen zu Berlin. Photo: Sandra Steiß.