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WITNESSES FOR TIBETAN CRAFTSMANSHIP: BRINGING TOGETHER PAPER ANALYSIS, PALAEOGRAPHY AND CODICOLOGY IN THE EXAMINATION OF THE EARLIEST TIBETAN MANUSCRIPTS*

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This study investigates the earliest surviving Tibetan paper, from the Dunhuang cave library, using paper fibre analysis combined with codicological, palaeographical and textual information. The hypotheses tested by this method concern the regional origins and production centres of early Tibetan paper and methods for dating this material. Using overlapping typologies, we classify a sample of manuscripts into coherent groups, relating them to particular 'book cultures'. By linking three main manuscript groups to different geographical regions, we offer new insights into an important manuscript collection, and show that the method of overlapping typologies has the potential to yield further insights.

KEYWORDS: PAPERMAKING, FIBRE IDENTIFICATION, CODICOLOGY, PALAEOGRAPHY, HISTORY, DUNHUANG, TIBET, MICROSCOPY, TIBETAN MANUSCRIPTS

INTRODUCTION

The origins of Tibetan paper

The historical origins of Tibetan papermaking are, even more than the origins of Tibetan writing, difficult to determine. According to the *Tang annals*, the Tibetan emperor Songtsen Gampo requested paper, ink and other items from the Chinese emperor in the year 648 (Pelliot 1961, 6). However, it seems that most Tibetan official documents were written on wood until the middle of the eighth century. The entry for the year 744/5 in the *Old Tibetan annals* records the transfer of official records from wooden 'tallies' (*khram*) to paper (Uebach 2008; Dotson 2009, 52–3, 124). The earliest surviving examples of Tibetan manuscripts are from Central Asian areas that were under the Tibetan Empire, and the earliest of these probably date to the second half of the eighth century. However, it has not been hitherto possible to determine whether the paper for these manuscripts was produced in Tibet, Central Asia or China.

In recent years, the question of the origin of Tibetan paper has taken on political overtones, especially regarding whether paper was introduced to Tibet from China. Some Tibetan scholars have argued that Tibetan paper actually originated in the ancient kingdom of Zhangzhung, in what is now western Tibet. It has also been argued that original Tibetan paper was made not from

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shrubs belonging to the *Daphne* and *Edgeworthia* species (*shog shing* or *dung lo ma* in Tibetan)—which still provide the basic materials for paper made in the Himalayan regions—but from the roots of both the *Stellera chamaejasme* species (*re lcag pa* in Tibetan) and, more seldom, *Euphorbia fisheriana* (*re lcag gi rtsa ba* in Tibetan) (Trier 1972, 56; Dawa 1999, 156–9, 320–1). *Stellera* is a small genus of fewer than ten species, found growing in comparatively dry conditions in areas such as Central Asia, Iran and parts of Tibet. It is widely distributed along the Himalayan range, where it is found at altitudes of 2700–4500 m.[1] In principle, it should not be difficult to determine the relative importance of each of these different fibres in the early history of Tibetan papermaking. *Stellera chamaejasme* fibres can be clearly differentiated from *Daphne* and *Edgeworthia* despite the fact that all of these plants belong to the *Thymelaeaceae* family.

It should also be possible to distinguish paper made from these *Thymelaeaceae* family plants from Chinese paper. According to traditional Chinese accounts, the first true paper was invented by Cai Lun in AD 105 in south-eastern China, and is said to have been made from mulberry bark, remnants of hemp, rags of cloth and fishing nets (Hunter 1932, 1978; Tsien 2004). We know that in Central China, fine paper was made for important documents primarily from hemp and mulberry (Tsien 1973; Whitfield 2007). Rattan was used from about the seventh century, until it was supposedly replaced by bamboo in southern China in approximately the 10th–11th centuries (Tsien 1973, 1985; Bloom 2001). In this way, by the end of the eighth century, the Chinese were probably using a variety of raw fibres that included the rags of hemp, flax (ropes) and ramie (known as 'Chinese grass'), bark of mulberry, bamboo and rattan, rice and wheat straw, and many other types of grass depending on the region of production. Some plants, such as ramie, were widely distributed and available in all China, while others were limited to particular geographical zones.

The above accounts are, however, based on secondary sources rather than on systematic analysis. The purpose of this study is to determine the nature of the earliest available Tibetan paper, through paper analysis combined with textual, palaeographical and codicological information. In this way, we hope to be able to deepen our current understanding of early Tibetan paper technology, going beyond simplistic statements about the origins of Tibetan paper. We also hope to give a more subtle account of the category 'Tibetan paper' itself, which is too general to cover the vast territory of the Tibetan cultural realm and the variations in materials and technology available to people within it.

Papermaking methods in Tibet

The actual method of making paper in Tibet seems to have evolved very little over the centuries, with each sheet of paper dried on individual moulds (Fig. 1). This mould type is called 'floating' because it is placed on a water surface such as lake, pond, river or puddle (Fig. 2). The other main type of paper mould is usually known as a 'dipping' mould, and is thought to have developed subsequent to the floating mould. The dipping mould allows faster paper production because it is

[1]This plant was first reported by Nikolai Przhevalsky in 1873, and subsequently by Hossie in 1910, along with some other 'plant hunters', botanists and geographers. The production of paper from these roots is practised in the highest places in the world, where practically nothing else grows. These root bast fibres create a very specific soft type of paper, which is considered to be of lower quality than bark paper. The roots are especially difficult to harvest, which places a serious limitation on the quantity of paper that can be produced. They additionally require a longer time for processing, and an extra step in the papermaking process. Thus, in general, they are only used in papermaking when other sources are not available. On the other hand, the poisonous properties of these plants make the paper resistant to damage caused by insects, meaning that it may ultimately be more durable than other types of paper.

Figure 1 *Sheets of paper left to dry on individual moulds on the mountain slope near Tawang, Arunchal Pradesh, 1914. MSS Eur/F157 (324), © The British Library.*

possible to remove a wet sheet of paper directly from the sieve just after its shaping. This means that papermakers do not need to wait until the paper has dried before reusing the mould to begin the next sheet. The main difference between the two types of mould is in their construction. The floating mould comprises a wooden frame with a woven textile attached to it. In the case of the dipping mould, on the other hand, a movable sieve made from bamboo, reed or another kind of grass is attached to the wooden frame.[2]

Independent of the techniques of sheet formation, any papermaking sieve makes an impression that is specific to the construction of the mould and sieve. This print is unaffected by most aging processes, and can be read centuries later. The print of a textile sieve made of cotton, hemp or flax differs clearly from that of a movable sieve made of bamboo, reed or other grasses. However, this information alone cannot be used for the identification of paper origin, nor for dating. According to Dard Hunter, the floating mould was often used in the south-western regions of China and in the Himalayas, whereas in the east the dipping mould with bamboo sieve was developed (Hunter 1978, 84; Schaeffer 2009, 8). However, both types of mould were used simultaneously during the first millennium for making paper along the Silk Road, and we have to take into consideration that the same papermaking workshop might use both types of mould at the same time.

A number of reports on papermaking methods in Tibet and the surrounding regions are available (Tschudin 1958; Sandermann 1968; Rischel 1985; Koretsky 1986; McClure 1986; Helman-Ważny 2001). Perhaps the earliest is the account, by the British official Samuel Turner, of papermaking in Bhutan in the mid-18th century:

[2]Modifications to this technology have been reported, including a floating mould resembling a wooden box with a movable screen. In this case, we would continue to classify this type of paper as laid, based on its sieve print.

Figure 2 *A large-size 'floating' mould, constructed with a wooden frame and attached woven textile, placed in water (a stream) in Gyantse,* c. *1910–1920. Photo 1112/2 (139), © The British Library.*

> In our perambulations down the valley, I often rested at the place where the chief manufacture of paper is established, which was made, I found, by a very easy and unexpensive process, of the bark of a tree, here called Deah, which grows in great abundance upon the mountains near Tassuisudon, but is not produced on those immediately bordering on Bengal. The method of preparing the material, as well as I could learn, is as follows. When a sufficient quantity of bark is collected and boiled in a lixivium of wood ashes, it is then taken up, and laid in a heap to drain; after which it is beaten upon a stone, with a wooden mallet, until it is reduced into an impalpable pulp; then it is thrown into a reservoir of water, where, being well stirred about, and cleansed from the coarse and dirty part, which floats upon the surface, it is still further depurated in another large reservoir of clean water. When the preparation is complete, the parts are finely broken, and that which sinks in the water appears mucilaginous to the touch. All that now remains is to form it into sheets, which is done upon small reeds set in frames. The labourer dips the frame in the water, and raises up a quantity of the pulp, which, by moving the frame in the water, he spreads, until it entirely and equally covers the surface of the reeds; he then raises the frame perpendicularly, the water drains off, and the frame is hung up till the sheet is nearly dry: it is then taken off, and suspended upon lines. (Turner 1800, 99–100; Schaeffer 2009, 8)

We also have photographs documenting this process from the early 20th century (Figs 3–5). We may cautiously draw upon observations such as these in reconstructing the methods and technologies used in Tibet in the first millennium AD, since they appear not to have changed radically since

Figure 3 *The process of making paper in the Kullu Valley, Himachal Pradesh, 1940s: paper pulp prepared by beating upon a stone with a wooden mallet being poured on the 'floating' type of mould placed in a puddle. Photo 523/1(151),*

the beginnings of papermaking (Whitfield 2002; Weber 2007, 103, 109).[3] However, we need to base our investigations upon the earliest manuscripts available to us. Since we lack any record of the papermaking tools used in particular workshops at particular times, the only way to obtain this information is to document dated manuscripts with known origins, and to collect data about papermaking technology and the usage of particular types of mould in particular regions. In the case of Tibetan manuscripts, the earliest sources available to us are not from central Tibet, but Central Asia—from the outer reaches of what was the Tibetan Empire in the mid-seventh to mid-ninth centuries.

Source material: Tibetan manuscripts from Dunhuang

The most important single Central Asian site for Tibetan manuscripts is the 'library cave' at Dunhuang, which was discovered at the beginning of the 20th century. Several languages are represented by the thousands of manuscripts taken from the cave, of which Tibetan is the second best represented, after Chinese. The cave was created in the early ninth century by a Chinese monk called Hongbian, the leader of the Buddhist community at Dunhuang. After his death in 862, the cave became a shrine to Hongbian; a statue of the monk was installed, along with an inscription recording his deeds. By the end of the 10th century, the cave was almost full of manuscripts, and the statue of Hongbian had been moved elsewhere. A number of theories have

[3]For example, according to Whitfield, there was an old centre of paper production at Khotan, on the southern part of the Silk Road, which produced coarser paper made from locally available plants, and supposedly survives today (2002). The same information about local production of paper is given in Weber (2007, 103,109).

Figure 4 *The process of shaping the sheet of paper in the Kullu Valley, Himachal Pradesh, 1940s: the papermaker stirs up the pulp by moving the frame in the water until it entirely and equally covers the surface of the mould; he then tilts the frame until the water drains off. Photo 523/1(153), © The British Library.*

Figure 5 *The drying process during papermaking in the Kullu Valley, Himachal Pradesh, 1940s: the papermaking moulds with newly made sheets of paper are left until the sheets are dry. Photo 523/1(154), © The British Library.*

been suggested for the depositing of this vast cache of manuscripts in the Dunhuang cave, and it seems likely that the cave served several functions.

When the cave functioned primarily as a funerary chapel for Hongbian, it is likely that manuscripts belonging to the monk were interred at the time of the cave's consecration. Later, as a continuation of this practice, manuscripts belonging to, or connected with, other deceased monks might also have been deposited in the cave. In connection with this, the cave seems to have become a repository for pious offerings of manuscripts and paintings. Since Hongbian's funerary cave was a consecrated Buddhist shrine, these could be considered relics of the dharma (*dharma-śarīra*). The depositing of manuscripts could have happened at first in an *ad hoc* fashion, beginning with the odd manuscript left as an offering, and later included discarded manuscripts and offerings collected when various other caves were cleaned up (Imaeda 2008; van Schaik and Galambos 2012). Overlapping with this is the idea of the Buddhist manuscripts as 'sacred waste', first proposed by Aurel Stein, and later by Fujieda (1966; see Fujieda 1970) and Fang Guangchang (1988).

At some point, the cave seems to have also been used as a repository for thousands of complete copies of donated or commissioned Buddhist scriptures, and some paintings, that could not be accommodated in the monastic libraries. These had no immediate practical use, but were still active as 'receipts' for the merit generated by their donors (Kieschnik 2003, 170). Furthermore, Rong Xinjiang (2000) has argued that the cave functioned as a storeroom for the monastic library of the Sanjie monastery, especially for the extra manuscripts obtained by the monk Daozhen to supplement the monastery's library. However, Dohi Yoshikazu (1996) criticized this theory, arguing that the manuscripts from the Sanjie monastery number no more than 200, only a tiny fraction of the cave's holdings.

The dating of the Chinese manuscripts from the Dunhuang cave has generally relied on dates found in manuscript colophons. The latest dated Chinese manuscript is from the year 1002, and it is likely that the cave was sealed up at some point in the early 11th century. The Tibetan manuscripts, on the other hand, rarely contain date information, and can often merely be assigned to the years between the Tibetan conquest of Dunhuang in the late eighth century and the closing of the cave in the early 11th century. Nevertheless, the Tibetan manuscripts preserved in the Dunhuang cave are probably older than any yet found in Tibet itself, and have been especially important for the study of early Tibetan history, religion and culture. The manuscripts are also, naturally, our most important resource for studying the early development of Tibetan techniques of papermaking, book production and writing.[4]

Tibetan book formats

By the fourth century AD, Central Asian Buddhist centres such as Kucha and Khotan had adapted the loose-leaf format found in palm leaf manuscripts, and usually known as *pothi* (Sanskrit: *pustaka*), to paper instead of palm leaves. This paper-based *pothi* became the primary book form adopted by the Tibetans. Like their Central Asian counterparts, the Tibetan *pothi* books were usually larger than the Indian versions, an adaptation made possible by the use of paper rather than palm leaves.

[4]Other early Tibetan manuscripts have recently come to light in central Tibet. These include four manuscripts discovered at the dGa' thang stūpa, which probably date to the 10th century (see Pa tshab 2007). Increasing access to monastic libraries has also revealed a number of ancient manuscripts, although so far the oldest of these appear to have been imported from Dunhuang itself (see, e.g., Ma De 2009).

The Dunhuang collections indicate that the *pothi* was the most common book form for Tibetan manuscripts by the 10th century, but other forms were in use as well. The scroll format was used for religious and literary texts, as well as official documents. Documents such as contracts and letters were written on single sheets and folded into thin rectangular packages. The concertina form was also in common use for religious books, often compendia comprising a variety of texts. Finally, the codex form (generally stitched at the left side or top) also became popular in the 10th century for religious texts, often ritual or liturgical in nature. It is not known, as yet, whether all of these book formats were in use in central Tibet at the time, but we are reasonably certain that official letters in the form of folded single sheets, and Buddhist scriptures in *pothi* and scroll form, were brought to Dunhuang from elsewhere in the Tibetan Empire in the early ninth century (see below for a further discussion of these).

Tibetan names for books related to their format include *dpe cha*, *glegs bam* or *deb ther*. We have numerous examples from the Dunhuang manuscripts of the early use of *dpe* or *dpe'* for 'book' (but not, interestingly, *dpe cha*). Even more common is *glegs bam*, which is found in Buddhist scriptures translated in the Tibetan imperial period, including sutras copied at Dunhuang in the early to mid-ninth century. In scribes' notes among the Dunhuang manuscripts, we find variations including *glegs bu* (small book) and *glegs tshas* (book covers, used by scribes as spare notepaper). For examples of the terms *dpe* and *glegs* in scribal colophons, see the catalogues of Tibetan Dunhuang manuscripts by Lalou (1939–61) and de le Vallée Poussin (1962). Pelliot tibétain 405, a scroll, is labelled along one side 'a book of golden dharma' (*dar ma gser can gyi dpe*'), showing that *dpe* could refer to a scroll. The colophon of IOL Tib J 220 refers to the Indian and Chinese books (*rgya gar dang rgya'i dpe*') that were used by the translator, Chos grub, who lived and worked in Dunhuang.

In these early sources we also find another term for Buddhist books, which did not survive into the later era: *dar ma*, presumably from the Sanskrit *dharma.* The use of the term *dar ma* to refer to books of Buddhist scripture was discussed by Stein (2010, 47–9). The loan-word *po ti* (and its derivative *pod*) has not been found in Dunhuang, but appears as early as the 11th century in transmitted literature (van der Kuijp 2006, 5–6). On the other hand, the word *deb ther* does not appear in any early sources. The probable Mongol origin of this term was also suggested by van der Kuijp (2006, 4–5). A loan-word from the Persian *daftar*, it probably dates from the period of Mongol dominance in Tibet in the 13th and 14th centuries.

Paper analysis

If we are to use the Dunhuang manuscripts to investigate the origins of book culture in Tibet, we are immediately faced with a problem. Dunhuang is far from the centre of Tibet, and even when it was part of the Tibetan Empire, the majority of its population was Chinese. In the ninth and 10th centuries, Dunhuang was also home to communities of Sogdians, Khotanese and Uighur Turks. Thus it is not surprising to find that many manuscripts have a multilingual character. Other elements of these books (including their raw materials, layout and binding) are also the result of the influence of a variety of different cultures. Because of this the common practice of classifying the features of manuscripts according to the language in which they are written, and thereby creating a typology of national or cultural features, is of little value here. On the other hand, since paper type may be specific to certain geographical regions, paper analysis offers a powerful tool for siting manuscripts in a particular regional culture.

Paper support is one of the most important physical features of a manuscript. It serves as means of distinguishing one type of manuscript from another, and can help to determine the origin of a

manuscript (Helman-Ważny 2009, 173–86). In particular, the scientific analysis of paper fibres offers an independent and objective source of information. Among the manuscripts from Dunhuang, there is a very wide range of different types and qualities of papers, and some scholars have distinguished these according to chronology and geographical origin (Fujieda 1970, 2002; Drège 1981, 2002; Savitskii 1991; Scherrer-Schaub 1999). In particular, Mitani and Fujieda (2009) have described a chronological standard for Dunhuang and Turfan manuscripts in which paper types and writing tools were considered a standard feature. Elsewhere, Fujieda (2002) stated that a rough and low-quality paper was made locally during and after the period of the Tibetan occupation of Dunhuang. However, such discussions have ignored the specific features of manuscripts written in Tibetan, which would allow us to discuss whether any of them might be classified as 'Tibetan paper'.

The distinctive character of any paper derives from the raw materials used in its creation. Fibres constitute the basic component of any paper sheet, yet the visual appearance of paper is also affected by the technological process of paper production and the tools used, and finally by the preparation of leaves during book production. This is why general typologies of paper can be misleading. In the case of the manuscripts from Dunhuang, what Mitani and Fujieda call 'hemp paper' might not necessary be a paper made of hemp; in most cases it should be called 'rag paper' (i.e., paper made from rag wastes composed of ramie, hemp and sometimes also paper mulberry). Furthermore, descriptions of thickness such as 'thin hemp paper' or 'heavy old hemp paper' are of dubious use for paper identification and typology, as they are simply too relative and dependent on the individual impressions of scholars.[5]

Our research here is an attempt to achieve a more fine-grained approach to the earliest Tibetan manuscripts by creating a series of complementary typologies. In particular, we aim for the first time to bring together data derived from the analysis of paper composition with codicological, palaeographical and textual information. Our aim is to use these overlapping typologies to classify the selection of manuscripts into coherent groups and relate them to particular 'book cultures' that may be associated with specific social, historical and geographical contexts. This should allow us to understand some differences between paper produced by differently affiliated communities in Tibet, Central Asia and China, and to follow technological changes in paper production that may offer clues regarding who acquired the technical expertise in paper production from whom.

METHOD

We selected 63 samples, taken from 50 manuscripts, from the Stein Collection in the British Library, to serve as the 'experimental field' for our research. The Tibetan manuscripts in the Stein Collection were originally acquired by Aurel Stein somewhat haphazardly, without attention to the nature of their textual content, script style or date, and therefore appear to be a representative sample of the original Tibetan manuscript contents of the cave (Stein 1921, 822–3). Stein's only explicit decision regarding these manuscripts was to exclude the large-format *pothi* manuscripts, but he did inadvertently acquire some of these as well, and samples from these have been included in the present study. The main criterion that we had at the beginning was to choose

[5]A proper measurement of thickness is not always possible due to preservation techniques that have resulted in paper fragments being sealed between melinex or lined with backing paper. Therefore this parameter should only be taken into account if it is an original value, measured precisely.

manuscripts in the Tibetan language, giving some priority of selection to those manuscripts for which we had information unrelated to paper type regarding their date and/or place of origin. For each manuscript, we gathered the following data: textual content; script and writing style; manuscript format and bookbinding style; page outline standards; and paper composition.

Textual content

On the basis of textual content, our selections took into account the information that texts could provide regarding date, place of origin or both. The main types of text in the selection are as follows:

(a) Official documents written during the Tibetan occupation of Dunhuang (786–848). These include letters copied in Dunhuang or the surrounding region, and one letter that was brought to Dunhuang from the court of 'On cang do in central Tibet (IOL Tib J 1459). We also include two official letters found in Miran, the Tibetan fort in the Lop Nor desert, occupied from the mid-eighth through to the late ninth century; one of these letters (Or.15000/5113) contains an official seal with the word 'palace' (*pho brang*), which suggests that it may have been sent from central Tibet.

(b) Three manuscripts belonging to a Chinese pilgrim travelling through Tibetan-controlled areas of modern Qinghai, firmly dated to the 960s. The manuscripts (IOL Tib J 754) include a series of letters of passage, a copy of a Chinese temple stele and a Chinese sutra scroll with Tibetan tantric texts on the verso. The date of the pilgrimage has been confirmed in a recent book-length study by van Schaik and Galambos (2012).

(c) Buddhist sūtra manuscripts written in the period of the 820s–840s. The manuscripts studied are the *Śatasāhasrikā-prajñāpāramitā-sūtra*, in *pothi* and scroll form. Since the work of Marcelle Lalou, the *pothi* manuscripts have been divided into one type thought to have been produced in Tibet (Type 1) and brought to Dunhuang, and another (Type 2) that was produced locally (Lalou 1954, 1957). Recent work by Iwao (forthcoming) has shown that a similar distinction can be applied to the *Śatasāhasrikā-prajñāpāramitā-sūtra* scrolls, on the basis of their format and *mise-en-page* (once again, Type 1 being from Tibet and Type 2 from Dunhuang). In consultation with Dr Iwao, we have included both types of scroll in our sample. A note on the back of one scroll fragment (of Type 1) suggests that it was brought from Tibet (Bod yul) to Dunhuang.[6]

(d) Buddhist manuscripts that, by palaeographic and/or textual analysis, are judged to have been written in the 10th century. These are mostly tantric Buddhist texts, which recent research by Takeuchi (2004) and van Schaik and Dalton (see Dalton *et al*. 2007) has placed in the middle to late 10th century. These include a manuscript of the *Guhyasamāja tantra* (IOL Tib J 438), tantric treatises (IOL Tib J 454 and 470), a prayer (IOL Tib J 587) and a ritual text (IOL Tib J 570). Some texts were selected for their intrinsic interest; these include the early Tibetan Buddhist text, the *Cycle of birth and death* ('*Skye shi 'khor lo*') (Imaeda 2007), a historical fragment related to an important early Buddhist text, the *Dba' bzhed* (van Schaik and Iwao 2008), and a text that may have been written by the hand of the famous translator Chos grub, who resided at Dunhuang (Ueyama 1990).

(e) As a control, we selected three Tibetan manuscripts from a later date, and not from the Dunhuang cave (IOL Tib M 58, 59, 60); these were found at the site of the ancient Central Asian

[6]See Pelliot tibétain 1855, verso: *// dar ma shes rab 'bum pa sde gchig bod yul nas dpe' bzhugs pa las reg {b}zid gyi nang mchog blangste / bab ma ste // dpe bde gams su blangs pa'o//*

city Kharakhoto, probably dating to the period of the Tangut kingdom, in the 12th or early 13th century.

Script and writing style

The writing style of the manuscripts was categorized by van Schaik on the basis of a typology of writing styles found in early Tibetan manuscripts, which has been treated in detail elsewhere (van Schaik forthcoming). The typology recognizes a paradigm shift that occurred after the fall of the Tibetan Empire in the mid-ninth century. It is therefore possible to use it to help date manuscripts to before, or after, the end of the Tibetan Empire, although this should be done with caution, and ideally supported by other factors. According to the typology, the basic stylistic types found in the imperial-period manuscripts are as follows:

(a) Square style: based on the style found in epigraphic sources from the Tibetan imperial period, with short descenders and a tendency to favour straight lines. Found in copies of imperial documents such as the royal annals and law codes. See Figure 6.

(b) Sutra style: based on the ductus of the square style, but adapted to writing swiftly with a flexible-nibbed pen (such as a reed pen); longer descenders and the collapse of square forms (e.g., *ba* and the head of *ga*) into triangular shapes. Found in mass-produced Buddhist scriptures from central Tibet and Dunhuang. See Figure 7.

(c) Official styles: comprising a headed style that is similar in ductus to the sutra style, but often written less carefully, and a headless style that alters the ductus in various ways to aid swift writing, including the exclusion of the heads of several letters. Found in official letters. See Figures 8 and 9.

(d) Monastic style: a headless style, with a similar ductus to the headless official style; vertically compressed but horizontally extended, and often difficult to read. Found in manuscripts associated with the Sino-Tibetan translator Chos grub, and interlinear notes in many Buddhist texts. See Figure 10.

After the imperial period (from the latter half of the ninth century through to the end of the 10th), the Dunhuang manuscripts show a much greater variation in writing style. For this reason, it is not possible to construct a typology with the same clarity as for the imperial-period

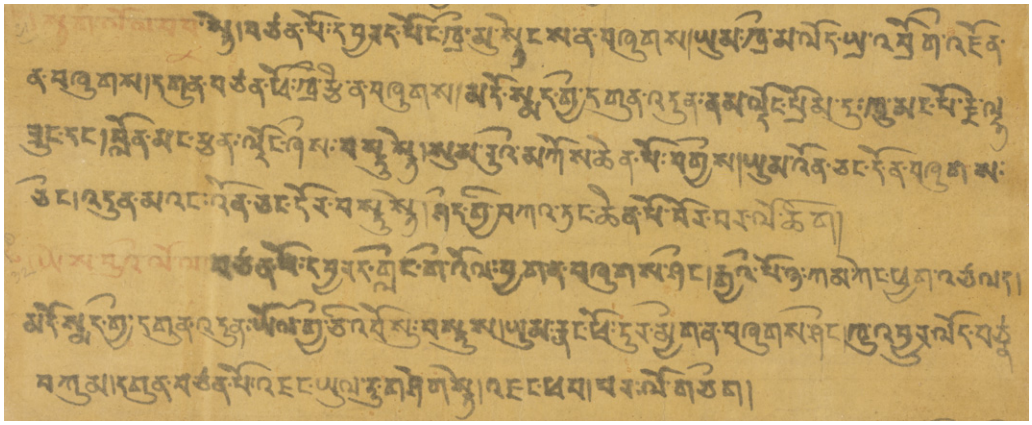

Figure 6 *The square style as seen in IOL Tib J 750, © The British Library.*

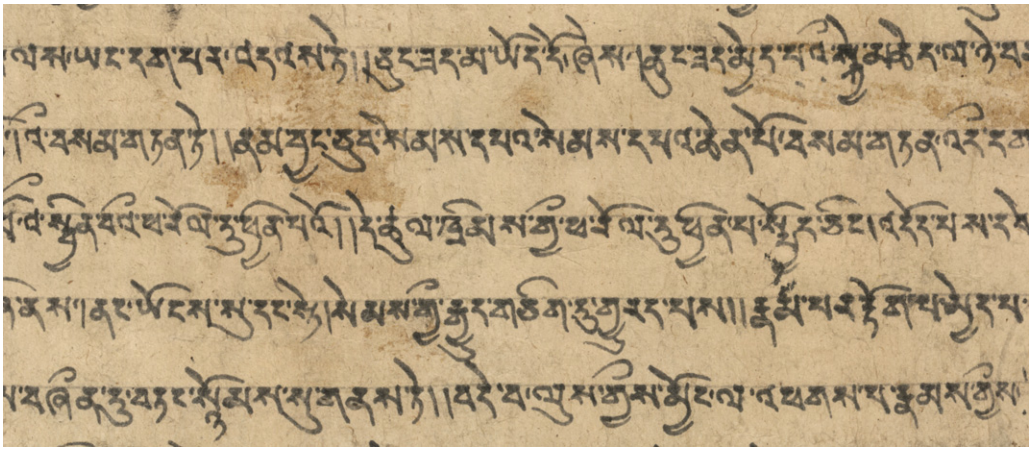

Figure 7 *The sutra style as seen in IOL Tib J 107.5, © The British Library.*

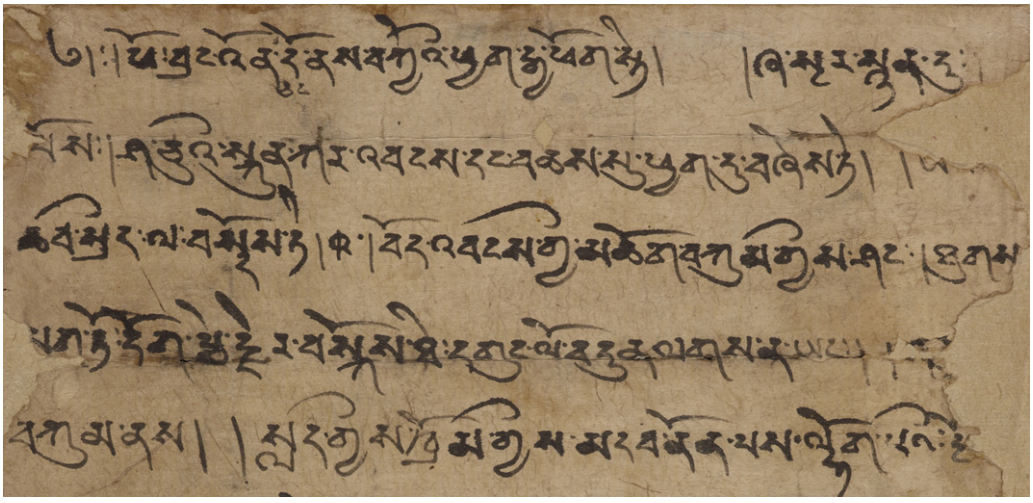

Figure 8 *The headed official style as seen in IOL Tib J 1459, © The British Library.*

manuscripts. However, it is possible to trace the development of Tibetan writing towards a more calligraphic form of the headless script, which is found both documents and Buddhist texts, but most fully developed in the latter. The manuscripts from the Tangut city of Kharakhoto show the continuation of this calligraphic style into the 12th century. Our sample group includes examples of styles found in both imperial and post-imperial manuscripts.

Manuscript formats and bookbinding style

As discussed above, the Dunhuang manuscripts include a wide variety of formats, and the manuscripts written in Tibetan include most of them. The most common types are *pothi*, scroll, concertina, codex (thread booklet) and single sheets. For our study, the general book format and

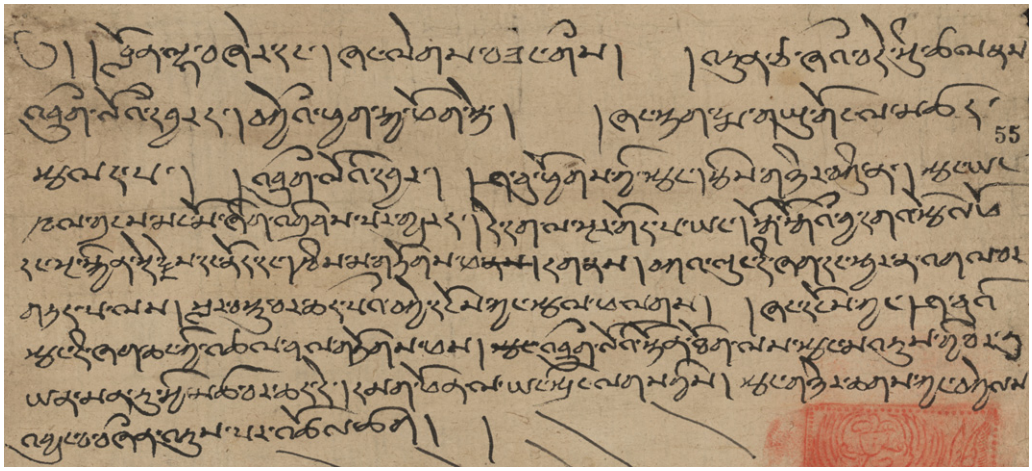

Figure 9 *The headless official style as seen in IOL Tib J 1126, © The British Library.*

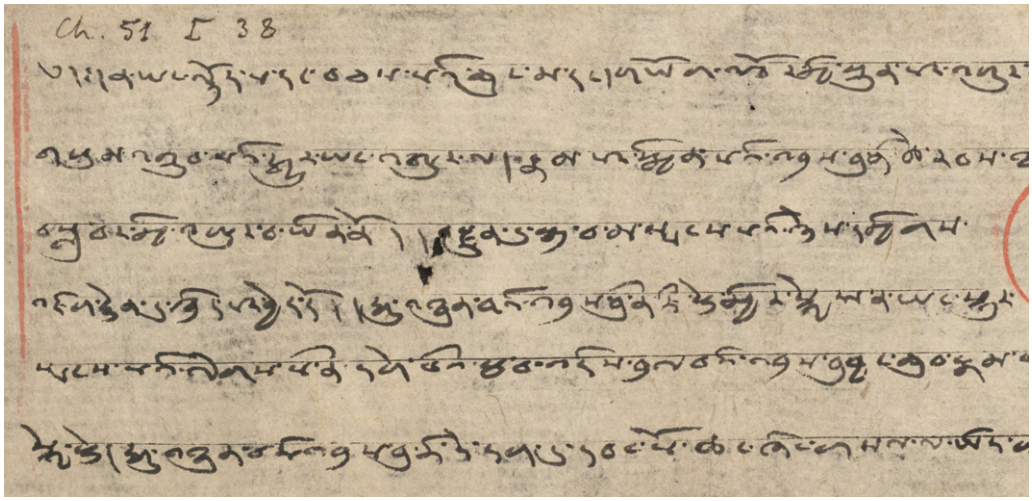

Figure 10 *The monastic style as seen in IOL Tib J 687, © The British Library.*

binding style was described. In our sample, the scroll format represents 28 of the 50 manuscripts. The most important physical distinction among the scrolls is found in the *Śatasāhasrikā prajñāpāramitā manuscripts.* As Kazushi Iwao has shown, these may be divided into two types:

- Type 1: constructed from large *pothi* pages, with the original string-holes sometimes visible. Only one layer of paper, often torn and repaired. These are thought to have been brought to Dunhuang from central Tibet.
- Type 2: constructed from two layers of paper (not originally *pothi* format), usually in better condition than Type 1. Thought to have been produced in Dunhuang.

Our aim in including these manuscripts was to complement Dr Iwao's work with analysis of the paper fibres in the two manuscript types, and to see whether this analysis might provide further confirmation of the different geographical origin of each type.

We also examined 12 *pothi* books, two concertinas, two thread booklets and six folded single sheets. The *pothi* books in our sample fell into two groups: a larger (20.5×72–73 cm) and a smaller size (7.5–10×26.5–46.5 cm). The larger size is only used for the *Śatasāhasrikā prajñāpāramitā* manuscripts. The smaller size includes Buddhist sūtra and tantra texts, as well as a ritual text.

The concertina manuscripts are both currently disjoined, but the original construction is evident in the narrow strips of paper that were previously used to join the individual panels of the concertina. Manuscripts in the concertina format tend to be made either of individual panels glued together with narrow strips, or of larger folded panels, or a combination of these two methods (Drège 1984).[7] In both of our samples, the manuscripts are incomplete, and the verso is written in a different ink and style to the recto. This is particularly evident in IOL Tib J 99, in which the writing on the recto is in the square style, with archaic orthography suggesting that it may predate the writing on the verso by some time.

The thread booklets were made in two ways. In IOL Tib J 401, *pothi* leaves are folded in half (8×38 cm) and stitched with leather thread. This form is not found in any other Tibetan manuscripts, and palaeographical analysis suggests that it may date to the ninth rather than the 10th century, making it earlier than other thread booklets. In IOL Tib J 530, the booklet is constructed by sewing two sections with silk thread, each section comprising four bi-folios. This method is also seen in other Dunhuang manuscripts.

Page outline standards

The format of the text on the page can provide clues as to the function, date and geographical origin of a manuscript, although as yet there have been no general studies of *mise-en-page* in the earliest Tibetan manuscripts.[8] For all manuscripts, we recorded the number of lines per page and the presence or absence of margins and guidelines. Among the *pothi* manuscripts, we recorded the presence of string-holes and whether these were surrounded by circles. For the scrolls, we distinguished those that are written with the scroll aligned vertically from those in which the text is arranged in horizontal panels (in some studies this form is referred to as a 'roll', to distinguish it from the previous type).

Paper composition

The first author's examination of the manuscripts combined three levels of criteria: (a) the raw material used; (b) the type of papermaking sieve print preserved in the paper structure; and (c) the visual features derived from methods of preparation of the leaves before writing.

(a) For the fibre composition identification, the first author used an Olympus BX60 transmitted–reflected light microscope with BF/DF/DIC/polarized light, with a Sony camera attached for photographic documentation. Image-Pro Plus software was used for image analysis during identification. She compared her results with a reference collection of fibres prepared earlier

[7]On this format of manuscript in the Dunhuang collections (there termed 'accordéons'), see Drège (1984). According to Drège's typology, the two manuscripts studied here are 'l'accordéon simple'.

[8]Note, however, that a study by Scherrer-Schaub and Bonani (2002) examined elements of *mise-en-page* in their threefold periodization of Tibetan manuscripts, providing an important starting-point for a fuller study of Tibetan book formats and layout.

directly from plants, as well as with criteria for identification found in the literature (Meisezahl 1958; Trier 1972; Ilvessalo-Pfäffli 1995; Helman-Ważny 2006).[9]

(b) Patterns of chain and laid lines in the paper structure allow us to distinguish a handmade woven paper and handmade laid paper characterized by particular numbers of laid lines in 1 cm. Whenever possible, the chain lines measurement of the interval between two chain lines was determined. This measurement is only given where measurement was possible (where chain lines are clearly visible). These intervals often vary within one paper sheet, and in this case the sequences of span values were given.

(c) Information on the preparation of the leaves includes the construction of the leaf and the visual properties of its surface. The presence of dyeing or insect-repellant substances usually results in a change in the colour of raw paper. The number of paper layers glued together influence the thickness of leaf. Then the sizing of the paper and the polishing of its surface influence the absorbency of the paper and its usability as a writing support. The thickness of the paper was not measured due to fact that most of the manuscripts had previously been conserved and often backed, which changed the original parameters.

RESULTS

This multi-level approach allowed us to sort these manuscripts, and distinguish the main groups characterized by similar features. We called these final groups 'types'. To fix our types in time and regional origin, we compared them to those few that have already been dated and identified. We created a record of every manuscript and kept these to be added gradually to the International Dunhuang Project database; many of the items have been digitized, and are available at the IDP website (http://idp.bl.uk) (see Table 1).

DISCUSSION

Our report is based on examination of 63 samples taken from 50 manuscripts. Although a much wider sample is needed for firm conclusions, these preliminary results are based on primary material that may be taken as a basis for further historical interpretation. We cannot exclude the possibility that other raw materials, not found in our sample, were used, and that the dates of usage of particular plants may vary. In any case, our results fall into the following three general groups, as follows.

Manuscripts composed of rag paper, primarily Boehmeria *sp. (ramie) and* Cannabis *sp. (hemp) (Figs 11–13)*

In our sample, the majority of manuscripts were rag paper primarily composed of *Boehmeria* sp. (ramie) and *Cannabis* sp. (hemp), sometimes with the addition of other fibres such as *Corchorus* sp. (jute) or *Broussonetia* sp. (paper mulberry).[10] In the majority of our samples, this type of paper has laid lines, showing that it was made on a moveable sieve constructed of bamboo, reed or grass (Figs 14 and 15). It is significant that our research on these rag paper manuscripts, based on textual, codicological and palaeographical evidence, showed that there was no reason to believe

[9]The first author conducted this research by using equipment at the Department of Plant Biology, Cornell University.

[10]We have to take into consideration that in the case of rag paper, textiles used for paper production could be obtained in areas quite distant from the place of production. This is why it is not useful to classify rag paper on the basis of the type of every single fibre component.

Table 1 *The characteristics of papers in the manuscripts from the IDP Collection at the British Library, London*

No.	*Shelfmark/sample location*	*Raw material*	*Type of paper*	*Find site/dating*	*Document/book format and size (h × w, in cm)*	*Language/script*	*Page layout*	*Content*
1	IOL Tib J 99 vol. 14: 1	Rag paper: *Boehmeria nivea* (ramie)	Laid paper: 4 laid lines in 1 cm	Dunhuang Cave 17, 9th c.	Originally concertina, now two loose leaves: 7.5 × 27	*dbu can* (recto, square style with archaic features; verso, sutra style)	5 lines/page, no margins or guidelines	Tibetan Buddhist text: *The Cycle of birth and death*
2	IOL Tib J 229 vol. 69: 33	Rag paper: *Boehmeria nivea* (ramie)	Laid paper: 5–6 laid lines in 1 cm; chain lines not visible	Dunhuang Cave 17, early to mid-9th c.	Scroll fragment (horizontal, Type 1): 26 × 20	Recto, Tibetan (sutra style); verso, Chinese	14 lines/section, margins and guidelines in black	Recto, *Pañcaviṃśatisāhasrikā-prajñāpāramitā*; patches on verso, Confucian text
3	IOL Tib J 354 vol. 69: 51	Rag paper: *Boehmeria nivea* (ramie)	Laid paper: 4 laid lines in 1 cm (one-layered paper); chain line intervals 6–7 cm	Dunhuang Cave 17, 9th c.	Scroll (horizontal): 19.5 × 27.7	Tibetan (sutra style)	20–22 lines/section, no margins or guidelines	*Uṣṇīṣa-sitātapatra-dhāraṇī*
4	IOL Tib J 401 vol. 76: 2	Rag paper: *Boehmeria nivea* (ramie)	Laid paper (one- or two layers): 4–5 laid lines in 1 cm, some of the folios might be reused	Dunhuang Cave 17, 9th c.	Thread booklet (8 × 19); *pothi* (8 × 38) folded in half and stitched with leather thread	Tibetan (official styles, headed and headless)	6–8 lines/page, no margins or guidelines	Collection of rituals owned by monk
5	IOL Tib J 401 vol. 76: 6	Rag paper: *Boehmeria nivea* (ramie)	Laid paper (one- or two layers): 4–5 laid lines in 1 cm; some of the folios might be reused	Dunhuang Cave 17, 9th c.	Thread booklet (8 × 19); *pothi* (8 × 38) folded in half and stitched with leather thread	Tibetan (official styles, headed and headless)	6–8 lines/page, no margins or guidelines	As above
6	IOL Tib J 401 vol. 76: 7	Rag paper: *Boehmeria nivea* (ramie)	Laid paper (one- or two layers): 4–5 laid lines in 1 cm; some of the folios might be reused	Dunhuang Cave 17, 9th c.	Thread booklet (8 × 19); *pothi* (8 × 38) folded in half and stitched with leather thread	Tibetan (official styles, headed and headless)	6–8 lines/page, no margins or guidelines	As above
7	IOL Tib J 438 vol. 33: 15	Rag paper: *Boehmeria nivea* (ramie)	Laid paper: 4 laid lines in 1 cm, chain line distance 7.5–8 cm	Dunhuang Cave 17, 9th–10th c.	*Pothi*: 9 × 46.5 with string holes	Tibetan (sutra style, with interlinear commentary)	5 lines/page, margins and guidelines in black	*Guhyasamaja tantra*, fine copy

8	IOL Tib J 454 (upper part)	Rag paper: *Boehmeria nivea* (ramie)	Laid paper (one or two layers), dye in the structure possible	Dunhuang Cave 17, 10th c.	Scroll (vertical): 30.5 × 430	Tibetan (sutra style)	~22 lines/panel, no margins, guidelines in black	Tantric treatise
9	IOL Tib J 530 vol. 79: 2	Rag paper: *Boehmeria nivea* (ramie)	Laid paper glued of layers: 4 laid lines in 1 cm	Dunhuang Cave 17, 10th c.	Thread booklet (15.8–16 × 11.5); two sections, four bi-folio in each, sewn with silk thread (7 folios in first section)	Chinese, Tibetan (post-imperial Buddhist style, headed)	6 lines/page (Tibetan text), margins and guidelines in black	Chinese Buddhist texts, Tibetan mantras and transcriptions of Chinese in Tibetan
10	IOL Tib J 530 vol. 79: 3	Rag paper: *Boehmeria nivea* (ramie)	Laid paper glued of layers: 4 laid lines in 1 cm	Dunhuang Cave 17, 10th c.	Thread booklet (15.8 × 11.5); two sections, four bi-folio in each, sewn with silk thread (7 folios in first section)	Chinese, Tibetan (post-imperial Buddhist style, headed)	6 lines/page (Tibetan text), margins and guidelines in black	As above
11	IOL Tib J 612 vol. 68: 77	Rag paper: *Boehmeria nivea* (ramie) + jute possible	Laid lines: 5 laid lines in 1 cm	Dunhuang Cave 17, 9th–10th c.	Scroll (vertical): 27 × 27.5	Tibetan (monastic style)	15, 16 and 22 lines/panel, light margins, guidelines in black	(i) *Pañca-skandha* (ii) Text on the *bodhisattva* path
12	IOL Tib J 1126 vol. 55: 55 (right bottom corner)	Rag paper: *Boehmeria nivea* (ramie)	Laid paper: 4–5 laid lines in 1 cm	Dunhuang Cave 17, early to mid-9th c.	Folded document (20–23 × 30.5–31); with a square vermilion seal at the bottom right: 6 × 6	Tibetan (official style, headless)	9 lines, no margins or guidelines, square red seal and cross-hatching at bottom	Letter from Dunhuang, Tibetan imperial period
13	IOL Tib J 1254 vol. 56: 73 (right upper margin)	Rag paper: *Boehmeria nivea* (ramie)	Laid paper: 4 laid lines in 1cm, thick	Dunhuang Cave 17, early to mid-9th c.	Sheet, folded: 26.5 × 41.5	Tibetan (official style, headed)	26 lines on sheet, no margins or guidelines	Letters regarding the copying of *Śatasāhasrikā prajñāpāramitā* manuscripts
14	IOL Tib J 1357(B) vol. 69: 46	Rag paper: *Boehmeria nivea* (ramie)	Laid paper: 4 laid lines in 1 cm	Dunhuang Cave 17, early to mid-9th c.	Scroll fragment (vertical): 52.5 × 30	Tibetan (official style, headed)	27 lines/panel, margins and guidelines in black	Official document: list of income for monasteries
15	IOL Tib J 107.1 vol. 57: 119 (left hole area)	Rag paper: *Boehmeria nivea* (ramie)	Laid paper glued of layers: 4 laid lines in 1 cm	Dunhuang Cave 17 early to mid 9th c.	*Pothi* (Type 2): 20.5 × 72.5 Two holes, with circles	Tibetan (sutra style)	12 lines, light guidelines, margins not visible	*Śatasāhasrikā prajñāpāramitā*

Table 1 *Continued*

No.	*Shelfmark/sample location*	*Raw material*	*Type of paper*	*Find site/dating*	*Document/book format and size (h × w, in cm)*	*Language/script*	*Page layout*	*Content*
16	IOL Tib J 107.1 vol. 57: 137	Rag paper: *Boehmeria nivea* (ramie)	Laid paper glued of layers: 4 laid lines in 1 cm	Dunhuang Cave 17, early to mid-9th c.	*Pothi* (Type 2): 20.5 × 72.5 Two holes, with circles	Tibetan (sutra style)	12 lines, light margins, guidelines in black	*Śatasāhasrikā prajñāpāramitā*
17	IOL Tib J 107.1 vol. 57: 138	Rag paper: *Boehmeria nivea* (ramie)	Laid paper glued of layers: 4 laid lines in 1 cm	Dunhuang Cave 17, early to mid-9th c.	*Pothi* (Type 2): 20.5 × 72.5 Two holes, with circles	Tibetan (sutra style)	12 lines, light margins, guidelines in black	*Śatasāhasrikā prajñāpāramitā*
18	IOL Tib J 612 vol. 68: 67	Rag paper: *Boehmeria nivea* (ramie)	*One layer of laid paper with irregular structure: 4–5 laid lines in 1 cm	Dunhuang Cave 17, 9th–10th c.	Scroll (vertical): 43.5 × 27.8–29	Tibetan (monastic style)	15, 16 and 22 lines/panel, light margins, guidelines in black	(i) *Pañca-skandha* (ii) Text on the *bodhisattva* path
19	IOL Tib J 612 vol. 68: 69	Rag paper: *Boehmeria nivea* (ramie)	*One layer of laid paper with irregular structure: 4–5 laid lines in 1 cm	Dunhuang Cave 17, 9th–10th c.	Scroll (vertical): 43.5–43.7 × 27.8	Tibetan (monastic style)	15, 16 and 22 lines/panel, light margins, guidelines in black	As above
20	IOL Tib J 612 vol. 68: 70	Rag paper: *Boehmeria nivea* (ramie)	*One layer of laid paper with irregular structure: 4–5 laid lines in 1 cm	Dunhuang Cave 17, 9th–10th c.	Scroll (vertical): 43.5 × 27.9	Tibetan (monastic style)	15, 16 and 22 lines/panel, light margins, guidelines in black	As above
21	IOL Tib J 612 vol. 68: 72	Rag paper: *Boehmeria nivea* (ramie)	*One layer of laid paper with irregular structure: 4–5 laid lines in 1 cm; chain line intervals 5–9 cm	Dunhuang Cave 17, 9th–10th c.	Scroll (vertical): 41.8 × 26.5–27	Tibetan (monastic style)	15, 16 and 22 lines/panel, light margins, guidelines in black	As above
22	Or.8210/S.9498 (A): f. 1A (bottom margin, close to missing part)	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp)	Laid paper glued in two layers: 4 laid lines in 1 cm	Dunhuang Cave 17, 9th–10th c.	Fragment of *pothi* or concertina: 9.5 × 24 (upper right corner is missing)	Tibetan (sutra style)	6 lines, guidelines in red	Historical fragment related to the *Dba' bzhed*

23	IOL Tib J 1404 vol. 72 f. 72 (bottom left edge)	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp)	Laid paper: 4 laid lines in 1 cm	Dunhuang Cave 17, 9th–10th c.	Scroll fragment (vertical): 61 × 31	Tibetan (official style) and Chinese	29 lines on fragment, no margins or guidelines	Recto, Tibetan transliteration of Chinese *Sukhāvatīvyūha sūtra*; verso, various memoranda concerning provisions
24	OR 15000/496 (left bottom corner, close to the seal)	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp) + unidentified addition	Laid paper: 4 laid lines in 1 cm	Miran, mid-8th to mid-9th c.	Sheet: 25 × 7.6	Tibetan (official style, headed)	8 lines, and seal with design of horse and rider, and the syllables *phyag rgya*	Official dispatch from an assembly convoked by Blon Mtsho bzher
25	IOL Tib 687 vol. 33: 109–11	Rag paper: *Boehmeria nivea* (Ramie) + *Cannabis* sp. (Hemp)	Laid paper: 5 laid lines in 1 cm	Early to mid-9th c.	*Pothi*: 45 × 8.5 One hole, with red circle	Tibetan (monastic style)	6 lines/page, margins in red	Compilation from the scriptures, composed by 'Go Chos grub (Facheng) and possibly written in his hand
26	IOL Tib J 321 vol. 23: 13	Rag paper: *Boehmeria nivea* (ramie) + addition of *Broussonetia* sp. (paper mulberry)/ *Cannabis* sp. (hemp) possible	Laid paper: 5 laid lines in 1 cm, chain lines hardly visible	Dunhuang Cave 17, 10th c.	*Pothi*: 9.8–10 × 31 Two holes, with circles	Tibetan (post-imperial Buddhist style, headless)	5 lines/page, no margins or guidelines	*Upayapaśa tantra*
27	IOL Tib J 321 vol. 23: 15	Rag paper: *Boehmeria nivea* (ramie) + addition of *Broussonetia* sp. (paper mulberry) and *Cannabis* sp. (hemp) possible	Laid paper: 5 laid lines in 1 cm	Dunhuang Cave 17, 10th c.	*Pothi*: 9.8–10 × 31 Two holes, with circles	Tibetan (post-imperial Buddhist style, headless)	5 lines/page, no margins or guidelines	As above

Table 1 *Continued*

No.	*Shelfmark/sample location*	*Raw material*	*Type of paper*	*Find site/dating*	*Document/book format and size (h × w, in cm)*	*Language/script*	*Page layout*	*Content*
28	IOL Tib J 321 vol. 23: 100 (verso, bottom right corner)	Rag paper: *Boehmeria nivea* (ramie) + addition of *Broussonetia* sp. (paper mulberry and *Cannabis* sp. (hemp) possible	Laid paper (thin one-layer): 6 laid lines in 1 cm	Dunhuang Cave 17, 10th c.	*Pothi*: 9.8–10 × 31 Two holes, with circles	Tibetan (post-imperial Buddhist style, headless)	5 lines/page, no margins or guidelines	As above
29	IOL Tib J 470 (upper part)	Rag paper: *Boehmeria nivea* (ramie) + addition of *Cannabis* sp. (hemp) and *Broussonetia* sp. (paper mulberry) possible	Laid paper: 4 laid lines in 1 cm	Dunhuang Cave 17, 10th c.	Scroll (vertical): 30.5 × 399	Tibetan (sutra style, with interlinear notes in a post-imperial style)	~22 lines/panel, with interlinear notes, margins and guidelines in black	Tantric treatise: *Rdo rje sems dpa'i zhus lan*; scribe is Chinese official
30	IOL Tib J 105 vol. 5: 2 (bottom right edge, from damaged area near corner)	Rag paper: *Boehmeria nivea* (ramie) + addition of *Cannabis* sp. (hemp) and *Broussonetia* sp. (paper mulberry) possible	Laid paper glued in layers: 4 laid lines in 1 cm, chain lines intervals 6–7.5 cm when visible	Dunhuang Cave 17, early to mid-9th c.	*Pothi*: 20.4 × 73.2 with holes for a string	Tibetan (sutra style)	12 lines/page, margins and guidelines in black	*Śatasāhasrikā prajñāpāramitā*
31	IOL Tib J 109.21 vol. 87: 8, bi-f. 2 (bottom right-hand corner)	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp) and *Broussonetia* sp. (paper mulberry) possible	Laid paper: 4 laid lines in 1 cm; chain lines not visible	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 2); presently three separated scroll sections: 26.5–28.2 × 48.2 in bi-folio format	Tibetan (sutra style)	16 lines/section, margins and guidelines in black	*Śatasāhasrikā prajñāpāramitā*

32	IOL Tib J 1587 vol. 87: 16, bi-f. 1 (top edge near corner); 2 (bottom edge, close to left corner); 5 (left bottom corner)	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp) and *Broussonetia* sp. (paper mulberry) possible	Laid paper: 5 laid lines in 1 cm, with hardly visible laid structure of paper in some places	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 1); presently five separated scroll sections: 26 × 38.5–39.5 in bi-folio format	Tibetan (sutra style)	15 lines/section, no margins or guidelines	*Śatasāhasrikā prajñāpāramitā*
33	IOL Tib J 1718 vol. 120: 2, bi-f. 1 (right edge, near top corner)	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp) and *Broussonetia* sp. (paper mulberry) possible	Laid paper: 5–6 laid lines in 1 cm (bi-f. 1) and 6–7 laid lines in 1 cm (bi-f. 2)	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 2); presently two separated scroll sections: 26.5–28 × 42–49 in bi-folio format	Tibetan (sutra style)	15 lines/section, margins and guidelines in black	*Śatasāhasrikā prajñāpāramitā*
34	IOL Tib J 82: vol. 22 F. 2-67: f. 11 and 51	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp) + addition of *Broussonetia* sp. (paper mulberry) in folio 11	Laid paper: 5 laid lines in 1 cm	Dunhuang Cave 17, 9th–10th c.	*Pothi*: 32 × 11.5	Tibetan (post-imperial Buddhist style, headless)	8–11 lines/page, no margins or guidelines	*Daśabhūmika sūtra*
35	IOL Tib J 587 vol. 68: 79	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp) and *Broussonetia* sp. (paper mulberry) possible	One layer of laid paper with irregular structure: 4–5 laid lines in 1 cm (reed/grass papermaking sieve)	Dunhuang Cave 17, 9th–10th c.	Originally concertina, now six loose leaves: 6.5 × 13.8	Tibetan (sutra style)	5 lines/panel, no margins or guidelines	Buddhist prayer
36	IOL Tib J 1726 vol. 120: 10, bi-f. 1 and 6 (top right edge)	Rag paper: *Boehmeria nivea* (ramie) + *Cannabis* sp. (hemp) and *Broussonetia* sp. (paper mulberry) possible	Laid paper: 4–5 laid lines in 1 cm	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal); presently six separated scroll sections: 29.5–30 × 41.5–43 in bi-folio format	Tibetan (sutra style)	15 lines on section, margins and guidelines in black	*Vajracchedika-prajñāpāramitā*

Table 1 *Continued*

No.	*Shelfmark/sample location*	*Raw material*	*Type of paper*	*Find site/dating*	*Document/book format and size (h × w, in cm)*	*Language/script*	*Page layout*	*Content*
37	IOL Tib J 1354 vol. 69: 32	Rag paper: *Boehmeria nivea* (ramie)/ *Broussonetia* sp. (paper mulberry)	Laid paper: 4 laid lines in 1 cm (grass/reed papermaking sieve)	Dunhuang Cave 17, early to mid-9th c.	Scroll fragment (horizontal, Type 2): 27 × 36	Tibetan (sutra style)	16 lines on fragment, margins and guidelines in black	*Śatasāhasrikā prajñāpāramitā*?
38	IOL Tib J 1355 vol. 69: 32	Rag paper: *Boehmeria nivea* (ramie)/ *Broussonetia* sp. (paper mulberry)	Structure hardly visible (grass/reed papermaking sieve)	Dunhuang Cave 17, early to mid-9th c.	Scroll fragment (horizontal, Type 2): 27 × 36	Tibetan (sutra style)	16 lines on fragment, margins and guidelines in black	*Śatasāhasrikā prajñāpāramitā*?
39	IOL Tib J 1356 vol. 69: 32	Rag paper: *Boehmeria nivea* (ramie)/ *Broussonetia* sp. (paper mulberry)	Laid paper: 3–4 laid lines in 1 cm (grass/reed papermaking sieve)	Dunhuang Cave 17, early to mid-9th c.	Scroll fragment (horizontal, Type 2): 27 × 36	Tibetan (sutra style)	16 lines on fragment, margins and guidelines in black	*Śatasāhasrikā prajñāpāramitā*?
40	IOL Tib J 232(a) vol. 69: 16	Bark paper: *Broussonetia* sp. (paper mulberry) + *Boehmeria nivea* (ramie) possible	Irregular laid paper: 4 laid lines in 1 cm; chain lines not visible; papermaking sieve made of grass/reed	Dunhuang Cave 17, early to mid-9th c.	Scroll fragment (horizontal, Type 2): 25 × 27	Tibetan (sutra style)	16 lines on section, margins and guidelines in black	*Pañcaviṃśatisāhasrikā-prajñāpāramitā*
41	IOL Tib J 570 vol. 13: 79	Bark paper: *Broussonetia* sp. (paper mulberry)	Laid paper glued in two layers: 6 laid lines in 1 cm	Dunhuang Cave 17, 10th c.	*Pothi*: 9 × 26.5, one string hole, no string	Tibetan (post-imperial Buddhist style, headed and headless)	6 lines/page, margins and guidelines in red	*Gtor ma* offering ritual

42	IOL Tib J 754 (A): vol. 72 f. 74 (left side margin, close to upper corner)	Bark paper: *Broussonetia* sp. (paper mulberry)	Laid paper: 6 laid lines in 1 cm	Dunhuang Cave 17, AD 968	Scroll (vertical): 63 × 24.5	Tibetan (post-imperial epistolatory style) and Chinese	Scattered notes, no margins or guidelines	Tibetan letters of passage for a Chinese pilgrim
43	IOL Tib J 754 (A): vol. 72 f. 77 (central part of right side margin edge)	Bark paper: *Broussonetia* sp. (paper mulberry)	Laid paper: 6 laid lines in 1 cm chain lines intervals 5–5.3–5–5–5–5–4–1–4–4.5–1–5.5 cm	Dunhuang Cave 17, AD 968	Scroll (vertical): 63 × 25.5	No text	n/a	Tibetan letters of passage for a Chinese pilgrim
44	IOL Tib J 754 (C): vol. 72 f. 78 (central part of bottom edge)	Bark paper: *Broussonetia* sp. (paper mulberry)	Laid paper: 6 laid lines in 1 cm	Dunhuang Cave 17, AD 968	Sheet: 25.5–26 × 34–35	Chinese	16 columns on sheet	Chinese copy of a stele inscription from Liangzhou
45	IOL Tib J 754 (B): vol. 72 f. 79 (middle part of right side margin)	Bark paper: *Broussonetia* sp. (paper mulberry)	Woven paper, two layers glued together	Dunhuang Cave 17, AD 968	Scroll (vertical): 69 × 25	Chinese and Tibetan (post-imperial style)	Recto, 28 columns/panel; verso, 41 lines, no margins or guidelines	Recto, *Baoenjing* (Chinese); verso, Tibetan tantric texts
46	IOL Tib J 754(B): vol. 72 f. 83	Bark paper: *Broussonetia* sp. (paper mulberry)	One layer of paper with unclear laid structure	Dunhuang Cave 17, AD 968	Scroll (vertical): 53.5 × 25	Chinese and Tibetan (post-imperial style)	Recto, 28 columns/panel; Verso, 32 lines, no margins or guidelines	As above
47	IOL Tib J 750	Bark paper: *Broussonetia* sp. (paper mulberry)	Woven paper (?); document after conservation—paper is sandwiched in between silk gauze (very difficult access to original material)	Dunhuang Cave 17, early to mid-9th c.	Scroll (vertical): 25.8 × 364	Tibetan and Chinese	Recto, 28 columns/panel; Verso, ~33 lines/panel, faint margins and guidelines	Recto, *Saddharmapuṇḍarīka sūtra* (Chinese); verso, *Old Tibetan annals* Version I
48	Or.8212/187	Bark paper: *Broussonetia* sp. (paper mulberry)	Woven paper	Dunhuang Cave 17, early to mid-9th c.	Scroll (vertical): 27 × 135	Tibetan and Chinese	Recto, 28 columns/panel; Verso, variable, no margins or guidelines	Recto, *Bhaiṣajyaguru sūtra* (Chinese); Verso, *Old Tibetan annals* Version II

Table 1 *Continued*

No.	*Shelfmark/sample location*	*Raw material*	*Type of paper*	*Find site/dating*	*Document/book format and size (h × w, in cm)*	*Language/script*	*Page layout*	*Content*
49	IOL Tib J 1732 vol. 120: 16, bi-f. 1 (bottom edge)	Bark paper: *Broussonetia* sp. (paper mulberry)	Unclear structure of paper: laid structure of paper visible in some places (5–6 laid lines in 1 cm)	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 1); presently six separated scroll sections: 28.5 × 45.5 in bi-folio format	Tibetan (sutra style)	15 lines on section, no margins or guidelines	*Śatasāhasrikā prajñāpāramitā*
50	IOL Tib J 1581 vol. 87: 10, bi-f. 1 (top edge, towards the centre)	Bark paper: *Broussonetia* sp. (paper mulberry) + *Cannabis* sp. (hemp) possible	Woven paper	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 2); presently four separated scroll sections: 28.5 × 43 in bi-folio format	Tibetan (sutra style)	17 lines on section, margins and guidelines in black	*Śatasāhasrikā prajñāpāramitā*
51	IOL Tib J 1586 vol. 87: 15, bi-f. 1 (bottom edge, near corner)	Bark paper: *Broussonetia* sp. (paper mulberry) + *Cannabis* sp. (hemp) possible	Both types: woven paper and laid paper characterized by 6 laid lines in 1 cm	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 2); presently seven separated scroll sections of different size: 26.5–30 × 28–45	Tibetan (sutra style)	14, 17, 18 and 19 lines of text on particular fragments respectively, margins and guidelines in black (faint)	*Śatasāhasrikā prajñāpāramitā*
52	IOL Tib J 241 vol. 69: 9	Bark paper: *Broussonetia* sp. (paper mulberry) and *Cannabis* sp. (hemp) possible	Unclear structure, suggesting that papermaking sieve is made of grass/reed; in fragments, 3–4 laid lines in 1 cm visible	Dunhuang Cave 17, early to mid-9th c.	Scroll fragment (horizontal, Type 1): 20 × 28	Tibetan (sutra style)	18 lines in section, no margins or guidelines	Sutra fragment: *Prajñāpāramitā*

53	IOL Tib J 1560 vol. 85: 2, bi-f. 2 (bottom edge, towards the middle of the edge)	Bark paper: *Broussonetia* sp. (paper mulberry) and *Cannabis* sp. (hemp) possible	Larger fragment on woven paper and smaller fragment on laid paper characterized by 5 laid lines in 1 cm	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 1); presently two separated fragments: approx. 26.5–27	Tibetan (sutra style)	13 and 16 lines on two fragments of scroll, no margins or guidelines	*Śatasāhasrikā prajñāpāramitā*
54	IOL Tib J 1561 vol. 85: 4, bi-f. 1 (top right corner, near damaged area)	Bark paper: *Broussonetia* sp. (paper mulberry)/ *Cannabis* sp. (hemp) possible	Woven paper	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 1); presently one bi-folio fragment: 28.5 × 38	Tibetan (sutra style)	17 lines on section, no margins or guidelines	*Śatasāhasrikā prajñāpāramitā*
55	IOL Tib J 1577 vol. 87: 3, bi-f. 4 (bottom of page, right-hand side of the corner)	Bark paper: *Broussonetia* sp. (paper mulberry)/ *Cannabis* sp. (hemp) possible	Laid paper glued in layers in three bi-folios: 6 laid lines in 1 cm Woven paper in one bi-folio; two bi-folios lined with backing paper during conservation	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 1); presently four separated scroll sections: 27.8–28 × 44.3 in bi-folio format	Tibetan (sutra style)	18 lines on every scroll section, no margins or guidelines	*Śatasāhasrikā prajñāpāramitā*
56	IOL Tib J 1578 vol. 87: 4, bi-f. 3 (bottom of page, right-hand side of the corner)	Bark paper: *Broussonetia* sp. (paper mulberry) + *Cannabis* sp. (hemp) possible	One-layered paper of two types: woven paper in two sections and laid paper characterized by 6 laid lines in 1 cm in section 13 of the original scroll	Dunhuang Cave 17, early to mid-9th c.	Scroll (horizontal, Type 1); presently four separated scroll sections: 27.8–28.2 × 44 in bi-folio format	Tibetan (sutra style)	17 lines on section, no margins or guidelines	*Śatasāhasrikā prajñāpāramitā*
57	IOL Tib J 194 vol. 13: 26	Bark paper: *Daphne* or *Edgeworthia* sp.	Woven paper (?) with a surface print of fabric on which the paper was dried	Dunhuang Cave 17, late 8th to early 9th c.	*Pothi*: 8 × 30, one hole, no circle	Tibetan (square style with archaic features)	5 lines/page, margins and guidelines in black	*Saṃdhinirmocana sūtra*
58	IOL Tib J 194 vol. 13: 30	Bark paper: *Daphne* or *Edgeworthia* sp.	Woven paper (?) with a surface print of fabric on which the paper was dried	Dunhuang Cave 17 late 8th to early 9th c.	*Pothi*: 8 × 30, one hole, no circle	Tibetan (square style)	5 lines/page, margins and guidelines in black	As above

Table 1 *Continued*

No.	*Shelfmark/sample location*	*Raw material*	*Type of paper*	*Find site/dating*	*Document/book format and size (h × w, in cm)*	*Language/script*	*Page layout*	*Content*
59	IOL Tib J 1459 vol. 73: 37	Bark paper: *Daphne* or *Edgeworthia* sp.	Woven paper with a surface print similar to laid lines	Dunhuang Cave 17, late 8th to early 9th c.	Folded document: 16 × 16 (fold distance 3 cm)	Tibetan (official style, headed and headless)	11 lines, no margins or guidelines	Letter from central Tibet, Tibetan imperial period
60	IOL Tib M 58 vol. 1: 58	Bark paper: *Daphne* or *Edgeworthia* sp.	Woven paper, two layers glued together	Khara Khoto, 12th–13th c.	*Pothi*: 10 × 30–32	Tibetan (post-imperial Buddhist style, headless)	8 lines/page, faint black margins, no guidelines	Commentary on a Buddhist treatise on service to the teacher
61	IOL Tib M 59 vol. 1: 59	Bark paper: *Daphne* or *Edgeworthia* sp.	Woven paper, two layers glued together	Khara Khoto, 12th–13th c.	*Pothi*: 10 × 30–34	Tibetan *dbu med* (post-imperial Buddhist style, headless)	5 lines/page, with interlinear notes, red margins, no guidelines	Commentary on tantric practice
62	IOL Tib M 60 vol. 1: 60	Bark paper: *Daphne* or *Edgeworthia* sp.	Woven paper glued in layers	Khara Khoto, 12th–13th c.	*Pothi*: 9 × 32–32.5	Tibetan *dbu med* (post-imperial Buddhist style, headless)	9 lines/page, red margins, no guidelines	Tantric ritual text
63	OR 15000/513 (left side margin)	Mixed components: *Daphne* or *Edgeworthia* sp. + *Broussonetia* sp. (paper mulberry) and straw possible	Woven paper glued in two layers, with the surface print similar to laid lines	Miran, late 8th to early 9th c.	Folded document: 12 × 2.5	Tibetan, *dbu med* (official style, headed).	4 lines (recto), no margins or guidelines; verso contains seal with bird design, and the syllables *pho brang* . . .	Letter to Jo co Lha 'brul, perhaps from central Tibet

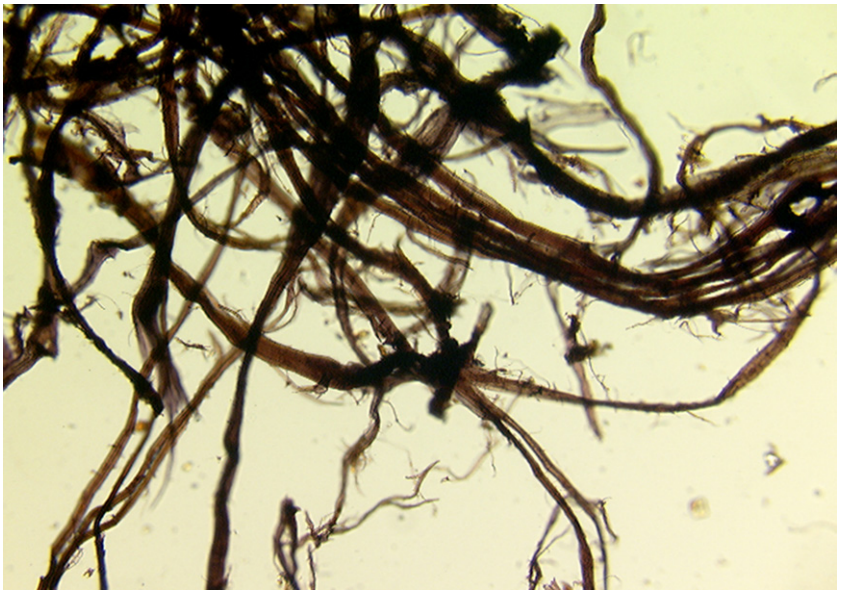

Figure 11 *Ramie (*Boehmeria *sp.) fibres coloured with Herzberg stain, found in a folded document (IOL Tib J 1254, vol. 56 f. 73) from China's Dunhuang caves, under the microscope (OM 150×).*

Figure 12 *Ramie (*Boehmeria *sp.) fibres coloured with Herzberg stain, found in a thread booklet (IOL Tib J 530, vol. 79 f. 2) from China's Dunhuang caves, under the microscope in polarized light (OM 600×).*

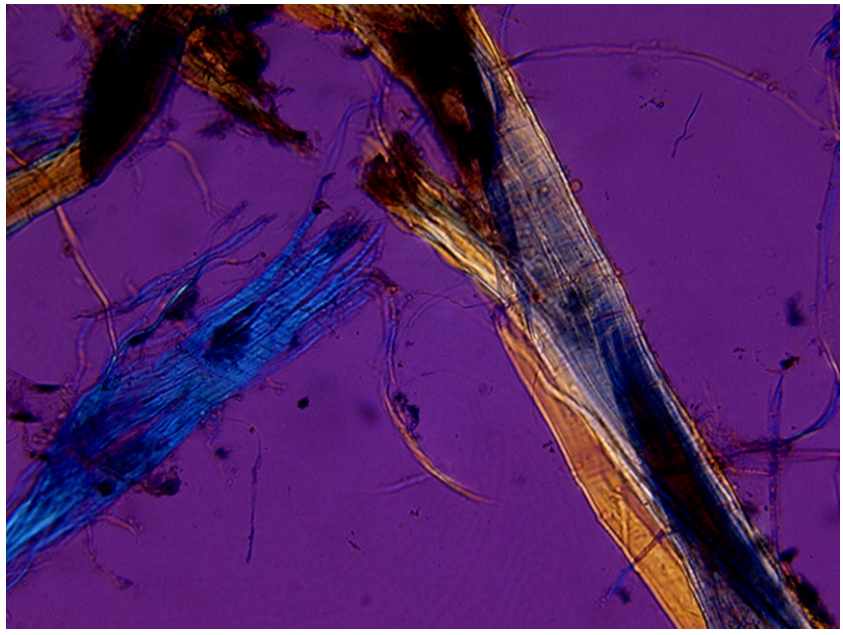

Figure 13 *Ramie (*Boehmeria *sp.) fibres coloured with Herzberg stain, found in a scroll (IOL Tib J 1357(B), vol. 69 f. 46) from China's Dunhuang caves, under the microscope in polarized light (OM 600×).*

Figure 14 *Rag paper based on ramie identified in a Tibetan letter from Dunhuang, with a square red seal at the bottom (IOL Tib J 1126, vol. 55 f. 55). The British Library Collection.*

Figure 15 *Rag paper based on ramie identified in a Tibetan letter from Dunhuang, with a square red seal at the bottom (IOL Tib J 1126, vol. 55 f. 55): the laid structure of the paper is visible against the light. The British Library Collection.*

that these manuscripts were produced in Tibet. In fact, the majority—including the *Śatasāhasrikā prajñāpāramitā* of Type 2—were probably produced locally in Dunhuang.

However, this type of paper, being the oldest known technology in China, could also have been produced in other parts of China. The presence of paper mulberry fibres not previously used for textile production might suggest a shortage of rags in the area and the need for technological innovation in paper production. It is interesting that Trier reported in 1972 that the oldest paper samples he examined in Nepal, dated to the 13th–15th centuries, were made of ramie and hemp, unlike those dated to later times. Additionally, Trier's group of manuscripts represents a variety of formats, such as scroll, *pothi*, booklets and concertina, suggesting the influence of a multicultural environment. His preliminary interpretation that those papers originated in India should probably be opened for discussion again in the context of our present research (Trier 1972, 57).

Manuscripts composed of Daphne *or* Edgeworthia *sp. paper (Figs 16 and 17)*

Thymelaeaceae family plant fibres (specifically *Daphne* or *Edgeworthia* sp.) were also identified in six manuscripts (Helman-Ważny 2009). Among these six samples, five were woven papers made on a textile sieve and one represented a laid type of paper characterized by six laid lines in 1 cm. It is highly significant that the only manuscript in our sample containing clear textual evidence of having been made in central Tibet during the Tibetan imperial period (IOL Tib J 1459) was found to have been constructed from *Daphne* or *Edgeworthia* sp. plant fibres. The only other Dunhuang manuscript made from these fibres is a fragmentary *pothi* book of the *Samdhinirmocana sūtra*, written in the archaic 'square' style; this too may have been brought from central Tibet. Conversely, none of the Tibetan manuscripts known to be made in Dunhuang was constructed from *Thymelaeaceae* fibres.

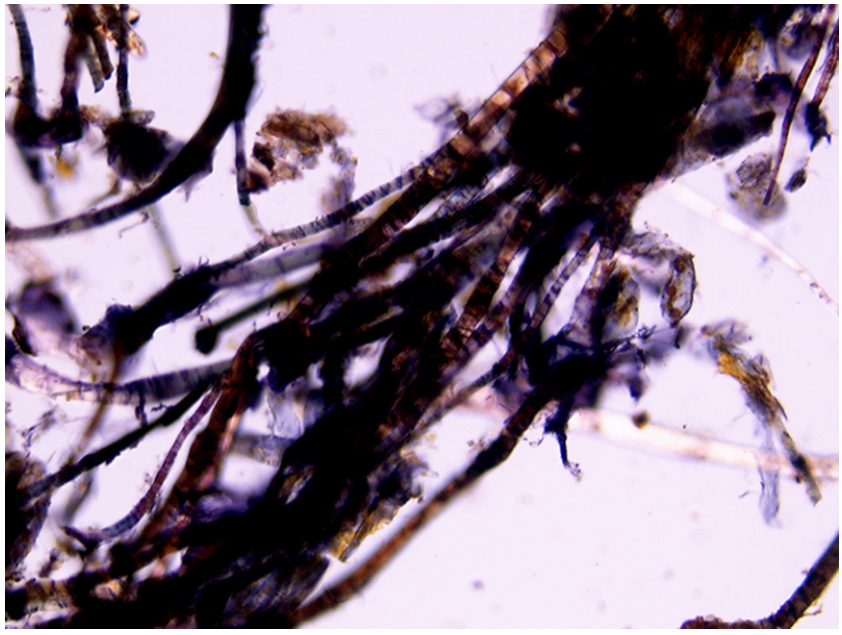

Figure 16 Daphne/Edgeworthia *sp. fibres coloured with Herzberg stain, found in a Tibetan* pothi *book (IOL Tib M 58, vol. 1 f. 58) from Khara Khoto, under the microscope in polarized light (OM 300×).*

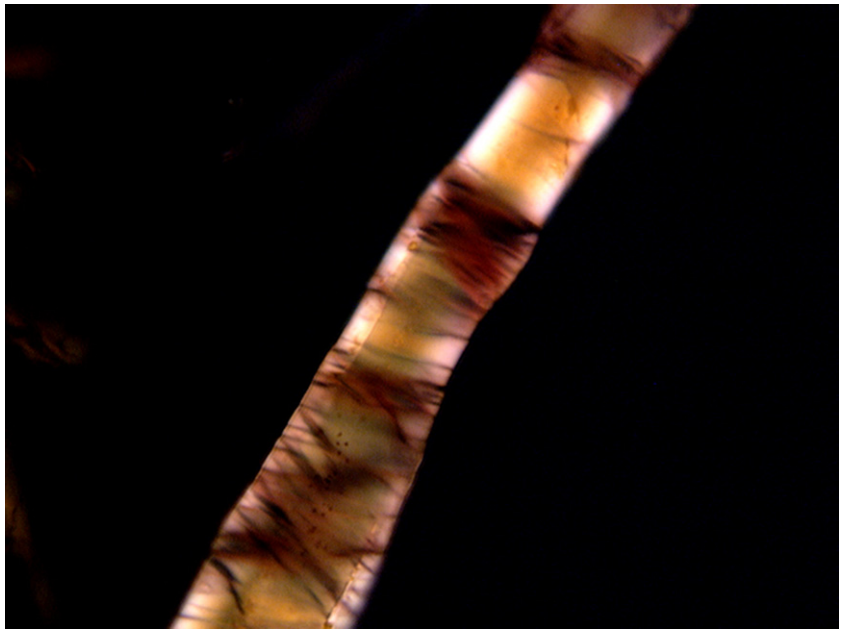

Figure 17 Daphne/Edgeworthia *sp. fibres coloured with Herzberg stain, found in a Tibetan* pothi *book (IOL Tib M 58, v. 1 f. 58) from Khara Khoto, under the microscope in polarized light (OM 1200×).*

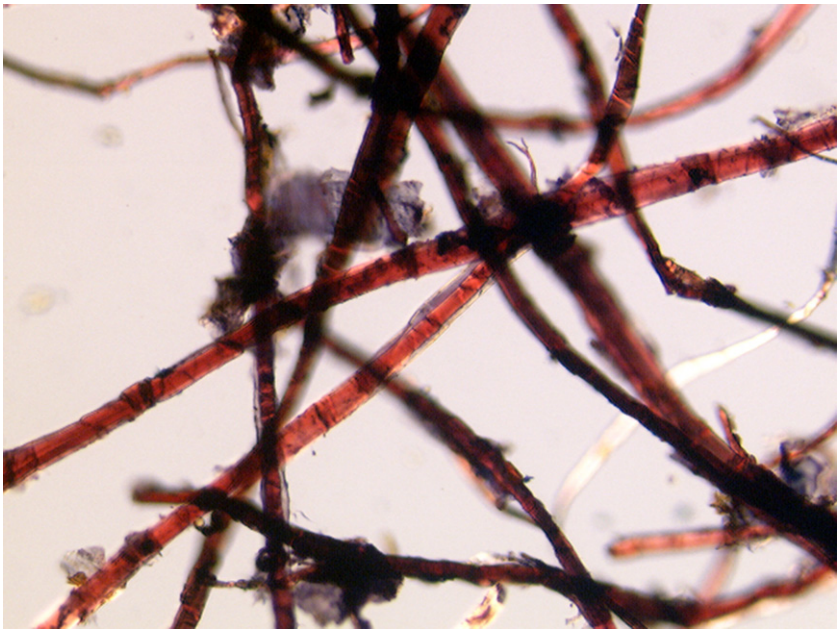

Figure 18 *Paper mulberry (*Broussonetia *sp.) fibres stained with Herzberg stain, found in a Tibetan scroll (IOL Tib J 1560, vol. 85 bi-f. 2) from China's Dunhuang caves, under the microscope in polarized light (OM 300×).*

Another letter, found in Miran (Or.15000/513) was also found to be composed of *Daphne* or *Edgeworthia* sp. plant fibres, this time mixed with paper mulberry fibres. This letter may well also have come from central Tibet, as it contains a seal that is partly effaced but contains the word 'palace' (*pho brang*), an imperial administrative centre, of which none are known to have existed in Central Asia. In addition, the three 12th–13th century manuscripts from Kharakhoto are also of *Daphne* or *Edgeworthia* type, and may have been brought to Kharakhoto by Tibetan monks, who are known to have been active at the Tangut court.

Manuscripts composed of Broussonetia *sp. (paper mulberry) paper (Figs 18 and 19)*

The majority of manuscripts on this type of paper were in scroll format, and some were in *pothi*. In particular, the *Śatasāhasrikā prajñāpāramitā* scrolls of Type 1 (not from Dunhuang) were found to be primarily composed of *Broussonetia* sp. (paper mulberry) paper, sometimes with the possible addition of hemp or *Morus* sp. (mulberry[11]), and in almost all samples were created on a textile sieve. These manuscripts share with the letter from central Tibet discussed above the fact that they were made on a woven mould, and textual evidence strongly suggests that these scrolls were brought to Dunhuang from Tibet. However, they are made from a completely different plant source from the two letters from central Tibet. Given the prevalence *Broussonetia* in eastern Tibet, it is likely that these manuscripts were created in the eastern regions of the Tibetan Empire, where this type of paper is still made. Note that one manuscript (IOL Tib J 570), a tantric ritual

[11]In fact, it is very difficult to distinguish paper mulberry from mulberry in historic papers, and we cannot exclude the possibility that many types of mulberry plants were used for paper production. Written sources are also very vague when using word 'mulberry' for paper mulberry. Similarly, the word 'hemp' is used interchangeably for all components of rag papers, including ramie and jute.

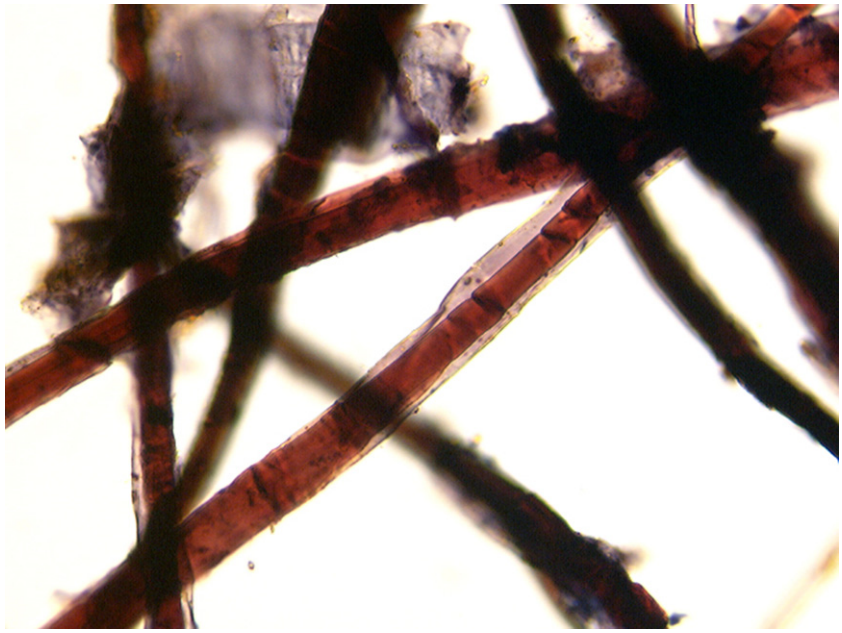

Figure 19 *Paper mulberry (*Broussonetia *sp.) fibres stained with Herzberg stain, found in a Tibetan scroll (IOL Tib J 1560, vol. 85 bi-f. 2) from China's Dunhuang caves, under the microscope in polarized light (OM 600×).*

probably written in the 10th century, is also composed of *Broussonetia* paper, but made on a moveable sieve rather than a woven mould; this reminds us that paper mulberry was also used in papermaking in China and Central Asia.[12]

In terms of dating the manuscripts, the paper analysis provided little basis for confirmation of dates. While the three main groups into which our samples fall seem to be distinguished by their geographical origin, there is no clear distinction in paper type between manuscripts produced in the early ninth century and those produced in the late 10th century. Thus we found no evidence that the changeover from the Tibetan occupation of Dunhuang to the post-Tibetan period was accompanied by a difference in papermaking techniques. Although further work may reveal evidence for this, it seems more likely that we will continue to find palaeographical analysis more useful for dating the manuscripts, and paper analysis most relevant to determining their geographical origin.

CONCLUSIONS

This preliminary study confirms that the use of a combination of textual, palaeographical, codicological and paper fibre analyses allows us to reach new conclusions about the early use of Tibetan paper. On the basis of our samples, we were able to suggest three different geographical origins for Tibetan manuscripts preserved in the sealed cave in Dunhuang, Central Asia.

In our sample, two manuscripts sent to Central Asia from Tibet, and dated to the early ninth century, were composed of the *Daphne* sp. type of paper. As far as we know, *Thymelaeaceae*

[12]This plant is usually associated with the very fine paper produced at the Imperial Court, or early Ming Dynasty paper of exceptional quality used for art and calligraphy; however, these were made with a fine bamboo sieve characterized by eight or more laid lines in 1 cm.

family plants such as *Daphne* or *Edgeworthia* sp. were not used in Central Asia or China for making paper. This supports the view that Tibetans were able to make paper during the period of the Tibetan Empire, and gives us material evidence of this from as early as the first half of the ninth century. The raw material for this technology was the *Thymelaeaceae* family plants, which occur widely in the Himalayas. On the other hand, we did not find any evidence of root paper (*Stellera chamaejasme* sp.) in any Dunhuang manuscripts. Although it is possible that further analysis of more early samples may reveal the existence of this paper, it is more likely that it was not in widespread use, given the relative ease of paper production from *Daphne* or *Edgeworthia* sp. As we mentioned in the Introduction, root paper was probably only made where other plant sources were unavailable, such as at particularly high altitudes. The date when this practice began remains to be determined.

We also have *Prajñāpāramitā* manuscripts, again from the first half of the ninth century, and produced in the Tibetan cultural area, composed of *Broussonetia* sp. (paper mulberry). Thus it seems that both *Daphne*/*Edgeworthia* sp. and *Broussonetia* sp. were used for papermaking in early Tibet. Given the patterns of plant distribution in Tibet, it is likely that the former was the primary type of paper used in central (and perhaps western Tibet) and the latter the primary type in eastern Tibet. Further research will be needed to confirm this.

On the other hand, it is very clear from our samples that the majority of manuscripts produced in Dunhuang and other Central Asian sites such as Miran are composed of rag paper. Thus, by linking these three types of paper to three different locations, we hope to provide a basis for better understanding these manuscripts, which are still the earliest Tibetan manuscripts available to us.

In this study, we have used textual and palaeographical information to align paper type with geographical origin. On the basis of the results shown here, we hope that it will be possible to estimate the geographical origin of a manuscript—at least on the basic threefold classification of Central Asia/central Tibet/eastern Tibet. Of course, the typology will also be tested by further work, and will undoubtedly need to be refined. To conclude, we hope that this study will allow for a more subtle and complex approach to the idea of 'Tibetan paper' and its origins, by showing that a variety of methods and materials were available to Tibetans in their imperial period. If we can begin to speak of a type of paper with specifically Tibetan characteristics during this period, it is of a paper composed of *Daphne* or *Edgeworthia* sp. or *Broussonetia* sp. And it is a paper made on a woven mould, a technology that continued through to the 20th century.

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