Z Badań nad Książką i Księgozbiorami Historycznymi 2020, t. 14, z. 3
The Studies into the History of the Book and Book Collections 2020, vol. 14, no. 3
www.bookhistory.uw.edu.pl
http://doi.org/10.33077/uw.25448730.zbkh

ARTICLES

Agnieszka Helman-Ważny
University of Warsaw, Poland
CSMC, University of Hamburg, Germany
a.helman-wazny@uw.edu.pl
0000-0003-1525-767X

Notes on the early history of paper in Central Asia based on material evidence

Abstract: The cultural background of the proliferation of early paper in Central Asia and its use outside China has rarely been explored. Since written sources are inconclusive regarding the origins and spread of papermaking, archaeological and material evidence assumes increased importance. The preserved manuscripts found along the Silk Road have been used as a key source in the study of religion, literature and the cultural history of Central Asia. They have, however, rarely been viewed as artefacts in their own right, with their own specific form and produced by a specific technology. Paper is one of the most important physical aspects of a manuscript and at the same time bears witness to early papermaking technologies. As an introduction to the volume *Asian paper as writing support*, this article outlines the early history and technology of papermaking as revealed by the oldest manuscripts in existence, those found along the Silk Road.

Key words: Early manuscripts, Silk Road, papermaking, Central Asia, China, microscopy, fibre analysis.

„Z Badań nad Książką i Księgozbiorami Historycznymi" – Udział zagranicznych recenzentów w ocenie publikacji; Stworzenie anglojęzycznej wersji wydawniczej publikacji; Digitalizacja tomów archiwalnych rocznika w celu zapewnienia otwartego dostępu do nich przez Internet oraz wdrożenie i utrzymanie cyfrowej platformy redakcyjnej – zadanie finansowane w ramach umowy nr 653/P-DUN/2019 ze środków Ministra Nauki i Szkolnictwa Wyższego przeznaczonych na działalność upowszechniającą naukę.

https://doi.org/10.33077/uw.25448730.zbkh.2020.628

Introduction

History traditionally shows paper as a global medium of communication disseminated gradually via trade routes from China to Europe via the Middle East, and on to the rest of the world. The meaning and value of paper in the ancient and medieval history of Asia is relatively unexplored. The technological and economic transfer of paper shows this writing material as a global commodity, unlike other writing supports, such as silk, bamboo and palm leaves, which had always had rather local market. The cultural background of the diffusion of paper, its existence and its use in cultures of Central Asia outside China, has barely been explored despite Central Asia's key rôle in the early history of paper. Paper has been assumed to be of Chinese origin and therefore was automatically incorporated as an integral part of the history of China. Production of paper quickly developed and permitted the wide diffusion of works designed for the spread of religious, scientific and literary ideas. Compared to other writing materials, paper also allowed its content to be copied inexpensively and relatively easily. We cannot be entirely sure, however, who the producers, sellers and buyers in Central Asia were. It therefore makes little sense to "nationalise" every technological achievement and new invention. The political borders of countries in the first millennium have changed, and it is therefore difficult to ascribe a cultural origin to certain archaeological discoveries.

Literary sources and their interpretations

The historical sequence of events leading to the invention of true paper is inextricably linked with legends that surround it. The year 105 CE is commonly cited as the date paper was invented. Historical records in the *History of the Later Han Dynasty* for that year show that the technique of papermaking was reported by Cai Lun to the Eastern Han Emperor Ho, and that those first paper samples were made of tree bark, remnants of hemp, cloth rags and fishing nets[1]. This one claim triggered great speculation and discussion that continue to this day. In 1931 Berthold Laufer commented on this passage, pointing out that those many components were not mixed together to result in one paper, but that each substance was the principal constituent in making a particular kind of paper[2]. Other scholars, however, has interpreted it as meaning that all the items went into a singular final product. In fact, both suppositions are vague, since Cai Lun's words are unclear as to the method by which this first

[1] T.-H. Tsien, *Paper and printing*, Cambridge 1985, Sciences and Civilization in China, ed. J.S Needham, vol. 5, p. 40.

[2] B. Laufer, *Paper and Printing in Ancient China*, Chicago-New York 1931, p. 15.

"true paper" was made. Shun-sheng Ling, for example, stressed that true paper was derived from bark cloth (tapa) manufacture, which involved the pounding of the inner bark, i.e. the phloem of paper mulberry bark, as was practised in southern China, Cai Lun's home[3]. According to Ling, Cai Lun's inspiration may also have sprung from silk paper technology[4], which at that point is unlikely to have existed at all[5].

On the margins of scholarly debate, other theories also abound. One such theory is posited by Li Fang in an article in *Hand Papermaking*, stating that the "materialist dialectics of Marxist Leninist theory led him to the conclusion that the oldest paper was formed by nature". According to Li Fang, ancient people living on the banks of the Feng River in Changan were inspired by plant material that dropped into a flooded river and produced the first paper[6].

While the fact and myth sometimes combine to confuse, it is commonly accepted that paper was invented in China and spread to the rest of world via the Silk Road.

Archaeological evidence

Early twentieth-century archaeological excavations in China provided new evidence that shed some light on the origin of paper. This topic is well-documented and discussed by Jean-Pierre Drège in his insightful article *Les débuts du papier en Chine*[7]. Based on an archaeological discovery in 1933[8] the archaeologist Huang Wenbi (1893-1966) put forward a new theory regarding the origin of paper in 1948 in his Lobnor Xinjiang archaeological report; that paper was devised by the craftsmen of the Western Han (206 BCE to 24 CE)[9].

[3] S. Ling, *Bark Cloth Culture and the Invention of Paper-making in Ancient China*, "Bulletin of the Institute of Ethnology, Academia Sinica" 1961, vol. 11, pp. 29-31, 35-40.

[4] There are no doubts that silk was used as writing support, but it is not known whether it was used in the form of paper, where fibres are interwound and felted as in paper, rather than woven. Such material, "silk paper", however would be extremely difficult to produce due to properties of silk fibres, and its existence is therefore doubted by many scholars, whose opinions Ling presents in his article. Ibidem, pp. 29, 36-38.

[5] By confronting the results of his technological experiments in making silk paper and analyses of arguments presented earlier by historians. J Dąbrowski came to the conclusion that silk paper had no chance to exist before Cai Lun's paper invention. For discussion on this topic, see: J. Dąbrowski, *Kwestia jedwabiu w wynalazku papieru przez Cai Luna*, [in:] *Emanations: To professor Jerzy Malinowski on the occasion of his 70th birthday. Fine Arts Diary 2020*, no. 15, pp. 149-153.

[6] F. Li, *My View of the Root of Papermaking in Chang'an*, "Hand Papermaking" 1995, vol. 10, no. 2, pp. 10-14.

[7] See: J.-P. Drège, *Les débuts du papier en Chine*, "Comptes rendus des séances de l'Académie des Inscriptions et Belles-Lettres" 1987, vol. 131, no. 4, pp. 642-652.

[8] J. Pan, *Review on the debate of paper history during recent 30 years in China*, "IPH Paper History. Journal of the International Association of Paper Historians" 2011, vol. 15, no. 2, p. 6.

[9] Interestingly in the area of Turfan archaeological excavations have been resumed in recent

This idea began to take hold among scholars as increasing amounts of ancient paper was excavated in the Western Han, some evidently earlier than 105 CE, the year of Cai Lun's breakthrough[10]. What began as an academic discussion, however, grew into a political affair, and in the late 1970s the government-run Papermaking Institute of the Ministry of Light Industries declared the debate closed[11]. This institute, having declared itself the sole technical authority on the identification of all ancient paper in China, proclaimed Cai Lun a national hero and affirmed that the theory that he invented paper in the Eastern Han Dynasty was a "final historical conclusion"[12].

Indeed, Pan Jixing's 2011 article for the *Paper History* (IPH) reads like a "Manifesto to the West". In it he describes the political blackout of virtually all scientific and archaeological study of paper in China for the previous 30 years. Despite this and the fact that all the archaeological samples have been inaccessible, most scholars continue to believe that the earliest paper is from the Western Han Dynasty, based on careful archaeological evidence prior to the 1970s, when Chinese archaeologists dated their earliest samples (made before the time of Cai Lun) according to "stratigraphy, combination of utensils unearthed together with paper, the characteristics of the paper itself, wooden slips with dates and other scientific methods"[13] (Fig. 1).

One of most important examples of early paper found is Baqiao paper, unearthed in the region of Changan (today Xian) and reported in 1957, and identified by Pan in 1964 as rag paper made of hemp and ramie fibres[14]. With the benefit of collective scientific research Pan dates the grave at Baqiao no later than 118 BCE. Even with Baqiao and other papers excavated in the Western regions of China (Fangmatan and Xuanquan) the Institute continues to insist that these Western finds are "not true paper". The map of those discoveries, however, is highly persuasive, since it raises the question why so many of those early paper samples were discovered along the Silk Road and in Western China (Fig. 2).

years, and it has yielded a great many new discoveries of paper and manuscripts. They are now catalogued by The Xinjiang Archaeological Institute in Turfan, but it may be years before they are examined, and this will be considered when revising the history of paper in China.

[10] For a well-documented overview of this debate on Cai Lun, archaeological discoveries of paper fragments and the origins of paper see: J.-P. Drège, *Les débuts du papier*..., op. cit., pp. 643-645; From technological point of view on the same debate see: J. Dąbrowski, *Remarks on the Invention of True Paper by Cai Lun*, "IPH Congress Book" 2006, vol. 16 Special Edition, pp. 5-16.

[11] J. Pan, op. cit., pp. 7-8.

[12] Ibidem, p. 7.

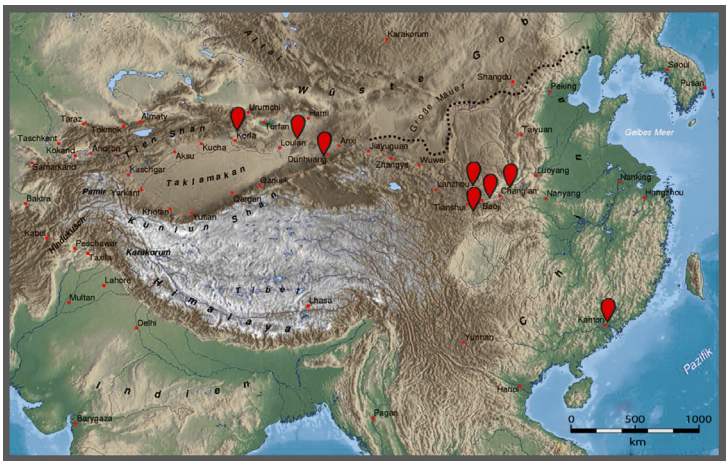
[13] Ibidem, p. 8.

[14] J.-P. Drège, op. cit., p. 645.

Fig. 1. Paper fragments examined by Pan Jixing, dated to the Western Han Dynasty and excavated in China (Summary based on J. Pan, *Review on the debate*…, 2011, p. 6)

	Name of paper	Assumed date of production	Discovery date	Size cm	Excavations	Pan Jixing's notes
1.	*Lobnor paper*	49 BCE	1933	4 × 10	Lobnoor, Xinjiang scientific excavation	Burnt in 1937
2.	*Baqiao paper*	Before 138 BCE	1957	10 × 10	Baqiao grave area, Xian	Rough, low degree of beating
3.	*Jingguan paper*	52 - 3 BCE	1973	9 × 11.5	ruin in Jinguan, Gansu	Without characters
4.	*Zhongyan paper*	1 - 55 CE	1978	6.8 × 7.2	ruin in Zhongyan, Fufeng region, Shaanxi	Without characters
5.	*Majuanwan paper*	65 - 25 BCE	1979	9 × 15.5	ruin in Majuanwan near Dunhuang	Without characters
6.	*Xianggang paper*	122 - 121 BCE	1983	3 × 4	grave of Nanyue King on Xianggang Hill, Guangzhou	Similar to the *Baqiao paper*
7.	*Fangmatan paper*	176 - 141 BCE	1986	2.6 × 5.6	grave area of the Qin-Han in Fangmatan, Tianshui, Gansu	A map drawn on the paper
8.	*Xuanquan paper*	140 - 7 BCE	1990	7 × 13.5	Xuanquan ruin at Tianshui Well near Dunhuang, Gansu	Characters written on the paper

Fig. 2. Map of early paper samples dated to the Western Han Dynasty unearthed by archaeologists (Map prepared by Olga Ważny)



Cotton paper from India and rag paper from China

The debate on whether cotton paper originated in India and predated Chinese paper returned in the nineteen eighties. Since 1984 paper technologist Prabhakar Gosavi has claimed that paper made of cotton was actually an Indian invention that then transferred to China via Turkestan[15]. He argues that the Chinese did not know the art of beating cotton to make paper, while Indians had done this since 327 BCE. He refers to Nearcticus (Nearchus), the Alexander the Great's ambassador to Punjab, who supposedly stated that Indians used to make paper by beating cotton derived from cloth[16]. Soon after, however, contradictory views emerged, that Indians use no letters at all[17]. These sources alone are unconvincing, since writing supports may have been described symbolically at that time, or old Latin words may have been mistranslated. Gosavi further asserts that this cotton paper was then used by Sogdian traders, who passed on the technology of papermaking to China. He further explains that paper in China was developed by pounding mulberry bark and that cotton first appeared much later in Eastern China, so all the papers among the Dunhuang manuscripts that contained cotton fibres must have been produced in India[18]. In this argument, however, he ignores that it has been an accepted fact for at least a century that the Chinese produced rag paper even before they used paper mulberry. The addition of singular cotton fibres therefore only suggests that cotton was added to other rags used in making this paper. This conclusion is especially supported by the fact that no pure cotton papers were found until recently among any of the manuscripts found along the Silk Road and dated to the first millennium.

Archaeological findings in a tomb from the Eastern Han Dynasty (25-220 CE) show that Xinjiang began to use cotton textiles no later than the third century CE[19]. More tombs from the third and fourth centuries yielded cotton

[15] P.G. Gosavi, *Did India invent paper?*, "Tappi Journal" 1984, vol. 67, no. 2, p. 42; idem, *Does Hand Made Paper (100% Cotton Rags) Need Acid Free Conditions?*, "Paper History" 2000, vol. 10, no. 3, pp. 54-56.

[16] P.G. Gosavi, *Did India invent*…, op. cit., pp. 42-44.

[17] For all discussion on the knowledge and use of letters by Indians based on Greek and Roman written sources, see F.M. Müller, *A History of Ancient Sanskrit literature*, Varanasi 1968, pp. 472-473.

[18] P.G. Gosavi, *Does Hand Made Paper*…, op. cit., pp. 54-56.

[19] Grey cotton cloths were produced as early as the last years of Eastern Han Dynasty, and then cotton was introduced to the Central Plains of China, see C. Weiji, *History of textile technology of ancient China*, New York 1992, p. 447. It is usually assumed that cotton found its way to Xinjiang from India, but the details of the route of transfer are unknown. We know that it was a commodity traded along the Silk Road. Evidence from Gurukly Depe (Turkmenistan) discussed by Dominika Kossowska-Janik, for example, suggests that cotton fibre may have played a major rôle in the textile economy of the Late Sasanian period at Gurukly Depe. Based on archaeological data, an increase

cloth[20]. According to notes found in the Dunhuang manuscripts, Turfan had been planting cotton and weaving even before the seventh century[21]. In early times cotton tended to be planted and used in regions populated by minorities, and only reached the most populous areas of inland China during the thirteenth century. Likely due to the fact that Chinese people had begun to plant hemp and breed silkworms during the Neolithic Age, they may not have needed to search out other fibre sources. Hemp and silk would have been sufficiently abundant to satisfy the market's requirements for clothing in early times. The fibre of cotton is, moreover, far shorter than that of hemp and silk, and thus more difficult to weave. When cotton was brought to China, the ability of the Chinese to weave cotton lagged behind its ability to weave hemp and silk, and it would have been more time consuming[22]. It was not until the thirteenth century, during the Yuan Dynasty, that the Chinese ability to weave, by means of spinning machinery, in the Hainan province reached the lower reaches of the Yangtze River and cotton planting was promoted. All this suggests that before the thirteenth century the availability of cotton plants was limited and that they were precious. After the fourteenth century, by contrast, silk became rare and precious. This demonstrates that the addition of cotton fibres in Dunhuang manuscripts does not suggest Indian provenance or anything unusual. It may, however, suggest that the paper used for those manuscripts would have been produced in local regions inhabited by minorities rather than in China proper at that time.

During the last century the credit for inventing rag paper has gone to a number of cultures, from Italians and Germans to Arabs and Persians, and the Chinese. The Chinese provenance of rag paper has finally been confirmed by the first results of fibre analyses from the Dunhuang manuscripts and other paper fragments excavated in Central Asia[23].

Joseph von Karabacek in fact supported the view that either Arabs or Persians produced the first rag paper based on linen and hemp, and he

in the use of cotton took place during the Parthian period (c. 250 BC-225 AD) in the Near East. Cotton textiles were imported from Arabia, Egypt, and probably India, but it is probable that only in this period did cotton begin to be introduced to the Near East and Central Asia as a crop. See D. Kossowska-Janik, *Cotton and Wool: Textile Economy in the Serakhs Oasis during the Late Sasanian Period, the Case of Spindle Whorls from Gurukly Depe (Turkmenistan)*, "Ethnobiology Letters" 2016, vol. 7, no. 1, p. 113.

[20] C. Weiji, op. cit., p. 447-448.

[21] Ibidem, pp. 180-181.

[22] Ibidem, pp. 131-144.

[23] J. von Wiesner, *Ein neuer Beitrag zur Geschichte des Papieres*, "Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Philosophisch-Historische Classe" 1903, vol. 148, pp. 1-26; R.H. Clapperton, *Paper: An Historical Account of Its Making By Hand from the Earliest Times Down to the Present Day*, Oxford 1934.

rejected the idea that the Chinese could have produced the first rag paper, mostly by citing the date of 940 CE as the beginnings of making paper from rags in China. It appears that the credit for the development of rag paper moved from Europe to China, exactly in the opposite direction from that of the spread of paper, from China to Europe. In fact, there are many conflicting arguments on the origin of paper and its spread, especially when taking into account scarce primary written sources. This suggests that theories based on written sources need to be verified by material evidence whenever possible[24]. They should also be viewed in a larger geographical context (cross-cultural and cross-disciplinary). It is thus inappropriate to posit that cotton paper was used in India before rag paper in China, especially in light of the fact that Julius von Wiesner and Joseph von Karabacek clearly denied its existence at the beginning of the twentieth century and nobody else has since been able to provide other substantial evidence[25].

Providing such evidence requires a great deal more research on fibre analysis and technical aspects useful in resolving problems on a statistically representative group of manuscripts. Current research on fibre analysis shows that cotton fibres are only an incidental component of rag paper of ramie, hemp, jute and paper mulberry varying combinations[26]. In my entire sample of 350 manuscripts from the Silk Road that have been tested for their fibre composition, a very small incidence of cotton was found in only two examples of the Chinese and Sogdian fragments from Turfan. Fibre analyses performed by Anna-Grethe Rischel and Kazuyuki Enami also report discovering only singular fibres of cotton in a small group of manuscripts, but never paper made purely of cotton pulp.

This suggests that cotton was but a minor addition to paper in the Silk Road manuscripts, and that there is little reason now to believe that this cotton was brought from India in the form of paper rather than rag. Neither do the Sogdian manuscripts seem obvious candidates as potential sources of Indian paper, since they were written at Dunhuang and farther east, more in the Chinese sphere of influence. The earliest dated examples of Sanskrit and Tocharian manuscripts should rather be considered for fibre analysis,

[24] For discussion based on written sources, see for example: T.-H. Tsien, op. cit., D. Hunter, op. cit., and J.-P. Drège, *Le papier dans la Chine impériale. Origine, fabrication, usages*, Textes présentés, traduits et annotés par Jean-Pierre Drège. Paris, Les Belles Lettres (Bibliothèque chinoise, 24), 2017.

[25] J. von Wiesner, op. cit.; J. von Karabacek, *Arab Paper*, transl. by D. Baker and S. Dittmar with additional notes by D. Baker, London 2001.

[26] The presence of single cotton fibres in rag paper from Central Asian manuscripts has been confirmed by microscopic analyses performed in the last decades by, for example, A.-G. Rischel, K. Enami and A. Helman-Ważny. None of papers examined, however, contained cotton fibre in amounts sufficiently sufficient to predispose it to be referred to as 'cotton paper'.

since due to early dating and cultural connections their paper may contain amounts of cotton fibres. China may not in fact have been the only ancient centre of papermaking technology, but we still have no irrefutable evidence for alternative centres, and the Chinese origins of paper are supported by written and archaeological evidence. It is also usually accepted that paper was unknown in India at that time.

The spread of papermaking technology

Chinese Buddhist monks and missionaries carried paper and papermaking itself at an early date to Korea and Japan. According to written sources referenced by many scholars, by 751 CE paper production had spread westward to Arabia via Samarkand[27]. There is a story about Chinese papermakers who were taken prisoner by the Arab army in the battle of Talas and who later settled in Samarkand. The Arabs supposedly learned the craft of papermaking from the Chinese prisoners and built the first paper mill in Baghdad sometime between 793 and 795 CE[28]. Though papermaking may have been practiced in Samarkand long before the battle[29]. By around that time papermaking had spread west of the Pamirs, probably not because of one event, but rather through a gradual transmission via a good many routes. The craft continued to spread gradually from Islamic Asia to Europe and, from there around the world. Little documentary evidence survives of the processes involved in book and paper production in the Byzantine Empire. What information we do possess tends to have been gathered from the surviving books themselves. The earliest written in Greek manuscript on paper was made around the 800 CE.

The westward spread of papermaking through Chinese Turkestan and along the Silk Road has been widely investigated, but its migration to the south towards the Himalayas, including Tibet and Nepal, and to India remains to be studied in detail. When we consider the dissemination of papermaking technology to the south, most scholars assume two possibilities for the route via which papermaking may have reached India. One is from China through Central Asia, Tibet and Nepal; the second through Islamic traders in the Indian Ocean and,

[27] E. Sutermeister, *The Story of Papermaking*, Boston 1954, p. 10.

[28] The date for the first paper produced in Baghdad differs slightly according to different sources. According to Dard Hunter, the date is 793 CE (see D. Hunter, *Papermaking. The History and Technique of an Ancient Craft*, New York 1978, p. 469), but according to Karabacek, the date is 794 or 795 CE (see J. von Karabacek, *Arab*…, op. cit., p. 27).

[29] J.M. Bloom, *Papermaking: The Historical Diffusion of an Ancient Technique*, [in:] *Mobilities of Knowledge. Knowledge and Space*, ed. by H. Jöns, P. Meusburger, M. Heffernan, Cham 2017, pp. 51-66.

later, via the Muslim invaders who invaded India from the thirteenth century onwards[30]. It is notable that several of the later centres of papermaking are Islamic-founded cities[31]. Perhaps the knowledge of papermaking arrived from more than one source.

Crucial for an understanding of the dissemination of papermaking from China to Tibet, Nepal, Bhutan, Burma and Thailand was the migration of Chinese communities that manufactured paper for their own needs. The development of papermaking in these countries was spurred on by Buddhist monks who copied vast tracts of religious literature. Many devout monks from all over Asia travelled in order to bring back the true word of the Buddha. Corridors connecting Tibet and other Himalayan regions across the Himalayas clearly facilitated the development of the distinctive crafts of papermaking and bookmaking in the region. Jahar Sen, in accordance with Bal Chandra Sharma, puts the beginning of India's commercial relationship with Nepal and Tibet as early as the fifth century BCE[32]. He maintains that there was trade between north-eastern India and south-western China in Chinese silk cloth and Chinese bamboo flutes, among other things. These were brought into Eastern India and were carried the entire length of northern India to as far west as Afghanistan and Central Asia. A continuous flow of commerce along the overland trade route from Bihar to Tibet and China through Nepal has been conjectured and the Nepal route played a surprisingly prominent rôle in the ebb and flow of the trade of Central Asia[33]. Actual figures, however, are lacking[34].

As mentioned above, sources for the dates when paper might have been introduced to and then produced in India are sparse in the extreme. This clearly offers no certainty regarding the origins of paper there. The history of Indian literature may help us to understand the reason it is so difficult to trace these dates. The ancient Vedic texts, created when the Aryan tribes moved into India,

[30] J.M. Bloom, *Paper before Print. The History and Impact of Paper in the Islamic World*, New Haven-London 2001; Losty (1982) makes some remarks about the earliest history of paper manufacture in Nepal, which predated the importation of paper technology from China (see: J. Losty, *The Art of the Book in India*, London 1982).

[31] Karabacek (2001) mentions the later centres of papermaking: Islamic-founded cities such as Ahmedabad, Hyderabad, Faizabad, and Aurangabad (see: J. von Karabacek, *Arab*…, op. cit).

[32] J. Sen, *India's trade with Central Asia via Nepal*, "Bulletin of Tibetology" 1971, no. 8, p. 21.

[33] W. van Spengen, *The Geo-History of Long-Distance Trade in Tibet 1850-1950*, [in:] *The Tibetan History Reader*, ed. by G. Tuttle and K.R. Schaeffer, New York 2013, pp. 491-524; R. Graafen, *The importance of trade for Kāgbeni*, [in:] *Kāgbeni. Contributions to the village's history and geography*, ed. by P. Pohle and W. Haffner, Giessen 2001, pp. 247-252; R. Graafen, C. Seeber, *Important Trade Routes in Nepal and Their Importance to the Settlement Process*, "Ancient Nepal" 1993. no. 133, pp. 34-48.

[34] J. Sen, op. cit., p. 35.

are generally ascribed to the second half of the second millennium BCE[35]. This literature went on to grow over many centuries, but for many generations was handed down orally. First among India's preserved written documents are thousands of inscriptions on stone, copper, iron, silver, gold, brass, bronze, clay, bricks, crystals, ivory and other hard plates, all of which are extremely difficult to date with any precision. Only much later do we have manuscripts written on organic materials such as birch bark, palm leaves, cotton and paper.

The earliest Indian manuscript written on birch-bark strips is dated as early as the first or second century CE[36]. David Diringer dates the earliest extant manuscripts on palm leaves to the fourth and sixth centuries CE[37]. The manuscripts found in Jaina libraries in Gujarat and Rajasthan may be the earliest manuscripts written on paper, which Arthur Macdonell (1900)[38] dates to the early part of the thirteenth century. Diringer (1982) dates the earliest of all preserved Indian manuscripts on paper to AD 1231, now in the Calcutta Sanskrit College (Library catalogue No. 582)[39]. Unfortunately, there is little new research that allows for greater precision in dating these manuscripts.

As with India, there are many and various claims that push back to early times the date the knowledge of papermaking was acquired in Nepal. Most of these claims, however, are unsupported by substantial evidence. Most commonly agreed is that Nepalese paper, used primarily for recording government documents and religious texts, has been known to exist since the twelfth century CE. Manuscripts dated earlier tended to have been written on palm leaves, the oldest known of which are dated to the ninth century and are preserved at the National Archives in Kathmandu, Nepal[40], the University

[35] D. Diringer, *The book before printing: ancient, medieval and oriental*, New York 1982, p. 357.

[36] The manuscript referred here is the Kharoshthi manuscript (the *Dutreuil de Rhins Manuscript*) found in Khotan and preserved partly in Paris and partly in St Petersburg. For more information see ibidem, p. 354.

[37] Ibidem, p. 358.

[38] A.A. Macdonell, *A history of Sanskrit literature*. New York 1900. Online version available at: https://archive.org/details/historyofsanskri00macduoft/page/n8 (accessed on 22.05.2019).

[39] These are the fragments from Kashgar in the Godfrey Collection and the Horiuzji manuscripts written in the cursive characters of the Siddhamatṛka script (pre-Devānāgarī script). See D. Diringer, *The book*…, op. cit., p. 362.

[40] One of the oldest dated manuscripts kept in the National Archives is the manuscript of the *Skandapurāṇa* (NAK 2/229 / NGMPP B 11/4) (Mānadeva Saṃvat 234, corresponding to 810/811 CE) (see R. Adriaensen, H. T. Bakker, H. Isaacson (eds.), *The Skandapurāṇa*, Groningen 1998, p. 33 as 810 CE; K. Harimoto, *In search of the oldest Nepalese manuscript*, "Rivista Degli Studi Orientali" 2011, vol. 84, no. 1/4, pp. 85-106 as 811; B. Bhattarai, *Dividing Texts: Conventions of Visual Text-Organisation in Nepalese and North Indian Manuscripts*, Berlin-Boston 2019, p. 18 as 811 CE following the date verified by Harimoto).

of Cambridge, Cambridge, UK[41], the British Museum in London, UK and the Kesar Library[42] in Kathmandu.

Jesper Trier suggested that techniques of papermaking were transferred to Nepal around 1000 CE[43]. The earliest datable example of twelfth century paper manuscript is probably the illuminated *Pancarakṣā* manuscript at the Asutosh Museum in Calcutta, which according to Masatoshi A. Konishi is written on paper made of four thin layers, glued together, consisting of Thymelaeaceae fibres akin to *Daphne*, as identified microscopically by Trier[44]. Despite uncertainty regarding the date of origin, we know that paper in Nepal began to supplant palm leaves as the dominant writing material from about the twelfth century. A general increase in the production of manuscripts in Nepal took place from the fourteenth century. The progressive proliferation of paper as a writing material culminates in the seventeenth century, when paper replaced palm-leaves almost completely as writing material[45].

In the second half of the fourteenth century the unstable political situation in the neighbouring Tibetan kingdom of Mang yul Gung thang was accompanied by intense cultural activity. Both King Trashi De, who reigned between 1352 and 1363 CE, and King Thrigyal Sonam De, who reigned between approximately 1371 and 1404 CE, commissioned the production of a set of *Kangyur* and *Tangyur*, and the latter king contributed also to the re-establishment of royal lineage and of *Sa skya* patronage over Gung thang, also taking political control of the Glo bo (Mustang) and Dol po areas[46]. He also founded the Gung thang

[41] Cambridge the *Bodhisattvabhūmi* manuscript, see *Bodhisattvabhūmi (MS Add. 1702)*, [online] https://cudl.lib.cam.ac.uk/view/MS-ADD-01702/6 [accessed 27.12.2019]. Just one part of the manuscript of the *Bodhisattvabhūmi* is in fact dated to Nepāla Saṃvat 914 (1794 CE) and the other part may be datable to the ninth century CE on paleographic grounds (K. Harimoto, *The Dating of the Cambridge Bodhisattvabhūmi manuscript Add. 1702*, [in:] *Indic Manuscripts Cultures through the Ages: Material, Textual, and Historical Investigations*, ed. by V. Vergiani, D. Cuneo, C.A. Formigatti, Berlin 2017, pp. 355-376).

[42] One of the oldest dated manuscripts kept in the Kaiser Library is the manuscript of the *Suśrutasaṃhitā* containing an Āyurvedic text (KL 699 / NGMPP C 80/7); Mānadeva Saṃvat 301, corresponding to 878 CE (see L. Petech, *Medieval History of Nepal (c. 750-1482)*, Roma 1984, p. 29; K. Harimoto, *In search*…, op. cit., p. 88; K. Harimoto, *Nepalese Manuscripts of the Suśrutasaṃhitā*, "Journal of Indian and Buddhist Studies" 2014, vol. 62, no. 3, p. 1087; K. Harimoto, *The Dating*…, op. cit., pp. 363-364; B. Bhattarai, *Dividing Texts*, Berlin-Boston 2020, p. 18). Other early palm-leaf manuscripts in the Kesar Library are MS no. 118, dated to 1122 CE, and no. 161, dated to 1182 CE.

[43] J. Trier, *Ancient Paper of Nepal. Result of ethno-technological field work on its manufacture, uses and history – with technical analyses of bast, paper and manuscripts*, Copenhangen 1972.

[44] M.A. Konishi, *Hāth-Kāghaz, history of handmade paper in South Asia*, New Delhi 2013, p. 38; J. Trier, *Ancient Paper*…, op. cit., pp. 132-133, 199.

[45] M.A. Konishi, op. cit., p. 187.

[46] R. Vitali, *A Short History of Mustang (10th-15th century)*, Dharmasala 2012; M. Beck, *Mustang Das Land der Lo-pa: Ein kultureller Reiseführer durch das ehemalige Königreich im nordwestlichen Nepal*, Berlin 2014, p. 15.

chos sde (ca. 1390) and the Shel dkar chos sde, where a printing house (*par khang*) was established. Such large editorial projects required the co-operation of a good many people, including craftsmen who produced the writing materials such as paper and ink. This certainly intensified the development of the manufacture of traditional handmade paper in the region. This was produced at several locations in the rural hills of Nepal.

The historical origins of Tibetan papermaking are difficult to determine. Traditional historiography in Tibet and China would link paper to the arrival of the Chinese wife of Emperor Songtsen Gampo (Srong btsan sgam po)[47]. The *Tang Annals* mention the date 648 CE in a report of the Tibetan emperor Songtsen Gampo's request for paper, ink and other writing equipment from the Chinese emperor[48]. Until the middle of the eighth century, however, most official Tibetan documents were written on wood. The entry for the years 744 CE and 745 CE in the *Old Tibetan Annals* records the transfer of official documents from wooden 'tallies' (*khram*) to paper[49]. That entry also provides the first dated attestation of the word *shog* (paper) in Tibetan literature. It thus appears that by the time writing arrived in Tibet the technology of papermaking was already known not only in the Far East, but also in Central Asia. While there is a suggestion that paper was already available in the Shangshung kingdom, which pre-existed the Tibetan empire, and that the letters of invitation to the Chinese imperial princess had been written on paper, this claim has so far been supported only by relatively late sources[50].

During antiquity a vague knowledge of the Tibetan plateau circulated in the West, while Tibetan people probably already had far better contact with neighbouring countries than is generally supposed. Accounts of relations between Tibet and the world beyond Tibet, however, date only from the early seventh century. The earliest documented contact between Tibet and the world beyond the plateau comes during the Sui dynasty (581-618 CE). Major relations with China date from the Tang dynasty (618-907 CE), which framed the Tibetan imperial period. The Silk Road, which encouraged intellectual and religious exchange, was a trade route that existed for more purposes than trading in silk. Many other commodities were also traded, among them paper. Of all the precious goods crossing this area, silk was perhaps the most remarkable for westerners. Paper was still unknown, and it took a thousand years to be appreciated and fully valued by the west.

---

[47] M.A. Konishi, op. cit., p. 187.

[48] P. Pelliot, *Histoire ancienne du Tibet*, Paris 1961, p. 6.

[49] H. Uebach, *From Red Tally to Yellow Paper: The official introduction of paper in the Tibetan administration in 744/745*, "Revue d'Études Tibétaines" 2008, vol. 14, p. 61.

[50] J. Tsundru, *Preserve and Development of the Manufacturing Technology of Traditional Tibetan Paper*, Lhasa 2010.

During the imperial period Tibet intermittently gained control over crucial parts of the Silk Road and would have been in a position at times to dominate trade between China and the West. At that time the production and circulation of manuscripts intensified. Thousands of manuscripts dated before the tenth century and written in the Tibetan language have fortuitously been discovered at Dunhuang, in Gansu province. Earlier estimates date these manuscripts to the time of the Tibetan occupation of Dunhuang that occurred between 781 and 848 CE, but recent research by Géza Uray, Tsuguhito Takeuchi and Jacob Dalton, Tom Davis, and Sam van Schaik has dated the majority of these manuscripts to the tenth century CE[51]. The earliest surviving examples of Tibetan paper in Dunhuang manuscripts made of *Daphne* fibres are dated to the nineth century CE and are assumed to have been produced in Central Tibet[52].

Material analyses of Central Asian manuscripts

Ideas regarding the history of paper began to change at the beginning of the twentieth century, when archaeological excavations were undertaken and vast new collections brought to Europe by Aurel Stein, Paul Pelliot and others. These collections as they appeared created new opportunities to review the history of paper. Stein commissioned fibre analyses for some of the manuscript papers he brought and the first microscopic examinations of these materials gave rise to the discussion between natural scientists and palaeographers[53]. Some of the earlier stories and ideas were then abandoned, ideas such as that posited by the palaeographers that cotton or silk paper predated the Chinese rag paper mentioned above.

---

[51] G. Uray, *New Contributions to Tibetan Documents from the post-Tibetan Tun-huang*, [in:] *Tibetan Studies: Proceedings of the Fourth Seminar of the International Association for Tibetan Studies. Schloss Hohenkammer - Münich 1985*, ed. by H. Uebach and Jampa L. Panglung, München 1988, pp. 515-528; T. Takeuchi, *Old Tibetan Buddhist Texts from the Post-Tibetan Imperial Period (mid-9 c. to late 10 c.)*, [in:] *Old Tibetan Studies: Proceedings of the 10th Seminar of the IATS 2003*, ed. by C. Scherrer-Schaub, Leiden 2012, pp. 205-216; J. Dalton, T. Davis, and S. van Schaik, *Beyond Anonymity: Paleographic Analyses of the Dunhuang Manuscripts*, "Journal of the International Association of Tibetan Studies" 2007, vol. 3, pp. 1-23.

[52] A. Helman-Ważny, S. van Schaik, *Witnesses for Tibetan Craftsmanship: Bringing Together Paper Analysis, Palaeography and Codicology in the Examination of the Earliest Tibetan Manuscripts*, "Archaeometry" 2013, vol. 55 no. 4, pp. 707-741.

[53] J. von Wiesner, *Über die ältesten bis jetzt aufgefundenen Hadernpapiere. Ein neuer Beitrag zur Geschichte des Papiers*. "Sitzungsberichte der Kais. Akademie der Wissenschaften in Wien, Philosophisch-Historische Klasse", 168. Band, 5, Wien 1911. English translation of the Austrian publication by Anna-Grethe Rischel in this volume. *A.-G. Rischel, Julius von Wiesner and his importance for scientific research and analysis of paper*, "IPH Paper History. Journal of the International Association of Paper Historians" 2014, vol. 18, no. 1, pp. 31-38.

Julius von Wiesner and Thomas Franz Hanausek first prepared botanical references and worked out the fundamentals for the fibre analyses of old papers[54]. In 1903 it was first demonstrated by Wiesner that paper made exclusively from cotton fibres had not been found among manuscripts from Central Asia[55]. This was the pressing matter of the day. Karabacek also noted cotton paper, but he was mainly concerned with the origins and history of paper from an Arab point of view. He explained the myth of cotton paper and confirmed that Arab and Persian sources available to him were totally silent about cotton as the raw material for paper. He ascribed this false hypothesis to a confusion of names used for 'cotton' in a variety of languages and also occasioned by the surface characteristics of paper[56]. His publication *Das Arabische Papier* laid the fundamentals for the European study of Arab paper[57].

In the thirties Robert H. Clapperton examined 15 samples from manuscripts collected by Stein in China[58]. He studied the documents in their entirety for general appearance, thickness and watermarks, and took a sample for fibre analysis. His analyses indicated the presence of ramie, paper mulberry and rattan in the composition of the Stein papers[59]. His results were verified at the end of seventies and Thomas Collings and Derek Milner, who evaluated the same 15 samples dated between 400 and 900 CE[60]. The samples were taken at the same places as Robert H. Clapperton had taken his in 1930, and were analysed using the polarised light technique and the atomic absorption analysis for trace metals, both of which techniques were unavailable to Clapperton. The most significant differences between the two were the Clapperton's failure to notice hemp fibres. The presence of hemp fibres in 10 out of 15 samples was confirmed by Collings' and Milner's examination, who also did not confirm the presence of rattan in any of the samples reported by Clapperton. For the first time here traces of aluminium, potassium and calcium were measured

[54] J. von Wiesner, *Studien über angebliche Baumbastpapiere*, Wien 1892; idem, *Mikroskopische Untersuchung alter ostturkestanischer und anderer asiatischer Papiere nebst Histologischen Beiträgen zur mikroskopischen Papieruntersuchung*, Wien 1902, pp. 583-632; idem, *Ein neuer Beitrag*…, op. cit.; T.F. Hanausek, *The Microscopy of Technical Products*, New York-London 1907, pp. 72-122.

[55] J. von Wiesner, *Mikroskopische Untersuchung*…, op. cit., p. 588.

[56] For a detailed explanation of terms see J. von Karabacek, *Arab*…, op. cit., p. 36.

[57] J. von Karabacek, *Arab*…, op. cit., this essay was first published in 1887 as *Das arabische Papier eine historisch-antiquarische Untersuchung*. Bd. 2-3, Wien 1897.

[58] R.H. Clapperton, op. cit.

[59] Clapperton sampled 15 manuscripts from the Stein Collection (S. 81, S. 86, S. 88, S. 116, S. 227, S. 312, S. 717, S. 797, S. 912, S. 2082, S. 2424, S. 3985, S. 4012, S. 4476, S. 4632).

[60] T. Collings, D. Milner, *The Identification of Oriental Paper-Making Fibres*, "Journal of the Institute of Paper Conservation" 1978, vol. 3, pp. 51-79; idem, *An Examination of Early Chinese Paper*, "Restaurator" 1979, vol. 4, pp. 129-151.

in the paper. This was an attempt to gain confirmation of the use of potassium alum, gypsum or calcium sulphate in order to achieve a greater smoothness of paper for writing[61].

In the thirties Dard Hunter also examined some examples of paper brought by Stein and Sven Hedin. He mentioned several folded papers from Turkestan, which on final analysis under the microscope proved to be formed partly of rag fibres, and he explained that authorities had dated these sheets to about 150 CE[62]. He refrains, however, from either explaining his method of examination of these samples or naming the authorities that had dated this paper and by what criteria. He also observed that many of the early papers from Central Asia were the 'laid' type, featuring an impression of a bamboo sieve print[63]. The papers mentioned earliest were dated to the third century. Clearly dated to 264 CE they were found by Hedin at Loulan, and those dated from 250 to 300 CE were found by Stein in Niya in Turkestan[64]. His references to Central Asian manuscripts and paper suggest that he had no opportunity to examine a large number of samples and that he was mainly concerned with the technological features of these papers.

Central Asian manuscript studies for decades took a turn in a linguistic and historical direction, focusing on cataloguing, which was urgently needed in order to identify and preserve such a vast collection. In the nineties, however, Anna-Grethe Rischel, inspired by Wiesner's methodology, undertook the analyses of Central Asian papers. She began with an examination of 23 Loulan fragments from the Hedin Collection in Stockholm and 5 from the Stein Collection in London[65]. In connection with the digitising of the Turfan Collection in the 2009 and 2010 then she examined a selection of paper fragments from the Berlin Turfan Collection. Results of her fibre identification of 62 Old Turkish fragments are published in the appendix of *Alttürkische Handschriften*[66].

Her examination of Loulan manuscripts revealed that the third century Loulan papers are a mixture of recycled hemp, ramie, linen and mulberry fibres. In addition to fibre analysis she also interpreted technological features

---

61 Idem, *An Examination of Early*…, op. cit., p. 146.

62 D. Hunter, *Papermaking*…, op. cit., p. 466.

63 Ibidem, p. 84.

64 Ibidem, p. 467.

65 A.-G. Rischel, "Written Materials Excavated from the Sands: A study on Lou-Lan and Niya documents" The Report of a joint study of the Hedin Collection in Sweden: Part 2 Documents from Central Asia.

66 S.-C. Raschmann, A.-G. Rischel, *Old Turkish Fragments from the Berlin Turfan Collection. Paper analysis of 62 manuscripts and block prints*, [in:] *Alttürkische Handschriften*. Teil 18: *Buddhica aus der Berliner Turfansammlung*. Teil 1: *Das Apokryphe sutra Säkiz Yükmäk Yaruk*, Stuttgart 2012, pp. 265-311, 26 udg., Chapter Appendix.

of the paper[67]. A macroscopic examination of the Turkish fragments revealed a difference in paper quality of 21 block prints (soft and thin with an average of 17 laid lines per 3cm) and 41 manuscripts (stiff and thin with an average of 12 laid lines per 3cm). The block print papers, together with 8 manuscripts, were made of pure mulberry fibres. The paper of the remaining 33 manuscripts was made of recycled ramie, hemp, flax and cotton fibres, in 4 cases also mixed with mulberry fibres. In both Tocharian and Sanskrit manuscripts she detected paper mulberry fibres in three of the 32 Tocharian manuscripts analysed, and in 30 of 66 Sanskrit manuscripts. 29 manuscripts were also written on rag papers, of which 7 also contained traces of mulberry fibres.

At the same time Enami and his collaborators examined paper dated to between the fourth and eighth centuries CE in manuscripts unearthed around the Tarim Basin and now kept at Ryukoku University, the Kyoto National Museum and Toyo-Bunko (Asian Library, Tokyo). Using Keyence VHX-500 and VHX-5000 high resolution digital microscopes he detected hemp, mulberry, foxtail millet and cotton. Enami's team also documented paper fragments made of rag paper found in Chinese military camps in Central Asia[68]. In addition to digital microscopy they also used X-ray Fluorescence to record elements in paper, mathematical analysis of laid line patterns in paper and smart image analysis techniques. This is an innovative methodology that allows the examination of fibres in the paper structure without sampling. It fails, however, to reveal anatomical details if the paper surface is sized or additionally treated with other substances. The main topics addressed by Enami and his followers were the transition from rag paper to plant fibre technology, the use of grass, cereal straw, reed stalks and bamboo for papermaking in Central Asia and mainland China, as well as forgeries among the Dunhuang manuscripts[69].

Along the same lines since 2005 I have undertaken systematic work on fibre analyses in collaboration with Susan Whitfield and Sam van Schaik as part of the International Dunhuang Project at the British Library. Between 2010 and 2013 I continued in collaboration with Michael Friedrich at the Asia and Africa Institute

[67] A.-G. Rischel, *Through the Microscope Lens: Classification of Oriental Paper Technology and Fibres*, [in:] *Looking at Paper: Evidence & Interpretation: Symposium Proceedings, Toronto 1999*, Ottawa 2001, pp. 179-188.

[68] K. Enami, S. Sakamoto, Y. Okada, *Origin of the difference in papermaking technologies between those transferred to the East and the West from the motherland China*, "IPH Paper History: Journal of the International Association of Paper Historians" 2010, vol. 14, no. 2, pp. 12-22.

[69] K. Enami, S. Sakamoto, Y. Okada, K. Masuda, *Paper made from Millet and Grass Fibre found in the Secular Documents of Pre-Tang and Tang Dynasty*, http://zopeman64.bbaw.de/bbaw/Forschung/Forschungsprojekte/turfanforschung/bilder/Vortrag_Enami.pdf; K. Enami, H. Ishizuka, E. Akao, Y. Okada, *History of Chinese paper witnessed by paper itself: Scientific analysis of paper used for Chinese manuscripts, documents and books of ancient to premodern eras preserved in Japan*, paper presented at the workshop "Chinese Paper as Writing Support: Terminology and Standards" hosted by the Centre for the Study of Manuscript Cultures, University of Hamburg.

at the University of Hamburg as part of a DFG-funded project[70]. The project primarily focused on Chinese manuscripts found in Dunhuang and then expanded to include manuscripts of other affiliations, such as Tibetan, Uighur, Sogdian, Tocharian and Manichaean. In 2010 a total of 350 manuscripts were selected from the Dunhuang collections in the British Library in London, the National Library of France in Paris (Bibliothèque Nationale de France), the Institute of Oriental Manuscripts in St. Petersburg (Институт восточных рукописей Российской академии наук) and from the Turfan collection in the Berlin Brandenburg Academy of Sciences (Die Berlin-Brandenburgische Akademie der Wissenschaften) and the Berlin State Library (Staatsbibliothek zu Berlin).

The predominant themes of this research, published in collaboration with specialists in philology, history, chemistry and mineralogy include the identification of materials from which manuscripts were made[71], the comparative studies of different culturally-affiliated groups of manuscripts[72], the development of cross-disciplinary methodologies[73] and the exploration of the possibilities of dating and determining the origin of the manuscripts discovered in the early twentieth century in Dunhuang and Turfan[74]. The above mentioned project also constituted a good opportunity to examine the small group of the most interesting manuscripts as case studies. One of most important

[70] My research at that time was funded by the German Research Foundation (DFG), Project No: 169966949, 08/11/2010 – 30/11/2013, PI: Prof. Michael Friedrich, entitled: *History and typology of paper in Central Asia during the first millennium AD: Analysis of Chinese paper manuscripts*. Department of Chinese Language and Culture, Asia and Africa Institute, University of Hamburg, Germany.

[71] A. Helman-Ważny, *More than meets the eye: Fibre and Paper Analysis of the Chinese Manuscripts from the Silk Roads*, "STAR: Science & Technology of Archaeological Research" 2016, vol. 2, no. 2, pp. 127-140; idem, *A Preliminary Study of the Paper of the Diamond Sutra (Or.8210/P.2)*, "International Dunhuang Project News" 2011-2012, vol. 38, pp. 6-7.

[72] D. Durkin-Meisterernst, M. Friedrich, O. Hahn, A. Helman-Ważny, R. Nöller, S.-C. Raschmann, *Scientific methods for philological scholarship: Pigment and paper analyses in the field of manuscriptology*, "Journal of Cultural Heritage" 2016, vol. 17, pp. 7-13.

[73] In our paper *Scientific methods for philological scholarship*…, op. cit., members of three research teams, i.e. the Turfan Project from the Berlin Brandenburg Academy of Sciences and Humanities, the Berlin-based research project on pigments in Central Asian paper manuscripts, and the Hamburg-based project on the history and typology of Central Asian paper manuscripts present some of the results of their co-operation. The manuscripts examined belong to the Berlin Turfan Collection. On the basis of different examples the contribution of scientific methods to philological scholarship within a multidisciplinary approach is demonstrated.

[74] A. Helman-Ważny, S. van Schaik, op. cit., pp. 707-741. Further results of this study were published in collaboration with S. van Schaik, curator of the Tibetan collection of the Dunhuang manuscripts at the British Library, and Renate Nöller, mineralogist from the Bundesanstalt für Materialforschung und -prüfung and other scholars: S. van Schaik, A. Helman-Ważny, R. Nöller, *Writing, painting and sketching at Dunhuang: Assessing the materiality and function of early Tibetan manuscripts and ritual items*, "Journal of Archaeological Science" 2015, vol. 53, pp. 110-132; B. Dotson, A. Helman-Ważny, *Codicology, Paleography, and Orthography of Early Tibetan Documents: Methods and a Case Study*, Wien 2016.

was the Diamond Sutra (Or.8210/P.2), the world's earliest complete surviving example of a printed book, dated to 868 CE[75]. This scroll, a continuous length of over 5 m of wood-block printed text, comprised seven panels of good-quality paper pasted together. The fine quality of the print is due to the choice of complementary ink thickness and type of paper. This conscious selection of materials created fine lines with sharp edges, displaying a highly refined printing technique. The visual appearance of paper is affected by the type of raw material used, the technological process of paper production and the tools used, and finally from the preparation of leaves during production of the book. A further aim of this study was to improve our knowledge of archaeometric research considered together with a revision and test of scientific methodology that may go on to be used for historical and philological scholarship.

Material analyses and the early paper history re-visited

Our knowledge about the beginnings and early history of paper remains fragmentary. We clearly do not know whether the dates provided in written evidence are salient in the history of papermaking. In fact, there exist no written records of papermaking in Central Asia in any of the languages known in the region, but this does not mean that paper was not produced there at that time. Since written sources cannot be sufficiently conclusive on the origins of papermaking, archaeological and material evidence is gaining in importance. Information provided by material analyses of manuscripts from Central Asia, which appears to have been a key region for early history of paper may help to fill some of the gaps and to better understand the whole picture.

As figure 3 shows, the existing paper manuscripts dated as early as to the third century CE found at sites in Gaochang, Loulan, Kucha, Khotan, Dunhuang and Turfan could be used to reconstruct the complete history of paper in Central Asia between the third and thirteenth centuries by analysing the paper of these existing artefacts, that witnessed a thousand years of paper production (Fig. 3). Since many of the Chinese manuscripts being studied (in fact the oldest preserved and dated artefacts from Central Asia) are fixed in time by dates given in colophons, they are reliable references points for building a typology of paper and for the comparative study of any yet-to-be-discovered papers from that region.

Paper is one of the most important physical features of a manuscript. The study of paper reveals the story of the manuscript and critically supplements its content, unveiling the untold details of its making. Careful attention to paper on a microscopic scale reveals the methods of its production and

[75] A. Helman-Ważny, *A Preliminary*…, op. cit., pp. 6-7.

discloses the plants used in the process. By characterising the paper optic and identifying the fibre composition, we may recover the history and geography of papermaking. The scientific analysis of paper fibres in particular offers an independent and objective source of information, a source that should be treated equally to the primary written sources and archaeological evidence.

Fig. 3. Summary of dating of the earliest preserved manuscripts from the Silk Road region based on Sam van Schaik

Site	Date range	Key Languages	Book forms	Materials and Techniques
Gandhara	1st – 3rd c.	Gandhari, Sanskrit	Scroll, *Pothi*	Birch-bark, palm-leaf manuscripts
Kucha	3rd – 6th c.	Sanskrit, Tocharian	*Pothi*	Paper, palm-leaf manuscripts
Khotan	4th – 8th c.	Sanskrit, Khotanese	*Pothi*	Paper manuscripts
Dunhuang	5th – 10th c.	Chinese, Tibetan, Khotanese, Turkic	Scroll, *Pothi*, Concertina, Codex	Paper manuscripts and printed books
Turfan	9th – 13th c.	Chinese, Tibetan, Turkic, Syriac	*Pothi*, Codex	Paper manuscripts and printed books

There is a wide range of different types and qualities of paper found in existing early manuscripts from Central Asia. Both paper of recycled textile fibres from rags as well as paper of new bast fibres were identified. In my sample of Chinese manuscripts the rag papers appear almost alone in manuscripts dated to the fifth and sixth centuries CE, and only a few manuscripts on rag paper are dated to between the seventh and ninth centuries, while this increases in the tenth century. According to secondary literature on papermaking around the tenth century, rag paper declined because of the shortage of raw materials and hence its high production cost. After rag paper the second largest group represented among the Turfan and Dunhuang manuscripts contains paper composed of woody plant inner-bark (*phloem*) fibres, such as *Broussonetia* sp. (paper mulberry) or *Morus* sp. (mulberry), derived from living plants. These are considered the best materials for producing high quality paper. In my sample I observed that paper made of mulberry or paper mulberry began to reach an equal footing with rag paper at the end of the seventh century, and then to prevail in the eighth. The documents about papermaking after the Song Dynasty (960-1279) occasionally mention rag paper and this is also confirmed

by the greater variety of plant components identified in manuscripts dated later than the tenth century. The inner white bark of paper mulberry from indigenous trees may have grown wildly or may have been cultivated for this purpose. In addition to paper mulberry in Tibetan manuscripts dated from ninth century *Daphne* sp. fibres were also found.

The rag paper is supposed to be found in all groups of manuscripts irrespective of the script in which they are written. It includes a good many of the Sogdian and Turkic manuscripts fragments produced in the Western regions of the Silk Road as far as Samarkand, located at the junctions of trade routes from China and India. The Arabs in the eighth century must therefore have witnessed the production of rag paper in Samarkand. The more advanced Chinese production of paper from pure new bast fibres had already developed in the third century according to Hedin's Chinese paper fragments from Loulan and according to Stein's Sogdian paper fragments. The technology did not spread westwards as far as Samarkand, but eastwards and southwards, where plants of the Moraceae and Thymelaeaceae families were available.

The findings concerning the use and distribution of paper in the selected manuscripts show the range of materials which might point to the provenance of the paper[76]. If the fibre consists of pure mulberry and the mould screen is made of bamboo splits, the paper is most likely of Chinese or more Eastern origin, but if the paper consists of a mixture of rag fibres and the mould is made of reeds or bamboo, the provenance cannot be given with any degree of precision, since rags could travel and be turned into paper anywhere. Rag paper may be produced anywhere along the Silk Road, but mulberry paper can only be produced in a region where mulberry trees grow. The technological development and the fact that bast fibres allowed the production of thinner, more even and better-quality paper, however, so we may hypothesise that the centres of rag paper production were more often located in the desert regions, where mulberry trees were sparce, and were used for breeding silk worms rather than for paper production. The rag-paper technology continued unchanged in regions with no natural growth of plants necessary for the production of paper, whereas the chemical maceration of new bast fibres continued in China and spread to Korea, Japan, Tibet, Nepal and other regions where these plants occurred.

The woven type of paper made with a textile sieve, in written sources assumed a characteristic of the oldest and most primitive technology, appeared to characterise a minority of my samples and, in dated papers, appeared only after 692 CE. The woven paper was represented more in samples of bark

[76] R. Nöller, A. Helman-Ważny, *The Materials of Turfan and Dunhuang Manuscripts: Analysis of Paper, Pigments and Dyes*, "International Dunhuang Project News" 2013, vol. 41, pp. 6-7.

(*phloem*) paper made of paper mulberry and mulberry. It is also worthy of note that all of the oldest samples dated by colophons to the fifth century CE were made of ramie and hemp rags. Their laid patchy paper additionally characterised by irregular laid lines suggests the use of a sieve made of reed or grass rather than bamboo. This type of paper, characterised by the above-mentioned combination of features does not appear in later dated manuscripts. The paper type I have found most widely associated with early paper produced locally around Dunhuang and Turfan is thus thicker rag paper characterised by 12 to 18 laid lines per 3 cm, often with uneven fibre distribution within a sheet. A second type that could have been produced along the eastern part of the Silk Roads is paper characterised by between 27 and 33 laid lines per 3 cm made of paper mulberry and mulberry.

The macroscopic observations suggest that the floating mould with a fixed screen of woven textile was replaced by the dipping mould equipped with the loose screen made of reeds as early as in the third century. Reeds were then used and soon thereafter bamboo sieves were more often used in the areas where these plants grow, but it cannot be excluded that the screens of papermaking sieves were also traded along the Silk Road and occasionally used in the more deserted Western regions. In the Himalayan regions woven moulds have been preferred up until today. This shows that the technological development of papermaking was conditioned by a number of co-existing factors, such as the local availability of raw materials and tools, as well as cultural habits originating from locally known technologies. The results also show that artists and scribes made technological choices regarding paper depending on the function of the objects they were creating. Understanding the broader Central Asian context of these results will depend on future analysis of material from other archaeological sites.

With regard to books in great numbers and large collections of manuscripts from along the Silk Road it is difficult to say when a group of manuscripts examined is sufficiently large to create historically valid results. From Wiesner's time until today scholars have managed to subject approximately 1500 Silk Road manuscripts to fibre analyses. Statistically, it is probably still too few, though sufficiently large to complete a history of paper with a great deal of valuable information. It is significant when we compare it to the scarce and vague information in the written sources. There are still vast collections of manuscripts available for research. Britain holds a collection of about 50,000 manuscripts, paintings and artefacts from Chinese Central Asia, as well as thousands of historical photographs, mostly from the first three Central Asian expeditions of Stein[77]. The largest

[77] See *British collections: Contents and Access*, International Dunhuang Project website,

collection of Dunhuang materials in China, held in the National Library of China, amounts to around 16,000 in total[78].

The challenge for future work is to learn more about the places the paper of those manuscripts was produced. Yet what we have available are paper manuscripts found at Silk Road sites dated as early as the third century CE. By expanding the scope of research from their textual content to their material characteristics, we move beyond legends to a more precise understanding of the early history of papermaking, as well as its defining developments.

Bibliography

Adriaensen R., Bakker H.T. , Isaacson H. (eds.), *The Skandapurāṇa*, Groningen 1998.

Beck M., *Mustang Das Land der Lo-pa: Ein kultureller Reiseführer durch das ehemalige Königreich im nordwestlichen Nepal*, Berlin 2014.

Bhattarai B., *Dividing Texts: Conventions of Visual Text-Organisation in Nepalese and North Indian Manuscripts,* Berlin-Boston 2019.

Bloom J.M., *Paper before Print. The History and Impact of Paper in the Islamic World*, New Haven- London 2001.

Bloom J.M., *Papermaking: The Historical Diffusion of an Ancient Technique*, [in:] *Mobilities of Knowledge. Knowledge and Space*, ed. by H. Jöns, P. Meusburger, M. Heffernan, Cham 2017, pp. 51-66.

Bodhisattvabhūmi (MS Add. 1702), [online] https://cudl.lib.cam.ac.uk/view/MS-ADD-01702/6 [accessed 27.12.2019]

British collections: Contents and Access, International Dunhuang Project website, [online] http://idp.bl.uk/pages/collections_en.a4d#2 [accessed 02.10.2020].

Clapperton R.H., *Paper: An Historical Account of Its Making By Hand from the Earliest Times Down to the Present Day*, Oxford 1934.

Collings T., Milner D., *An Examination of Early Chinese Paper*, "Restaurator" 1979, vol. 4, pp. 129-151.

Collings T., Milner D., *The Identification of Oriental Paper-Making Fibres*, "Journal of the Institute of Paper Conservation" 1978, vol. 3, pp. 51-79.

Dalton J., Davis T., and van Schaik S., *Beyond Anonymity: Paleographic Analyses of the Dunhuang Manuscripts*, "Journal of the International Association of Tibetan Studies" 2007, vol. 3, pp. 1-23.

Dąbrowski J., *Remarks on the Invention of True Paper by Cai Lun*, "IPH Congress Book" 2006, vol. 16 Special Edition, pp. 5-16.

[online] http://idp.bl.uk/pages/collections_en.a4d#2 [accessed 02.10.2020].

[78] Ibidem.

Dąbrowski J., *Kwestia jedwabiu w wynalazku papieru przez Cai Luna*, [in:] *Emanations: To professor Jerzy Malinowski on the occasion of his 70th birthday. Fine Arts Diary 2020*, no. 15, pp. 149-153.

Diringer D., *The book before printing: ancient, medieval and oriental*, New York 1982.

Dotson B., Helman-Ważny A., *Codicology, Paleography, and Orthography of Early Tibetan Documents: Methods and a Case Study*, Wien 2016.

Drège J.-P., *Les débuts du papier en Chine,* "Comptes rendus des séances de l'Académie des Inscriptions et Belles-Lettres" 1987, vol. 131, no. 4, pp. 642-652; [online] http://www.persee.fr/doc/crai_0065-0536_1987_num_131_4_14537.

Drège J.-P., *Le papier dans la Chine impériale. Origine, fabrication, usages*, Textes présentés, traduits et annotés par Jean-Pierre Drège. Paris, Les Belles Lettres (Bibliothèque chinoise, 24), 2017.

Durkin-Meisterernst D., Friedrich M., Hahn O., Helman-Ważny A., Nöller R., Raschmann S.-C., *Scientific methods for philological scholarship: Pigment and paper analyses in the field of manuscriptology*, "Journal of Cultural Heritage" 2016, vol. 17, pp. 7-13.

Enami K., Sakamoto S., Okada Y., Masuda K., *Paper made from Millet and Grass Fibre found in the Secular Documents of Pre-Tang and Tang Dynasty*, http://zopeman64.bbaw.de/bbaw/Forschung/Forschungsprojekte/turfanforschung/bilder/Vortrag_Enami.pdf

Enami K., Ishizuka H., Akao E., Okada Y., *History of Chinese paper witnessed by paper itself: Scientific analysis of paper used for Chinese manuscripts, documents and books of ancient to premodern eras preserved in Japan*, paper presented at the workshop "Chinese Paper as Writing Support: Terminology and Standards" organised by The Centre for the Study of Manuscript Cultures, University of Hamburg.

Enami K., Sakamoto S., Okada Y., *Origin of the difference in papermaking technologies between those transferred to the East and the West from the motherland China*, "IPH Paper History: Journal of the International Association of Paper Historians" 2010, vol. 14, no. 2, pp. 12-22.

Gosavi P.G., *Did India invent paper?*, "Tappi Journal" 1984, vol. 67, no. 2, pp. 42-44.

Gosavi P.G., *Does Hand Made Paper (100% Cotton Rags) Need Acid Free Conditions?*, "Paper History" 2000, vol. 10, no. 3, pp. 54-56.

Graafen R., *The importance of trade for Kāgbeni*, [in:] *Kāgbeni. Contributions to the village's history and geography*, ed. by P. Pohle and W. Haffner, Giessen 2001, pp. 247-252.

Graafen R., Seeber C., *Important Trade Routes in Nepal and Their Importance to the Settlement Process*, "Ancient Nepal" 1993. no. 133, pp. 34-48.

Hanausek T.F., *The Microscopy of Technical Products*, New York-London 1907.

Harimoto K., *The Dating of the Cambridge Bodhisattvabhūmi manuscript Add. 1702*, [in:] *Indic Manuscripts Cultures through the Ages: Material, Textual, and Historical Investigations*, ed. by V. Vergiani, D. Cuneo, C.A. Formigatti, Berlin 2017, pp. 355-376.

Harimoto K., *In search of the oldest Nepalese manuscript*, "Rivista Degli Studi Orientali" 2011, vol. 84, no. 1/4, pp. 85-106.

Harimoto K., *Nepalese Manuscripts of the Suśrutasaṃhitā*, "Journal of Indian and Buddhist Studies" 2014, vol. 62, no. 3, pp. 1087-1093.

Helman-Ważny A., *More than meets the eye: Fibre and Paper Analysis of the Chinese Manuscripts from the Silk Roads*, "STAR: Science & Technology of Archaeological Research" 2016, vol. 2 no. 2, pp. 127-140.

Helman-Ważny A., *A Preliminary Study of the Paper of the Diamond Sutra (Or.8210/P.2)*, "International Dunhuang Project News" 2011-2012, no. 38, pp. 6-7.

Helman-Ważny A., Schaik S. van, *Witnesses for Tibetan Craftsmanship: Bringing Together Paper Analysis, Palaeography and Codicology in the Examination of the Earliest Tibetan Manuscripts*, "Archaeometry" 2013, vol. 55 no. 4, pp. 707-741.

Hunter D., *Papermaking. The History and Technique of an Ancient Craft*, New York 1978.

Karabacek J. von, *Arab Paper*, transl. by D. Baker and S. Dittmar with additional notes by D. Baker, London 2001.

Karabacek J. von, *Das arabische Papier eine historisch-antiquarische Untersuchung*. Bd. 2-3, Wien 1897.

Konishi M.A., *Hāth-Kāghaz, history of handmade paper in South Asia*, New Delhi 2013.

Kossowska-Janik D., *Cotton and Wool: Textile Economy in the Serakhs Oasis during the Late Sasanian Period, the Case of Spindle Whorls from Gurukly Depe (Turkmenistan)*, "Ethnobiology Letters" 2016, vol. 7, no. 1, pp. 107-116.

Laufer B., *Paper and Printing in Ancient China*, Chicago-New York 1931.

Li F., *My View of the Root of Papermaking in Chang'an*, "Hand Papermaking" 1995, vol. 10, no. 2, pp. 10-14.

Ling S., *Bark Cloth Culture and the Invention of Paper-making in Ancient China*, "Bulletin of the Institute of Ethnology, Academia Sinica" 1961, vol. 11, pp. 1-51.

Losty J., *The Art of the Book in India*, London 1982.

Macdonell, Arthur Anthony, *A history of Sanskrit literature*, New York 1900. Online version available at: https://archive.org/details/historyofsanskri00macduoft/page/n8 [accessed 22.05.2019].

Müller F.M., *A History of Ancient Sanskrit literature*, Varanasi 1968.

Nöller R., Helman-Ważny A., *The Materials of Turfan and Dunhuang Manuscripts: Analysis of Paper, Pigments and Dyes*, "International Dunhuang Project News" 2013, vol. 41, pp. 6-7.

Pan J., *Review on the debate of paper history during recent 30 years in China*, "IPH Paper History. Journal of the International Association of Paper Historians" 2011, vol. 15, no. 2, pp. 6-12.

Pelliot P., *Histoire ancienne du Tibet*, Paris 1961.

Petech L., *Medieval History of Nepal (c. 750-1482)*, Roma 1984.

Raschmann S.-C., Rischel A.-G., *Old Turkish Fragments from the Berlin Turfan Collection. Paper analysis of 62 manuscripts and block prints*, [in:] *Alttürkische Handschriften*. Teil 18: *Buddhica aus der Berliner Turfansammlung*. Teil 1: *Das Apokryphe sutra Säkiz Yükmäk Yaruk*, Stuttgart 2012, pp. 265-311.

Rischel A.-G., *Through the Microscope Lens: Classification of Oriental Paper Technology and Fibres*, [in:] *Looking at Paper: Evidence & Interpretation: Symposium Proceedings, Toronto 1999*, Ottawa 2001, Ottawa 2001, pp. 179-188.

Schaik S. van, Helman-Ważny A., Nöller R., *Writing, painting and sketching at Dunhuang: Assessing the materiality and function of early Tibetan manuscripts and ritual items*, "Journal of Archaeological Science" 2015, vol. 53, pp. 110-132.

Sen J., *India's trade with Central Asia via Nepal*, "Bulletin of Tibetology" 1971, no. 8, pp. 21-40.

Spengen W. van, *The Geo-history of Long-distance Trade in Tibet 1850-1950*, [in:] *The Tibetan History Reader*, ed. by G. Tuttle and K.R. Schaeffer, New York 2013, pp. 491-524.

Sutermeister E., *The Story of Papermaking*, Boston 1954.

Trier J., *Ancient Paper of Nepal. Result of ethno-technological field work on its manufacture, uses and history – with technical analyses of bast, paper and manuscripts*, Copenhangen 1972.

Takeuchi T., *Old Tibetan Buddhist Texts from the Post-Tibetan Imperial Period (mid-9 c. to late 10 c.)*, [in:] *Old Tibetan Studies: Proceedings of the 10th Seminar of the IATS 2003*, ed. by C. Scherrer-Schaub, Leiden 2012, pp. 205-216.

Tsien T.-H., *Paper and printing*, Cambridge 1985, Sciences and Civilization in China, ed. J.S Needham, vol. 5.

Tsundru J., *Preserve and Development of the Manufacturing Technology of Traditional Tibetan Paper*, Lhasa 2010.

Uebach H., *From Red Tally to Yellow Paper: The official introduction of paper in the Tibetan administration in 744/745*, "Revue d'Études Tibétaines" 2008, vol. 14, pp. 57-69.

Uray G., *New Contributions to Tibetan Documents from the post-Tibetan Tun-huang*, [in:] *Tibetan Studies: Proceedings of the Fourth Seminar of the International Association for Tibetan Studies. Schloss Hohenkammer - Münich 1985*, ed. by H. Uebach and Jampa L. Panglung, München 1988, pp. 515-528.

Vitali R., *A short history of Mustang (10th-15th century)*, Dharmasala 2012.

Weiji C., *History of textile technology of ancient China*, New York 1992.

Wiesner J. von, *Studien über angebliche Baumbastpapiere*, Wien 1892.

Wiesner J. von, *Mikroskopische Untersuchung alter Ostturkestanischer und anderer asiatischer Papiere nebst Histologischen Beiträgen zur mikroskopischen Papieruntersuchung*, Wien 1902.

Wiesner J. von, *Ein neuer Beitrag zur Geschichte des Papieres*, "Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Philosophisch-Historische Classe" 1903, vol. 148, pp. 1-26.

Wiesner J. von, *Über die ältesten bis jetzt aufgefundenen Hadernpapiere. Ein neuer Beitrag zur Geschichte des Papiers*. "Sitzungsberichte der Kais. Akademie der Wissenschaften in Wien, Philosophisch-Historische Klasse, 168. Band, 5. Abhandlung von J. v. Wiesner, wirkl. Mitgliede der kais. Akademie der Wissenschaften (Vorgelegt in der Sitzung am 10. Mai 1911). English translation of the Austrian publication by Anna-Grethe Rischel in this volume.