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Conference

Authors and Editors in the Literary Traditions of Asian Buddhism

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Material Analysis of Sanskrit Palm-Leaf Manuscripts Preserved in Nepal

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1 Introduction

This article presents the findings resulting from the material analysis of several Sanskrit palm-leaf manuscripts from a corpus partly preserved in Nepal, viz. in the National Archives, Kathmandu (NAK), and in the Kaiser Library (KL), which is likewise situated in Kathmandu. The analysis was undertaken in March 2013. The colleagues of the NAK allocated a room in their precincts to us, where we could set up our mobile laboratory, and gave us access to the required manuscripts from their holdings. The officials of the KL, in turn, allowed us to take some of their valuable and ancient manuscripts to the NAK. In this way, we were enabled to conduct multi-instrumental studies on writing materials of great antiquity and interest.

[1] The findings presented in this article are the results of ongoing research generously funded by the DFG (SFB 950/CSMC, University of Hamburg). The projects involved in the present article are "A Twelfth-Century East Indian Monastic Library and its Fate," and "Material-Scientific Methods for Reconstructing the History of Manuscripts." We would like to use this opportunity to thank the National Archives and the Kaiser Library for granting us access to the manuscripts and the staff of the National Archives for their kind assistance and for hosting us at their institution. We are also grateful to Bidur Bhattarai, Christina Kaminski and Dr. Irina Wandrey (CSMC), Dr. Albrecht Hanisch (Nepal Research Centre/Nepalese-German Manuscript Cataloguing Project) and the German Embassy in Nepal for their support during some or all stages of our journey. We are also greatly indebted to Prof. Dr. Harunaga Isaacson for extremely helpful comments on one of the last drafts of this paper as well as for checking our English on the same occasion.

To the best of our knowledge, the ancient Sanskrit palm-leaf manuscripts preserved in Nepal have hardly ever been chemically and physically analyzed with a multitude of instruments. Only Jesper Trier's pioneering and meritorious investigations are to a certain degree comparable to and overlapping with what we did.[2] It is generally rather astonishing how rarely use of such methods has been made, in particular, if one takes into consideration that the primary *textual* sources which give information or clues regarding the chemical and physical characteristics of ancient Indian writing supports and inks are obviously very limited.[3] Moreover, only material analysis can provide us with information on the *actual* chemical composition of the writing materials in the case of *any* given manuscript.[4] Therefore, we are confident that this article presents truly original findings regarding the rich cultural heritage of ancient Sanskrit manuscripts. However, precisely because we are more or less striking out in new directions here, and because of the limited time we had at our disposal during our journey to Nepal,[5] the reader should not expect here more than some first and – due to

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[2] Trier 1972. Many of Trier's investigations were conducted on research trips to Nepal. They were mainly concerned with Nepalese paper. However, he also analyzed some palm-leaf MSS. In this connection he also made use of XRF spectrography, though in Copenhagen rather than in Nepal. Seemingly, he has for this purpose used manuscript materials from Copenhagen and some fragments from writing supports which have been sent to him. In the present paper, we will make use of his observations several times.

[3] See, e.g., the remarks on primary text passages with ink-recipes made in § 3.2, n. 43 and 44. Regarding the coating of the palm leaves with organic or inorganic substances (see the discussion of this topic in § 3.2), the situation is certainly not better.

[4] This does, of course, not entail that material analysis can render the intensified search for relevant primary texts superfluous. In particular, one should not expect from material analysis that it can provide us, e.g., regarding the ink used, with a full list of its organic and inorganic ingredients and the steps taken in its manufacture, like textual information can do.

[5] The main problem involved was that our instruments arrived at the NAK one week later than scheduled. Nevertheless, we have been able to examine all the MSS that we had preselected for this purpose. However, time constraints made it impossible to make another selection of MSS in the light of the results of our examination of the first set of MSS.

the rather limited number of folios we were able to examine – to a certain degree preliminary insights.

In order to understand the objectives of our examinations, it is necessary to explain the background of our interest in this corpus and to give a brief overview of it.[6] Ongoing research in the Centre for the Study of Manuscripts at the University of Hamburg (CSMC) is devoted to the library or manuscript collection(s) of Vikramaśīla, which was one of the most important and famous Buddhist monasteries of early medieval India. In accordance with the general approach emphasized at the CSMC, we try to gain some insight in various aspects of the physical organization of knowledge at this library including the production and later fate of its manuscripts rather than being interested in these manuscripts only as carriers of texts in certain states of their transmission.

Vikramaśīla was founded by one of the first rulers of the East Indian[7] Pāla dynasty in the early 9th century and was deserted and destroyed about 1200 CE. It can be considered as fairly certain that ruins excavated in the East of present-day Bihar near the South banks of the Ganges and the village of Antichak are the remains of this famous monastic establishment.[8] There can be no doubt

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[6] This overview should not be confused with a full presentation of our research done on this topic. Rather, it should be noted that in the present article results of material analysis and the question of how they contribute to our research forms the main focus of our attention. Considerations that are based on evidence of a different nature (especially palaeography, but also colophons, results of archaeological excavations, study of pertinent primary textual sources etc.) will only be mentioned here in the introduction and throughout our article, when they are necessary for putting the material analysis conducted and its results in context, and presented in due detail in several publications that are in the state of preparation.

[7] In the present contribution, 'East Indian' or 'Eastern India' refers roughly to the area that is nowadays politically divided into the present-day states of Bihar and West Bengal of the Republic of India and the independent country of Bangladesh.

[8] This identification has been made quite early by the Indian excavators of the site. More recently, Sanderson (2009: 88 n. 156) has argued in favour of this assumption. See also the only book-length report on the excavations near Antichak (Verma 2011).

that most of the manuscripts produced there are irretrievably lost. Moreover, none of those that have survived are extant *in situ*. However, a significant number of manuscripts produced in this or other similar monasteries of early medieval East India have been discovered in modern times in Nepal and Tibet. Due to the fact that only a small minority of these important materials bear an explicit mark or note regarding their exact place of origin, it is very hard to determine which of these manuscripts come from Vikramaśīla.

There is, however, a certain relatively large corpus of manuscripts that is likely to provide many interesting new insights on the library of Vikramaśīla. The core (henceforth: group I) of the corpus consists of the following five manuscripts:

1. A complete MS of the *Kalyāṇakāmadhenuvivaraṇa* ascribed to Nāgārjuna. Folio 4 is preserved in Kathmandu under the shelf number NAK 5–20. Henceforth we will refer to this folio as NAK 5–20 (K).[9] All other folios of the manuscript have been found in Tibet.
2. An incompletely preserved MS of the *Trisamayarājaṭīkā* by an anonymous author. Folios 2, 3, 5–9, 11–15, 18, 19 are stored in Kathmandu under the same shelf number as above [henceforth: NAK 5–20 (T)]. Folio 4 has been found in Tibet.
3. A complete MS of the *Ratnāvalī Hevajrapañjikā* [KL 231 (R)] composed by a certain Kamalanātha aka Mañjuśrī, which is available in Nepal.
4. A complete MS of the *Samājamaṇḍalopayikā* or *Viṃśatividhi* by Nāgabuddhi (aka Nāgabodhi), which is preserved in Tibet.
5. A MS of the *Vajrāmṛta*(*tantra*)*pañjikā* by Vimalabhadra. It is likewise preserved in Tibet.

[9] In this article, we have decided to refer to the MSS and manuscript folios simply by the shelf numbers at the respective institution. Since, however, often folios from different MSS are mixed up in one bundle and have hence one and the same shelf number, we have to add a further specification in some cases to avoid ambiguity. In the present case, we add "(K)" to signify that we are referring to the folio of a *Kalyāṇakāmadhenuvivaraṇa* MS.

For material analysis, only those folios could be examined that are stored in Kathmandu. In the case of those manuscripts (or stray manuscript folios) extant in Tibet which are listed under nos. 1, 2 and 4 above, we have at least black-white photographs at our disposal. Unfortunately, we have to rely completely on a catalogue entry in the case of no. 5.[10] All manuscripts of group I have been written at Vikramaśīla. This can be concluded from the fact that in the colophon of the *Kalyāṇakāmadhenuvivaraṇa* manuscript both the place of copying and the person who commissioned the copying of the manuscripts, viz. the "scholar-monk" (*paṇḍitabhikṣu*) Jinaśrīmitra, are mentioned, whereas the colophons of the other four manuscripts only contain the last-mentioned piece of information.[11]

It fits very well to the obviously common origin of the manuscripts of group I that they bear an extra-ordinarily great amount of similarities: All five manuscripts contain texts that belong to Tantric Buddhism and are more or less exegetical in nature. The dimensions of the palm leaves are always the same, and every page consists of seven lines of text surrounded by margins that are likewise of roughly equal size. The spaces cleared for the two binding holes always interrupt the running text of lines 3 to 5 only, and the breadth of these empty spaces is also similar. The manuscripts are written in the so-called Proto-Bengali script as it was widely used in the 12th century CE. Again, the hand-writing is extremely similar in them. They must have been written in the same period (probably rather towards the end of the 12th century), and at present

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[10] Sāṅkṛtyāyana 1937: 45 (catalogue entry no. 303).

[11] There are two objections which one could raise regarding the production of these five MSS at the Indian Buddhist monastery of Vikramaśīla. One of them consists in the fact that a very old monastery in the Kathmandu Valley was sometimes also called by this name. The other possible objection is that Jinaśrīmitra is nowhere explicitly designated as a monk belonging to the Vikramaśīla monastery. Theoretically, he might have been active at another monastery and sent a scribe to Vikramaśīla in the case of the only MS where the place of copying is mentioned (viz. in the *Kalyāṇakāmadhenuvivaraṇa* MS). In our view, both these scenarios are much more improbable than to assume that Jinaśrīmitra belonged to the Indian monastery of Vikramaśīla. Therefore, they will be disregarded in the present article and discussed in full detail on another occasion.

it even seems not to be impossible that they have been written by one and the same scribe.

Besides these five Vikramaśīla manuscripts, there are about fifteen other extant manuscripts that are also similar – including the script used, viz. Proto-Bengali of roughly the 12th century –,[12] but contain neither a place of production nor a reference to the scholar-monk Jinaśrīmitra. Most noteworthy about this second group of manuscripts (which will henceforth be called group II) is the fact that the dimension of the palm leaves and the layout are identical with those of the first group. It is also important to note that quite a few of these texts have been composed by scholars who were active in the monastery Vikramaśīla. Moreover, one may also mention that the majority of these manuscripts contain exegetical Buddhist Tantric texts. We have already seen above that all the texts in the group I of manuscripts belong to this class of texts. In this connection, attention should also be drawn to the fact that Vikramaśīla was especially well-known for being a strong-hold of esoteric Buddhism. From all these facts taken together one might propose the working hypothesis that this group II of manuscripts has also been written there.[13] Admittedly, at the present state of our knowledge this is a rather bold assumption, since the monks of Vikramaśīla did not live and work in isolation. However, it is, at least, highly unlikely that the great amount of similarities between the two groups of manuscripts came about by mere accident. Rather, the producers of the manuscripts certainly were people who roughly belonged to the same region (Eastern India with its thriving Buddhist monasteries), time-period (12th century CE) and cultural environment and who influenced each other in various respects.[14]

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[12] They are, however, definitely written by other hands than the hand(s) that is (are) involved in the copying of the five MSS dealt with above.

[13] The similarity of the MSS of our corpus has originally been discovered by Prof. Harunaga Isaacson and communicated in oral form on various occasions. He has also developed the working hypothesis that the MSS from group I and II might all be products of Vikramaśīla (cf. Szántó 2012: vol. 1, 103–105). One of the authors of this article (M. Delhey) is since 2011 closely collaborating with Harunaga Isaacson in our ongoing pertinent research project at the CSMC.

[14] There was even a larger network of Buddhist thinkers and practitioners

Rather than giving a full list of this group II of manuscripts,[15] only those items will be listed here that were available to us in Kathmandu (some of the manuscripts are stored in Tibet rather than in Nepal)[16] and that have been selected by us for material analysis:

1. A MS of the *Abhayapaddhati*, a commentary on the *Buddhakapālatantra* composed by Abhayākaragupta, a famous Tantric master of Vikramaśīla, who flourished in the late 11th and early 12th century CE.[17] Most folios of this codex are preserved in the National Archives of Kathmandu under the shelf no. NAK 5–21.
2. Stray folios of the *Ḍākinīvajrapañjarapañjikā* written by Mahāmatideva included in the bundles of palm leaves preserved under the shelf nos. NAK 5–20 [NAK 5–20 (Ḍ)], NAK 5–23 and (not examined by us) KL 134.
3. Stray folios of the *Cakrasaṃvarābhisamayapañjikā* by Prajñārakṣita [NAK 5–20 (CA)].
4. A MS of the *Catuṣpīṭhanibandha* written by Bhavabhaṭṭa,[18] preserved in the Kaiser Library in the MS numbered KL 134 with some stray folios contained in KL 231 [KL 231 (C)].
5. A MS of the *Laghutantraṭīkā* attributed to Vajrapāṇi, which is preserved under the shelf no. KL 225.

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extending as far as Kashmir in the West and Nepal (more precisely: the Kathmandu Valley) and Tibet in the North. However, the use of the Proto-Bengali script (and some other features) narrows the probable places of origin considerably down.

[15] This will be done on another occasion.

[16] This is yet another similarity between group I and II. Moreover, the MSS of both groups that are preserved in Tibet have in modern times all been found in the monastery of Zha lu (also spelt Zhwa lu).

[17] See Luo 2010: XXV f. for brief information on this author and for many further references.

[18] According to historiographical information, Bhavabhaṭṭa was a Tantric preceptor of Vikramaśīla. Moreover, he seemingly was a native of Eastern India and can probably be placed in the middle of the 10th century CE (Szántó 2012: vol. 1, 97 f.).

Finally, there is a small third group of manuscripts (group III), which can be distinguished from group I and II by a difference of script (which seems to be typical for 12th or 13th century Nepal rather than for 12th century Eastern India) and perhaps also by a layout that is not as strictly standardized as in the case of the first two groups. According to our working hypothesis, these might be Nepalese imitations of the manuscript style exhibited by the first two groups. In Kathmandu, only one of these manuscripts is preserved, viz.

- A MS of the *Khasamā*, a commentary on the *Khasamatantra* by Ratnākaraśānti (KL 227), another celebrated scholar and Tantric master of Vikramaśīla.[19]

Regarding the ongoing research project on manuscripts from Vikramaśīla and on the corpus sketched above, the material analysis in Kathmandu had the following objectives: (1) We aimed to obtain insights into the question of characteristic features of the writing materials used in 12th century Vikramaśīla based on their chemical compositions. Special stress was laid on the material analysis of the writing support and the inks. Naturally, the only safe starting point for answering this question was the investigation of those manuscripts that can be proven by paratextual evidence to have been produced in Vikramaśīla. To begin with, these included those three manuscripts of group I that have been partly or completely available to us,[20] viz. NAK 5–20 (T), NAK 5–20 (K) and KL 231 (R).

Additionally, a palm-leaf manuscript that is written in a format different from our corpus (and is hence not included in one of the groups I to III) but contains an explicit reference to Vikramaśīla as place of production in its colophon and is datable on palaeographical grounds to the 12th century as well has been taken into consideration for this purpose:

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[19] It is generally agreed that he was active in the early 11th century CE, see Isaacson 2002: 457. For information on his Tantric works extant in Sanskrit, see ibid.: 482–484.

[20] I.e. those which are partly or completely stored in Kathmandu rather than in Tibet (see above).

- A MS preserved in the Kaiser Library (KL 128) of the *Hevajra-tantrapiṇḍārthaṭīkā* aka *Ṣaṭsāhasrikā* written about the year 1000 CE and attributed to Vajragarbha.

(2) In addition, we wanted to examine whether our hypotheses regarding the common origin of group I and II of manuscripts mentioned above and the slightly different origin of group III can be corroborated and refined or rendered unlikely by finding further markers of similarity or dissimilarity. For this purpose, the other manuscripts listed above had to be analyzed as well. Moreover, we hoped to attain some further relevant data by analyzing selected apparently secondary elements (foliation, notes, etc.) of partly far later age in the margins of the manuscripts.

2 Experimental Part

For X-ray fluorescence measurements, we used a commercial, transportable (though not portable) micro-XRF spectrometer specially designed for archeometric studies *in situ* (ArtTAX, Bruker Nano GmbH, [Bronk et al. 2001]). It consists of an air-cooled low-power X-ray tube, polycapillary X-ray optics (measuring spot size 70 µm in diameter), an electro-thermally cooled X-flash detector and a CCD camera for sample positioning. All measurements were made using a 30 W low-power Mo tube, operated at 50 kV and 600 µA and with an acquisition time of 50 s (live time).

Our three colour USB microscope (Dino-lite AD413T–I2V) was extremely useful in determination of the ink typology, surface morphology and detection of the living organisms. The microscope possesses in-built LED illumination at 395 and 930 nm and an external white light source.

FTIR spectra were collected with a hand-held 4100 ExoScan spectrometer. FTIR spectra collected from the palm leaves were less indicative than those of the paper. Since arsenic compounds, orpiment (AsS) and realgar (As_4S_4), absorb in far infrared region (< 650 cm^{-1}) we could not detect them with the mobile FTIR equipment whose range covers 4000–650 cm^{-1}. Therefore, the presence of arsenic compounds could be certified by X-ray fluorescence only.

3 Material Analysis: Results and Discussion

First, we will present an introductory overview of the composition of the palm leaves and the principal inks used by means of some selected samples, which are accompanied by full X-ray fluorescence (XRF) spectra. Afterwards, we will provide full details about the most important characteristics of the palm leaves and inks in the four manuscripts from Vikramaśīla by means of partial spectra and a table. Moreover, we will discuss the results against the broader background of Sanskritic manuscript culture and history. Two poisonous substances, viz. arsenic (in the palm leaves) and mercury (in one of the principal types of inks used), will play a prominent role in this discussion. Finally, we will present the results regarding the group II and III manuscripts and compare them to the results regarding the three group I manuscripts and the fourth manuscript from Vikramaśīla.

3.1 Introductory Overview

Figure 1a presents a full XRF spectrum collected from two palm leaves belonging to KL 128 and the group I manuscript KL 231, respectively. Elements Si–Fe correspond to the elements common for

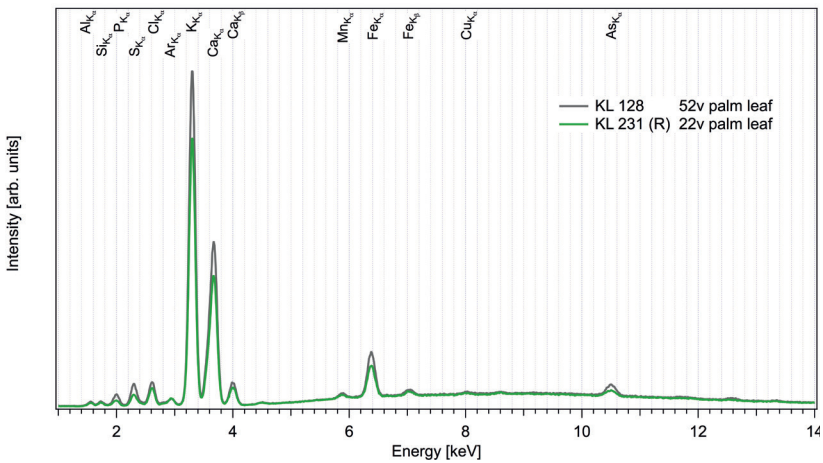

Fig. 1a. X-ray fluorescence spectrum of two examined palm leaves.

the composition of palm leaves. The additional presence of the element As (i.e. arsenic), however, is noteworthy. In the figures beginning from number 2 we will only present partial spectra. However, they will all contain the information whether arsenic was found on the respective palm leaves, since this aspect will remain important throughout our discussion.

Figure 1b shows the left pagination on folio 5v of the group I manuscript NAK 5–20 (T). On the left side, there is an image in the visible region. This is compared with another image taken in the near infrared region on the right side. We observe no change in the opacity, since the ink belongs to the carbon type. The XRF spectrum in the middle of the picture shows presence of mercury (Hg) in addition to the elements of the palm leaf. Therefore, we have here mercury enriched carbon ink.[21]

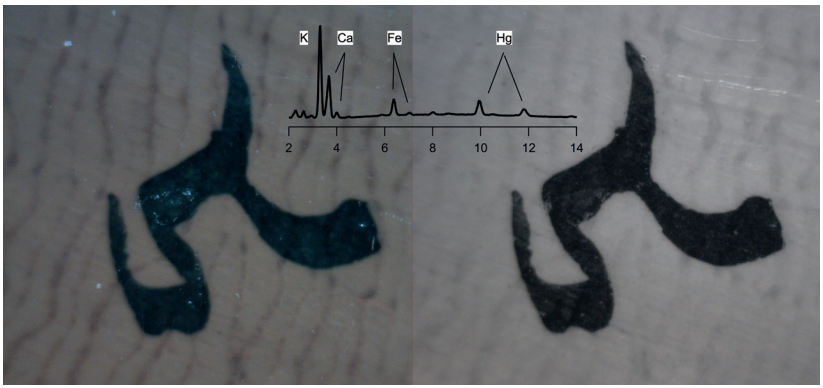

Fig. 1b. Left pagination on NAK 5–20 (T) 5v; micrographs in visible (left) and near infrared (right) regions of electromagnetic spectrum, and the corresponding XRF spectrum of the ink.

In the next image (fig. 1c), carbon ink of the pagination on the right side of the same palm leaf manifests itself in the constant opacity when the wavelength changes from visible to the near infrared. However, the corresponding XRF spectrum (top) does not display a mercury peak in contrast to the XRF spectrum of the figure 1b.

[21] See below (§ 3.2) for some further remarks on this correction.

Furthermore, the ink of the correction (thick line that crosses the number on the left) disappears in the near infrared image on the right testifying to another ink type – this time the basic component of the ink is not carbon. This is corroborated by the corresponding XRF spectrum (bottom) that shows that the amount of iron in this ink is considerably higher than in the ink used for pagination. Thus, we conclude that the correction was executed most probably in an iron gall ink.

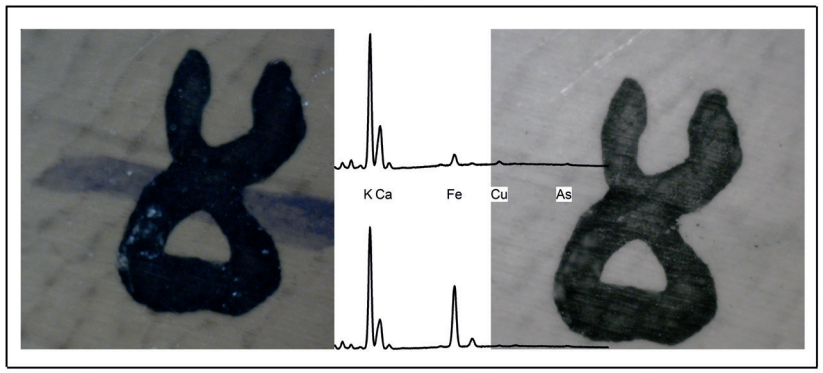

Fig. 1c. Right pagination on NAK 5–20 (T) 5v; micrographs in visible (left) and correspond to the ink of pagination (top) and the cancellation stroke (bottom).

3.2 Manuscripts from Vikramaśīla

Now, we would like to present our results regarding those four manuscripts that are, judging from historical information contained in their colophons, products of the monastery Vikramaśīla, viz. NAK 5–20 (T), NAK 5–20 (K), KL 231 (R), and the slightly different case of KL 128.

Figure 2 shows presence of arsenic not only on two (see fig. 1a above) but on all four manuscripts from Vikramaśīla. It is noteworthy that this feature is shared not only by the three manuscripts belonging to group I but also by the special case KL 128. The arsenic is found evenly distributed over the entire leaves. The yellow colour of the leaves as opposed to the clear black of the text indi-

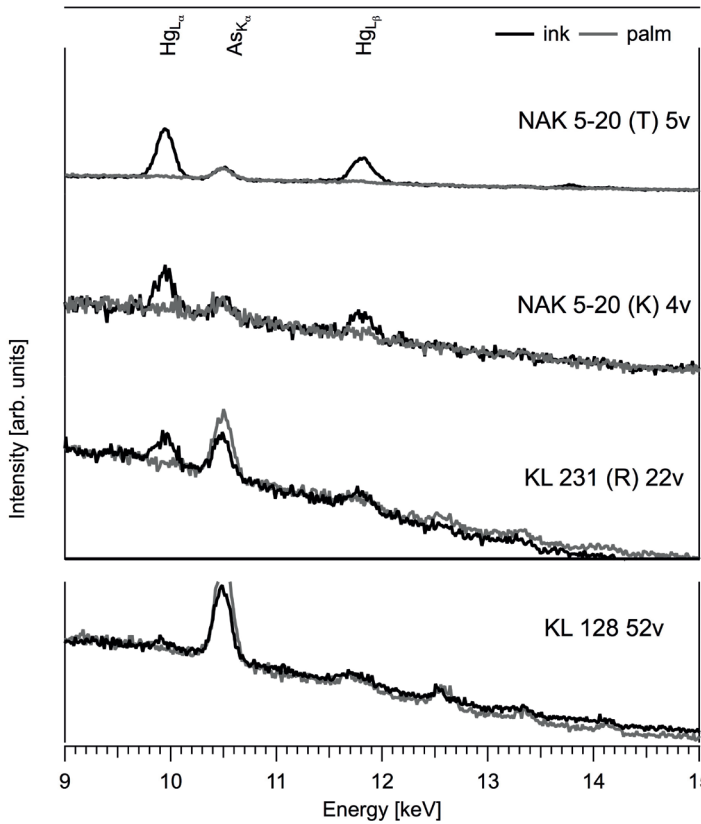

Fig. 2. Excerpts from the XRF spectra of palm leaf and ink; the latter from the main body of text.

cate strongly that arsenic compounds (orpiment and/or realgar)[22] entered the palm leaves before the writing process started. Arsenic compounds could be introduced intentionally or unintentionally through water contamination. In the latter case, natural contamination would serve as a marker for a geographical location. In our case, the substantial presence of arsenic compounds manifested through the detection of the element arsenic and the yellow colour,

[22] For reasons described above (see § 2), it was not possible to determine the exact arsenic compound by means of material analysis.

would have required a degree of water contamination corresponding to a region heavily poisoned with arsenic. Studies of the water pollution, however, show that even in our days the region of Vikramaśīla does not display high levels of arsenic.[23] Therefore, accidental contamination of palm leaves by water naturally containing arsenic can be most probably excluded.

Moreover, it is well-known that arsenic compounds have intentionally been applied in various ways and for various purposes in Sanskritic manuscript culture. To begin with, the pieces of cloth into which paper and palm-leaf books have traditionally been wrapped up consisted often of "cotton dyed with an orpiment preparation containing arsenic." This has been done to protect the manuscripts "against the ravages of insects (termites, white ants, silverfish) and the extremes of temperature and humidity."[24] On the manuscript pages, yellow orpiment (*haritāla*) was used, when one wanted to write text in yellow rather than in black letters.[25] Furthermore, it was a very common custom to cover single letters or a few of them in the text by orpiment in order to delete them.[26] If manuscripts were illuminated, there was another possible way for arsenic to enter the manuscript, viz. as pigment in the miniature paintings.[27]

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[23] Ministry of Water Resources (Govt. of India), Mid-Eastern Region PATNA 2009.

[24] Losty 1982: 13.

[25] Sircar 1965: 81. Cf. also the remarks on golden ink in Tibetan manuscript culture in the article by Almogi, Kindzorra, Hahn, and Rabin in the present JIABS issue.

[26] See e.g. Gode [1946] 1969: 35, Sircar 1965: 81, Mitra 1875: vi, Goswamy 2006: 55 f. (the latter with reference to an eye-witness account from the beginning of the 20th century), and Thaker 2002: 137 f. and 152. Thaker (2002: 152) states that this correction technique was a new invention made in c. the 16th century CE. However, he presents no evidence or reference to support this claim. See also Gode ([1946] 1969), who notes that making corrections in this way is "very common in all old MSS."

[27] Gode ([1946] 1969: 34 f.) refers to the *Mānasollāsa*, a 12th century work in which among the materials for painting the use of orpiment (*haritāla*) is recommended for the yellow colour. Other primary works mention orpiment in this connection as well, partly as the only alternative and partly as one among several possibilities (see Nardi 2006: 128). See also Mahapatra

None of these uses of arsenic on manuscripts can explain the above-mentioned distribution of arsenic on our palm leaves.[28] There is, however, another wide-spread custom in Indian manuscript production that has not yet been mentioned. When paper replaced palm-leaf as writing support in 15th century Bengal, "one side of [the paper] was dyed with yellow orpiment containing arsenic to act as an insecticide."[29] A very similar practice can be observed in the case of Nepalese paper manuscripts.[30] According to one of the pertinent publications, in Nepal a mixture of two arsenic compounds, viz. yellow orpiment (Skt. *haritāla*) and realgar (Skt. *manaḥśilā*), is traditionally spread uniformly over the paper.[31] Among the paper manuscripts listed by Trier, the oldest one containing arsenic (orpiment) dates from 1505 CE.[32] It may be mentioned in passing that Hoernle surmised sizing of a group of far older (first millennium CE) Central Asian paper manuscripts, which are mostly written in Sanskrit, with an arsenic substance.[33] In the description of a *sāñcīpat* manuscript (aloe bark, a peculiar kind of organic writing support used predominantly in Assamese manuscript culture), Losty draws attention to the fact that yellow arsenic was applied to the leaves "to act as ground and insecticide."[34] Trier found signifi-

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1996: 25, Bisoi 1996: 52, and Gupta 2010: 52, where explicit reference to manuscript paintings is made.

28 When Cort (1995: 80) reports that in the famous Jain libraries of Gujarat and Rajasthan the MSS were "sometimes dusted with red arsenic powder" to protect them from insects, he seems to refer to a measure taken once in a while in order to protect the old MSS at their storage places rather than to a coating of the still empty leaves with an arsenic substance. If this is true, then we are dealing here with yet another use of arsenic that has to be distinguished from the use on the MSS examined by us. The powder would have left traces in the form of pigments on the black ink.

29 Losty 1982: 113; see also Mitra 1875: ii on the same topic.

30 Trier 1972: 93, Gajurel & Vaidya [1984] 1994: 167–170, Singh 1995: 86; for illustrations of MSS treated in this way see Buescher 2011: passim.

31 Gajurel & Vaidya [1984] 1994: 168.

32 Trier 1972: 248.

33 Hoernle 1894: 3; cf. Trier 1972: 93.

34 Losty 1982: 140. See also Gupta 2010: 52, 54; Goswamee 2006: 79 f.; and Datta 1970: 110 for further details.

cant amounts of orpiment on an aloe bark manuscript that according to him can be dated to the 15th or 16th century.[35]

Similar statements can be found with regard to palm leaves, but judging from the secondary sources, this practice seems to be less well attested.[36] Trier even observes that none of the Nepalese palm-leaf manuscripts examined by him have been treated with orpiment.[37] In view of these facts it is certainly noteworthy that our investigations have shown that in palm-leaf manuscripts from Vikramaśīla such a practice probably has occurred. As regards the reason for this treatment of the palm leaves with arsenic, the parallels cited in the last two paragraphs make it very likely that is was – at least predominantly – applied in order to protect the manuscripts from insect infestation.[38]

If Trier's above-mentioned observation should be true and could be generalized by further investigations, the presence of this substance on our palm leaves could even serve as a 'marker' of their East Indian rather than Nepalese provenance. Trier seemingly wants to imply something like this when he tries to explain the exceptional presence of arsenic in one of the palm-leaf manuscripts analyzed by him with the fact that it has probably been written in Bengal.[39]

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[35] Trier 1972: 135. The item examined by him would then belong to the oldest extant specimen of MSS written on this writing support (see, e.g. Losty 1982: 9; Goswamee 2006: 73 f.).

[36] Chaubey 2004: 14 (with reference to Indian palm-leaf MSS in general); Mahapatra 1996: 26 (with reference to palm leaves from Bengal). Both agree in stating that only a little arsenic trisulphide has been used for covering the leaves. Moreover, Chaubey gives the use of orpiment only as one of several alternatives for protecting the leaves from insects, and Mahapatra writes that this practice has only "sometimes" been applied.

[37] Trier 1972: 93; cf. ibid.: 248.

[38] In secondary literature, sometimes additional reasons are given. See e.g. Renou & Filliozat [1953] 2000: 711, where Filliozat with regard to paper MSS first only describes the aesthetic effect that the use of orpiment has. Then he adds with reference to Nepalese paper that it can also act as an insecticide, when a large quantity of it is used.

[39] Trier 1972: 205, cf. plate 110 and p. 248. One might, by the way, wonder whether the amount of arsenic on the exceptional MS no. 173 as given by

However, in view of the great amount of palm-leaf manuscripts preserved in Nepal and the very few manuscripts listed by Trier (1972: 248), his observation should be treated with the utmost caution.[40]

Above, it has already been shown that the left pagination on NAK 5–20 (T) 5v is written in a mercury enriched carbon ink (see fig. 1b and the accompanying explanation). On figure 3 it can be seen that the main body of text on this manuscript is written in the same ink. Figure 2 and table 1 show that the same enrichment with mercury can also be found in the main text and in the left pagination of the other two group I manuscripts.[41] In KL 128 the presence

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Trier (1972: 248) does not point to a contamination with traces of arsenic rather than to systematic treatment of the palm leaf with such a substance.

[40] Our group III MS, which according to our hypothesis has been written in Nepal, does contain arsenic. However, this is a special case (see § 3.4). Therefore, it cannot be used to falsify Trier's hypothesis. During our research trip, we had no opportunity to systematically examine the question whether the palm leaves have sometimes been treated with arsenic in MSS that can be proven to have been produced in Nepal. However, it is at least interesting to note that the 9th century Nepalese MS of the medical treatise *Suśrutasaṃhitā* (KL 699; see on this topic Harimoto 2014), which has been examined by us for entirely different purposes, contains arsenic (though seemingly not on all leaves). In this particular case, accidental contamination cannot be excluded.

[41] We found only very few exceptions to this rule in the folios from group I MSS examined by us: On NAK 5–20 (T) 19, which is the last folio of the MS, the primary text on the recto folio seems to contain only a minute amount of mercury at the spot examined by us. This poses no great problem. The left pagination on the verso of the same folio seems to be written in a pure carbon ink. Maybe in this case the pagination was added slightly later. Since we are dealing here with the easily recognizable folio page that contains the colophon, the scribe might not have regarded it as indispensable to add a folio number here. Later he or another person might have added the foliation, but had only pure carbon ink at his hand. Finally, one must mention the case KL 231 (R) 23 (viz. the last folio of the *Ratnāvalī Hevajrapañjikā* MS), which is rather enigmatic: on the recto page it contains carbon ink with a significant amount of copper but no mercury. The material analysis has partly been conducted with regard to text that follows the colophon and is clearly an addition by a later, almost certainly Nepalese, hand. We have found ink with a similar composition in other secondary additions. However, it seems that material analysis of one letter that belongs to the primary Proto-Bengali hand yielded exactly the same result. One can, of course, not exclude that the

of mercury is also observed both in the left pagination and in the main text but as a minute amount rather than as a clear enrichment (fig. 2; cf. table 1). In manuscripts from the region and period with which we are dealing here (and generally in North India), the folios were usually paginated on the left margin of the verso. It is natural to assume that this was usually already done during (or shortly before or after) the writing process.[42] Accordingly, it is not astonishing that the ink of the main text and of the left foliation are identical or very similar.

Carbon based black inks were exceedingly common in ancient India. In marked contrast to this, it is not easy to find references to the admixture of mercury to the ink. It is true that the state of research regarding the history and regional varieties of ink-manufacture in ancient South Asia is far from satisfactory. Nevertheless, one can easily gather a fairly large amount of recipes from the pertinent literature.[43] Judging from these sources, mercury seems to be

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original scribe had to change the ink on the last folio and that the new ink had accidently the same composition as the ink later used by a Nepalese scribe. However, this is a rather astonishing coincidence and its correctness should certainly be checked on the next occasion when we can perform material analysis in Kathmandu.

[42] One circumstance can render this assumption perhaps especially likely: The manuscript folios of our corpus are not held together – and thus also not kept in order – by strings, although they all contain string holes. This phenomenon is met with quite often, and it is not impossible that the MSS of our corpus have never been bound in this way. However, some of the binding holes on the folios of NAK 5–20 (T) seem to be damaged in the margins, which might point to the use of strings.

[43] Gode [1946] 1969: passim and Janert 1995: 89–96 contain fairly detailed treatments of the topic and many references to earlier pertinent literature. Gode's article is arguably still the most important publication on this subject. One of the merits of his contribution consists in the fact that he made contributions to the history of ink-manufacture by collecting material from datable primary sources. He pointed out the difficulties in this endeavour, but was at least successful in presenting some sources which are old enough to be roughly contemporaneous with our MSS. Thaker (2002: 104–117) seems to rely heavily on an earlier article by Muni Puṇyavijaya written in the Gujarati language, to which brief reference is also made by Gode ([1946] 1969: 38). However, the value of Thaker's contribution consists in present-

a rather rare ingredient, at least of black ink.[44] It is – in the absence of explicit statements in this regard in the primary or secondary literature – also unclear for what purpose this substance was added to the ink. Mercury played, as is well-known, a pivotal role in ancient Indian medicine and Tantric alchemy.[45] However, instead of searching in those sources for some possible obscure reasons, it is more straightforward to assume a very practical purpose. It is, for instance, possible that mercury as a poisonous substance was added to the ink in order to provide the letters on the manuscript folios, which have, as seen above, been impregnated with arsenic, with an additional protection against insect infestation. Interestingly enough, not only the first three manuscripts from Vikramaśīla but also the fourth manuscript, in which persons different from those of the first three manuscripts were involved, contains mercury in its ink. Still, the fact already mentioned above that there is a recognizable difference regarding the amount of mercury that has been used is also significant and should be kept in mind.

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ing the important information contained in the earlier Gujarati publication extensively in an English language publication. One might also add Datta 1970: 125–127 and Murthy 1996: 52–54 to this list of general treatments of the subject. Regarding the regions (but not necessarily the historical periods) that are most important for our present research, one might refer to Gajurel & Vaidya [1984] 1994: 162–166, Trier 1972: 94, Singh 1995: 92 f. (Nepal); Mitra 1875: vi f., Datta 1970: 127 (Bengal). For Tibetan ink, see the reference in n. 54.

[44] Among the six ink-recipes for black ink to be used on palm leaves listed by Thaker (2002: 104–117), the second one contains mercury (*pārada*) as one of the ingredients (ibid.: 106). The pertinent verses cited and translated by Thaker are probably about 300 to 400 years old (see Gode [1946] 1969: 38) and seem to derive from Jaina sources of Western India. In the case of *red* ink, the relevant literature suggests that the use of cinnabar (Skt. *hiṅgula*) was a very common alternative (Thaker 2002: 112 f., Mitra 1875: vi). See also Nardi 2006: 127, where it is mentioned as one of the sources of red colour in painting.

[45] For further information and many references to pertinent primary and secondary literature, see the most recent contribution on this topic by Dagmar Wujastyk 2014.

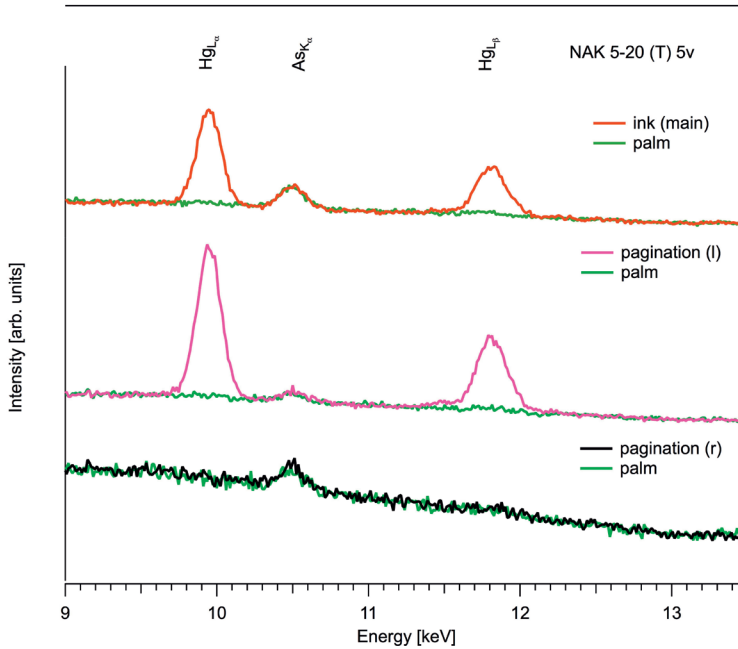

Fig. 3. Excerpt of the XRF spectra of ink in main text, left pagination and right pagination.

Furthermore, it is noteworthy that the (first)[46] pagination on the right margin is executed in all four cases with carbon ink without mercury (fig. 3, table 1; cf. fig. 1c). Above it has already been mentioned that the preferred place for the pagination was the left margin of the verso. If there is a second pagination in the right margin of the verso, it is always very likely that this is a later addition. This seems also to be corroborated by palaeographic considerations; some of the numerals have a shape that is recognizably different from the numerals used in the left margin and the main texts. We may assume that the right pagination was added (much?) later in Nepal, and this difference in place and time-period might account for the different recipes used.

[46] We have seen above in the discussion of fig. 1c that the right pagination has been sometimes corrected with a different ink. This special case will be briefly dealt with again below.

Finally, we may briefly return to the right pagination on NAK 5–20 (T) 5v (fig. 1c). The secondary right pagination contains erroneously the number "4." Later on, this wrong number has been crossed out and the right number, viz. "5," has been added under the crossed-out wrong one.[47] The cancellation stroke is, as already mentioned above, written in an iron-gall ink, while the primary and secondary inks have – besides their differences regarding the presence and absence of mercury – in common that they are carbon based. In this case, we can observe that three historic stages of production, use and re-use of the manuscript correspond to the uses of three distinct inks. It may be noted that the use of iron-gall ink for the youngest layer of ink makes it very likely that the last correction was made in rather recent times. This is at least suggested by the fact that the secondary literature on Nepalese ink characterizes the use of such an ink as a modern development.[48]

MS	Page	Ink (main text)	Pag left	Pag right
NAK 5–20 (T)	3r	A		
	3v	A	A	D
	5r	A		
	5v	A	A	D[49]
NAK 5–20 (K)	4r	A		
	4v	A	A	D
KL 231 (R)	22r	A		
	22v	A	A	B
KL 128	52r	B*		
	52v	B*	B*	D*

Table 1. Inks used on all the four manuscripts. Ink A and B* contain considerable amount and trace amount of mercury (Hg), respectively. Inks B, D and D* contain no mercury, but pure carbon, carbon and copper, carbon, copper and iron, respectively.

[47] This part of the image is not contained on fig. 1c, since the cancellation stroke is sufficient for the point that we want to make here.

[48] See especially Gajurel & Vaidya [1984] 1994: 166.

[49] This is the ink used for the original right pagination. The ink used for its correction is not included in the present table.

In our corpus, some text passages (e.g. magic spells [*mantra*]) or the boundaries between two sections or chapters have been thinly covered with a red substance in order to highlight them. Material analysis yielded the result that the substance used for this purpose in our four manuscripts as well as in all other manuscripts examined contains a very high amount of iron; in all likelihood, it is red ochre.[50]

Among the four Vikramaśīla manuscripts we only examined two of the larger ornaments that are used in order to highlight the colophons. Here we notice again a certain difference of inks between the group I manuscripts and KL 128. KL 231 (R) 23r is mercury enriched, the symbol in KL 128, 59r seems to contain not even traces of mercury.

3.3 The Manuscripts of Group II and Their Relation to the Vikramaśīla Manuscripts

After this presentation of material features of manuscripts originating certainly from Vikramaśīla, we would like to turn our attention first to the fairly large group II of manuscripts, which contain, as stated in the introduction, a high amount of very similar codicological features visible to the naked eye. The manuscript of group III, which we have – mainly for palaeographical reasons – kept apart from the manuscripts of group II, will be dealt with in the next section.

To begin with, the palm leaves not only of the manuscript NAK 5–21 (for which see fig. 4) but of all manuscripts of group II examined by us contain significant amounts of arsenic, as was also the case with group I manuscripts. Moreover, almost[51] all inks in prima-

[50] This result of the material analysis is further corroborated by Indological secondary literature (see Mitra 1875: vi and Thaker 2002: 138).

[51] The only exception is the colophon folio of the *Ḍākinīvajrapañjarapañjikā* MS (NAK 5–23); the ink used seems to be characterized by pure carbon without any trace of mercury. In the two other folios of this MS examined by us [NAK 5–20 (Ḍ)], this is not the case. Seemingly, we have to suppose here change of ink. At present, there seems to be no reason to suppose that this was accompanied by a change of hand.

ry text passages share the important characteristic with the manuscripts of group I that they contain significant amounts of mercury (see fig. 4 for a sample). The situation is again similar regarding the different sets of pagination on the left and right margin of the folios. The ink of the first-mentioned set of folio numbers is again enriched with mercury. If there is a second set of numbers,[52] it is written with an ink that contains no mercury, but consists of pure carbon or is characterized by elevated amounts of copper or iron.

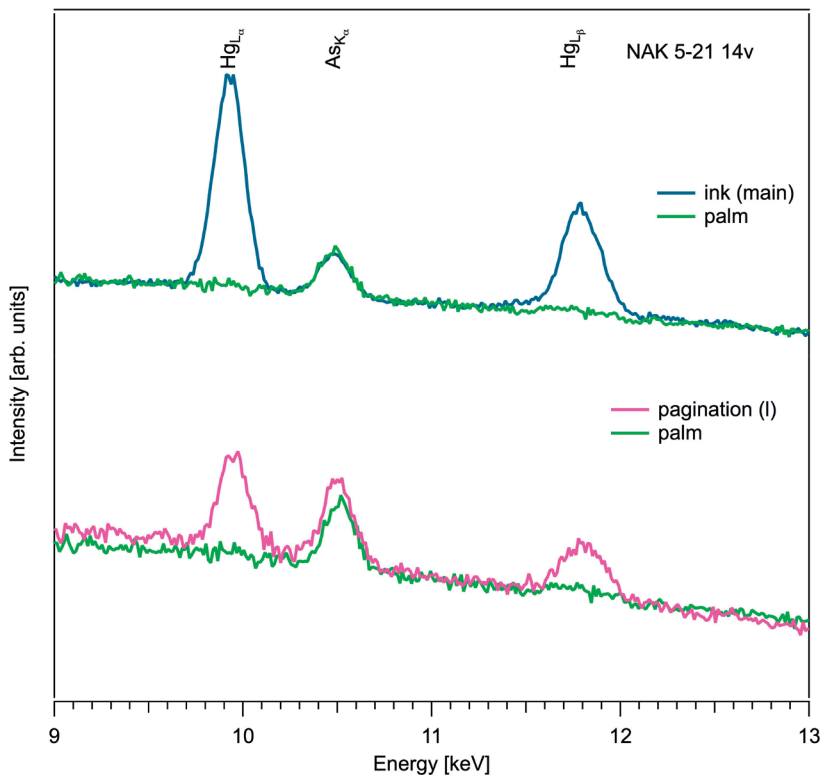

Fig. 4. Excerpt of XRF spectra of palm leaf and ink in main text and left pagination in NAK 5–21, 14v (specimen of group II).

[52] Some of the MSS belonging to group II – e.g. NAK 5–21 (see fig. 4) – contain no secondary foliation in the right margin.

This group of manuscripts contains two very interesting secondary notes placed on the first recto pages. Usually, these pages were left blank when a manuscript was written. Therefore, this was an ideal place to add various secondary pieces of text to the original manuscript. To begin with, KL 231 (C) 1r contains an identification of the Sanskrit text written in the Tibetan language.[53] This note is written again in pure carbon ink. It is very probable that it has been added after the manuscript had already been brought away from India, either in Tibet or by a Tibetan visitor to the Kathmandu Valley. Therefore, it is only natural that it was written with an ink that shows no traces of mercury and is thus different from the ink of the primary text.[54]

The second case is a little bit different. On KL 225, 1r we find, among others, an edifying Sanskrit verse. This time the carbon ink used contains a high amount of copper and, again, no mercury. However, this verse is written in the Proto-Bengali script; only the hand is different from that of the primary text. This addition must have been made within the first c. 100 years, probably even less, after the production of the manuscript. If the remark has not been written in Nepal,[55] this is a further indication of the fact that mercury enriched ink cannot have been the only ink that was in use in Vikramaśīla or in the regional manuscript culture or sub-culture from which our corpus of manuscripts originates.[56]

The verso of the same folio (i.e. KL 225, 1v) contains yet another secondary addition, this time in the form of a marginal note. The hand is somewhat similar to the hand of 1 recto. At any rate,

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[53] For further particulars, see the introductory part of § 4 of the article by Almogi, Delhey, MacDonald and Pouvkova in the present JIABS issue.

[54] On the use of ink in Tibetan manuscript culture, see the article by Almogi, Kindzorra, Hahn, and Rabin in the present JIABS issue.

[55] One must, of course, always be aware of the fact that especially in the end of the 12th century and in the 13th century, Bengalisms can sometimes be recognized in MSS written in Nepal, as it has already been noted by Bendall (1883: XXII). A good example of strong influence from the Proto-Bengali script is the Cambridge MS Add. 1648 (written in Nepal and belonging to the first decades of the 13th century); see Bendall 1883: XXVIII.

[56] See, e.g., n. 51 for a further example.

it is also a Proto-Bengali hand. The ink contains a certain amount of copper as well. However, this ink is, again, clearly mercury enriched. A marginal note in a Proto-Bengali hand that can be found on another group II manuscript, viz. NAK 5–21 (14r), is written in a similar ink. Another interesting feature about the latter folio page is the fact that a small symbol between two double *daṇḍa*s (i.e. punctuation signs), which form together a section marker, is written with pure carbon. This suggests that the symbols were inserted into the free space between the two double *daṇḍa*s by another hand or at least in a second, later step. NAK 5–20 (CA) contains notes in the margins written in a Proto-Bengali hand, which is perhaps slightly different from the hand of the primary text. The ink used is similar to that of the main text, that is, it contains a certain amount of mercury. Finally, attention may be drawn here to yet another note, which can be found in the top margin of NAK 5–20 (Ḍ) 13r. The ink is here carbon based and contains no mercury; instead, high amounts of copper can be found. Therefore, it is not only similar to some of the secondary paginations on the right margin of our manuscripts but also to the secondary verse on KL 225, 1r. However, as opposed to the latter-mentioned addition, this marginal remark is written in a typical Newari (and hence Nepalese) script. The note serves as a book-mark to a certain topic dealt with in line 4.

In this section, we have observed that the group II manuscripts share with the group I manuscripts (and basically also with the fourth manuscript from Vikramaśīla) the predilection of the use of mercury as an ingredient of the primary ink. Moreover, we have seen that secondarily added text examined by us exhibits – with one exception – the same tendency, if it is written in the Proto-Bengali script, while two added notes written in the Newari and Tibetan scripts, respectively, as well as secondary pagination figures in the right margins of the manuscripts do not show any traces of mercury use. Finally, the probably intentional treatment of the palm leaves with substances containing arsenic is also common to both group I and group II.

3.4 The Manuscript of Group III and Its Relation to the Other Manuscripts

Manuscript KL 227 needs a special treatment, since it belongs to a small group of manuscripts that is very similar to group I and II in layout but creates from a palaeographical point of view the impression to have been written in Nepal (i.e. in the Kathmandu Valley). As can be seen in figure 5, the material analysis reveals that the writing support contains again arsenic and that the ink contains mercury, though tentatively less than in the case of figure 4 (and in the case of most of the other group I and group II manuscripts). This entails that our working hypothesis that this is some kind of Nepalese imitation of the manuscript style seen in manuscripts from group I and II receives no additional corroboration.

However, this does not mean that the assumption of a Nepalese origin of the writing is proven to be wrong by these results. To begin with, it is not clear whether the presence of arsenic on the leaves proves anything. It has already been mentioned above that Trier's observation that arsenic is not found on Nepalese palm-leaf manuscripts is based on a very small proportion of the extant manuscripts and is therefore not by necessity valid. Moreover, it is quite likely anyway that in the case of KL 227 the empty palm leaves have been brought from India by people who were involved in the production, storage or transport of the other manuscripts of our corpus. This is not only suggested by the fact that they have the same dimensions as the manuscript leaves of group I and group II. Their very oblong shape (more than 50 cm in length) makes an independent origin rather improbable as well. Palm leaves of such a great length had by the end of the 12th century become very rare in Nepal.[57] The Nepalese had difficulties to import such leaves from India.

If it is true that the empty palm leaves have come to Nepal from India together with other manuscripts of our corpus, then it is not very far-fetched to assume that the whole pre-production process of the manuscript, including its probably intentional treatment with

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[57] Trier 1972: 136.

arsenic substances, happened already in Eastern India. The empty leaves might have been brought by Indian Buddhist monks who fled from Vikramaśīla and other Buddhist monasteries of Eastern India around the year 1200 CE when this area was invaded by Muslims from Afghanistan. The use of mercury can either be explained by the possibility that in this time-period mercury was used not only by North Indian but also by Nepalese scribes or, perhaps slightly more plausibly, by the assumption that the Indian monks who brought the empty leaves exerted an influence on the composition of the ink. However, it is also possible that a Nepalese visitor to East India wrote this manuscript there and used the writing materials that were locally available.

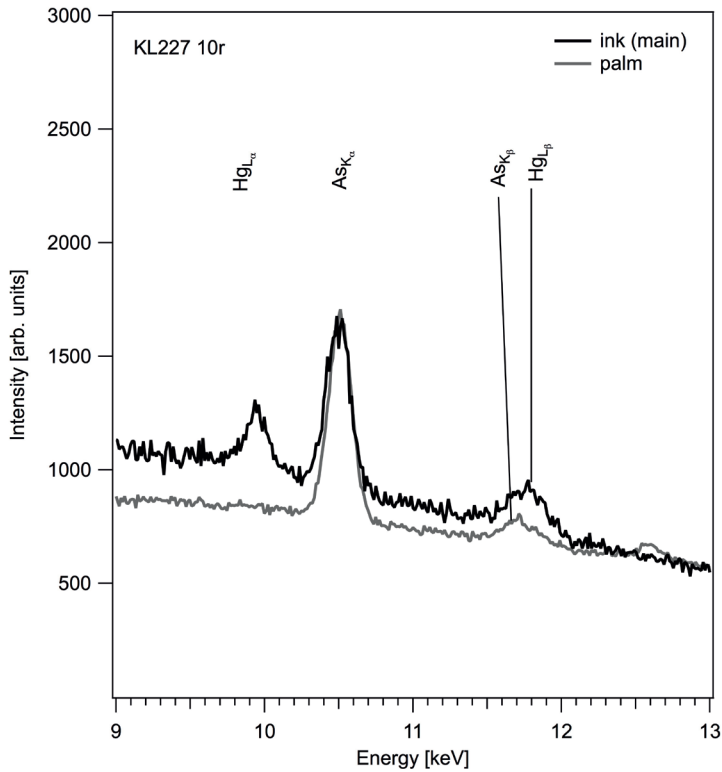

Fig. 5. Excerpt of the XRF spectrum of palm leaf and ink in main text in KL 227, 10 recto (specimen of group III).

Finally, we would like to add some remarks on another manuscript that belongs, judging from the dimensions and layout, to our corpus as well without belonging to one of the three groups defined in the introduction. This is a manuscript of the *Abhisamayālaṃkārālokā* by Haribhadra (NAK 3–738). It was not on the list of manuscripts which we planned beforehand to be examined for the present research project. Since, however, it has been analyzed during our research trip for different purposes, some interesting results should at least be briefly mentioned here. The script used exhibits clearly the characteristic feature, viz. the 'hooks,' of the Nepalese hooked script. The designation 'Nepalese' of the script certainly also makes sense, if one considers that for some centuries this script was extremely common in Nepal. However, it seems to be doubtful whether these hooks exclusively occurred in Nepal. At any rate, the script in our manuscript should, if we leave the hooks aside, rather be subsumed under the appellation Proto-Bengali script. Therefore, we tend to assume that both Eastern Indian and Nepalese origin of the manuscript are possible. Both arsenic and mercury can be found on this manuscript. Because of the special characteristics of the script used here, it is somehow set apart from group I and II (but also from group III, which is written in old Newari script). If the manuscripts from group I and II should really all belong to the monastery Vikramaśīla, it is possible that this manuscript originates from another place in Eastern India or from Nepal (or that it has at least been written by a visitor to the region of Vikramaśīla). Since this manuscript represents a very special case, we will certainly deal with it in much more detail in a full-fledged description and analysis of our corpus, which is in preparation.

4 Conclusion

Through material analysis we have gained considerable fresh insight in the production of manuscripts at the famous East Indian Buddhist monastery of Vikramaśīla. In particular, the finding of (probably intentionally added) arsenic in the palm leaves and the mercury enriched carbon ink are significant. The latter feature and probably also the first-mentioned one were seemingly far

from omnipresent in Sanskritic manuscript culture using palm-leaf manuscripts as writing support.

Precisely for this reason, our results described in § 3 also have an impact on the question of how the historical connection between group II and group III manuscripts of our corpus and the group I manuscripts has to be conceived of. The hypothesis that there is an intimate relationship between these groups was originally formed on evidence of a different nature, especially, but not exclusively, the striking similarities regarding the dimensions and the standardized layout of the pages. By material analysis we have discovered further similarities and thus corroborated the hypothesis of a common or very similar origin. We have also seen that one of these newly discovered similarities (i.e. the use of mercury) sets our original manuscripts apart from some recognizably later additions made on them.

In our view, the working hypothesis that not only group I but also group II of our corpus have been produced in Vikramaśīla has been given some support through the results of our examinations. The group III manuscript might still have been produced in Nepal, but the influence from Vikramaśīla has then – in view of the use of mercury in the ink – possibly even be slightly greater than we originally supposed. However, we still cannot rule out the possibility outright that the similarities in the groups of our corpus are due to a certain manuscript standard (including the dimensions of the leaves, the layout, the script used and even the ink-recipes and coating of the empty leaves) that was adopted in several interrelated East Indian Buddhist monasteries (including, of course, Vikramaśīla) and even influenced scribes or monk-scholars working in the Kathmandu Valley or hailing from there.[58]

Certainly, our research trip to Kathmandu has not finally settled the problems surrounding our corpus. However, we are confident

[58] It is, however very unlikely that it ever became the only possible manuscript standard in one of the big monasteries. Even in this article we dealt with one MS (KL 128) produced in Vikramaśīla during the 12th century that shows manifold deviations, in particular regarding the dimensions of the leaves and the layout, from the standard adopted in the other examined MSS.

that we have, by means of material analysis, made some progress regarding *both* of our objectives mentioned in the introduction. Finally, it is probably not too bold to claim that the material peculiarities discovered on our manuscripts provide us with an important additional heuristic tool not only for the research on our corpus but also for other imaginable endeavours to determine the provenance and interrelationships of palm-leaf manuscripts originating from East India and Nepal. In view of the well-known relative paucity of explicit manuscript colophons and of pertinent remarks in historiographical and other works by pre-modern South Asian and Tibetan authors, and in view of the vexing problems of East Indian and Nepalese palaeography, we are hardly in a position to disdain the use of the research method presented here. Regarding our own further research, the next logical step to be taken, besides the material analysis of further accessible manuscripts and folios from our corpus, is to examine systematically whether the use of arsenic on the palm leaves and mercury in the ink appears in manuscripts that are by paratextual evidence known to have been produced either in one of the other East Indian monasteries or in the Kathmandu Valley.

General Abbreviations

CSMC	Centre for the Study of Manuscript Cultures, University of Hamburg
KL	Kaiser Library, Kathmandu
NAK	National Archives, Kathmandu

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