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Conference

Authors and Editors in the Literary Traditions of Asian Buddhism

Guest editors
Cathy Cantwell, Jowita Kramer, Robert Mayer,
and Stefano Zacchetti

Inks, Pigments, Paper

In Quest of Unveiling the History of the Production of a Tibetan Buddhist Manuscript Collection from the Tibetan-Nepalese Borderlands

Orna Almogi, Emanuel Kindzorra, Oliver Hahn, Ira Rabin [1]

1 Introductory Remarks

The Nepal-German Manuscript Preservation Project (NGMPP) microfilmed two sets of the *rNying ma rgyud 'bum* (NyGB): in 1989 the set stored in the National Archives in Kathmandu (NAK) and in 1992 another set during an expedition to Nubri, Samagaon. Both microfilmings were carried out under the supervision of Franz-Karl Ehrhard, who was at the time the local director of the Nepal Research Centre (NRC) in Kathmandu, and who has also discussed the two (and other) NyGB sets on several occasions.[2] The NAK

[1] The findings presented in this article are the result of an ongoing research conducted within the framework of the Centre for the Study of Manuscript Cultures (CSMC/SFB 950) generously funded by the Deutsche Forschungsgemeinschaft (DFG). The subprojects involved in the present article are "Doxographical Organisational Schemes in Manuscripts and Xylographs of the Collection of the Ancient Tantras" and "Material-Scientific Methods for Reconstructing the History of Manuscripts." We would like to take this opportunity to thank the National Archives for granting us access to the manuscripts and allowing us to use their space and for helping us in various matters throughout our stay. Our thanks also go to Bidur Bhattarai, Christina Kaminski, and Dr. Irina Wandrey (CSMC), Dr. Albrecht Hanisch (NGMCP/NRC, Kathmandu), and the German Embassy in Kathmandu for their invaluable help in organisational and logistical matters, which greatly contributed to the success of our trip.

[2] Particularly see Ehrhard 1997. As pointed out by Ehrhard, the Nubri set was produced in Brag dkar rta so at the behest of Brag dkar rta so sprul sku

and Nubri NyGB sets were extensively studied and catalogued (Almogi) within the framework of the Tibetology subproject "The Manuscript Collections of the Ancient Tantras (*rNying ma rgyud 'bum*): An Examination of Variance" (2008–2011).[3] Two of the main findings of this study have been that (a) despite their similarity in terms of the structure and contents, the two sets differ from one another in various ways, including occasional differences in the order of the texts or the organisation of the individual volumes, and (b) the NAK set, which is unfortunately incomplete, shows numerous irregularities regarding its organisation – that is, in terms of both the assignment of volume numbers and the foliation within the individual volumes – and also inconsistencies regarding the layout in general and the quality and style of its illuminated folios in particular. These two observations raise several questions regarding the relation between these two sets and the circumstances regarding the production of the NAK set as well. Further aspects of these two sets have been studied (Almogi) within the framework of the Tibetology subproject "Doxographical Organisational Schemes in Manuscripts and Xylographs of the Collection of the Ancient Tantras," which is currently conducted at the Centre for the Study of Manuscript Cultures (CSMC), at the University of Hamburg.[4] In March 2013, a team from the CSMC consisting of members of the

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Chos kyi dbang phyug (1775–1837) and was later brought to Nubri for safety. Ehrhard also suggests that the NAK set was most probably produced by a disciple of Brag dkar rta so sprul sku called O rgyan 'phrin las bstan 'dzin, from the Nyang clan of gZhung in Rong shar, which was in charge of the main temple of Junbesi in Solu Khumbu (i.e. an area near Mt. Everest which is located to the east of Nubri). An overview and a discussion of Ehrhard's studies on these two Tibetan-Nepalese borderlands sets and other NyGB editions will be provided in Almogi forthcoming-a and forthcoming-b.

[3] The subproject was conducted within the framework of the Researcher Group "Manuscript Cultures in Asia and Africa" at the University of Hamburg and was likewise funded by the DFG.

[4] A detailed discussion of the NAK and Nubri sets, the differences between the two, the differences between them and the other known editions, and particularly the irregularities observed in the NAK set in terms of organisation and editorial practices will be presented in separate publications. See Almogi forthcoming-a and forthcoming-b. A catalogue of the Nubri and NAK sets is in progress and planned for publication in Almogi forthcoming-b.

Tibetological and Indological subprojects and of two of the Centre's scientific subprojects that focus on material analysis and multispectral imaging have travelled to Kathmandu in order to jointly examine Tibetan and Sanskrit manuscripts stored at the NAK and the Kaiser Library (KL). The present article presents the findings of the collaborative efforts consisting in the above-mentioned textual-cum-historical studies of the NAK set (Almogi) and the material examination of it executed during the research trip to Kathmandu (Hahn, Kindzorra, Rabin), followed by some preliminary conclusions based on the analysis of the material examination and some codicological, mainly palaeographical, observations.[5] We would like to emphasise, however, that due to the enormous size of the NyGB collection, on the one hand, and the limited time at our disposal, on the other, a material analysis could be merely executed on a limited number of pages. The conclusions presented here are thus preliminary, and it is hoped that they could be corroborated with further data in the future.

The fact that the NAK set is incomplete and suffers from some disorganisation in terms of the numbers assigned to the individual volumes led to difficulties in the past in identifying and determining the actual number of available volumes. This was, however, enabled by the cataloguing of the set and the comparison of its content to the Nubri set, which has similar structure and content and thus clearly belongs to the same group of transmission of the NyGB collection (i.e. the Tibetan-Nepalese Borderlands group).[6] The various aspects of the disorganisation and inconsistencies observed in the NAK set cannot be discussed in detail within the framework of the present article, which will merely focus on the following two issues:

(1) During the cataloguing of the set, it became clear that altogether 35 volumes – that is, out of most probably originally 37

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[5] The findings of the multispectral imaging undertaken with the NAK set and several Sanskrit palm-leaf manuscripts are presented in a separate article in the present JIABS issue (Almogi, Delhey, MacDonald, Pouvkova).

[6] A scheme of the history of the transmission of the available NyGB editions, including their classification into groups, will be presented and discussed in detail in Almogi forthcoming-a.

(Ka–Ji) – are present at the NAK, with volumes Za and Sha missing. There are, however, two additional volumes (this, in turn, makes the total number of the available volumes 37). The organisational deficiencies seem to go back to the time of the production of the set, as we find, among other things, that in three cases the same volume number has been assigned twice, and in two other cases a volume number probably has not been assigned at all.[7] Two volumes are assigned the number Ja, and during the cataloguing it has become clear that one of them, which will be referred to as Ja2, should be in fact volume Zha, which at first seemed to be missing. Moreover, beside the volume numbered Tha that corresponds to its counterpart in the Nubri set, we find another small volume with the same number. This volume, which will be referred to as Tha2, consists of 133 folios and merely contains one single text. Unlike in the case of most of the other volumes of the set, the first two folios of Tha2 are not illuminated. We also find two volumes with the number Ma. However, here the situation is somewhat complex. The volume referred to as Ma2 is incomplete – its first 191 folios are missing. Moreover, it has been initially numbered Pha, which was later changed to Ma.

(2) Considering the fact that the first two written pages (i.e. fols. 1v & 2r) of each volume are in most cases illuminated – that is, the pages are written in golden ink on black paper and have painted illustrations on both sides – the NAK set seems to have been conceived as a prestigious undertaking. A quick look at the set, however, shows that not all illuminated folios have been written in golden ink on black paper, but that some of them have been written in red ink on black paper, and some with both golden and red inks. Furthermore, in those cases, in which golden ink has been used, its quality seems to vary, and in some cases passages originally written in red ink have been overwritten with golden ink. The miniatures also do not seem to be uniform in terms of their quality and style, and the general layout of the illuminated folios also varies,

[7] Problems with the foliations could be observed as well. On this, see the article by Almogi, Delhey, MacDonald, and Pouvkova in the present JIABS issue.

mainly in terms of the number of lines, size of script, and the size of the frames. What is striking is the fact that these differences do not point to distinctive groups into which the individual volumes can be clearly classified. Moreover, the similarities or differences do not necessarily correlate with the order of the volumes. An exception perhaps are some of the last volumes (Sa, Ha, Khi, Gi, Ngi, Ci, Chi, Ji) which show a particularly poor quality of the illuminated folios: in some of them no golden ink has been used at all, in some others the quality of the illustration is particularly poor inasmuch as they were either sketched but left unpainted or in some cases not sketched at all, and in some other cases only one page instead of usually two has been illuminated.

The exact circumstances of the production of the NAK set and the reasons that led to these inconsistencies could perhaps be fully determined only if and when a historical record (such as a *dkar chag* or a biography) describing this undertaking will come to light. Meanwhile we employed material analysis of the inks and paper to address the following questions: (a) Have volumes Tha2 and Ma2 (< Pha), and possibly Ja2 (=Zha), been an integral part of the set from the outset or are they of external origin, produced separately, in a different time or place? And (b) could the disorder displayed in the arrangement of the individual volumes and the discrepancies in the decoration of the illuminated folios result from a production of the set in different scriptoria, poor editorial work, or perhaps financial difficulties faced by the patrons during their execution of this colossal project?

To address the first question we studied the composition of the black and red inks (i.e. found in the main text, marginal caption, or ruling) and that of the paper in volumes that are believed to have been an integral part of the collection from the outset (i.e. already at the time of their production) and compared it with those in the volumes suspected to be of external origin. Due to time constraint we were unable to analyse the writing materials of all volumes during the research trip. Therefore, we examined select ordinary, or so-called "white" (*skya*), folios (i.e. such consisting of unpainted, "white" paper written in black and occasionally red inks) from altogether fifteen volumes – that is, folios from twelve volumes that

are assumed to be an integral part of the collection and folios from volumes Ja2 (=Zha), Tha2, and Ma2 (< Pha). In addition, we analysed the inks and pigments in ten illuminated folios selected from seven volumes. The findings of the material analysis combined with some palaeographical and codicological observations allowed us to draw certain conclusions on the composition and quality of the materials employed and make some suggestions regarding the circumstances surrounding the production of the set as well. Composition of the ink used for corrections brought further insight into the scribal and editorial work.

2 Description of the Systems and Methods Employed for the Material Analysis

For the material analysis discussed in this paper we used our mobile laboratory described in detail elsewhere.[8] In short, we used a commercial Artax µ-XRF spectrometer to record elemental distributions in the paper and inks. 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 20 s (live time). With our FTIR spectrometer we have mainly studied paper and pigments of the text and illustrations in the illuminated folios. The investigation of the inks was unfortunately impeded by a low spatial resolution of the spectrometer.

Dyes and pigments were evaluated by means of visible reflectance spectroscopy. The investigations were carried out using a VIS-NIR spectrometer JAZ-EL350 (Ocean Optics), which measures visible reflectance in the 350–1000 nm range. This device allows measuring a small spot of about 1 mm in diameter using a fibre optic. The instrument was calibrated using a white $BaSO_4$ standard. In addition, we used a three-colour imaging USB microscope (Dino-lite AD413T-I2V) to study the surface morphology and typology of the inks.

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[8] The setups are presented in a separate article in the present JIABS issue (Delhey, Kindzorra, Hahn, Rabin).

3 Material Analysis: Results and Discussion

3.1 Paper

We have been able to examine a select number of folios from seven volumes. The analysis of the trace elements in the paper does not show a unique pattern throughout the set. The paper sheets were probably made in different places since the impurities do not display a unique profile across the volumes inspected. However, the investigation with vibrational spectroscopy shows neither differences in the molecular composition nor presence of sizing. Close similarity of the FTIR spectra with that of the plain Nepalese paper manufactured in a traditional way from the bark of Daphne and Edgeworthia sp. leads to a tentative conclusion that the different sheets were presumably made with the same main manufacturing technique using the same plant species. Fig. 1 compares IR spectra of two folios form the set with that of the modern, traditionally made Nepalese

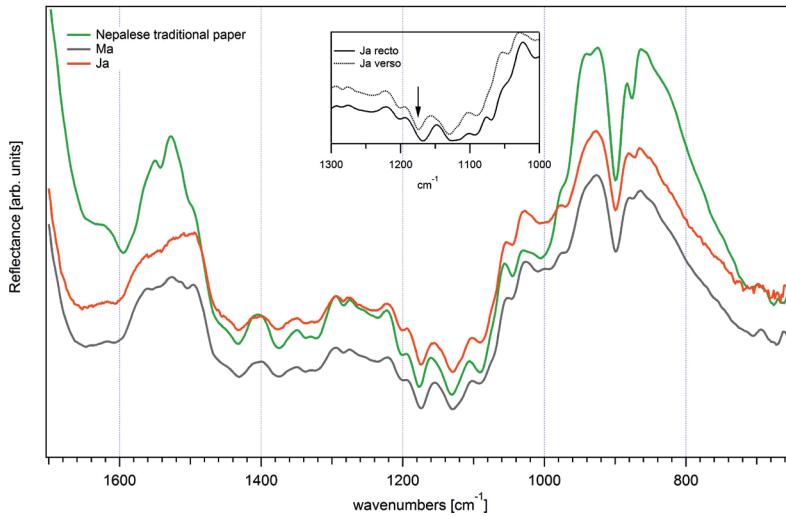

Fig. 1. Comparison of the infrared spectra of paper from the volumes Ma (grey) and Ja (red) and of Nepalese traditional paper purchased in Kathmandu (green). The insert shows a portion of the spectra taken on the recto and verso sides of a folio from volume Ja.

paper measured in reflection modus. It is noteworthy that the paper used in the set has slight differences between the recto and verso, which can be seen as a small shift in the spectra (see insert of fig. 1). Although it is impossible to distinguish between the Daphne and Edgeworthia sp. using non-destructive techniques alone, we believe that Edgeworthia sp. was possibly used. The paper of the set is severely damaged by an insect attack that seems to be incompatible with the use of Daphne sp. since the latter is believed to possess natural insecticide and, therefore, to be impervious to insects.[9]

3.2 Black Inks

3.2.1 Main Text, Marginal Captions, and Ruling

The analyses of the black inks used in the main text, marginal caption (commonly containing a marginal title, and volume and folio numbers), and ruling provided much more insight into the production processes. In all cases we examined, except for some of the corrections, the inks were found to be of the carbon type. In general, carbon inks are produced by a dispersion of soot particles in a water-soluble binder. Therefore, the XRF method cannot detect the main component of these inks. However, in addition to organic compounds, the inks may contain characteristic trace elements that would make them distinguishable. In such cases, we can use the XRF method for their comparison and classification.[10] Moreover, ageing phenomena do not alter elemental composition of the inks detectable with XRF since chemical corrosion would rather affect the chemical composition of the binder.

Secondary components such as various inorganic salts commonly encountered in carbon inks may result from the local recipes

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[9] Helman-Ważny 2006.

[10] For a discussion on carbon-based inks in general, see Hahn et al. 2007 and Rabin et al. 2009. For Tibetan carbon-based inks, see Cüppers 1989, which contains a translation of the chapter from Mi pham rNam rgyal rgya mtsho's (1846–1912) *bZo gnas nyer mkho'i za ma tog* (*Craftsmanship*: *A Basket of Necessities*), where instructions for the manufacturing of nine different kinds of carbon-based black ink are provided.

(intentionally added) or impurities from the water and tools associated with the inks (unintentionally added). Therefore, even inks prepared according to the same recipe would differ from each other if they were prepared at different locations or time, or by different people. Hence, the composition of the characteristic additives allows us to fingerprint historic carbon inks. Usually, examination of different instances of ink in an actual text with its diverse sections, corrections, inscriptions, etc. would offer insight into the history of the manuscript production by establishing whether it was created in a single, short term period (i.e. the same ink from the same batch) or in stages (i.e. either the same ink from different batches or different types of ink). When dealing with a mammoth set of ca. 15,000 folios we should consider the possibility that numerous scribes were simultaneously involved in its creation. This is undoubtedly the case with the NAK set, where numerous scribal hands are observed, not only in different volumes but also within the one and the same volume. Therefore, we made an attempt to compare the inks of as many folios as possible within the limited time at our disposal in order to try and establish common features of the set in this regard.

On the basis of our examination, the carbon inks used to write out the main text, the marginal captions, and the ruling (i.e. all instances of black ink except some of the corrections) can be roughly divided into four varieties according to the content of the inorganic impurities as follows: mostly iron (A), mostly copper (B), mixed (C), and no measurable metal impurities (D). The table below summarises the results of the XRF analysis for the carbon inks that were sampled from twelve volumes believed to originally belong to the set and the three volumes suspected to be external. Finding carbon ink with no measurable inorganic impurities (D) testifies to a recipe with no intentionally added inorganic components. Assuming that all inks used by the scribes (i.e. excluding those used by the editors-cum-proofreaders for corrections) were produced according to the same recipe, we attribute iron and copper of the ink varieties A, B and C to impurities originating from the inkwells and/or vessels in which the soot or inks were prepared.

Vol. No.	Fol. No.	Ink Variety Marginal Caption	Ink Variety Main Text	Ink Variety Ruling
Ka	32r, 51r	C, C	B, B	A
Ja	4r, 46r	D, A	B, C	D
Tha	12r	B	C	–
Da	54r	D	D	–
Ma	50r, 195r	C, B	B, C	A, A
Tsa	51r	C	A	–
Ra	29r	C	C	–
La	4r	A	B	–
A	9r	C	A	A
Khi	38r	A	A	A
Gi	159r, 162r	A, A	A, A	A, A
Ji	2r	C	A, A	A
Ja2 (=Zha)	171r, 330r, 331v	C, A, –	C, A, A	D, A, A
Tha2	40r	–	C	C
Ma2 (< Pha)	253r, 274r	B, C	B, C	–

Table 1. Carbon inks classified according to metal impurities: iron (A), copper (B), iron and copper (C), none (D).

Since the results of the random sampling presented here do not indicate existence of a characteristic pattern within a single volume, we could not establish characteristic properties of the set as a whole. The carbon inks of the suspected external volumes display the same ink varieties and variability, so that the question as to whether they have been an integral part of the set from the outset or whether they were produced separately could not be answered on the basis of the analysis of the ink composition alone. Certainly, the short duration of the research trip made it impossible to collect the statistics necessary to determine whether there was a prevalence of any of the ink varieties within one volume or how many folios were written in one variety. Nonetheless, taking into consideration some palaeographical evidence (though likewise limited in scope), several suggestions could be made and some conclusions could be drawn. As evident from the above table, more or less consequent pages are written in the same ink variety (i.e. Gi 159r & 162r and Ja2 (=Zha) 330r & 331v, but also Ka 32r & 51r). However, as already pointed out, the carbon ink composition is not preserved throughout a single volume. Here, a palaeographic examination could answer the question whether a change in the ink composition is accompanied by a hand change. Since neither a palaeographic study of the entire set nor an ink analysis in each instance of a hand change has been possible at this time, in the following passages some mere suggestions will be made on the basis of some observations regarding several of the examined folios.

In the two examined folios (50r & 195r) from volume Ma, we find two ink varieties in the main text (B & C, respectively), while in the respective marginal captions we find the same two varieties but in reverse order (C & B, respectively). Moreover, we seem to have the very same hand in both the main text and the marginal captions in both folios (fig. 2).

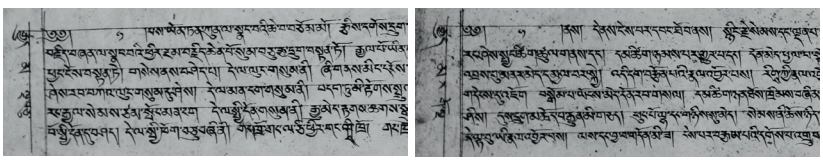

Fig. 2. NAK NyGB, Ma 50r (left) & 195r (right).

In volume Ma2 (< Pha), we find the same ink variety (B) for the main text in the two examined folios (253r & 274r), where we also observe the same scribal hand. In the two marginal captions we again find the same ink variety (C), which is, however, different from the one used for the main text. The fact that the marginal caption of 274r contains neither the marginal title of the entire collection as in 253r (i.e. *rgyud*) nor the volume and folio numbers, but merely the marginal title of the new text that begins there, it is difficult to compare the two marginal captions in palaeographical terms. They seem, however, to have been written by the same hand (this is also supported by the marginal captions of the following folios, which allow a better comparison), and they likewise seem to have been written by the same hand as the main text (fig. 3).

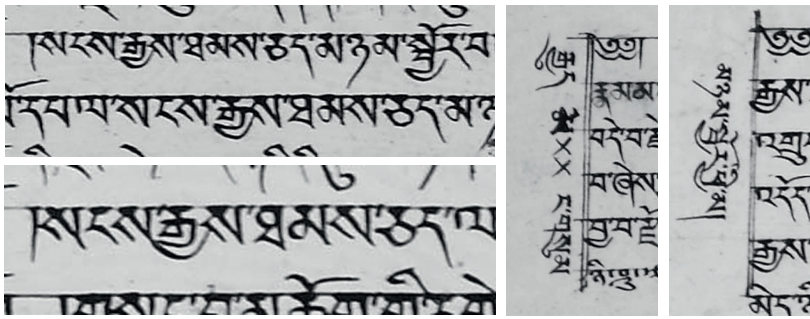

Fig. 3. NAK NyGB, left: Ma2 (< Pha) 253r (top) & 274r (bottom): detail of the phrase *sangs rgyas thams cad* (occurring twice and once, respectively); right: Ma2 (< Pha) 253r (left) & 274r (right): marginal captions.

We thus observe that in the four examined folios from volumes Ma and Ma2 (< Pha), the same two ink varieties (B & C) were used for both the main text and the marginal captions. Moreover, the scribal hand in all four folios appears to be the same. We may therefore conclude that the two volumes (or at least the examined portions of them) were written by the same scribe, using, however, two ink varieties in both volumes. Thus, despite some discrepancies in the employment of the ink, we may suggest that the two volumes were produced by the same scribe, and this in turn would mean that Ma2 (< Pha) – at least the extant portion of it – has probably been an in-

tegral part of the set already at the time of its production. However, considering the fact that the first 191 folios of Ma2 (< Pha) are missing and the fact that its volume number was originally Pha, we are still left with ample unanswered questions as to the circumstances surrounding its production.

In volume Ka we witness several scribal hands (a change of hand is observed, e.g., in fols. 103 and 292, where the script, despite its similarity to that found in the previous folios, shows several distinctive features, particularly regarding the subscribed letter *ya*). In the examined folios (32r & 51r), we find the same ink variety (B) in the main text, and the hand seems to be the same as well (the text on each of the folios, however, was most likely written with a different pen). We also find the same ink variety (C) in both marginal captions – which is, however, different than that of the main text. Moreover, both captions seem to be by the same hand, which in turn seems to be identical with that of the main text. To be noted, however, is the completely different style in which the volume number Ka is written in folio 51r (fig. 4), which is found in the vicinity on three successive folios (51–53) – but also elsewhere on two successive folios (21–22) – for which no explanation could be found.

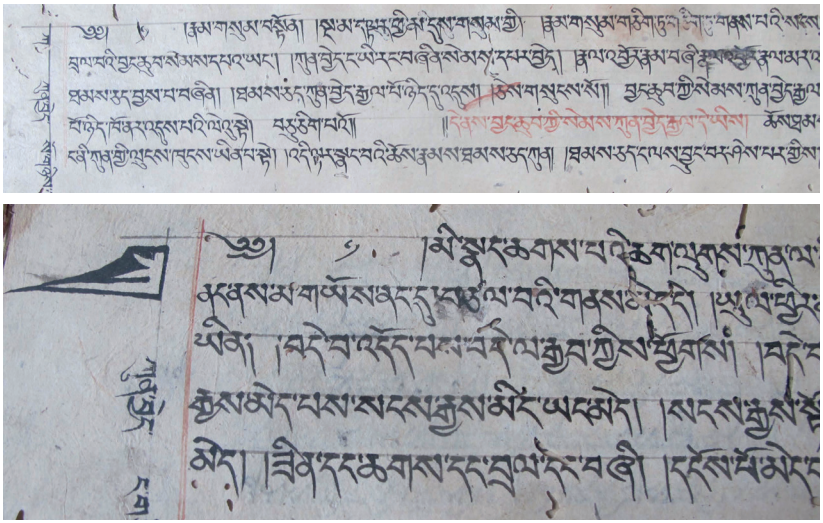

Fig. 4. NAK NyGB, Ka 32r (top) & 51r (bottom).

Also in volume Ja we find several hands, sometimes on the same page, as can be observed, for example, in folio 35r (fig. 5), where half of the fifth and the sixth lines are clearly written by a different hand (while 35v continues in the former hand!).

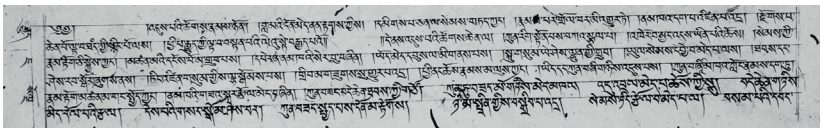

Fig. 5. NAK NyGB, Ja 35r.

In the examined folios (4r & 46r) we find two different ink varieties for the main text (B & C, respectively) and yet two different ones for the marginal captions (D & A, respectively). Despite a careful comparison of the hands of the main text in the two folios, it could not be verified with certainty whether the hand is identical, since no distinctive characteristics could be determined (regarding, e.g., particular letters, ligatures, or vowels), although the script on 46r seems to be slightly slanted. Provided we have here the same hand, this difference could be either due to the fact that 4r is a part of the few first folios which enjoy a different layout and are often written with more care, or perhaps due to the scribe's using a different pen (probably from fol. 30r, where a new text starts). The text of the marginal captions is too short to allow a thorough palaeographical comparison, but it nonetheless seems that the two captions are by different hands (fig. 6).

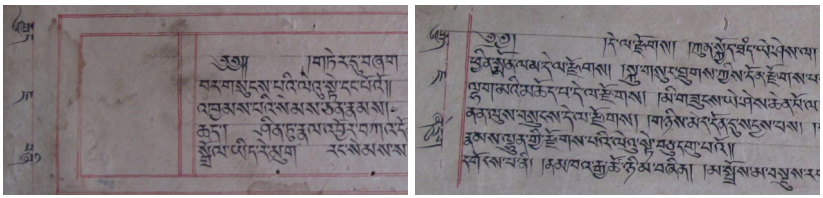

Fig. 6. NAK NyGB, Ja 4r (left) & 46r (right).

We likewise observe several hands in volume Ja2 (=Zha). Concerning the examined folios, we find different ink varieties in 171r (C), on the one hand, and in 330r and 331v (A), on the other.

The ink variety used in the pertinent marginal captions is identical with that used in the main text, respectively (C, A), and the hands seem to be respectively identical with that of the main text. We also clearly observe that the hand in 171r is different from that found in 330r and 331v (the latter hand commences on fol. 182r, where a new text begins).

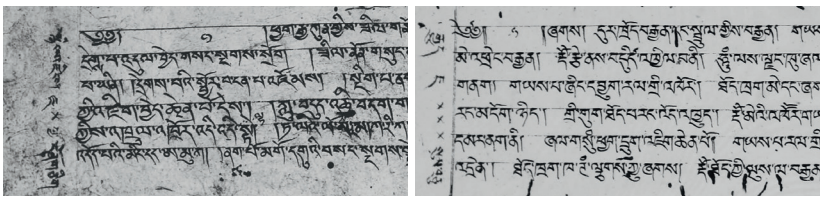

Fig. 7. NAK NyGB, Ja2 (=Zha) 171r (left) & 330r (right).

These observations suggest no particularly common features for volumes Ja and Ja2 (=Zha): the hands are different and there seems to be no shared pattern of the employment of the ink varieties either in the main text or in the marginal captions. Notably, the ink varieties used in Ja2 (=Zha) show more similarity with the inks used in some of the last volumes, which are mainly written in the ink variety A, and more so with volume Ji, in which the ink variety C was likewise used. As will be suggested below, these last volumes were possibly produced towards the end of the project, perhaps by another group of scribes, and probably also under some financial difficulties.

We seem to have the same hand almost throughout volume Gi (a different hand is found, e.g., in fol. 367). In the two examined folios (159r & 162r) we find the same ink variety (A) in the main text, and the writing seems to be by the same hand as well. The two marginal captions were also written in the same ink variety as the main text (A), and they too seem to be by the same hand. The hand of the main text and that of the marginal captions seem to be identical as well. The corrections' ink on 159r (i.e. both of the folio number and the substitution of the missing text in the bottom margin) is clearly distinctive (for more on this, see the following paragraph). The corrections are too short for sufficient palaeographical comparison. However, one may carefully suggest that they were made

by a different hand – compare, for example, the syllables *'khor* on 159r2 and *bsgrub* on 159r5 with those found in the correction in the bottom margin, and likewise the instances of the vowels *o* and *i* found in the main text and the same correction (fig. 8).

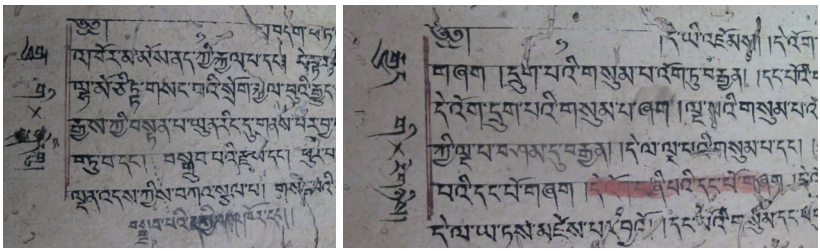

Fig. 8. NAK NyGB, Gi 159r (left) & 162r (right).

If we compare the two examined folios from volumes Tha (12r) and Tha2 (40r), we find that despite the fact that the main text in both cases was written in the same ink variety (C), the hand is evidently different (fig. 9).

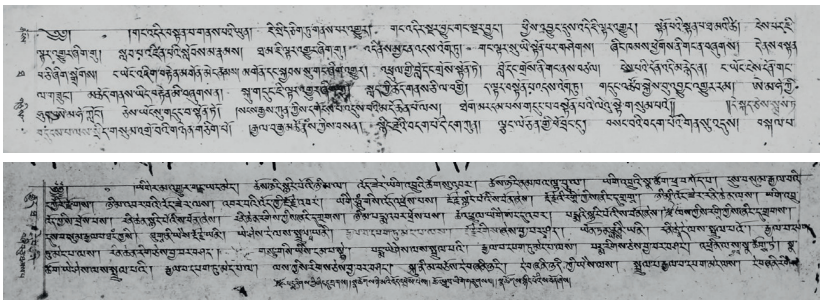

Fig. 9. NAK NyGB, Tha 12r (top) & Tha2 40r (bottom).

The above findings clearly suggest that a different ink variety does not necessary imply a change of hand and vice versa. Furthermore, in the majority of the cases, the ruling and the marginal captions were not written in the same ink as the main text of the pertinent page. However, the composition of the inks found there fits into the varieties A–D. The findings also suggest that even in the cases where the hand of the main text is identical with that of the perti-

nent marginal caption, the two were not necessarily written simultaneously, since they were often written in different ink varieties. Furthermore, since in most volumes the ruling was executed in the ink variety A, we may also conclude that it was a different scribe, or a group of scribes, who was (possibly solely) assigned with this task. We may thus carefully suggest that while the ruling was most probably in most cases executed by a separate team, the marginal captions were written by the same scribes that copied the main text, though not necessarily by the same individual, and also not necessarily simultaneously with the main text but probably after finishing copying it, or at least portions of it.[11]

As already pointed out, the results of the material analysis show that the main text of some of the last volumes, including A, Khi, Gi, and Ji, has been written in the same ink variety (A), which has not been found in the remaining examined volumes (an exception is observed in vol. Tsa). Moreover, in these cases solely red ink has been used for writing out the main text in the illuminated folios. This observation allows us to tentatively suggest that these volumes were most probably produced in a different scriptorium or by a different team of scribes. If so, as already proposed, volume Ja2 (=Zha) could possibly belong to the same group. However, whether the volumes that were written out in the ink varieties B, C and D stem from a single scriptorium or whether they were written in several scriptoria by different teams must remain open. Further, while it has been proposed that volume Ma2 (< Pha) was probably an integral part of the collection from the outset, and that volume Ja2 (=Zha) was possibly produced towards the end together with the last volumes, thus far no sufficient evidence has been gathered so as to allow one to draw any conclusions regarding volume Tha2.

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[11] A study of some of the irregularities in the folio numbers in several instances throughout the NAK set suggests that the division of labour in terms of folios among the scribes could have been carried out in bundles of 10. For more on this, see the article by Almogi, Delhey, MacDonald, and Pouvkova in the present JIABS issue. In this case, it is conceivable that the marginal captions were written in bundles of 10 as well, that is, after the scribe finished copying the main text on each bundle.

3.2.2 Editorial Corrections

While we seem to have sufficient evidence that the set was produced in at least two scriptoria (or by two different teams of scribes), we also seem to have evidence that the proofreading might have been executed in a centralised manner, that is, in one place or possibly even by one person. The light tint of the black ink used for corrections that appear to have been introduced by the editors[12] seems to suggest that this ink is different from the carbon-based ink discussed above. The composition of this ink, examined in two corrections from two different volumes, is in agreement with this assumption. The corrections of the volume number in Ma2 (i.e. from Pha to Ma) are clearly not written in carbon ink: Whereas soot, which is the colouring pigment of carbon ink, preserves its opacity at the wavelength of 930 nm, the ink of these presumably editorial corrections becomes almost transparent at this wavelength. At the same time XRF spectra show that this ink does not contain a measurable amount of elements characteristic of the iron gall ink so that this type of ink can also be ruled out. We thus conclude that it is plant ink that contains a small amount of carbon.[13]

Furthermore, we find a correction written in the same type of ink in volume Gi, folio 159r, where the folio number has been corrected and a gloss supplementing a missing passage has been added in the bottom margin (see above, fig. 8). Despite the poor statistics in the case of the ink of the presumably editorial corrections, we may carefully conclude that the hitherto available evidence appears to support the assumption that at least some of the editorial processes, such as proofreading, were executed in a centralised manner.

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[12] In contrast, some of the corrections appear to have been executed in carbon ink, either of the same or a different variety as the initial writing (and either by the same or a different hand), and we assume that they were executed by the scribes at the time of copying or writing, or shortly afterwards. We cannot, however, rule out that some of the editors used carbon-based ink. For more on this issue, see the article on multispectral imaging in the present JIABS issue by Almogi, Delhey, MacDonald, and Pouvkova.

[13] On this case, see also the article by Almogi, Delhey, MacDonald, and Pouvkova in the present JIABS issue.

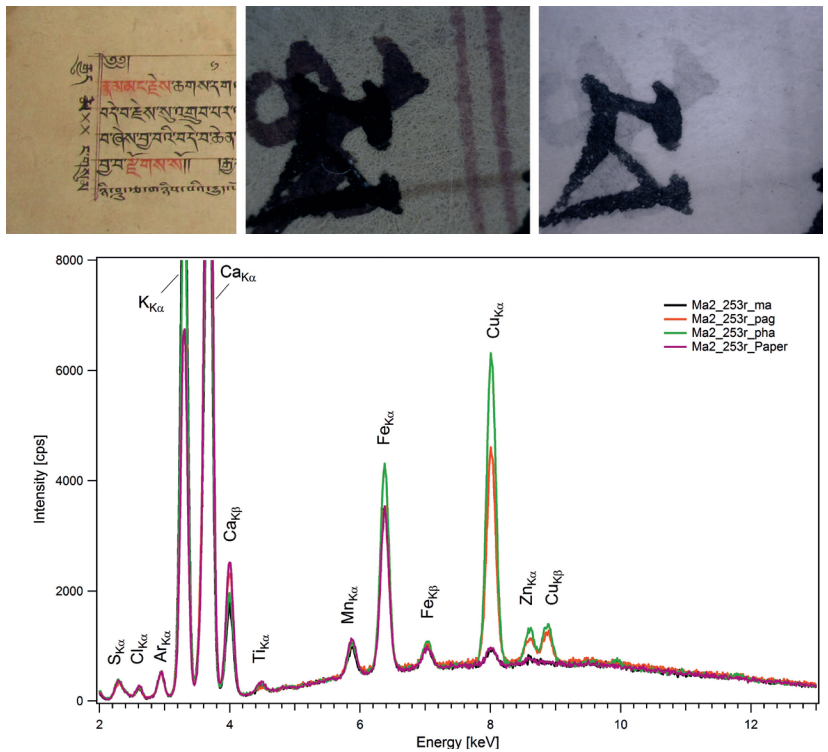
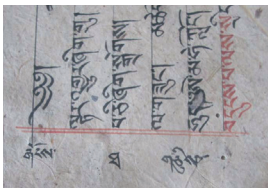


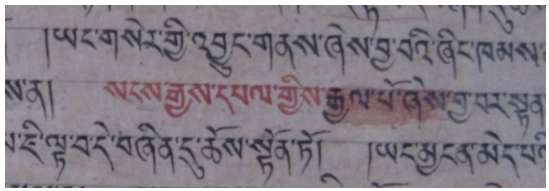
Fig. 10. Correction of the volume number from Pha to Ma on Ma2 253r. Top from left to right: colour photograph, micrograph at ambient light, micrograph at 930 nm; bottom: comparison of the XRF spectra of the inks and paper.

3.3 Red Inks

Red ink has been used throughout the set for rubrication[14] and for the frames, that is, the vertical lines on both right and left sides of

[14] The numerous instances of rubrication found throughout the NAK set have not been employed to mark the beginning (or the end) of textual units, but rather for the sake of emphasising certain words or phrases in various locations within the texts. However, while in some cases the rationale behind the rubrication is obvious (e.g. in instances of designations for or names of *buddha*s and deities), in most cases the rationale for their employment remains unclear.





Left: Fig. 11. NAK NyGB, Tha 12r: rubrication and frame in red ink.
Right: Fig. 12. NAK NyGB, Tha 23r: rubrication and highlighting in red inks.

the folios (figs. 11 & 12). A (somewhat brownish) red ink was also used for highlighting (fig. 12). [15]

Red inks were sampled from twelve volumes. Pure cinnabar or cinnabar with lead oxide prevail in the majority of the cases, whereas the rubrications and the frames found on a single page are executed in the same red ink. The instances of highlighting tested are never executed in the same red ink as the one used for the rubrications and frames. Volumes La and Ra are exceptional: the red frames in both La and Ra are executed in a dye, and the red ink of the rubrication in La (fol. 4r) is red lead. Interestingly, the illuminated folios in volume La (and to a certain extent also Ra) likewise show dissimilarities in terms of style and layout in comparison with the illuminated folios of the rest of the volumes (figs. 13 & 14). In addition, the golden ink used in La is different from that used in the other examined volumes (see § 3.4 below). While in the case of volume Ra, the evidence is not decisive, in the case of La it might hint at a different scriptorium or at a different time of production.

[15] The differentiation between 'rubrication' and 'highlighting' has been made here merely on the basis of the technique employed by the scribes (or editors) to emphasise a portion of the text, namely, 'rubrication' refers to emphasis by means of writing a portion of the text in red ink and 'highlighting' refers to emphasis by means of smearing red ink over a portion of the text that is written in black ink. Like in the case of rubrication, the rationale behind the highlighting is often unclear. Furthermore, there seems to be no fundamental difference between the instances of rubrication and highlighting in terms of their function. One possible explanation is that while the rubrication was made by the scribes during the process of copying, the highlighting is a later addition, possibly by the editors.

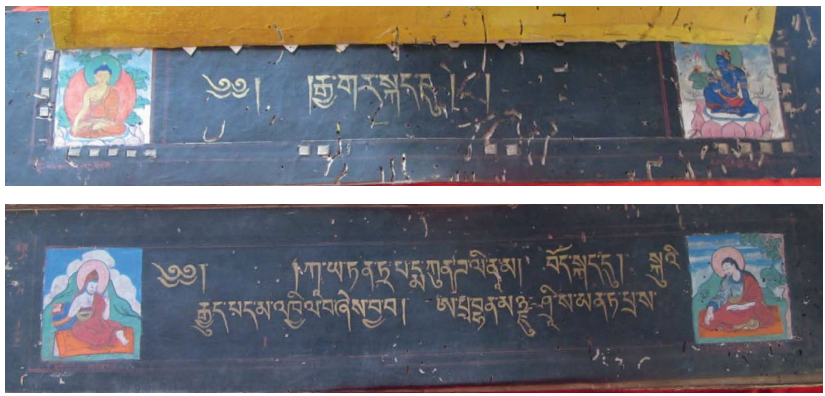


Fig. 13. NAK NyGB, prevalent style of illuminated folios throughout the set, here exemplified by fols. 1v (top) and 2r (bottom) of vol. Nga.

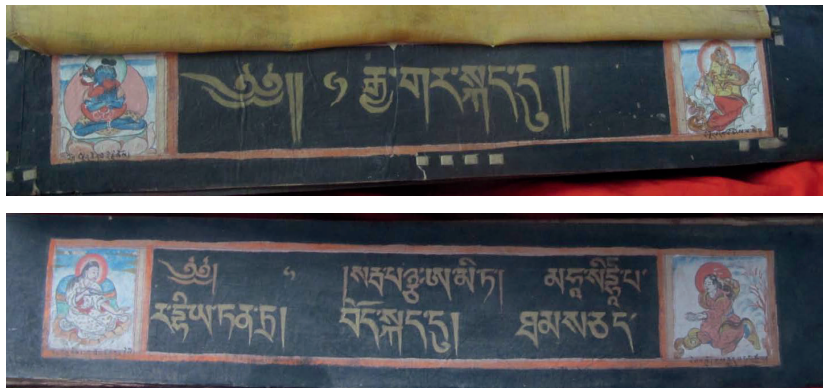


Fig. 14. NAK NyGB, illuminated fols. 1v (top) and 2r (bottom) of vol. La, which clearly have a distinct style: particularly notable are the bigger and thicker script and the distinctive thick frames not found elsewhere in the set. The illustrations could also possibly hint at a different artist (e.g. preference of reddish pigments over bluish or greenish, or differences regarding the background sceneries), but since not all illustrations in the set are painted and some are only partly painted, it is not possible to make a definite statement in this regard. Note, however, that while in all other cases the illustration captions are written in red ink on the black bottom margin, i.e. below the illustrations and outside the red frames, at least the inner ones (as exemplified by the images in fig. 13), vol. La is the only case where they are written in black ink at the bottom of the illustration on the borderline with the painted margin.

3.4 Golden Inks

Golden inks in ten illuminated folios from seven volumes were examined. The analysis clearly supports the impression gained through the observation that the golden inks varied in quality. Pure gold ink was found only in two of the examined cases: in volume Da, folio 1v, pure gold ink was applied on top of text written in golden ink made from orpiment (arsenic sulfide),[16] whereas in folio 2r of the same volume and in volume Ma it was applied on top of text written in red ink. In the majority of the cases the golden ink was found to be consisting of a mixture of gold and orpiment with or without addition of iron (fig. 15).

Also in this connection volume La presents a single case: the golden ink found there is made from orpiment with only a small addition of gold. While orpiment has been traditionally employed to write the first draft before writing out the final version with the costly golden ink (whether pure or mixed with orpiment),[17] it is unclear why some portions of the text in the illuminated folios were first written in red ink only to be later equally overwritten with golden ink as well.

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[16] The employment of orpiment (arsenic sulfide) to produce golden inks (i.e. either such that contain both gold and orpiment or such that only contain orpiment) within the Tibetan cultural sphere has often been reported. Moreover, it has also been reported that orpiment had been used to treat paper for protection from insects. However, no orpiment could be traced in the paper of the NAK set we examined. And indeed, Dr. Agnieszka Helman-Ważny, who conducted extensive examination of Tibetan paper, informs us that despite reports along these lines, orpiment is not traced in Tibetan paper as often as one would have expected. She also informs us that in spite of ample reports regarding the employment of orpiment to produce yellow colours, examinations show that in many instances yellow colours are either organic dyes or other mineral pigments. We thank Dr. Helman-Ważny for sharing with us this information. The employment of orpiment to produce yellow colours and for the sake of protection of the writing support is known in the Indian manuscript culture as well, on which see the article by Delhey, Kindzorra, Hahn, and Rabin in the present JIABS issue.

[17] Thanks to Dr. Agnieszka Helman-Ważny for this information.

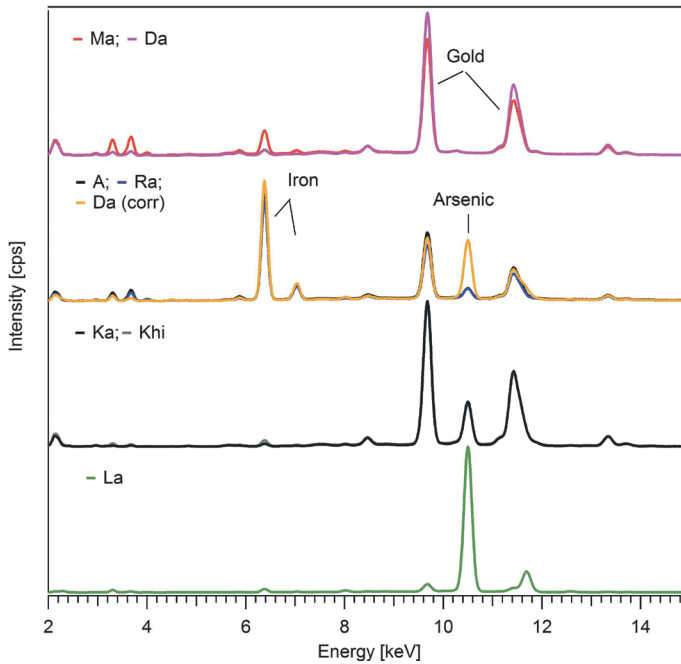

Fig. 15. XRF spectra of the various golden inks from the examined title pages.

4 Conclusion

Our sampling has not displayed any unifying characteristics of the set in terms of the materials used: No pattern could be determined regarding the employment of the carbon ink varieties throughout the set. Similarly, we find no specific tendency regarding the red and golden inks, although they display by far larger variation in terms of their composition. In addition, the random changes in the ink varieties indicate that the set was not necessarily produced in a strict order (e.g. following the volumes' order), in a single scriptorium or by a single team of scribes. Hence, the question as to the origin of the suspected external volumes could not be answered by the measurements alone. Combined, however, with some palaeographical evidence, we could make some preliminary suggestions in this regard. It is, nonetheless, not to be ruled out that a statistically valid study could shed more light on the circumstances of the

production of the set in general and of the origin of the suspected external volumes in particular. We also tentatively suggest that the last volumes, which are primarily written in the ink variety A, were produced at a different scriptorium, and that too, at the last stage of the undertaking, and that volume Ja2 (=Zha) was probably also produced under the same circumstances. Moreover, from the few measurements of corrections' ink, we could tentatively deduce that the proofreading has most probably been done in a centralised manner. In regard to the differences in quality and style of the illuminated folios, the analysis results seem to support both the hypothesis that the individual folios were illuminated by different artists (possibly in various locations) and the hypothesis that the sponsor(s) of this undertaking faced financial difficulties towards the end. The latter hypothesis is not only supported by the particularly poor quality of the illuminated folios of the last few volumes, but also by the apparently decreasing quality of the golden ink.

General Abbreviations

CSMC	Centre for the Study of Manuscript Cultures, University of Hamburg
KL	Kaiser Library
NAK	National Archives in Kathmandu
NGMPP	Nepal-German Manuscript Preservation Project
NRC	Nepal Research Centre
NyGB	*rNying ma rgyud 'bum*

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