The British Library Studies in Conservation Science

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Dunhuang and Turfan

Contents and Conservation of Ancient Documents from Central Asia

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Ancient Documents from Central Asia

edited by Susan Whitfield and Frances Wood

The British Library 1996

The British Library Studies in Conservation Science
Consultant Editors: Dr Mirjam M. Foot & Professor Kenneth R. Seddon

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Preface

The conference, 'The Preservation of Material from Cave 17', held in Sussex from 13-15 October 1993 and organized by The British Library, broke new ground in bringing together for the first time conservators and curators of all the major collections of documents from Dunhuang and Turfan, important sites on the Silk Road in Chinese Central Asia. We were honoured by guests from China, India, Russia, France, Germany and the USA. The conference was also unique in considering the new scientific techniques developed as a result of problems specific to the preservation and conservation of pre-tenth century material and we were particularly pleased to welcome colleagues from the fields of chemistry and paper science.

Following the discussion resulting from the frank and thought-provoking papers given by all the participants, it was unanimously agreed that co-operation is essential for the future, so that past mistakes in conservation are not repeated and that the specific knowledge acquired by each institution should be freely shared. The International Dunhuang Project was therefore established to provide a forum for international co-operation and with the aim of aiding conservation and scholarship by making the documents available in digitized form. All the Conference papers are reproduced in this volume and the discussion is summarized in the final paper, which also describes the objectives of the International Dunhuang Project and its work over 1994 and 1995.

It was also decided, since the relatively new field of conservation science is not represented by any existing publication, that this collection of papers should form the first in a British Library series entitled *British Library Studies in Conservation Science*. This will present the latest developments in the field and provide a unique insight into conservation practice, methods and theory. Of course, many of the developments in this field, such as the pH probe being developed at the Queen's University of Belfast in conjunction with The British Library, will have applications outside the specific field of paper conservation. We are delighted that Dr Mirjam Foot, Director of Collections and Preservations at The British Library, and Professor Kenneth R. Seddon, Chair of Inorganic Chemistry at the Queen's University of Belfast, have agreed to be consultant editors.

We are all grateful to everyone who attended the conference and helped to make it so successful, including the principal sponsors the Ko Ho Ning Memorial Bursary and Dr Abraham Sek-Tong Lue, as well as the British Council and the British Academy. We are also particularly indebted to Peter Lawson, then Manager of the Oriental Conservation Studio at The British Library, who had the patience, perseverence and vision to realize his hope of a new era of international co-operation.

Brian Lang, Chief Executive, The British Library

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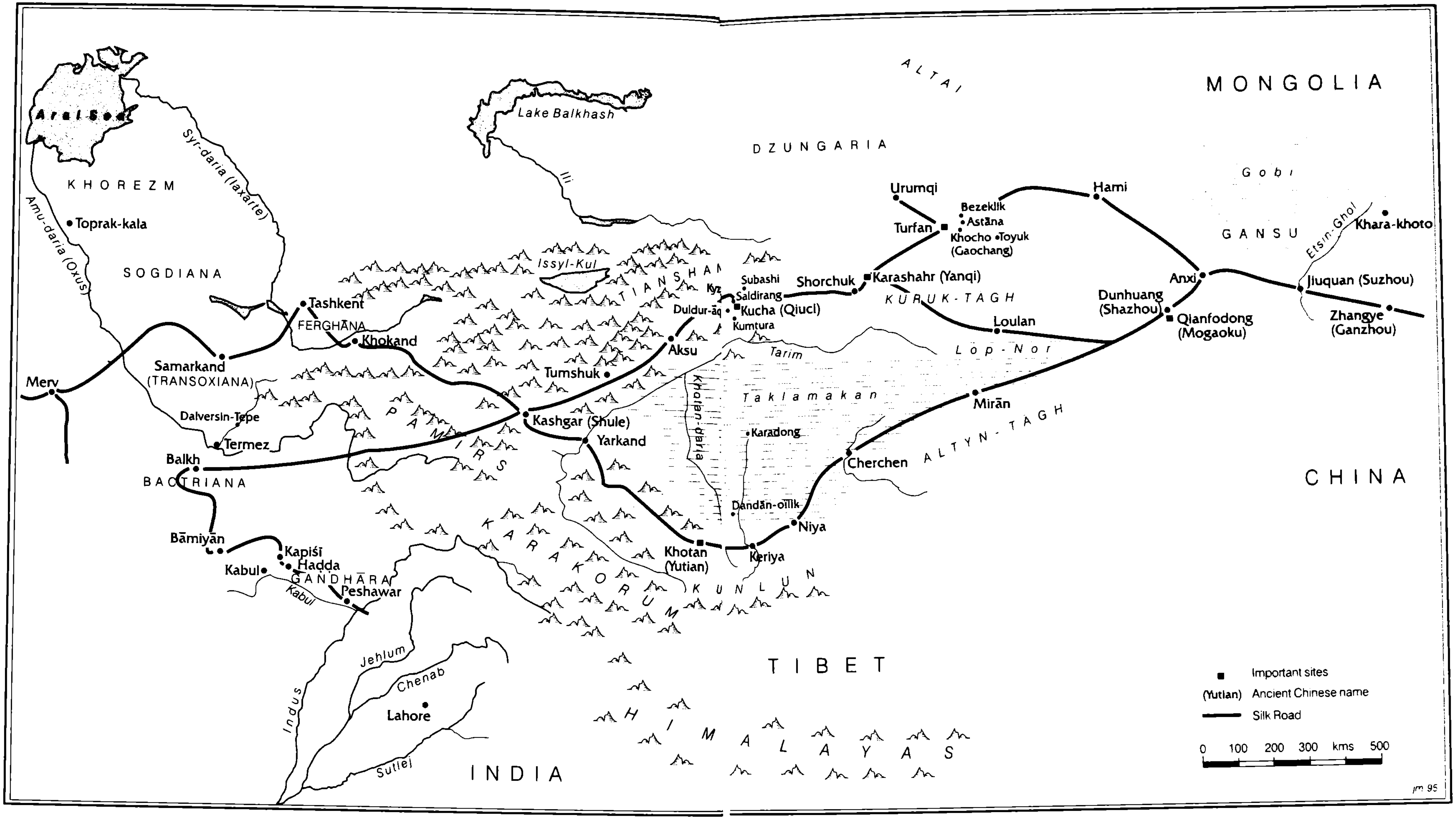

MONGOLIA
ALTAI
DZUNGARIA
Lake Balkhash
Ili
Aral Sea
KHOREZM
Syr-daria (Iaxarte)
Amu-daria (Oxus)
Toprak-kala
SOGDIANA
Issyl-Kul
TIAN SHAN
Tashkent
FERGHĀNA
Khokand
Samarkand
(TRANSOXIANA)
Merv
Dalversin-Tepe
Termez
Balkh
BACTRIANA
PAMIRS
Bāmiyān
Kapiśī
Hadda
Kabul
GANDHĀRA
Peshawar
Kabul
Indus
Jehlum
Chenab
Lahore
Sutlej
INDIA
Tumshuk
Aksu
Kashgar (Shule)
Yarkand
KARAKORUM
Khotan
(Yutian)
Keriya
Niya
KUNLUN
TIBET
HIMALAYAS
Duldur-āq
Kumtura
Subashi
Saldirang
Kucha (Qiuci)
Shorchuk
Karashahr (Yanqi)
KURUK-TAGH
Urumqi
Turfan
Bezeklik
Astāna
Khocho
Toyuk
(Gaochang)
Hami
Loulan
Lōp-Nor
Tarim
Khotan-daria
Taklamakan
Karadong
Dandān-oilik
Mirān
Cherchen
ALTYN-TAGH
Dunhuang
(Shazhou)
Qianfodong
(Mogaoku)
Anxi
Gobi
GANSU
Etsin-Ghol
Khara-khoto
Jiuquan (Suzhou)
Zhangye
(Ganzhou)
CHINA
Important sites
(Yutian) Ancient Chinese name
Silk Road
0 100 200 300 kms 500
jm 95

Two thousand years at Dunhuang

Frances Wood

Conservation work on Dunhuang and related manuscripts forms the main theme of this conference; curatorial work is in the background, yet its history affects the stages of conservation, through the personalities and approaches of the curators themselves. Conservation work also affects curatorial work. Where, in the past, description of the manuscripts, whether of their contents or their physical state, was the preserve of the curator rather than the conservator, recent preservation work has served to emphasise the importance of making and keeping records in the conservation studio. The conservation history of a manuscript has become as important as its traditional documentation in the form of catalogue record.

The history of the Dunhuang manuscripts after their arrival in London is one of a complex relationship between curatorial attention and subsequent conservatorial intervention. Where a curator marked out a manuscript for particular attention, its condition was assessed in the light of contemporary knowledge. The more recent history of the manuscripts in London has been a re-working of this process in reverse as current conservation skills are applied to undo earlier treatments.

When Sir Marc Aurel Stein deposited his Central Asian collections in the British Museum in London, he did not regard this as the end of his task. His writings and correspondence reveal how much Stein himself cared that experts should see and pronounce upon his finds. The fact that scholarly attention to a particular document might lead to conservation attention and that conservation methods of the first decades of the twentieth century were to create worse problems for curators of the last decade of the century was an unfortunate side-effect of Stein's passion to make his finds known. His letters demonstrate the difficulties of dealing with teams of specialists and their jealousies. Stein was keen, even when thousands of miles away and living in a desert tent, to promote publication and suffered from the academic temperament: 'The lines of collaboration for my team of 17-18 specialists are getting straightened out. But I begin to dread their demands for separate volumes: both Chavannes and Pelliot must have their own ...'.

Poor Stein: such efforts expended, such hardships endured and when the manuscripts were safely brought to the Museum, such promises, such hopes dashed. It is obvious, not only from the story of the race to the Thousand Buddha Caves but from the passionate desire to be associated with the Dunhuang manuscripts, that these were the greatest finds of Stein's career. Such was the desire for access that Pelliot, surely sufficiently occupied with his own manuscripts, offered in July 1910 to compile an inventory of 10,000 items for the small sum of £200. By 1912, Stein was 'fearing delay' and in 1913 Pelliot acknowledged defeat, at about the same time that Stein made his first request that Lionel Giles cast his eye over the paper used in both Chinese and Uighur documents. Giles's catalogue of half of the Chinese manuscripts, which had been abandoned by Pelliot, was not to appear for nearly forty years.

By the time Stein died in 1943, only two catalogues of his collections had appeared and only one, Arthur Waley's *Catalogue of Paintings*, represented his second and greatest expedition. At the time of his death, Stein had outlived Chavannes, Petrucci, Hoernle and Sir Edward Denison Ross, and nearly two decades were to pass before the catalogues of Maspero, Giles and de la Vallée Poussin and Enoki were finally published. A substantial amount of material remains uncatalogued and even unlisted.

Examination of departmental archives reveals two periods of hectic curatorial activity related to the Stein materials from the second expedition. The first lasts from 1914-16, during the period when Sir Edward Denison Ross was serving as 'Keeper of Stein Antiquities' in the British Museum (a title which, as far as I know existed only from 1914-16 and has never been revived, though during the last ten years, some of us might have aspired to claim it). The second period of concentrated curatorial activity dates from 1952-57 when a concerted effort was made to get Giles's catalogue published at last.

In the light of these well separated and all too brief flurries, it is hardly surprising that Stein very quickly lost faith in the British Museum and, as early as 1912, wrote, 'The arrangement with the BM will not be repeated ... There is a strong bias now at Simla in favour of Oriental studies being encouraged in the interests of Indian politics ... and there is no desire whatever to take so rigidly an English institution into partnership.' In 1914, writing from Turkestan on his third expedition (for which he did not seek the Museum's support) he stated that he was 'cautious of putting myself again into the meshes of that time-honoured godown of learned things and men.' The term 'godown' is appropriate for it indicates a storehouse whose contents are perhaps inventoried but not catalogued in detail.

It is probable that Stein's personal interest in the future of his finds was slightly difficult for the Museum authorities, too. Even within the 'caves' of the British Museum, Stein ordered that the unpacking, photography and compilation of a descriptive list be the responsibility of his friend Fred Andrews (who had been introduced to Stein by Rudyard Kipling's father, Lockwood). Since Fred Andrews could only manage the job part-time, for he was also working at the Battersea Polytechnic Institute, he was assisted by Miss F.G.M. Lorimer, the 'Recording Angel'. She made notes in the basement and sent copies to Stein in India. She also pursued recalcitrant experts such as Denison Ross on Stein's behalf writing to him on 21 October 1914, 'kindly let me have your Uighur Appendix' (underlined in both black and red). Stein chose the rest of his associates with a double aim: first they were to provide him with 'slips' containing information about his finds as fast as possible for inclusion in his own massive archaeological reports, and secondly they were to compile catalogues. He reported from Srinagar in early 1912: 'Slips are reaching me now steadily from Francke, Hoernle, de la Vallée Poussin. Even from Ross half a dozen arrived by last mail.'

Stein was generally exasperated by Edward Denison Ross. He marked him down as a 'flitter', a description to some extent borne out by his curriculum vitae which includes the following posts: Professor of Persian at University College, Officer in Charge of the Records of the Government of India, Director of SOAS 1916-37, Honorary Lecturer in Portuguese at Kings College, Commercial Counsellor at Istanbul and author of *A Polyglot List of Birds in Turki, Manchu and Chinese, An Introduction to Beckford's Vathek* and the *Life and Times of Omar Khayam* amongst others.

Stein refers to Ross's 'skittish' catalogue slips, his 'peripatetic researches', lack of orderly presentation and inability to decide whether all the Uighur manuscripts were of the same date ('Could you get Giles who is a sober and reliable worker to look?' he asked Dr Barnett), and it came as a matter of regret to Stein that Barnett, an Indianist with diplomatic skills, was relieved of all responsibility for the Stein collection when the 'flitter' Ross was put in charge in 1914, as the Keeper of Stein Antiquities.

During his tenure of office, although he left a little notebook with pencil notes on Uighur manuscripts, Ross's major concern remained the 'distribution' of the spoils. Lists detail the distribution of 'miscellaneous objects': textiles, stuccos, wooden architectural details, seals and intaglios (12 March 1915) or Sanskrit and Khotanese manuscripts with red ink marks to denote items intended for the British Museum collections and lists in French of 'Drawings'. There are lists of paintings divided into classes according to their quality as assessed by Raphael Petrucci (a rare expert on Chinese painting who died on 17 February 1917 and whose cataloguing work was consequently taken up by Waley) and fearfully mathematical divisions of the finds.

One list stipulates that Sanskrit and Prakrit manuscripts be divided with four fifths going to India (ending up in the India Office collections in London) and one fifth to the British Museum. These divisions were then to be sub-divided: 'it being stipulated that the proportion be applied separately to the three classes: Valuable, of moderate value, of little value, into which the mss. should be distinguished and (b) that the birch bark fragments form part of the BM's share. Bilinguals to be assigned to the language to which they predominantly belong and any residue of doubtful cases, involving 2 or more languages which are parted in the above division to be shared in the original proportion of 3/5 India and 2/5 BM.' (Letter from Ross to the India Office, 22 February 1916.)

During the First World War, the arguments over shares of the paintings and manuscripts became increasingly acute. Petrucci was called up for military service and Ross himself was seconded to the War Office, on whose headed paper he continued his correspondence relating to the Stein collection. The War was, in a sense, a boon to the British Museum for even those items 'destined for India' were stored *pro tem* in the Museum, allowing people like Laurence Binyon (the poet and art critic and perhaps the most important populariser of Chinese art in Britain) to grow fonder of them and to organise some restoration work, possibly with ulterior motives for he writes with some guile from the Museum, 'My Dear Ross ... I think you might mention, without making any claim for the Museum on the score of it that the Miran frescoes have been repaired and backed and framed'. He may here have been trying to strengthen the Museum's claims against those of New Delhi for he continues, 'I have not, after all, said anything about the banner with the Jataka scenes, as on thinking it over, I believe it would be to our advantage to have specimens of the different styles and the two given to the India Office are reproduced in colour in Stein's book.' The India Office cannot have been unaware of his intentions for two days later he writes after an interview with the Director, 'Kenyon has just sent for me to talk over the Stein affair which from the official point of view appears to look rather dishevelled ...'

There follow carefully argued letters requesting exchanges of paintings previously assigned by stressing the style of painting with Indian to go to India, Chinese to the British Museum and Binyon.

With reference to manuscripts, Dr Lionel Barnett wrote to Ross about Hoernle's proposals for splitting the collections. He reckoned that the Museum was not getting a fair one fifth of the Sanskrit and Prakrit and said firmly, 'The British Museum ought not to be allotted any rubbish such as some of the rotting bundles which it is proposed to assign to us ...' (23 December 1916); he continues, 'I venture to repeat my protest against the proposal to assign rubbish to the Museum. Many of the fragments which it is proposed to allot us are merely scraps, and some of them are rotting lumps in which not a word can be deciphered ...' It is interesting to note the purely philological interest of the traditional curator: during the last couple of years when we have been greatly assisted by scientists in their work on the chemicals in papers, we have finally had occasion to use some of the contents of two jars of Stein 'dust', the debris from the packing cases, in the hope that they might furnish information on the background chemistry of the caves themselves, thus even rotting rubbish can have its long-term uses.

The War affected the experts involved: Raphael Petrucci, in a Christmas note to Ross in 1914, refers to the War Office as 'votre prison' but less than a fortnight later, he sent Ross a postcard, postmarked Dunkirk, 10 January 1915. It was written from the Ambulance du Colonel Depage at La Panne, a rather ominous name when associated with motor vehicles but where Petrucci says he is 'bien installé' and simply wants to send a friendly message from the sand dunes. Petrucci had been assigned to the Medical Department of the Belgian Army and Denison Ross to the War Office, where it appears that he was in charge of the translation of enemy and suspicious documents. Barnett writes, for example, on 7 January 1916, 'My Dear Ross, this batch of letters is all right. It comes from a family in Madras and deals with matters of purely domestic interest. Thanks for your letter regarding the Stein colln ...'

It would also appear that Ross approached Sir Fredrick Kenyon, the Museum's Director, for linguists in November 1916 when Sir Frederick recommended Bell from the Department of Manuscripts, 'who can deal with German, French, Italian and Welsh and Thomas from Printed Books, 'who has French, Spanish, Portuguese, Dutch, German and Italian' and Flower also from Manuscripts, 'who adds Irish to the ordinary foreign languages'. Irish is a less surprising inclusion than Welsh given the Casement and Childers cases. With reference to German (whose best practitioner was a German and therefore in a difficult position), he wrote, 'Waley, né Schloss, is equally German in origin and moreover could not be spared without prejudicing Binyon's chances of serving.'

It was not until some time after the end of the War, in 1920, that the material destined for India was finally removed from the Museum, and only in 1919, after Stein had first proposed in 1917 (after Pelliot's default) that a Japanese scholar be entrusted with the Chinese catalogue, that Giles began his work on the Chinese paper manuscripts.

After years of archival silence, the next flurry of curatorial activity concerned the preparation for publication of Giles's catalogue in the 1950s. Throughout the 1930s, Giles published some of the results of his work in the long series on dated manuscripts from Dunhuang, that appeared in the *Bulletin of the School of Oriental and African Studies*. It is apparent, however, that it was not until he retired in 1940, that he was able to concentrate on getting the catalogue into a publishable form, without the distractions of administrative work.

The publication, which included the use of Chinese characters, was not easy, for the Second World War had interrupted publishing to a greater degree than the First. When approached in 1947, Oxford University Press regretfully declined, owing to 'the shortage of skilled workers and materials' but a solution was found in 1947 in Stephen Austin and Sons, a long-established printing firm from Hertford which had specialised in non-European language printing since 1768. Some of the considerable delays in publication were due to the difficulty of finding enough characters for a catalogue of mainly Buddhist texts. A letter from Mr Pamphelon, the Works Manager, dated 13 November 1950, says, 'There is no doubt this shortage of Chinese characters is likely to persist and will, no doubt, impede progress of the work. The most practical way of overcoming it is by advancing the make-up thus allowing sheets (of 8-page sections) to be printed off to release the Chinese characters.' A four-page list, dated 1950-57, is crammed with entries, detailing the coming and going of page-proofs between the printers, the Museum and Giles, who seems to have felt the delays for, in November 1953, when returning proofs to the Museum he asks if 'you might hurry them up a bit'. The Keeper wrote to Austins in 1954, mentioning Giles's approaching eightieth birthday and that 'he would dearly like to see in print the whole of his catalogue while he is still alive'. Austins countered with the pressure of University exam papers (which they still produce) and extra work for the British Trade Fair in Baghdad.

Poor Giles wrote on 1 August 1955, 'Though I have been rather seedy and confined to my pyjamas, so to speak ... I was delighted to receive those index proofs ... if only to be assured that the printers could not be dead and buried after all, as I had begun to fear after such a long interval of stagnation ...' Dr Giles's wife had died in 1955 and he continued to suffer from asthma and was eventually to retire to a nursing home. He seems to have been somewhat deprived there, for he wrote on 8 April 1957, 'I will return the script if required, but just at present I happen to have smashed my pen (this is borrowed) and in any case, to be without money, and not allowed to set foot outside these premises!'

Owing to his inability to escape to the Museum and the shortage of pens, as well as time, it is clear that Giles's preface to the catalogue was created in the Museum, using the text of *Six Centuries at Tunhuang* (a lecture given to the China Society in 1941 and published in 1944). This was not, however, done without Giles's knowledge for it was gently suggested in a letter to him from the Museum in late October, 1956. The race against time was won and the catalogue published a year before Giles died at the age of 83. It is interesting to see that shortage of characters in the Austin font was a complicating factor for the most recent flurry of Dunhuang activity in the British Library has taken place as Stephen Austin computerises (and has given, amongst others, its Chinese font to the Library) and as the Chinese section has embarked upon a database of Stein materials which we hope will hold all the scattered information about each manuscript: gathered from Conservation records, from the catalogues which were so long in production and from the publications and notes of the teams of specialists that Stein tried to marshal so long ago.

I have relied heavily upon Jeannette Mirsky, *Sir Aurel Stein*, Chicago, 1977; all other quotations from Departmental archives.

The preservation of pre-tenth century graphic material

Peter Lawson and Mark Barnard

This paper was originally given at the 1988 Kyoto Congress of the International Institute for Conservation of Historic and Artistic Works, The Conservation of Far Eastern Art, *and published subsequently in the congress papers. Though our policies and basic method have not changed, we feel that we have made many improvements, from both the conservation and the visual aspect, since this was first written.*

BACKGROUND

As historians of paper become more interested in the wider aspects of early paper production, so we become increasingly aware of the damage that has been perpetrated in the recent past by attempts at, and instances of, the mounting of ancient oriental scrolls and other paper artefacts. This not only applies to material in the British Library but also to many other collections of paper, both ancient and modern, that are kept in rolled form. The easy option of lining and rolling paper of any nature must be avoided. We are also increasingly conscious of the loss of evidence that can result, relating to minor and major chemical elements of the paper. Thus, out of respect both for the traditional form itself and for the requirements of the future development of paper history, the Oriental Conservation Studio of the British Library's Department of Collections and Preservation, has developed methods of conserving early paper materials, mainly in scroll form, that interfere with the originals as little as possible.

THE BRITISH LIBRARY COLLECTIONS

There are some 6000 virtually complete Chinese scrolls and approaching 8000 fragments in the collection which the British Library inherited from the British Museum on its formation in 1973. In 1982 the Library took over responsibility for what was the India Office Library and Records, which had been administered by the Foreign and Commonwealth Office. Its collection includes some 5000 items, mainly of Tibetan material but also some Sanskrit, and it is also rich in accompanying documentary support material such as the notes of Stein, Hoernle and photographs. Sadly this had all been very neglected. A planned programme for putting this into good order is now in hand, but in the current economic climate, planning and obtaining the resources to do this takes in its turn a large slice of the Library's means. This paper therefore deals only with that material which formed part of the previous collection of the Oriental Manuscript and Printed Book Department of the British Museum.

The storage and treatment of this collection up to the mid-1960s also left something to be desired. However, in 1990 we embarked on a project to conserve the remainder of the uncatalogued Chinese material, specifically the secular material not covered by Giles's catalogue, finally published in 1957.[1] Altogether some 4500 items were conserved, the bulk of which were encapsulated. To achieve this we had the good fortune to be assisted by our colleagues Mr Du Weisheng of the National Library of China, Ms Zhou Zhiyuan from the Hunan Provincial Museum, and latterly Mr Dai Liqiang and Ms Shao Zhuangwen of The Liaoning Provincial Museum.[2]

THE PROBLEMS

In the early 1970s there was a strong feeling in favour of mounting these scrolls in the manner of oriental paintings. Though the number of items in the collection might seem to be the factor militating against this method, it was not the prime factor. The most important point is that they formed part of a library, not a collection of paintings. In their original form, they were simply sheets of paper pasted carefully together in a roll form. A small number of the scrolls are on a wooden roller with a tie, but more often without. There is in this vast collection only one document that has a crude resemblance to a mounted scroll, and in all probability this was just a contemporary repair. As evidence of a tradition of mounting early documents, it can be discounted.

Scrolls or rolled material that have been lined inevitably crack, whether they are oriental or occidental. The main factor governing the cracking is the difference of travel of the two layers: the original and the lining. The items when lined are worked on flat with linings that in some cases are made from a multiplicity of papers and adhesives and then rolled. It is obvious that the lining has much further to travel than the original material when it comes to rolling the scroll. The two components, the linings and the lined, being completely covered with adhesive and bonded together, create a tension which causes the roll to crack or in some rarer instances (mainly silk oriental scrolls) to become delaminated.

Prior to early 1989 the most effective method we had for removing old starch adhesives from the original scroll was by using enzymes.[3] An alternative, in our experience less effective, was N-methyl-2-pyrrolidone.[4] The accepted solution of gently damping from the reverse to remove old backings does not solve the problem of the residue adhesive left in between the fibres of the original. If the scroll is to function safely, the residual paste must be removed. Since 1989 we have resorted to removing modern backings with a controllable steam-generator. Though slow, it offers the operator far more control, but it will, however, still leave a residue of starch between the fibres.

Another problem that has arisen with mounted early Chinese papers that has given us much cause for concern, is the soluble yellow dye (*huangbo* 黃檗), which is by tradition phellodendron from the cork tree (*Phellodendron amurense* Ruprecht and *Phellodendron amurense* var. *sacchaliense* F. Schmidt).[5] This was considered to discourage insect attack and it is most prominent on Buddhist documents. Though the chance of attack by insect type pests would be unlikely in Dunhuang, the material would have come from an extensive geographical area. There is, however, little evidence of damage from this source. We have found the dye to be soluble in any medium, leaving the problem of the removal of the starch adhesive mentioned above. We therefore feel at present that the best option is to do nothing, or to remove these backings (with the steam generator as previously mentioned) on those scrolls where the dye is likely to bleed. Since the original paper was written, we have had generous help from the School of Molecular Science, the University of Sussex,[6] which has carried out research into the various properties of the yellow dye. Their research so far has shown that there is a high probability that the dye can be consolidated in the paper without harmful effect. We are also very grateful to UMIST, the Department of Paper Science of Manchester University, which is testing the stability of paper treated in this manner. We feel that adding a further dimension to the chemistry of the paper which has already been adulterated must be acceptable in the interest of retaining the paper's intended character. A brief analysis of the foregoing shows that we have the following problems to resolve with scrolls that have been fortunate enough to have received no previous treatment.

1. Nothing should be added to the scrolls in the form of paper, adhesives or chemicals which interfere either chemically or physically with the original materials.

2. The scroll should retain its character and yet be easily accessible to the reader. This requires the scroll to be unrolled and not to behave like a spring and re-roll itself to the inconvenience of the reader and the danger of damage.

EXPERIMENT AND METHOD

A simple experiment to demonstrate cracking can be shown by stapling together at one edge two sheets of A4 paper 0.08 mm thick and rolling round a diameter of 30 mm which produces a difference of 2 mm or so. A diameter of 10 mm using the same A4 paper produces a 40 mm difference. It takes little imagination to see that a scroll, some 6 metres long with a paper thickness of 0.1 mm, would produce a far greater difference of travel. Other factors contributing to cracking are the thickness of the adhesives, their type and method of manufacture and application, and also, as already shown, the diameter of the roll and the thickness of the paper. Working practices,[7] *eg* grain direction, etc, are assumed to be obvious in the context of this paper.

Some of the more deplorable methods used to counteract cracking are the thinning of paper by removing fibres from the back of the original, either by rubbing with wet fingers or a similar action to abrade the fibres, or by picking them out with tweezers; or the European bias towards trying to solve the problem by brute force, using a woven fabric lining and thick paste. It need hardly be said that this only produces more cracking.

THE ANSWERS

The conservator has at his disposal several options other than lining and rolling. The simplest and most effective of these is to encapsulate fragments into a clear polyester film (Melinex), which has proven itself over the last forty years or so to be chemically stable.[8] There are some problems with static electricity but these can be turned to good advantage when positioning the material. There are two methods of sealing the material into the polyester film:

1. An impulse sealer, which welds the polyester sheet electronically with high-frequency waves. It is not possible to weld polyester sheet with a conventional heat sealing device such as is used with polythene sheet. The capital cost of the equipment is very high and there are also some reports of earlier models being somewhat temperamental and having limited scope.

2. An industrial sewing machine, which is far more labour-intensive but has the advantage of low capital cost and is readily available to purchase and repair. (A refinement is to seal the edges and then sew. The edge sealer as district from the impulse sealer in (1), though not cheap, is less than 10% of the cost of the former.)

Encapsulation is probably the best form of conservation for any graphic material, since it provides a secure mini-environment and leaves the material retrievable; a further attraction is its cost-effectiveness. However, the bulk is considerably increased by encapsulation and the amount of material that can be stored in this way is restricted by the dimensions of the storage space available. The British Library can exceptionally store documents up to 1500 × 500 mm in polyester film; however, this size is rather clumsy for the reader to handle and 1000 × 350 mm is more often our normal maximum. There is also some justifiable reader criticism of reflections from the plastic film. The criticism of the material being 'plastic' is just one of fashion and this is far outweighed by the improved safety of the material. Encapsulation is a method with which we feel confident.

The material in the Oriental Collections which will not be encapsulated due to size, can, for the purposes of this paper, be divided into two groups:

1. Those which have had some lining carried out prior to 1960 and which are now cracking to a lesser or greater degree and which are also, in many cases, chemically unstable due to the use of inappropriate materials. These fortunately represent only a small percentage of the collection but are obviously where our efforts are concentrated.

2. Those which have undergone no attempts at mounting (by far the largest proportion of the collection). These are only worked on if there is a likelihood of further damage to a scroll due to intensive past, present or future use. It is with this latter group that we follow a policy of minimum intervention, and lining or the use of other detrimental materials is avoided.

In the instance of the former group, damage and loss of paper history evidence has already occurred. We therefore have no compunction in removing the old linings and adhesives in the most effective way, commensurate with good conservation practices.

REPAIR

Damaged scrolls are repaired locally using a long-fibred Japanese *kozo* paper. The paper preferred is approximately 14-15 g per square metre. The paper is stained, not to match, but to be visually acceptable when viewed with the original. We rely mainly on manufactured dyes which are made for the paper-making industry of today. Their main attributes are consistency and the wider range of shades than can be obtained from a few basic colours, as well as the cost-effectiveness of convenience. The dyes at present in use are manufactured by the Sandoz Company and display the best chemical stability and light-fastness of those that we have tried.

The problem of repair or infill of the missing areas on scrolls where no lining can be considered is how to bond the repair material to the original without creating an obscuring overlap, bearing in mind that there must be minimum interference with the original, and the scroll will lack the reinforcing support of a lining. The method employed is that of a simple water cut. This is achieved by laying the original on a light box, placing over this a transparent plastic film and laying on top of this the prepared repair paper. The missing areas are then traced onto the repair paper with water, using a capillary-pen or an artist's brush. The paper is then pulled apart along the wetted areas, which will draw out the fibres. The fibres and the minimum of the repair paper are then pasted and attached to the back of the original. A further sheet of repair paper is added to the front but this is not overlapped. It is attached by the fibres only, which are also trimmed to some 2-3 mm long. There is a tendency to place the lighter of the two repair papers to the back and the heavier to the front. The stained fibres are fine enough to be visually lost when the scroll is viewed from the front but are readily discernible in detail. On rare occasions, mainly when dealing with the thicker and cruder later papers in this collection, it has been necessary to sandwich further paper in between the two layers to build up an even thickness compatible with the rest of the scroll.

For visual effect and convenience of application, the repairs are started or finished at the joins of the original sheets which form the scroll. This system of attaching the infill gives not only a good bond but a progressively flexible join and a pleasing appearance. At this stage runners are added to both ends of the scroll. It is imperative that all joins are absolutely square, since otherwise the scroll will not roll straight. The scroll is then lightly dampened and fixed to a plywood drying board with a light folded paper strip. The paper strip is folded and creased across the paper in the opposite direction to the grain, the creases being 10 mm or so apart. This gives the paper strip a small amount of stretch in both directions when the scroll is under tension. The paper strip, being weaker than the repaired scroll, also acts as a safety margin which will tear should the scroll come under too much tension, though this has never happened in our experience with material from Dunhuang, probably owing to the elasticity of a long-fibred paper. Ideally the scroll is then left to mature on the drying board for a year. Originally they were left for three months or so, but experience has shown that leaving scrolls through the four seasons greatly improves the final compatibility and malleability of the various papers. These times can only be approximate and have to be adjusted to our working patterns.

There are in the collection a small proportion of original rollers, but the vast majority of scrolls have either lost or never had a roller. The modern wooden rollers we employ are made of sycamore (*Acer pseudoplatanus*), a light wood which is easy to turn and is readily available in the UK. The diameter of this is 10 mm much the same as the few original rollers in the collection. The roller and a light hemispherical stave at the beginning of the scroll are fixed neatly onto the runners in the same manner that would have been employed originally. The roller in its turn is placed in a 12 mm groove routed out of a larger roller which is 30 mm in diameter. The scroll is then wound round the larger roller with the original roller or its modern counterpart firmly anchored in the groove of the larger roller. This has the advantage of preserving the original roller, while rolling the paper scroll onto a larger diameter, should a scroll be allowed to unroll and fall off the end of a desk the heavy roller will fall away, and not tear or damage the scroll. Should the stave have survived this is replaced in its original position. However these are often broken and our present practice is to make the stave up to size with a similar wood. To complete the scroll a silk braided tie is added to the stave and the finished scroll is placed into a Japanese *kiri* wood box.

ALTERNATIVE METHODS

We have yet to come across a scroll so fragile that we cannot conserve it by the methods described in the previous section. However, it is probable that this will happen in the future. Alternatives to rolling or lining (or both) that have been successfully used elsewhere than the British Library are picture type stretchers, or a surrogate or dummy mount.

Stretchers are an attractive way of conserving scrolls and paintings, especially one that has been mounted and where the mount itself has historical or visual interest and must also be conserved intact. It is, however, somewhat limiting in size. While ideal for paintings with two long dimensions *eg* a square, it is obviously not practical for a scroll say, six metres long by thirty centimetres high. A light wooden frame is constructed, suitably braced and covered on both sides with fabric. The scroll is then attached to the fabric by means of a light paper strip (some 50-100 mm wide depending on the size of the original). The purpose of the strip of paper is to tear should there be excessive shrinkage. The criticism of this method is the loss of character of the rolled scroll. However this is far outweighed by the advantage of solving the problem of cracking and the continued remounting of the scroll.

For long scrolls which are not lined and are still too delicate for normal handling, we would suggest that consideration be given to a surrogate or dummy mount. The surrogate mount is constructed in much the same way as a hand scroll. In its simplest form this could be a roll of chemically stable paper wound round a large diameter roller, leaving plenty of room for the original to roll inside. In a constructed mount the original is lightly fixed at the end of the surrogate mount (made in the form of a blank scroll), and it must be left free on the other three sides to allow movement as the completed assembly is rolled. This simple solution is particularly attractive to an individual scroll, or in a small collection where conservation knowledge is limited and mounting skills are paramount.

STORAGE

Much has been said and written about the correct environment, which we have no doubt is a necessity for the continuous well being of any artefact. However, we start in the happy position of scrolls and fragments having no fixed edge. Unlike books they are free to move with changes in humidity and temperature. The British Library's original collection is now kept in a fully air-conditioned store. This has worked effectively since its installation (1 January 1990). A steady environment can never be guaranteed, no matter how rich or efficient the society in which the material resides. Full air conditioning is dependant on many factors, the major ones being capital costs, fuel costs, maintenance, water supply and drainage. The moving mechanical parts will rarely have a life span in excess of fifteen years. Fuel and the other services are also vulnerable to disruption, whether this be caused by hostile weather, civil commotion, act of war, or perhaps the strain on the world economy as fuel availability declines. We can only accept air-conditioning for what is: a complex mechanical system that is prone to break down and is vulnerable to the failures of outside agencies beyond the control of museums, libraries and similar institutions.

The British Library keeps these collections in well-insulated wooden cabinets. The material that has been conserved is kept in a cotton fabric, while the more valuable scrolls are kept in silk fabric lined with cotton. The bags have at present been superseded by a traditional Japanese *kiri* wood boxes (made from Paulownia wood: *P. tomentosa*). Traditionally, the grain of *kiri* wood progressively closes with an increase of humidity and is used in Japan to store such treasures as scrolls or a valued kimonos. Although the climate in southeast England is relatively mild, we have found that the cabinets, wrappers or boxes will smooth out the vagaries of any air-conditioning system. However, even with these precautions, it is inevitable that at some time in the future the material will be exposed to a bad environment. Their ability to survive undamaged will be greatly enhanced if they are not lined, and their immediate environment, in storage cabinets and boxes, is designed to cope with a loss of conditioned air.

CONCLUSIONS

Paper scrolls that have been lined, and composite rolls of paper and fabric, invariably crack over a period of time, no matter what precautions are taken to stop the progress of the damage. This paper sets out of the processes used by the British Library to avoid this disfiguring damage to its pre-tenth century Oriental Collections, and the obliteration of primary material evidence for early paper-making by lining with unsuitable materials.

ACKNOWLEDGEMENTS

We would like to thank the staff both past and present of the Oriental Conservation Studio who have contributed to the successful production of an acceptable mounting system over the last twenty years and also our many friends and colleagues in other institutions who have been unstinting with advice and tuition. We are also particularly indebted to the University of Sussex for their research work on the properties of dyes in these papers. Nor would our work have been possible without advice and patient encouragement from the Chinese Section of Oriental and India Office Collections, The British Library.

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The British Library Stein collection: its conservation history and future preservation

Mark Barnard

My aim is to describe how the physical conservation of Dunhuang materials in London evolved over the past eighty years and the significance this history has for our future development programme and the long-term preservation of the scrolls. I hope that it does not appear as a catalogue of disasters.

Following the removal of the Dunhuang rolls from the Cave of the Thousand Buddhas during Sir Aurel Stein's second expedition and their arrival in the British Museum in January 1909, conservation work started immediately on the most vulnerable items. These mainly consisted of silk banners and paintings for, although Stein recognised the importance of the paper scrolls, priority was given to, and possibly greater care taken of, the silk items.

The first repairs to the paper scrolls and fragments were carried out by Stein's assistants. This simply consisted of pasting a lining of thin paper to the verso of the scroll fragments.

It is possible that the first scroll to be 'mounted' (lined) was the *Diamond Sutra* (Or.8210/P.2). It was during this mounting that the heavy stain which disfigured the frontispiece was removed: possibly by chemical bleaching, along with a pre-eleventh century repair in the form of a strip of paper that supported the damaged central part of the frontispiece.

The *Diamond Sutra* and other items from Dunhuang were prepared and displayed in the exhibition of paintings, manuscripts and objects collected by Sir Aurel Stein on his second expedition, which was held in the British Museum during 1914.[1]

After the appointment in 1918 of Lionel Giles as Keeper of Chinese, a repair programme for the paper rolls was started that ran parallel with the cataloguing of approximately 6000 scrolls.[2] The repairs were undertaken in the British Museum Bindery. They involved the lining of selected scrolls and fragments using thick grey paper and paste adhesive. This style of repair continued for approximately twenty years.

Between 1940 and 1945, the bulk of the Stein collection along with other highly prized manuscripts from the British Museum library was transferred to Wales for safe storage in slate caverns. Following their return to London in 1946, the scrolls were repaired with various types of lining paper, including thick Kraft paper and, later, a Japanese tissue from 'Berrick Bros.'. It was during this period that silk gauze was used for support of scrolls which had text on both recto and verso. Wheat paste was still in use, as well as two proprietary adhesives, Clam and Stadex.

The use of these materials and the excessive amounts of adhesive used to attach the silk has left the treated scrolls distorted owing to the uneven expansion of the repaired areas. An additional problem is the brittle nature of the repaired scroll, due to the increased thickness and the inflexibility of the adhesive. This inevitably leads to mechanical damage when the scrolls are handled.

This style of mounting continued until 1973 when, with the foundation of the British Library, the Stein collection was divided between the British Museum and the British Library. Serious attention was then given to the conservation of the Stein manuscripts.

Following a visit to China in 1975 by Peter Lawson and Howard Nelson (then Assistant Keeper of the Chinese collections), two conservators were employed to work on the Stein collection. From that period, the scrolls were mounted in a Chinese style, using Chinese repair paper and silk and scroll knobs. We mounted in this style for about eight years. During that period, several disadvantages emerged.

Firstly, the style was inappropriate for the manuscripts. They were being mounted as if they were 'handscroll' paintings, with a series of lining papers for backing support, together with heavy burnishing of the completed scroll with stone or glass beads. The instrinsic nature of the 'book' or 'text' scroll was lost, with a corresponding loss of information for paper scientists and historians. In addition, the full backing of scrolls dyed with *huangbo* affected the density and uniformity of the yellow colour as *huangbo* is soluble in water and alcohol. Since 1982, we have been developing a system of repair that avoids the disadvantages and damage that conventional mounting can cause.

Today, our scrolls are never lined, only relaxed and repaired where necessary using only the highest quality materials from known papermakers and suppliers. Skills continue to be developed and experience gained, enabling us to reach correct conservation assessments when any intervention is required.[3]

Our future conservation programme stresses understanding of the problems that we are now starting to identify with pre-1973 repairs. Prior to this period, no conservation records were kept. This has greatly hindered our research into the conservation history of these scrolls. Although well-intentioned, the repairs have left us with a legacy of problems that we are only now beginning to unravel. The problems that currently face us include:

1. Past use of low-grade mounting and repair papers. Ideally these should be removed to prevent further damage.
2. The addition of alum (aluminium sulphate) to the adhesive. This has long been a common practice but its long-term effect on paper is, as yet, unknown.
3. Possible low pH value of the scrolls.
4. The past use of silk gauze which can cause embrittlement and discolouring of the paper.

5. Possible use of bleach on, for example, the frontispiece of the *Diamond Sutra*.
6. The past use of gelatine size.

The problems that we have identified as deriving from pre-1973 repairs to the scrolls form the basis for our current and future research. The nature of the *huangbo* dye is a major pre-occupation. As we are faced with the problem of removing adhesives and repair paper from scrolls dyed with phellodendron *huangbo* (soluble in alcohol and water), we are grateful for the research into the identification of the *huangbo* dye by Professor Seddon and his research team at the Queen's University of Belfast.[4] This work is essential to the study of the present condition and long-term stability of the *Diamond Sutra* currently underway in the Oriental Conservation Studio in the British Library.

As well as work on the *Diamond Sutra*, the Oriental Conservation Studio has embarked upon a complete conservation survey of 8000 items in the Stein collection (the Dunhuang material brought back on Stein's second expedition). The survey is being entered on a database and it will allow us to describe fully the preservation status of each document as well as to establish priorities for our future work programme.

Development is currently underway at the Queen's University of Belfast on a new micro-sampling technique that will take pH readings from within the paper structure, allowing for the first time the possibility of an accurate measurement of pH. This will have a profound effect on our ability to monitor the acid/alkali balance of the scrolls.

Other areas of future research may include:

1. The use of alum in paste and its possible degredation of paper
2. Analysis of dyes, printing and writing inks
3. Analysis of Chinese paper-making fibres
4. Optimum storage conditions for these documents

This conference represents the first opportunity for conservators of pre-tenth paper manuscripts to share their experiences and future plans. It also demonstrates our more recent reliance upon scientists to help us solve problems that have arisen through the best efforts of our predecessors. Our experience over the past twenty years shows that both national and international collaboration will be the key for the long-term preservation of this unique collection of documents – through the joint efforts of conservators, curators and preservation scientists.

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An investigative study of the frontispiece of the *Diamond Sutra*

Kumiko Matsuoka

The ultimate aim of our project is to discover the reason for the degradation of the frontispiece of the *Diamond Sutra* and, in particular, whether bleach was used to remove a heavy stain that once ran across it. It seems that some kind of treatment was applied to remove the stain prior to an exhibition, possibly in 1914. The possibility that bleach had been used at that early stage came to light when members of the Conservation Studio studied the picture of the frontispiece in Stein's *Serindia*,[1] a picture which was believed to have been taken soon after the scroll arrived in the British Museum. It showed a much more pronounced stain than is visible today. It is also presumed that the yellow dye was washed out (or bleached out), probably at the same time.

Investigation into the properties of the fugitive yellow paper dye, berberine, derived from *huangbo*, and research into methods of fixing the dye was begun by students under the supervision of Professor Seddon, formerly at Sussex University (now continuing at The Queen's University of Belfast). The Conservation Studio decided to look into the background of early 'conservation' work although it was recognised that chemical identification of bleach or other specific agents was beyond the capacities of the conservators. Not only that, but when dealing with an international treasure of this significance, minimum intervention is permitted but maximum results are required.

It was felt that at the same time as supporting the work of the scientists, there were certain investigations that could best be carried out in the Studio, particularly since the conservators were in the fortunate position of being able to handle, compare and, in some selected instances, carefully test other items in the collection of 'lesser' significance.

A rough list was made of the sorts of investigations that could and should be carried out in the Conservation Studio. These included measurement of the pH of paper, the washing of the paper, sun-bleaching, bleaching and fibre analysis.

It was hoped that controlled measurement of the pH of other documents in the Stein collection might provide some understanding of the base pH and the effects of *huangbo* and alum on pH. In the case of the *Diamond Sutra*, it was possible that simple washing, perhaps with hot water, had removed the stain. What would the pH of washed paper be like, especially with the *huangbo* removed?

The *Diamond Sutra* had been on exhibition for a very long time, possibly on and off ever since Lionel Giles became Keeper of the Department of Oriental

Manuscripts and Printed Books in 1936. Even in restricted light, some fading would have been inevitable. The effect of sun-bleaching might have been to whiten the stain over the years.

What would a paper look like if it had once been dyed and then been bleached? What effect would these treatments have on the paper fibres? What would the pH be after bleaching? Judging by traditional bindery practice which was to use oxalic acid dihydrate first, to remove stains, followed by potassium permanganate and sodium hypochlorite, all of these should be tested to examine their effect on paper structure. It was also important to discover whether we could test the fibres chemically to check for the presence of bleach.

It was decided to use microscopic analysis to see whether paper fibres looked different after washing and whether the presence of bleach could be detected; also whether bleaching affected the fibres by shrinking or tearing. Microscopic analysis was to be tested to see whether it could reveal the presence of *huangbo*, paste, gelatine or alum.

First, samples were prepared, both new and old. A modern *kozo* paper[2] was selected as it resembled the paper of the *Diamond Sutra*. It was tested to make sure that it did not include lignin or alum. Samples were prepared as follows:

1. Un-aged, undyed
2. Un-aged, dyed, stained
3. Dyed, stained, aged 1 month (dry at 45 degrees centigrade)
4. Dyed, stained, aged 2 months (1st month dry, 2nd month some humidity, 45 degrees centigrade)
5. Dyed, unstained, aged 3 months (1st month dry, 2nd and 3rd months some humidity, 45 degrees centigrade)

Huangbo dye was prepared using a Chinese recipe.[3] The length of time the paper was aged was entirely arbitrary. It is impossible to simulate paper from Dunhuang; even if a thousand-year old paper were reproducible, we do not know the conditions in which the manuscripts were kept before the mid-eleventh century when they were stored in Cave 17. I therefore considered that at this stage it was sufficient to use the samples for testing and comparing results. The new samples were cut into pieces of 80×40 mm.

The old samples were taken from fragments of mulberry paper from the Dunhuang manuscripts acquired by Stein that had no characters on them and which had been kept for such purposes ever since the days of Clapperton.[4] I chose old samples which most closely resembled the paper of the *Diamond Sutra*. The sample size depended upon the nature of the test but, in order to retain as much old paper as possible for future research, the smallest possible size was used each time.

This paper covers the first three tests that have been made so far. It should be noted that testing is still in its early stages.

pH TESTING

A Jenway 2030 metre and Sensorex combination probe were used. Spot tests were carried out in all cases rather than cold/hot extraction methods for the obvious reason that the pH of the *Diamond Sutra* could only be measured by the least interventionist technique. Measurement of pH is fast developing into a subject in itself: there is at present no apparent standard procedure so that whenever one is told the pH of an item this brings forth all kinds of questions, including the suggestion that current measurements of pH are so inaccurate as to be meaningless, particularly where only the surface pH is measured. I can only state at this stage that efforts were made to test in as consistent a manner as possible in order to achieve reasonably useful results. I am aware that the results can only be used for comparative purposes within the context of this project.

Both distilled and de-ionised water were used intitially, both boiled and cooled before use. There was no noticeable difference between the results achieved and subsequently distilled water was chosen. 0.3-0.5 ml of water was dropped on a sample supported underneath by a rubber mat. The probe was placed on the spot. Dwell time was approximately three minutes. The probe was washed and immersed in fresh distilled water for ten minutes after each reading. Five readings were made per sample, in different spots each time. Average results obtained are shown below. It may be noted that using the cold-extract method on K42 samples, the results were, on the whole, 15-20% higher than those achieved through spot testing.

Spot test	mean pH
K42 (untreated)	6.4
Huangbo dye (solution)	5.5
K42 dyed, un-aged	5.7
K42 aged 1 month, undyed	6.3
K42 aged 1 month, dyed	5.5
K42 aged 2 months, dyed	5.5
K42 aged 3 months, dyed	5.2
6 Dunhuang samples (small pieces)	5.5-6.3
Diamond Sutra (frontispiece) (2 spots)	4.8-5.1
Second panel (5 spots)	5.3-5.6
Third panel (4 spots)	5.3-5.5
Fourth panel (1 spot)	5.5
(Fifth panel not yet tested)	
Sixth panel (1 spot)	5.8
Colophon (4 spots)	4.6-4.7

As expected, the pH of K42 grew lower as it was aged. Though it is not evident from the figures listed above, the K42 that had been artifically aged for two months had a fractionally lower pH than that aged one month.

Surprisingly, the old Dunhuang papers had a fairly reasonable pH. The *Diamond Sutra* had, on the whole, but with the significant exceptions of the frontispiece and colophon, a higher pH than the dyed K42 paper that had been artificially aged for three months. The low pH of the frontispiece was, perhaps, to be expected as we suspected the use of bleach and we knew of its long exposure on exhibition which might have had an effect. The amount of exposure to atmosphere of the frontispiece, compared with the rest of the scroll, was certain to have had a negative effect. It was interesting to note that the pH of the colophon was so low and this led us to the surmise that a bleach test might have been carried out on it first of all before any work was done on the frontispiece. This question appeared well worth investigating as the colophon appeared to show no trace of yellow dye and it had previously been assumed that it had never been dyed yellow. It seems with hindsight that this was probably not the case and that the suspicion that it had been bleached is likely to be borne out.

WASHING

Four sets of new samples and one set of old samples were tested.

1. New (K42 all dyed, 7 samples per set)
(a) un-aged, stained
(b) stained, aged 1 month
(c) stained, aged 2 months
(d) dyed but unstained, aged 3 months

2. Old (yellow paper with stains, cut into 20 × 30mm, 7 samples)

Washing was carried out as follows:

1a. 5 minutes, cold
1b. 10 minutes, hot
1c. 30 minutes, hot
1d. 1 hour, hot
1e. 2 hours, hot

2a. 5 minutes, hot
2b. 10 minutes, cold

Cold washing was done in distilled water; hot in tap water heated to fifty degrees centigrade.

The reversal of 1 a,b and 2 a,b was to see if starting with hot water made a crucial difference. Although each set of papers was taken from the same batch of samples, they were not absolutely identical which was an important factor when colour loss was being measured.

The results from the new sets showed that a surprising amount of stain disappeared. This result does not present any sort of direct parallel with the stain on the frontispiece of the *Diamond Sutra* as these were recent stains on recently dyed papers, but the old samples also lost their original yellow colouring, together with the stains, the longer they were washed. After test 1e, the sample looked uniformly pale and lifeless; reminiscent of the frontispiece of the *Diamond Sutra*. It is therefore a strong possibility that the *Diamond Sutra* was washed.

Using the EEL abridged reflectance spectrophotometer (model 99) with a nine filter wheel covering the nine visible regions of the spectrum, the fading of each of the sets was measured. Though the machine was basic, it managed to provide a rough percentage reflectance, a quotable figure, which was a huge improvement over measurement with the naked eye, with no way of quantifying the degree of fading or the shift of colour emphasis within the visible spectrum.

One month aged and stained paper provides a typical example. The percentage reflection in the violet region increased steadily but the rate of increase slowed down as the spectrum moved towards the red. The bands were all similar in shape but only got flatter as washing time increased, indicating loss of hue and lack of pure colour, resulting in the sample looking greyish.

The un-aged but stained and dyed set was measured for pH. As the dye was washed away, the pH went up. Was the rise due purely to the loss of dye or was it hot London tap water depositing alkali material in the paper?

Un-aged, dyed, stained	mean pH
1a.	5.5
1b.	5.9
1c.	5.9
1d.	6.0
2e.	6.1
2a.	6.0
2b.	6.1

SUN BLEACHING

Although we are familiar with the fact that light contributes to the fading of dyes or colours and the 'browning' of paper, exactly how they fade and the effect, in particular, on different sorts of stains, is unclear. To test the effects of sun-bleaching, I chose the natural method rather than using a drum. Under this method, the samples would not be subjected to consistent light, day in and day out, but I felt that monthly measuring for a year or more to examine colour change could produce interesting results.

Six samples were chosen:

1. K42 un-aged, undyed (new, untouched)
2. K42 dyed, stained, un-aged
3. K42 aged 1 month, dyed, stained
4. K42 aged 2 months, dyed, stained
5. K42 aged 3 months, dyed, unstained
6. Dunhuang paper

Examples of the six samples with acid-free board backing were stuck on north and south-facing windows. Every two weeks, colour changes were monitored using the spectrophotometer Y-filter which has a similar response curve to the average eye with a peak wavelength at around 5500 Angstrom units (the green region). Thus the percentage reflectance value shown on the machine should be in theory a figure physically reflecting our own perception of colour change; if lighter, then the percentage should be higher. Every four weeks, the filter wheel was used to monitor changes in the nine visible spectrum regions.

The experiment was started in June 1993. In October 1993, the samples were already showing some interesting colour changes. It was also noted that the underside of each sample had retained quite a lot of colour.

After four weeks, sample (1) had become quite light in colour, both on the north and south windows. After the initial leap, the reflectance rate slowed down considerably in subsequent monitoring. The graph followed a similar shape to that seen in the washing experiment with the largest increase in the violet/blue region and a steady decrease as the spectrum moved towards the red. Twelve weeks into the experiment, on both north and south windows, sample (1) showed a further flattening of the curve with a drop in the orange/red region.

With the stained samples two points, a stable light area and a stable dark area, were chosen on each paper and the same places were monitored each time. After four weeks, most samples lost their reflectance on both light and dark areas between 4900 to 6000 A.U. region, from blue/green to orange, although to the eye they seemed 'lighter' than before. To the eye it appeared that the bright yellow colour was disappearing, making the samples look browner. Later, as the reflectance percentages started to rise, the curve of the graph became slightly flatter (though not as flat as after washing) with the violet region rising faster than any other. After twelve weeks, some dark areas still reflected less than before sun-bleaching began. Interestingly, while the *huangbo* dye was losing its original intensity, the stain on each sample was getting visually darker. Also, in all cases but one (sample 1), the samples attached to the north-facing window faded (as far as reflectance rate was concerned) faster than those on the south side. The long-term results will be interesting. Sample 5 had one area monitored (as it had not been stained) and it behaved similarly to the stained samples after four weeks. After that initial period, the percentages rose, the amount generally decreasing from the violet region to the red. The old Dunhuang paper (sample (6)) got lighter all the time with the slope of the graph gradually flattening like all the other graphs. Visually, as with washing, the surface facing the window began to look pale and greyish.

These observations lead to the possibility that a simple examination of the reverse of the frontispiece of the *Diamond Sutra* by removing a small piece of the Kraft-paper backing would reveal whether more colour remains on the reverse than the front. If some yellow colouring survived, then the degree of its intensity might enable us to determine which treatments had not been applied.

At the same time, the *Diamond Sutra*'s panels were all colour-monitored. This was done to check the rate of fading, and to be repeated at intervals. If the frontispiece and the colophon lose more colour than the other panels, this might indicate a residue of bleach or other reasons. The monitoring process continues.

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Japanese conservation techniques as applied to pre-tenth century material

Andrew Thompson

The British Museum holds over two hundred paintings on silk and paper from Dunhuang, some as large as two metres by two metres, which have received various conservation treatments since the 1920s. The most recent work of the Eastern Pictorial Art Conservation Studio in the British Museum on the Stein collection from Dunhuang has been to conserve the remaining small fragments from silk paintings. Roderick Whitfield, formerly of the Department of Oriental Antiquities, now Professor of Far Eastern Art and Archaeology at the School of Oriental and African Studies, University of London, has been examining and grouping the fragments by thread count, pictorial association and reference to paintings in the British Museum and elsewhere.

The Eastern Pictorial Art Conservation Studio is laid out with a Japanese matting floor (*tatami*). The floor is very much a working part of the studio, offering a 360 degree work space. Scrolls, for example, are laid on the floor on drying felt after lining. There are three Japanese mounters' benches, lacquered on one side, the other side of untreated wood. The lacquered side is used for wet work while assembly and cutting is done on the dry side.

We use Japanese drying boards to dry the scrolls and fragments that have been lined. The core of a Japanese drying board is usually a lattice of white cedar covered in at least nine layers of Japanese paper treated with persimmon juice to create a semiporous membrane. This is important as moisture will evaporate through both the back and the front of the object. When lined objects are on the drying board, they are attached just at the edge so that the centre is floating.

Unlike the Chinese, the Japanese have tended to develop one tool for each specific task over the centuries. Each process has a separate brush: for pounding, smoothing, dying or joining, etc. The same is true of edge tools.

We make Japanese starch paste in the traditional way, using gluten-free starch in a ration of 1:3 with water and cooked over direct heat. Some modern Western conservation studios now use microwaves and electronic stirrers but these do not make such a good adhesive as starch cooked and vigourously stirred all the while on direct heat for about thirty-five minutes after overnight soaking.

Gluten is tremendously hard and is therefore particularly inappropriate in scroll mounting, yet when the gluten is taken out the stickiest part of the starch is removed so the paste has to be prepared in such a way as to increase the adhesiveness as much as possible. The paste is reduced through a traditional Japanese horse-hair sieve which is faster and easier than nylon, then the paste is worked across a wooden paste bowl with a *shigoke*, a short-fibred brush of pig bristle and wool. Once it becomes shiny, it is also at its stickiest.

Once a year, in the winter months, one large jar of studio paste is made for up to ten years storage and eventual use as aged paste. This is a weaker, more flexible adhesive than freshly-made paste. There are two ways of making it, one in which the mould that forms on top is allowed to sink down into the paste (this tends to discolour the paste, reducing its usefulness for mounting pale coloured materials). Alternatively, the jars are covered with top-water, in our case some four inches of de-ionised water inside each jar as a seal, and some of this top water is taken to 'seed' next year's jar with the right moulds. Recent mild winters have meant that aging the paste takes longer.

Paste of some ten years old is ground with a pestle and mortar to reduce crystallinity which, in turn, increases adhesiveness. The paste is then sieved through silk and is ready for use. In Japan, aged paste was traditionally used in the last four or five linings or for mounting weak, fragmentary silk and therefore we use it for the delicate Stein fragments. New starches are far too strong, especially for flat mounting. We reduce the strength of new paste by mixing it with aged paste. Sometimes fresh wheat starch mixed with seaweed adhesive is used in Japan as a poultice for cleaning silk or in the last lining of handscrolls as it increases flexibility: it could therefore be useful in manuscript mounting.

For a size, we use soy milk prior to any re-touching and we use Japanese hand-made mulberry paper (*kozo*) for lining, rather than Chinese papers. It is the strength and versatility of Japanese hand-made paper that makes it so valuable. The best Japanese paper is that which is hand-made in winter when fibres are especially tight and compact. It is made with no chemical additions apart from lye (woodash), used in the fibre preparation. Natural dyes are used wherever possible, alder cones (found widely in London) being most commonly employed. Paper is brush dyed from the reverse.

The fragment is laid on a light table on a thin sheet of rayon for support and is relaxed gently with water. Of the pigments and colours used on the silk fragments, all seem stable with the exception of black which appears to be closer in composition to that found on Mughal miniatures, rather than Chinese ink. Then the fragment is covered with a rayon sheet and aligned from back and front. Paste, a mixture of aged and new, is brushed quickly up and down the chain lines and then squeezed off the lining paper. It is then left on the drying felt until the surface dulls when it is used for the lining. Where several fragments are mounted together, a hinged lining is used to avoid the need for any future adjustment. The fragments are left to dry overnight on felt then placed on the drying board to dry evenly and slowly.

For conservators in the Studio, the Dunhuang paintings have a particular significance. The entire Japanese scroll-mounting tradition which we follow in the Studio is built upon the scroll format, the origins of which are apparent in the material from Cave 17.

The restoration of the Dunhuang Manuscripts in the National Library of China

Du Weisheng

The National Library of China has a collection of about 16,000 Dunhuang manuscripts, of which some 1000 have been previously conserved or restored in the traditional Chinese way of 'scroll binding'. The restoration of the manuscripts was carried out using two basic methods: full mounting and part mounting. A typical full mounting may be seen in the *Wushang biyao* (無上祕要) of the sixth year of the Kaiyuan Period of the Tang Dynasty (718 AD), which is included in the collection of the National Library of China.

The *Wushang biyao* is written on nine folded sheets of 'stiff yellow paper' (actually a pale brown). At the end of the last sheet there is a short note, forty-nine characters long: 'The sixth day of the second month of the sixth year of the Kaiyuan Period of the Tang Dynasty...'. The inclusion of this dated colophon makes it one of the most precious manuscripts discovered in the Dunhuang Caves.

The process of the manuscript mounting is to attach the manuscript to both front and end papers, and then two layers of rice paper are pasted on the back of the manuscript. The lower right-hand section of the end paper is stamped with the words: 'Restored by the Restoration Section of the Imperial Museum'. The restoration is recognised as excellent craftsmanship, the manuscript is smooth, and easy both to open and roll up. However, according to current ideas the following disadvantages are intrinsic to this traditional method:

1. The original form of the manuscript no longer exists as it has been trimmed on the upper and lower margins.

2. The original paper thickness can no longer be measured after the manuscript has been completely mounted. The traditional method requires that, in order to ensure that the conserved manuscript is as flat and as easy to open and roll up as the original, the back of the manuscript should be torn off to make it thinner before it is mounted. It is virtually impossible to see that the back of the *Wushang biyao* has been removed, nevertheless this must have happened.

3. The use of vitriol to reduce the buckling of the manuscript. It is known to all that paper, especially Chinese hand-made paper, will swell after wetting and contract after drying. Vitriol is used to control the swelling and contracting, but it leads to darkening and increases the fragility of the paper.

This author recognises that the value of the manuscripts is determined not only by their contents, but also by their physical condition. The length, width and thickness of paper, the selection of paper as well as the binding and layout, all constitute an indivisible whole. The original manuscripts are invariably damaged somewhat in the process of restoration by thinning or cutting the paper.

The purpose of the restoration is essentially to preserve the material in its original condition. Restoration should, therefore, be undertaken carefully. The aim of traditional restoration emphasizes the conservation of the manuscripts, but the results are not wholly satisfactory. The restoration method has been improved in the conservation of a manuscript of the *Daodejing* (道德經), another masterpiece in the Library Collection.

The manuscript of the *Daodejing* consists of two sheets of paper, each with fifty-nine lines of Chinese characters and fifty-nine lines of Tibetan characters on both sides. The papers are partly mounted in the manner used by the British Library staff. This method is recognised really as an effective conservation of sheets with characters on both sides.

Drawing on previous experience of the restoration of Dunhuang manuscripts we now conduct restoration according to the length of the manuscripts, dividing them into three main categories: complete manuscripts; incomplete manuscripts; and fragments shorter than 500 mm.

In the process of restoration, hand-made yellow paper with long fibres is used to fill the tears in the manuscripts. The thinner the filling paper used, the better the results that can be achieved. Slightly larger sheets of paper are used to mount parts of the manuscript which have been affected by damp and mould. Thick paper should be used if the original manuscript is thick, to make the conserved manuscript neat and smooth. Generally speaking the damaged parts of a manuscript should remain as they were, so long as it is possible to open it out. An advantage of the practice is that further conservation is a simple matter.

Painstaking attention should be given to keeping the characters on the manuscript intact. Thus the following steps should be taken:

1. Flattening. The manuscript is slightly moistened and then rolled it out bit by bit with a brush, fitting the torn edges together.

2. Dust-removal. Dust and dirt are removed from the manuscript with a brush. Clean water should be used to help remove thick dirt deposits.

3. Mending. Torn edges are fitted together, then the whole is mounted with a small piece of thin paper.

4. Flattening again. The mended manuscript is laid in between two bigger sheets of paper with a board and stone pressing on the top to flatten it.

5. Cutting off the waste filler paper along the edges of the conserved manuscript.

The preservation of complete manuscripts requires two sheets of Chinese hand-made paper of the same size as the manuscript, one is first rolled up, then the manuscript, which is fitted into, but not stuck to, the end of the rolled paper, should be rolled up accordingly. The other sheet is used to wrap up the rolled manuscript.

The preservation of incomplete manuscripts requires a slightly bigger sheet of Chinese hand-made paper, mounted on the back of the manuscript and then rolled up together with the manuscript. The method is particularly suitable for those without complete mounting.

In the preservation of fragments, the restored manuscript fragments, divided into three categories by length, are wrapped up in Chinese hand-made paper, then the wrapped remains are stored in envelopes made of *xuan* (宣) paper, with one hundred per box.

These restoration methods make it possible to maintain to the greatest extent the original condition of the manuscripts. They also consume less material and cost less than previous methods. At the same time, the methods are easy to master and this also speeds up the restoration.

Up to now the National Library of China has conserved and restored more than 4000 fragments as well as some 100 complete and incomplete manuscripts using the methods introduced above. In short, the advantages of the methods should be fully realised and promoted.

The conservation of Cave 17 material in the Bibliothèque Nationale, Paris

Monique Cohen

In Paris, the documents from Cave 17 (Pelliot 163) have been classified into several series, generally according to the language of their texts. The *Fonds Pelliot tibétain* is the largest collection with 4174 items (950 not yet catalogued). Most of the manuscripts are written on paper, some are in poṭhī format, other are scrolls, many are unpasted scroll leaves, leaflets or fragments, and there are also Buddhist paintings.

The *Fonds Pelliot chinois* is the second largest collection comprising about 3900 documents. There are about 3000 scrolls (among them a few illuminated manuscripts), booklets, concertinas, two hundred leaves of Buddhist pictures (paintings, woodblock prints or stencils), and seven hundred fragments. The fragments are pieces of paper originally used in early manuscript restoration that have been removed from the scrolls.

Very much smaller are the *Pelliot sogdien, Pelliot ouïgour* and *Pelliot sanscrit T.H.* collections comprising fewer than one hundred documents altogether, in the form of scrolls, fragments, manuscripts or woodblock prints.

Beside the material from Cave 17, in the cave he himself numbered 181 (Cave 465), Pelliot also discovered several hundred fragments in Tangut (mostly woodblock prints), Tibetan, Chinese, Sanskrit, and Uighur (both blockprints and manuscripts). These fragments are generally in poor condition.

Although there are some Sanskrit pieces from Cave 17, most of the 4000 pieces of the Pelliot Sanskrit collection were found in the oasis of Kucha, mainly at Duldur-āqur, near Kumtura, while the wooden slips were excavated at Subashi, not far from the city of Kucha.

The documents of the *Fonds Pelliot koutchéen* are written on wood (caravan passes) or paper, and comprise about 2000 pieces, most smaller than a poṭhī leaf. They come from different sites in the oasis of Kucha, such as Duldur-āqur and Saldirang.

While registering manuscripts, Pelliot had himself specified how to preserve some of the documents; some should be framed between two pieces of glass, or, in the case of manuscripts written on silk, mounted on silk. His notes are indeed very interesting.

Describing a fifth to sixth century silk manuscript, Pelliot wrote: 'très fragile et très précieux. Voir si on doit le recoller sur soie mince de ton approprié. Mon avis serait de garder tel quel un des rouleaux, afin qu'on puisse toujours avoir une idée de l'aspect original, quitte à ne communiquer qu'avec des précautions spéciales ce type de mss …'.

It clearly shows that these recently acquired collections involved new preservation problems, and that Pelliot's main objective was not to alter the original appearance of the documents. This is the reason why glass has been used on a large scale to frame paintings or fragments of paper sheets.

In fact the first problem for the conservators was how to store the documents. Initial protection in the early days varied with the format of the manuscripts. Scrolls were kept rolled on pine batons where the original roller was missing (as was generally the case). They were wrapped in a paper wrapper tied with a cotton ribbon. Special cardboard boxes with internal partitions were designed to house two, three, four or six scrolls. Booklets and individual leaves were wrapped in the same paper with the same cotton ribbons and kept in cardboard boxes.

Until the late 1940s, painted leaves, woodblock prints and most of the leaves in the Pelliot Sanskrit and Kuchean collections were framed between two sheets of glass. When the collection had to be moved out of Paris during the Second World War, many of the glass sheets were broken, and from the early 1950s these were replaced by Rhodoïd. It appears that this process of replacing glass with Rhodoïd was completed by the end of 1962.

Since 1981, the pine rollers have been removed from the scrolls, and the paper scroll wrappers replaced by cotton lustre (pH of 4.90). The boxes have been retained, since their pH was found to be 6.70. The booklets have also been wrapped in cotton lustre; this re-wrapping was completed in 1993.

In 1990, it was decided to remove all the documents from the Rhodoïd (about 175 paintings and woodblock prints, and about 2000 Sanskrit and Kuchean fragments, and poṭhī leaves). The progamme of removal began with the paintings and prints. They were unframed, their pH was tested, and they were put in an acid free paper wrapper. A form, specially designed in conjunction with the Preservation Service, detailing their condition and proposed treatment was completed for each document. Some restoration, such as paper repair or the removal of old repairs, was undertaken. The paintings and blockprints were mounted, in the same way as European prints and drawings, in acid-free cardboard and put in acid-free cardboard boxes according to their size.

A year later, in July 1991, the pH of ten documents was tested again but it had not improved significantly. After three years, in June 1993, these ten documents were tested again, together with thirteen other documents. Their pH seemed to have improved. We shall test the pH of the documents every two years.

The history of conservation within the Bibliothèque Nationale is not easy to trace, since no detailed archives have been kept. Except between 1947 and 1950, when we find some 'instructions', such as 'to be pasted on Japanese paper', or 'wash fly droppings', or 'flatten', the notebooks only bear figures: shelfmarks and dates. In fact, most of the manuscripts in Chinese were restored between 1953 and 1963, and those in Tibetan from 1964 to 1967.

The oldest registered restorations were done in 1947 for the exhibition held at the Musée Guimet. Generally, thin Japanese paper was used, either to repair holes or splits or pasted on the back of the manuscripts. Such restorations, still extant, were appropriate. Later, but as early as 1949 and 1950, silk gauze was occasionally used, pasted on the back or sometimes on both sides of manuscripts in very poor condition.

From 1951 to 1963, all the Chinese manuscripts were systematically checked and then given conservation treatment. Some repairs were very slight (holes or splits), but others were extensive. Where paper was severely damaged, it was repaired with Japanese paper, and then pasted with silk gauze, sometimes on both sides. The paste was thick and very often caused cracking.

The manuscripts in Tibetan, which were conserved at a later date, were often written on coarse brown paper. Their condition was generally bad, and silk gauze was used on a large scale for their restoration.

Since the mid-1970s, silk gauze was no longer used for restoration and now we only use Japanese paper. Quite recently, a manuscript which had previously had silk gauze pasted on both sides has had the gauze taken off, the many holes and splits have been repaired, the very narrow and badly split margins have been enlarged, and a thin Japanese paper has been pasted on the back. Many documents require such treatment.

Much has been done to preserve and to restore the collection, but some errors have been committed, albeit in good faith. These include the use of silk gauze and heavy paste, the use of Rhodoïd, and the failure to compile and keep detailed restoration reports.

After many years of 'intense use' of the original documents which have been microfilmed, catalogued and studied by researchers (the microfilm of the entire collection, completed in 1981 has not entirely supplanted the use of the originals), the manuscripts are not in very good condition.

Now, a new campaign should be initiated. The priority is to define the proper way to preserve the Sanskrit, Kuchean, Uighur and other fragments still under Rhodoïd. This is to be begun over the next months, and the knowledge of the solutions adopted by other libraries will be of great help in making our decisions.

After this, we must urgently undertake a new survey of the condition of the entire collection, document by document, and record the data, together with the existing data, so that a full conservation programme can be planned, funded and established. The task is large, but cooperation will help us to complete it.

Development of new solutions for protective enclosures for the documents from the Pelliot collection of the Bibliothèque Nationale, Paris

Astrid-Christiane Brandt

Before the Second World War a number of documents kept in the Oriental Division of the Bibliothèque Nationale in Paris were put between glass panes. The main drawback with glass is that it is easily broken, so that between the early 1950s and the mid-1970s the glass sheets were gradually replaced by cellulose acetate sheets produced by the French chemical firm Rhone-Poulenc and sold under the trade name of Rhodoïd.

Most of the documents mounted in this way were part of the Pelliot collection and they comprised ninety-four manuscripts with paintings from the ninth and tenth centuries, sixty-five tenth century woodblocks printed on paper, and some 2000 text fragments written in Sanskrit, Kuchean, Chinese or Uighur dating from the sixth to the tenth century.

Unfortunately, over time, the Rhodoïd sheets have degraded and now show varying degrees of warping, a greasy exudation, and a smell of acetic acid. For these reasons, it was decided that the most precious documents should be removed from the Rhodoïd sheets and mounted in passe-partout like Western drawings or prints.

Although this has been done, there are still some 2000 text fragments that also require treatment. They need protection because of their fragility and their fragmentary character and mounting in passe-partout would not be appropriate. Nor would it be appropriate to leave them in the long term in acid-free paper envelopes. Furthermore these documents have text on both sides. For handling it would therefore be more practical to enclose them between transparent sheets.

Before choosing a new mount it is, however, first necessary to study the alterations that have already occurred in the documents as a result of their encapsulation in cellulose acetate.

Cellulose acetate was discovered by Schutzenberger in 1869 and worked on by Franchimont. In 1890 Cross and Bevan had the idea of choosing cellulose acetate for the manufacture of artificial textile fibres and during the First World War, Clément and Rivière used the material as a varnish for aeroplane tarpaulins.

The following description of the manufacture of cellulose acetate is based on the work of Champetier.[1] In general, the raw material used is a wood pulp of high alpha-cellulose content (94-99%), because the acetylation induces a strong degradation of cellulose. Acetic acid, very slightly diluted with water and, if necessary, a small amount of sulphuric acid, is added to induce a slight hydrolysis of the chains to increase the reactivity of the cellulose. The reaction of acetylation is achieved with acetic anhydride and a catalyst ($ZnCl_2$, H_2SO_4, $HClO_4$ etc). Acetic acid is added to facilitate the penetration of the solution into the fibres (acetylation in an homo-genous medium). The product of this reaction is a primary acetate combined with 62.5% acetic acid which contains a small amount of sulphuric acid or perchloric acid in a esterified form. The transformation into a secondary acetate reduces the amount of acetic acid from 62.5% to 54-56%.

The secondary cellulose acetate precipitates when water or dilute acetic acid is added. After drying, pulping, and washing with hot water, the cellulose acetate is dried with hot air. The acetic acid is recovered. If all these operations are well done, the sulfuric or perchloric esters will be destroyed and the secondary acetate will be stable at heat.

In the manufacture of sheets for protection or packing, cellulose acetate combined with 54-56% acetic acid is used. This acetate is dissolved in acetone in the presence of a softener (triacetine or triphenylic phosphate). After filtration and gas-removal the collodion is poured into a drum or onto a continuous metal band and transformed into a film. The film is removed with a knife and dried over rollers in an air chamber.

For many years cellulose acetate was considered to be a long-term stable polymer. It has been used widely as an archival material to encapsulate fragile paper. Scientists consulted in the 1950s by curators at the Bibliothèque Nationale only mentioned the possible deformation of cellulose acetate sheets under the influence of heat or humidity. When mounting, they recommended that the sheets should first be cleaned with an alcohol-soaked cloth. As a preventive measure, they advised the disinfection of sheets and documents with trioymethylene (paraformaldehyde). The documents were then put between two sheets of Rhodoïd and linen strips were pasted around the edges to keep air out. A fungicide, probably formol, was added to the paste. We do not know whether any of these precautions contributed to the degredation of the cellulose acetate sheets.

According to Edge,[2] the degredation of cellulose acetate is the cause of deacetylation and hydrolysis, accelerated in the presence of strong acids. This could be the result of an inefficient washing of the initial product or of the absorption of sulphur dioxide (SO_2) at the surface of the sheets. The oxidised form of sulphur dioxide is sulphur trioxide which combines with humidity in the air and is transformed into sulphuric acid (H_2SO_4), a strong acid. The degredation is characterised by the strong smell of acetic acid and the presence of a crystalline deposit at the surface of the sheet and the document. The greasy film could be due to the release of the softeners.

The first measures we took were to remove the most precious documents – manuscripts with paintings and woodblocks – from the Rhodoïd mounts and to measure their surface pH. The pH value of most of the documents stands in a range between 5.20 and 5.50; the minimum value was about 3.55 and the maximum 6.80.

Because it is impossible to take samples of the original documents for destructive analysis or even a spot test, we do not know whether the acidity is due to acetic acid (a weak organic acid) or sulphuric acid (a strong mineral acid). In the first case, the risk of hydrolysis is limited but in the second case it is very high even when the pH value is close to 6.

Finally, we decided to mount these documents (about two hundred in number) in passe-partout frames of acid and lignin-free paper board containing a calcium carbonate alkaline reserve. In that way we hope that the acidity of the original papers will gradually be neutralised. In fact, the pH measurements taken after one year showed that the pH values had risen. Because of the fragile and precious nature of the documents, we did not want to de-acidify the paper, even by spraying in an alcoholic medium. The risk of bleeding of the colours was too high and we did not want to introduce further chemicals to the original.

Colour photographic records were taken of all the documents treated in this way. Microfilms already exist and handling of original documents is no longer allowed.

Two thousand text fragments still wait adequate treatment. We have to identify the degredation that the documents have undergone and investigate the proper way to treat them.

Such documents as those under discussion need protection from dust, light, atmospheric pollutants and handling. The ideal protective enclosure would be chemically inert, stable, impermeable to atmospheric pollutants, water-repellent and transparent. Nowadays there are a lot of plastic transparent materials on the market: cellophane, polystyrene, cellulose acetate, polyethylene, polypropylene, polyvinyl-chloride, polycarbonate, polyester and more. These products are not all suitable for conservation purposes.

Taylor[3] offers some information for the preservation of stamp collections. Cellophane film is to be avoided. In its manufacture, it is necessary to impregnate cellulose with soda (NaOH) and then treat it with carbon sulphur (CS_2) to form a cellulose xanthate which is dissolved into diluted soda solution. The viscous solution is then transformed into sheets. Residues might remain in the final product and induce degredation. In the same way, polyvinyl-chloride must be avoided because under the influence of heat or humidity, hypochloric acid (HCl), a strong mineral acid, can be formed.

All in all, every film which contains additives such as softeners, mineral charges, antioxydants and solvents, has to be eliminated. The softeners can migrate. Poly-vinyl-chlorides and polyacrylates which contain such softeners have to be avoided. Mineral charges, used to modify the optical properties of the film are abrasive. Solvents used during the manufacture of polyethylene, for example, or for induc-tions, can remain in film for a long time. Antioxydants can cause yellowing.

Taylor also presents the results of tests which were done in 1985 with five films used for the conservation of photographic materials: cellulose triacetate, polystyrene, polypropylene, polyvinyl-chloride and polyester. The best result was obtained with a polyester film called *Mylar D* made by Dupont at Nemours.[4] According to Taylor, films made from cellulose triacetate (more stable than a cellulose diacetate such as Rhodoïd), polypropylene and polyethylene without additives, and polystyrene, are also suitable. Films made from cellophane, polyvinyl-chloride and polyvinylide must be avoided.

In general, poyester films without any additives are recommended by most of the professionals in the field of preservation. Unfortunately, these films are electrostatic and therefore cannot be used for the protection of documents which contain friable media (pastel, charcoal, lead pencil etc), as Laroque has indicated.[5] Polycarbonate sheets are also very stable and might be less electrostatic according to Verdu.[6]

Today, a group of students from the Sorbonne working towards the MSc in the conservation and restoration of art objects are working in the Oriental Division of the Bibliothèque Nationale, removing the Rhodoïd sheets from the documents and enclosing them temporarily in four-flap envelopes of permanent paper. A fourth-year student is working on analysis of the degredation that the documents have undergone and studying new protective enclosures. He will also undertake a bibliographic survey of the materials and techniques involved and work on a plan of action.

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Conservation and restoration problems of oriental manuscripts in the Institute of Oriental Studies, St Petersburg

Yuri A. Petrosyan

I would like to begin this paper by looking at the collection of oriental manuscripts in the St Petersburg Chapter of the Institute of Oriental Studies, Russian Academy of Sciences. It was formed over a rather long period of time starting with the establishment of the Asiatic Museum as a part of the Imperial Academy of Sciences in 1818. The Institute of Oriental Studies became its direct successor in 1930. But the first small collection of oriental manuscripts existed even before the times of Peter I and consisted of diplomatic gifts from various oriental rulers to the Russian tzars. Later these were incorporated into the manuscript stock of the Asiatic Museum.

Within the hundred years between 1818 and 1918 the curators of the Asiatic Museum managed to amass the largest collection of oriental manuscripts in Russia and one of the most important collections in the world. It numbers over 100,000 items with documents written in sixty languages and dialects of the Ancient and Medieval East. It contains all the known writing materials and almost all the most important texts, which in their written form preserve the cultural heritage of the peoples of the East.

In many ways this collection is unique. It includes written documents and whole sets of materials which are not available in other depositories. First of all are the Khorezm manuscripts from Toprak-kala, found at the end of the 1940s by the Russian archaeologist and orientalist S. P. Tolstov. They are mostly economic and legal documents written on wood and leather in the third to fourth centuries AD and number up to fifty items. Besides precious information on the economy of ancient Khorezm, the texts are of extreme importance for study of the Khorezmian language and script. Such documents are not only extremely rare, but of fundamental significance even though the reconstruction of the Khorezmian language is still not complete.

Next in importance is the Sogdian collection of economic, diplomatic and legal documents of the eighth century AD numbering nearly one hundred items of leather, wood and paper. They belonged to the archives of the Sogdian king Devashtich, who died during the war with the Arab conquers of Middle Asia. This archive, discovered in the 1930s by Russian archaeologists, is, like the Khorezmian collection, unique.

Then there is the collection of Tangut texts which include secular and Buddhist texts, found along with pieces of applied art by P. K. Kozlov at the beginning of this century in the long deserted town of Khara-khoto in Central Asia. The bulk of the Tangut written material is kept in our Manuscript Department. It includes dictionaries, folk-lore texts, law documents and the Tangut translations of Chinese texts, some of which survive only in the Tangut translation. As a whole, this Tangut collection contains nearly 9000 items and gives a fairly complete idea of the intellectual achievements of the Tanguts during three centuries of their empire from the tenth until the beginning of the thirteenth century.

In addition I would also like to mention the documents of the Crimean Karaim community in Hebrew and Turkic languages. Fortunately this collection appeared in our Manuscript Department in 1928 and thus escaped destruction during the fascist occupation of the Crimea.

Dr Menshikov and Dr Brovenko speak about the Dunhuang collection in detail in their papers, thus I shall not discuss this question.

The existence of such a representative manuscript collection formerly held in the Asiatic Museum and now in the Institute of Oriental Studies of the Russian Academy of Sciences, is due to the disinterested and selfless activity of Russian scholars, travellers and diplomats of the nineteenth century, who donated their private collections of oriental manuscripts.

The problem of preservation, conservation and restoration of the damaged texts was already apparent at the formation of the Museum. To my mind, the primary necessity for preservation is the stability of location. The collection needs to be housed in an adequate building with properly arranged stock. Nevertheless, during its history, the collection of the Asiatic Museum (now in the Institute of Oriental Studies) has changed its location three times. Naturally every removal was potentially a disaster but thanks to the devoted labour of the curators we managed to carry out these moves without loss.

I would like to stress the fact that the Russian orientalists and curators saved the collection twice from complete destruction. I refer to the hardships endured in Petrograd during the Civil War (1918-20) and the Second World War. The most dangerous period was the Leningrad siege of 1941-44. To protect the manuscripts from German air-raids and artillery, the curators packed them carefully in boxes and carried them down from the upper floors into the basement of the Library of the Academy of Sciences. As you know, there was no electricity supply from the first days of the seige. There was thus no light or central heating either. In those years winters were very severe and the Institute was evacuated to Tashkent. Only three curators, one man and two women, remained in besieged Leningrad at their own wish to protect the collection. They lived in the library and from time to time opened boxes, checking for mould, and generally doing their best to preserve the manuscripts: this, I am glad to say, they did successfully.

At the moment, the Oriental Manuscripts are kept in dry rooms in the Novo-Mikhailovsky Palace on the Palace embankment in St Petersburg. The peculiarity of the micro climate in this district of the city allows us to maintain a more or less stable temperature (+16°+18°) and humidity (45-50%) without air-conditioning.

The Novo-Mikhailovsky Palace is a monument of nineteenth-century Russian architecture. The stock is situated in the largest halls, and it is almost impossible to install a permanent air-conditioning system without damaging the palace decoration. The State Inspectorate of Architectural Monuments thoroughly checks the preservation of artistic decoration and does not allow the introduction of modern technology into the architecture and stucco-moulding of the Palace.

The manuscripts are stored in red-wood bookcases made some time ago for the Asiatic Museum and are protected from sunlight. The stock rooms are supplied with fire-alarms sensitive to smoke, electronic security systems, and day-and-night security and fire control is organized by the fire-prevention service of the Ministry of Home Affairs.

All these measures were introduced recently. For many years we tried to convince the Head of the USSR Academy of Sciences to organize protection of our collection. But all this requires significant investment. The leaders of the Academy of Sciences, intellectuals themselves, clearly understood the historical importance of our collection, but when the question of finance arose they preferred to support physics, chemistry, biology and technology. Only after a terrible fire in the Library of the Academy of Sciences, of which you may have heard, was our voice at last heard. Nevertheless, a lot of pressure was still required to organize appropriate protection of the collection.

Another difficult task was the conservation and restoration problem. For systematic work in this field we have a small conservation and restoration laboratory, which uses new scientific methods of conservation. Much has been done for the conservation of the Chinese texts from Dunhuang and the Tangut texts from Kharo-khoto.

I should say that very often the manuscripts and fragments acquired by the Asiatic Museum in the nineteenth and early twentieth centuries needed immediate conservation or restoration treatment. But in those days the Museum did not have a special conservation service. Such a service did not exist either in St Petersburg nor anywhere else in Russia. But some attempts were made to repair materials with ordinary stationery glue and transparent tracing-paper. We can still see traces of this barbaric work in the collection.

Serious scientific research into conservation methods started in Leningrad in the middle of the 1930s, and much later in our Institute. Russia still does not have a special training centre for the conservation and restoration of ancient texts and oriental materials in particular. Neither is there a scientific centre for the study of oriental writing materials. There is no production of special equipment for the restoration of ancient and medieval materials. The Soviet and Russian authorities did not and still do not pay much attention to this side of culture.

Fortunately for culture and its monuments, both in Russia and the whole civilized world, there are always people whose aim in life was to serve culture. It is thanks to these people that Russia still has museums and manuscript depositories. These enthusiasts overcame obstacles and hardships, created conservation and restoration laboratories in museums, libraries and manuscript departments. Such enthusiasm enabled the establishment of the laboratory in our Institute. But the problems of poor financing, constant difficulties in finding the necessary materials, lack of space and specialists, and the iron curtain which prevented contact with foreign colleagues for a long time limited the possibilities of organizing the conservation of oriental manuscripts at the appropriate level. All this meant that 80% of our collection needed conservation treatment.

Nowadays much has been changed, but much remains to be done. There is understanding of our problems, but still no financing and no provision of the necessary space. We have freedom of contact, but no money to get equipment and or pay for our specialists to train in European and American conservation centres. There are high level specialists, but no possibility of paying them an adequate salary. And once more, as in the past, we must rely upon their enthusiasm and devotion. It is due to them that was possible to finish the conservation of the Dunhuang texts, comprising nearly 20,000 items, and organize their storage. Thanks to the effort of our specialists we continue the difficult conservation of badly-damaged Tangut texts, and now we can see the results. The Director of the Getty Conservation Institute, Dr Corzo, and his colleagues visited our Institute last summer. They became acquainted with the work of our conservators and praised them highly.

We are satisfied that our conservators have the necessary experience and have learnt from the work of chemists and restorators from the Hermitage, Russian Museum, specialists in paper and leather production and specialists from the Document Conservation Laboratory of the Academy of Sciences. We are looking forward to co-operation with the British Library and the staff of its oriental Conservation Studio who are working in the same field. We hope to realise the possibility of organizing an international centre for document conservation in St Petersburg with the help of Getty Foundation and the Getty Conservation Institute.

We are very grateful to the British Library and especially to Peter Lawson, for proposing and organising the training of our restorator Dr B. Nadezda Brovenko in the Library. We look forward to welcoming her colleagues to our Institute.

At present in Europe and the United States there are major scientific centres that work on new conservation methods and train specialists in this field. To my mind close contacts between these centres and museums and libraries with holdings of oriental manuscripts are essential. The number of orientalists and specialists studying oriental documents is constantly increasing. The number of professional specialists in the conservation of oriental manuscripts is also growing. Thus it occurs to me to propose that we should set up an International or European association of specialists in the study and conservation of oriental manuscripts, with its own journal and regular conferences.

Translated from Russian by Tatiana Pang

The conservation history of the Dunhuang Collection preserved in the Institute of Oriental Studies, Russian Academy of Sciences

Nadia Brovenko

The history of the conservation of the Dunhuang collections is closely connected with the history of the conservation of oriental manuscripts kept in the Institute of Oriental Studies. To reconstruct this history, we have to look at archives and remininscences, always bearing in mind that the first half of the twentieth century in Russia was a period of staggering change.

The 'Dunhuang' collection consists of artefacts brought back from the Russian Turkestan expedition headed by the academician S.F. Oldenburg (1914–15); S.F. Malov's Khotan expedition (1909–10); and those collected by N.N. Krotkov (1909–10). All these manuscripts were taken to the Asiatic Museum[1] and became 'an inexhaustible source for the studies of history, economics, culture, art, literature, philosophy and religion (mainly Buddhism) of the fourth to eleventh centuries AD'.[2] The study of these materials began in the 1920s and a special group headed by L.N. Menshikov was organised in the 1950s.[3] Its aim was to organise and catalogue the collection and publish the results of its research. The resulting inventory shows nearly 18,000 manuscript numbers, including 365 scrolls, the remainder being fragments or small manuscripts.[4]

Not much is known about the condition of the materials in these early days. P.Y. Skachkov wrote: 'Very often people stopped at the Dunhuang caves; they burnt fires and walked over the rubbish scattered about on the floor, thus it is not surprising that many of the manuscripts have burnt edges. Having been put into packages and bags, this mass of manuscripts, crumpled and stuck together, often mixed with clay and sand, was brought into the Asiatic Museum...'.[5] At the same time, '... the dry air and loess soils of Central Asia did not do much damage even to manuscripts left out in the open air. The manuscripts sealed in the Mogao caves were in good condition, despite the fact that they were preserved there from the eleventh century until 1900.'[6]

It seems that their condition allowed scholars to work with them – to read, analyse and study them. Nevertheless, during the 1920s and 1930s, the recent destruction in Russia meant that few people were concerned about the conservation of these manuscripts and, indeed, we know nothing of the storage conditions of the whole manuscript collection at that time.

In 1932, a 'beetle' was discovered in the stacks and the members of the Manuscript Department asked the Russian State Museum to send them a specialist biologist.[7] It was decided to construct a fumigation chamber,[8] and a certain number of manuscripts were transferred to the Russian State Museum for disinfection[9] and the stacks were gassed.[10]

We did not have our own specialists, nor did we have a conservation laboratory. In 1933, for example, manuscripts were being conserved both in the Russian State Museum[11] and in the Institute of Historical Technology.[12] And 138 items from the Chinese collection suffering from mould were disinfected with Thymol in the Document Conservation and Restoration Laboratory of the Academy of Sciences (DCRL).[13] The Chief of the Manuscript Department ordered that, 'before beginning work, all staff must wash their hands in order to protect the manuscripts'.[14]

There were other large collections of manuscripts in institutions elsewhere: the Library, the Archives, and the Institute of Russian Literature. In all places, scientific organisation of manuscript storage, conservation and restoration, was urgently required. In 1935, the Institute of Oriental Studies addressed the Praesidium of the Academy of Sciences, requesting the establishment of a special laboratory for this purpose.[15] As a result, the Document Conservation and Restoration laboratory was established and took charge of the oriental manuscripts, including the Chinese scrolls and fragments.[16]

The laboratory staff were well aware of the importance of good storage conditions to prevent deterioration of the paper. From 1935, they made regular stock checks, established conservation priorities and made recommendations on storage conditions.[17]

The Dunhuang collections were the first to be restored because scholars were concerned about the condition of the manuscripts, noting that: '... some Tangut manuscripts were probably folded in the twelfth century and it is now impossible to unfold them as they have become a solid mass.'[18] Between 1935 and 1941, more than 1000 items from the Dunhuang collections were disinfected, cleaned and preserved.[19]

All these materials arrived in the bags in which they had been brought back from expeditions, with accompanying reports: 'Bag no.2 contained 375 Chinese written documents and a heap of small fragments.' We know very little about the method of treatment at the time, only that documents 'were unfolded, cleaned of dust and dirt and disinfected.'[20] Some of the fragments were mounted on a friable white paper with flour paste (for example, SJ 0/7). Now, in 1993, though the paper colour is stable, and there are no large cracks, the paper has become thick and rigid.

A little more is known about the treatment of a scroll that had got wet and mouldy. The difficult task of unfolding it was achieved by using static electricity. Once unfolded, the manuscript was glued on thick paper and only some 500 mm of the upper part of the manuscript was destroyed.[21]

In 1938, a five-year plan of restoration and disinfection was drawn up. According to the plan, the Manuscript Department was to receive 63,000 roubles each week to carry out the work.[22] This did not happen because of the outbreak of the Second World War. Documents in the Institute's archives dating from 1942-3 tell of the evacuation of the Institute and how manuscripts and books were saved from air raids.[23] By 1944, there are references to the condition of the books and manuscripts and a return to order in the stacks.[24]

In 1949, a conservation laboratory was established in the Institute of Oriental Studies and a professional conservator, R.V. Kandinskaya, started work there. She had considerable experience of conservation thanks to her work in the DCRL before the War.[25] For ten years, she worked on oriental manuscripts, particularly those from the Far Eastern and Central Asian collections, selecting, cleaning, disinfecting and conserving. The curators and the conservator understood that the usual methods of European paper treatment could not always be applied to oriental paper. It was necessary to make a special study of oriental paper and its conservation and take a different attitude to the selection of glue and pastes, as well as paper for reinforcement. There was a proposal to invite a specialist from China, to help conserve part of the collection and teach conservators who could continue the work after his departure.[26] At the same time, in 1953, a special letter was sent to the Praesidium of the Academy of Sciences about the need to enlarge and equip the conservation laboratory in order to work on 'the unique collection of Chinese documents from Dunhuang.'[27]

Work on the manuscripts continued without interruption and once cleaned, manuscripts were put into envelopes, boxes and cases. Unfortunately it was impossible to obtain Chinese paper for conservation work or to find anything similar in Russia.[28]

Almost all of the oriental manuscripts were in urgent need of attention and it was impossible for one person to do all the work. In 1956, the Institute of Oriental Studies once again asked the Praesidium of the Academy of Sciences to provide extra staff and equipment for its conservation laboratory[29] but no action was taken and the consequences of this cannot be underestimated.

The pressure of the intensive work of scholars who were making inventories, deciphering and cataloguing the manuscripts meant that the conservator was compelled simply to apply traditional Western techniques and had no time to investigate the peculiarities of oriental papers and inks. It was common practice to reinforce a weak paper with gelatine, a method which yielded good results when applied to European paper. Hot liquid gelatine covered the paper fibres and filled the gaps in between them. It had been assumed that this would have no effect on the colour of paper[30] but in practice, this was not the case. Later, the treated fragments darkened and the density of the paper changed – thin, elastic Chinese paper became stiff and fragile.

For mounting and repairing, various types of colour-matched paper were used, including mica or silicon paper. Very often, the physical qualities of these papers did not match with those of the paper to be conserved and the difference has become more marked over the past twenty years. For example, electrolytic paper stretched the dry fragment, to the point where cracks appeared. Other types of paper made the original document curl so that subsequently it had to be mounted between sheets of glass. A silicon paper was used in the conservation of scrolls. In spite of its mechanical strength, it was used in two layers, thus loading the scroll. This type of paper needs a lot of adhesive and the scrolls became thick, solid tubes. It was almost impossible to unroll them without cracking. It is unfortunate that in the 1960s, we had no method of checking the longevity and appropriateness of the methods and materials used. The storage boxes for the Dunhuang collection were made of 'technical cardboard', covered with coloured paper. As a result, by the 1980s, the outer areas of all the scrolls have turned a brownish-yellow colour, though the central layers remain lighter. This is the result of oxidation of the paper through contact with the cardboard of the boxes.

With no possibility of altering the storage system, the conservators wrapped each scroll with blotting paper or silicon paper to provide a protective layer between the scroll and the box.

A report sent to the Archives of the Academy of Sciences in 1956 contains the statement that 'the Manuscript Department of the Institute of Oriental Studies has the following items which have not been conserved: Samaritan collection – 40 manuscripts; Hebrew collection – 70 manuscripts and scrolls; Tangut collection – 87 large boxes full of manuscript fragments, 128 small boxes and 13 boxes of the Nevskij collection; Dunhuang collection – 184 boxes and three bundles of manuscripts; ... Tibetan collection – several thousand manuscripts and woodblock prints in bundles ...'[31] It was apparent that the small conservation laboratory could not solve all the conservation and storage problems.

At this point we should recall with gratitude and appreciation, the names of the first conservators of the oriental manuscripts in the Institute's collections, R.V. Kandinskaya, B.I.Pankratov, N.N.Talanov and G.S.Makarihina.[32] Our scholars are grateful to them for it was only through their efforts that the scholars were able to work on the oriental text at all. This was acknowledged by the senior Research Fellow V.S.Kolokolov, who said: 'The conservation of the fragmentary manuscripts from the Dunhuang collection enabled members of the Far Eastern section to start their scientific research work.'[33] Owing to the small number of staff-members, it was only possible to carry out the minimum work necessary,[34] cleaning, dusting, flattening, mending (gluing) tears and lining with backing paper and mounting between glass. The better preserved xylographs were bound in groups, in cardboard or leather bindings, often without consideration for the historical book format and the inappropriate use of modern materials. Some of the Chinese woodblock books were bound in blue calico and with sewn bindings in the European style.

Recent examination of the Dunhuang collection reveals that the best preserved manuscripts and fragments are those that have had the least 'conservation'. Most of the surface dust has been removed, though traces of loess remain in folds and sewing holes. These relatively untouched examples demonstrate the nature of the Chinese paper, its flexibility and its colour, and indicated the best direction for conservation work on Dunhuang manuscripts. This was to intervene as little as possible. In certain cases, more intensive 'restoration' work may be undertaken, for exhibition or publication, and with the specific needs of the document taken into account.

Unfortunately, many curators do not accept the importance of 'conservation' rather than 'restoration'. Their wish to study a 'complete' manuscript has often involved joining fragments together in a false 'restoration'. The conservators, who often have to remove and make good earlier restoration 'interference', deal with a mixture of illusion and reality. They understand that it is impossible to re-create lost reality, it can only be imitated with the help of modern materials. Written documents more than any others are harmed by inadequate restoration. They are first and foremost bearers of information and this function must be preserved for the future.

In the 1980s, the staff of the conservation laboratory of the Institute of Oriental Studies started making records and photo-documentation of the conservation process. They also expanded the range of materials used, acquired new equipment and began to use new methods developed in leading Russian conservation centres like the Document Conservation and Restoration Laboratory, the Lenin State Library and the State National Library. With the help of new methods and practical experimentation, we developed a new method of conservation of Chinese paper which may be applied to other oriental collections in the Manuscript Department.

Our current practice involves the following stages: 'dry' cleaning and then 'damp' cleaning if necessary, using distilled water; flattening when wet; drying under cloth and a light weight. Where the paper is badly damaged, we reinforce it with paper of similar type[35] and 'combined glue no.2'.[36] The paper we use answers some of the main demands of conservation; it is thin (and does not make the document thicker); it is durable, bio-stable, elastic and transparent; it does not buckle and is easy to work. 'Combined glue no.2' is an 8% flour paste with the addition of methyl cellulose (3% water solution). Thymol and other disinfectants are used. Depending upon the condition of the document, the glue is used in a water-spirit dilution of 1:5:2 or 1:7:2 which allows for good adhesion between paper and backing-paper. Drying is done in a press between cloths. Finally the backing paper is cut with scissors leaving a protective edge of 3-5 mm. For storage, we use blotting paper or drawing paper to make an envelope or 'shirt'.

At the end of the 1980s, the conservators acquired Melinex,[37] a thin, transparent polyester film that greatly simplified the conservation process. The material allowed us to stop mounting weakened paper. The Melinex envelope both protects the documents and makes it possible to study and copy them. Preparation for encapsulation in Melinex is limited to cleaning and flattening the document thoroughly. To avoid movement or loss, the document is fixed by a soldering needle or sewn with thread.

Our own experience with Melinex is not extensive but observation shows that the documents are stable. The material promises well for the treatment of the Dunhuang manuscripts and other collections in the Institute of Oriental Studies. It is also significant that the use of Melinex will speed up the treatment of the documents and, of great significance for our department, will save space in the stacks by obviating the need for cardboard boxes, envelopes, etc.

The history of the conservation of the Institute's Dunhuang collection is by no means finished; much work, of course, remain to be done.

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The history of conservation in the Dunhuang library itself

Lev N. Menshikov

The Dunhuang 'library', consisting of mainly Chinese material, was collected in the first millenium AD. It also includes a small quantity of material in other Central Asian languages written prior to the tenth century AD. In about 1900, 40,000 items were discovered in Cave 17 at Dunhuang. They were subsequently divided, mainly between London, Paris, Beijing and St Petersburg, though there is also material in Kyoto, Taibei, Lanzhou, Dalian and other sites. Continuous research into the library's contents has given rise to a specialisation within sinology known as Dunhuang Studies (or Dunhuangology) which has become akin to an international corporation over the last few years in the scale of its operations.

The Dunhuang material has many particular characteristics. The documents are not quite like other Chinese manuscripts and printed books from other periods of Chinese history. The paper – its form, structure and colour – also the design of the scroll and the method of construction represent a very specific (early) form in the development of the Chinese book.

The durability of the paper and the strength of the adhesives, the paper colourant that also repelled insect pests, and the dry climate, helped to preserve the Dunhuang cave library in very good condition. Many scrolls look as new today as when they were first deposited in the cave and no conservation is necessary.

The use of the material by pre-tenth century readers and for ritual purposes, however, often necessitated their repair. The main defects appear on scrolls that have been rolled and re-rolled many times. The beginning and edges of the scrolls suffer the most damage and loss. The loss of some scrolls from multi-scroll sets and single sheets elsewhere form lacunae in the texts. The most common method of contemporary conservation at Dunhuang was to line a scroll with a backing paper, inserting new sheets which often contained re-written text. These re-written manuscripts can sometimes now be identified through seals.

When the lacunae in the library became too numerous, a wealthy patron might give a donation to support the library. A document, dated 1002 AD, in the St Petersburg collection tells us that the then ruler of Dunhuang, Cao Zongshou (曹宗壽), and his wife Fan (氾(范)氏), gave financial support to renew damaged or destroyed documents. There are two copies of this document, one incorporating corrections.

The text refers to an order for a list of manuscripts kept in Baoen Monastery (報恩寺). The list noted lacunae and other defects in these manuscripts, in order that errors could be corrected and deficiencies made good. Cao Zongshou ordered the Master of the Office to make an envelope or cover for each ten rolls, in bamboo, silk or cotton. All of this was done in 1002, the year in which Cao Zongshou became ruler of Dunhuang. There are other related manuscripts which testify to the fact that the orders were carried out. The monk Yingbao (應寶) (whose name occurs with variant characters (應保)) of Liantai Monastery (蓮臺寺), noted that he could not find many of the texts he wanted to read and requested Cao Zongshou to let him go to the capital to find copies of manuscripts that had disappeared, fallen to pieces or had never existed in collections in the Dunhuang area. The monk needed official permission to make the journey to the capital in order to pass through the customs posts en route. He wrote that he wished to travel by foot (rather than on horse or donkey-back which would, presumably, have been more expensive).

The St Petersburg collection also contains a list of the Buddhist works in the Dunhuang monasteries, including notes of how many sheets of paper would be needed to re-write each work, and remarks about the author of the particular translation, and how many rolls (*juan*) were involved. There is also a list of texts that were not to be found in Dunhuang monasteries, and remarks on defective copies. On the basis of the list, it is interesting to consider whether we can determine if any of the work was actually carried out?

Another document in this group (which is illustrated in the first volume of the descriptive catalogue of the St Petersburg collection)[1] is a list of envelopes or manuscript covers with notes on the material from which they were made – bamboo, silk or cotton – which tallies exactly with Cao Zongshou's order. Some manuscripts are marked as 'lacking envelope'.

If we compare the paper of extant manuscripts of the seventh to eighth centuries, which is thin and of an intense yellow colour, with that of early Song manuscripts, written on thick white paper, they are quite different. The paper of the early manuscripts has seven laid-lines per centimetre, while that of the later manuscripts has only four laid-lines per centimetre. Thus the two periods can be clearly distinguished on the basis of paper characteristics.

There are some six hundred rolls of Prajñāpāramitā sutras in the St Petersburg collection, some written on fine yellow paper of the type presented by the Empress Wu at the end of the seventh century, and many have colophons written in Chang'an. The colophons are long, with many names including those of the special inspectors from the imperial palace who directed the translation and copying of the text. This group of manuscripts probably represents the surviving part of a complete set of Prajñāpāramitā sutras presented by the Empress Wu. Of the many first rolls, some were re-written in the early Song (tenth century). These re-copied scrolls are evidence that Cao's orders were executed.

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A survey of research on the materials from Turfan held at Berlin

Simone-Christiane Raschmann

Among the various archaeological expeditions that set out at the beginning of this century from numerous countries to explore the ruins in the deserts of Central Asia, then *terra incognita*, there were German Turfan Expeditions. Between 1902 and 1914 German scholars under the leadership of Albert Grünwedel and Albert von Le Coq made excavations in the area of Turfan, Hami, Kucha and Karashahr.

Their finds included a large quantity of manuscripts and blockprints, written in about fifteen different languages with about twenty-five scripts. Most of these texts are written on paper, with only few of them on other materials like silk, leather, birch bark, palm leaves or wooden tablets. Though originating in various sites in Central Asia, the group as a whole is referred to as the 'Turfan collection'.

Immediately after the return of the first expedition, scientific research on these texts began. Friedrich Wilhelm Kark Müller deciphered some fragments written in a 'small script', the Manichaean Estrangelo. His work, published as early as 1904, marked the beginning of a new stage in the investigation of Manichaeism. But other scholars like Richard Pischel, Karl F. Geldner and Karl Foy also published the first results of their studies on the manuscripts in 1904.

After these sensational publications appeared, the Oriental Commission was established at the Berlin Academy of Sciences in March 1912. It was set up in order to co-ordinate research on the more than 30,000 fragments of the so-called 'Turfan Collection'. Among the excavated manuscripts and blockprints there were some texts in then unknown or little-known scripts. Albert von Le Coq himself supplemented his profound knowledge of Central Asian Art by becoming a specialist in the interpretation of some of these languages. He made many transcriptions from these texts, which were used also by scholars such as F.W.K. Müller, Willy Bang and Annemarie von Gabain for their studies and remain of great interest today.

Other manuscripts written in Brāhmī script in an until then unknown language, which included some Indo-European elements, were discovered in the Kucha region. F.W.K. Müller found the word Toxrï used as the name of a language in the epilogue of a large Uighur text, of which a parallel version in this unknown language was also discovered. Thus the language became known as Toxrï or Tokharian. Fragments of Tokharian texts were also found in the Turfan oasis. Later Emil Sieg and Wilhelm Siegling wrote a 'Tokharian Grammar' on the basis of this material.

Before the discoveries of the Old Turkic manuscripts in Central Asia, the only written sources for Turkic history were the old Turkic inscriptions from Mongolia and the Ottoman manuscripts from the West. The first study of this group of texts was made by K. Foy and the first important studies were published by F.W.K. Müller in his three-volume work *Uigurica*. This work was continued by Willy Bang and Annemarie von Gabain. Beside preparing further editions of the texts, both of them began to use them as sources for investigations into ancient Turkic history.

The Turkic part of the collection is a good example of the great variety of the Turfan texts. It consists of about 8000 fragments of various sizes. These fragments are parts of scrolls, folded books, Poṭhī-books and blockprints. Most of them are written in the so-called Uighur script, which was developed from the Sogdian, while there are also some fragments in Sogdian script. The Turkic Manicheans used the Manichaean and Uighur scripts for transcribing their texts. A small number of the fragments were written in Turkic Runic script, Syriac, Tibetan and Brāhmī scripts. Contained within the seal of a Mongolian document there is a short Uighur text written in 'Phags-pa script.

Sometimes the choice of script gives a hint as to the contents of the text. Thus, just as it is certain that Uighur Buddhists did not use the Manichaean script, there are, similarly, no Manichaean texts in Brāhmī script. Also formal signs like punctuation can help to characterize a text. A major problem is dating the texts for most of them are undated. If there is a date in the text, in the colophon for instance, it appears as the name of the cyclical year which allows no absolute dating. But it is possible to say that most of the Manichaean Turkic texts and the oldest Buddhist texts were written between the eighth and tenth centuries. Sometimes, in carefully composed texts, the writers used red ink for special words like Buddha, Bodhisattva etc, or to indicate the beginning of Gāthās. Some manuscripts and blockprints are illustrated. These pictures were made by Uighur artists. The Buddhist texts are mostly written in Uighur script with only a small number in Tibetan and Brāhmī script. Most of the Uighur Buddhist texts are translations from Chinese, Tibetan, Sanskrit, Tokharian or Sogdian languages. But there are also some examples of original Buddhist literature among the Uighur texts, for example, fragments of Buddhist alliterative poetry and Buddhist layman's literature.

Apart from the numerous Uighur Buddhist texts there are some fragments of Christian-Nestorian literature in Syriac script. Among the non-religious texts there are medical texts, astronomical texts and a group of economic documents. While the study of these economic texts is of a great importance for the history of the Uighur kingdoms, the edition of this text group poses great difficulties because of the cursive script and the fact that most of the texts are small and fragmentary.

The finds made by the four German Turfan expeditions were sent to Germany wrapped in paper by the members of the expedition. On the top of every package was a list of the contents together with an abbreviation signifying the number of the expedition and the site where the documents were found.

When the packages were opened in Berlin, the abbreviated expedition number was noted on every fragment. Later the fragments were put between glass plates which were sealed with a special kind of adhesive strip. On these glass plates a second, more detailed, label was glued. This is the way in which the fragments are preserved even today.

For the first few years after the expeditions, all finds were kept at the Indian Department of the Museum für Völkerkunde in Berlin. In 1926, the texts were separated and the responsibility for the preservation, conservation and edition was given to the Prussian Academy of Sciences until such time as the publication of all the materials was completed. After 1926, a systematic arrangement of the Turfan manuscripts, especially the Sanskrit texts, was begun. The first important publications of Turfan texts apart from those mentioned above include: *Central Asian Sanskrit Texts in Brāhmī Script from Idikutsahri, Chinese Turkestan* by Heinrich Stönner (1904), *Fragments of a Sanskrit Grammar from Chinese Turkestan* by Emil Sieg (1907 and 1908); *Fragments of Buddhist Dramas* (1911) and *Sanskrit Medical Texts* (1927) by Heinrich Lüders; and three volumes of *Turkische Turfan-Texte I-VII* published by Willy Bang, Annemarie von Gabain and Gabdul Reşid Rachmati between 1932 and 1936.

In the autumn of 1943, late in the Second World War, the Turfan collection was sent to various places in Germany for safekeeping: to the mines at Winthershall, Solvayhall and Schönebeck/Elbe, for instance. In this way, the manuscripts were mostly saved from destruction.

As result of the division of Germany after the Second World War, the Turfan collection was also split up. Those parts which had been sent to places in the areas that later became the Soviet zone of occupation were returned by the Soviet forces in August 1945 to the Oriental Commission in Unter den Linden. This institution then became the Institut für Orientforschung at the newly founded Deutsche Akademie der Wissenschaften zu Berlin. Other parts of the collection, including those from places in the western occupation zones such as Ansbach, were eventually (in 1947) handed over to the Mainzer Akademie der Wissenschaften und Literatur. Because there were no local specialists for several groups of the manuscripts, this collection was split again. A number of manuscripts (Iranian in particular) were sent to Hamburg University where Wolfgang Lentz was working. Another group, mostly of Sanskrit texts, was sent to Göttingen.

A great portion of the fragments (about one third of the total) had to be restored at this time because the glass plates were broken during transportation. A further task was restoration of order and the cataloguing of the various parts of the collections.

In Mainz, Šinasi Tekin wrote a provisional catalogue of all the fragments preserved there. In the meantime those fragments had been given a supplementary new shelf number, 'Mainz', with a running number for each single fragment. Although this catalogue is unpublished, copies of it are still used today.

Further work on the large group of Sanskrit texts was done during the first years after the Second World War in cooperation between Göttingen, under the direction of Ernst Waldschmidt, and Berlin, where his pupil, Dieter Schlingloff, was working up to 1961 and where the main body of Sanskrit text fragments is still preserved today. Under Ernst Waldschmidt's direction and with the support of the Akademie der Wissenschaften zu Göttingen, several publication series concerning the Sanskrit Turfan texts were founded, for instance *Sanskrittexte aus den Turfan-funden* and *Sanskrit Wörterbuch der buddhistischen Texte aus den Turfan-funden*. Soon after the establishment of the project for a union catalogue of oriental manuscripts in Germany (*Katalogisierung der orientalischen Handschriften in Deutschland*) Ernst Waldschmidt and his colleagues began to prepare a catalogue of Sanskrit fragments. This work still continues today, though it is now under the direction of Heinz Bechart. Up to now six volumes of the catalogue *Sanskrithandschriftung aus den Turfanfunden* have been published; the seventh is in press. A supplementary volume by Lore Sander deals with palaeographic aspects of the Sanskrit manuscripts of the Berlin Turfan collection. In 1960, Mary Boyce published her *Catalogue of the Iranian Manuscripts in Manichean Script in the German Turfan collection.*

More than sixty years ago, F.W.K. Müller, the founding father of Turfan studies in Berlin, used to give a piece of advice to the students who were privileged to attend his lectures at Berlin University. He admitted with some resignation that it was impossible for an ordinary European scholar to understand a Buddhist text thoroughly without the help of a Japanese buddhologist or a Buddhist priest from East Asia. So it was fortunate that for more than twenty years, the Turfan research team of the former Academy of Sciences of the GDR, was able to co-operate with Japanese colleagues, especially members of the Dunhuang-Turfan Research Group in the Institute of Buddhist Cultural Studies of Ryukoku University. One of the results was the publication of two volumes of the *Katalog chinesischer budhhistischer Textfragmente*.

In 1971, in continuation of the earlier series *Turkische Turfantexte*, a new series *Berliner Turfantexte* was established at the former Institute of Ancient History and Archaeology at the Academy of Sciences of the GDR. Seventeen volumes of this series including editions of Iranian, Turkic, Tibetan, Chinese and Mongolian Turfan texts have been published up to now. Smaller editions and studies were published in the research journal *Altorientalische Forschungen.*

In 1956 the Iranian texts from Hamburg were returned to Mainz. Later, responsibility for the so-called 'Mainz fragments' was passed to the Staatsbibliothek - Preussischer Kulturbesitz in Marburg. In the seventies the State Library, including the Turfan collection moved to Berlin. In 1987, the first volume of a catalogue of Turkic Turfan texts including 269 fragments of the Mainz collection was published by Gerhard Ehlers.

After the reunification of Germany in 1989, the Turfan collection was also reunited and is now being cared for by the Oriental Department of the State Library at Berlin. Two research groups are currently working on the Berlin Turfan texts, one editing Turkic and Iranian texts, one cataloguing these two text groups. An English colleague, Nicholas Sims-Williams, is preparing a catalogue of the Sogdian fragments in Nestorian script. Further catalogues of Turkic Turfan texts are being prepared.

Conservation of Central Asian collections in the National Museum, New Delhi, India

Surinder Pal Singh

The National Museum is privileged to be the repository of a rich collection of art treasures from Central Asia. The Central Asian collection, also known as the Stein collection, includes wall paintings, silk and cotton banners, terracottas, stuccos, and paper documents, comprising over 10,000 items.

The variety of materials involved presents considerable problems of conservation. The biggest depository contains wall paintings from grottoes and open air temples in places like Mirān. They offer a rich variety of styles with Indian elements dominating fourth century paintings and a mixture of Indian and Central Asian style, together with improved colour schemes in paintings of the sixth to eighth centuries from the Khotan region. Chinese and non-Chinese elements can be seen in wall paintings from sites such as Bezeklik of the tenth to twelfth centuries and Mongolian murals of the eighth to ninth centuries.

Some seven hundred paintings collected by Stein between 1906-8 and in 1916 from a variety of Buddhist sites are now held in New Delhi and the pigments involved in the tempera include gold leaf, lead oxide and iron oxide (all tested in our laboratories). The wall paintings were laid face-down upon glass and, once the back was scraped, a smooth gypsum layer was applied. Several slabs cut from the same wall painting were assembled together on a back frame, plastered and housed in a surrounding framework of asbestos sheeting. Until 1962, the paintings were stored in the 'old building' of the Archaeological Survey of India where there was poor temperature control and the added problem of water seepage. There was no public access. Eventually the building had to be demolished. All the wall paintings had to be removed and they were beginning to suffer from flaking and bulging. The paintings varied in size from 10 inches by 18 inches to two foot by three foot and their entire surface area of 5275 square feet had to be conserved. They are now installed in a new gallery in the National Museum which is open 24 hours a day.

There are also banners on silk and paper, dating from the seventh to tenth centuries, decorated with Buddhist themes, sometimes depicting the donors of the paintings. From Astāna, Stein brought back silk painting fragments which have been mounted on fresh silk or Japanese mulberry paper.

The terracottas are of very skilled workmanship, in the form of horses, camels, ducks and other animals, also a very rare figure of a monkey carrying a child. Dating from the fourth to sixth centuries, their surfaces are prone to chipping and cracks causing dust accumulation and loss. The stuccos are of figures, some in combat, and are painted. Numbering some 2000, they are in a very fragile condition, prone to vibration damage. Some from the Astāna area have lost their glaze. The Mirān figures are large, cast in sections and painted in tempera. They have been reinforced with plaster of paris and gesso.

There is a tremendous variety in the textile collection, including wool, silk and cotton in a variety of patterns and designs. Microscopic studies made over the course of a year reveal the use of goat hair, sheep wool, camel hair and single examples of ramie and cellulose fibre.

The wooden artefacts include painted figures, carvings and architectural fragments from various sites such as Niya and Astāna, and the collection also includes stone, pottery, Chinese coins, bone, glass, seals of stone and metal, metal figurines, scrolls and gold ornaments, all of which present different conservation problems.

The most complex conservation problems are those of the giant stucco wall-paintings which had suffered from darkening and cracking. They are very fragile and any hard coating applied tends to give rise to further cracking so that repairs in the mid-1970s, for example, have created further cracks that now require repair.

The National Museum building is now air-conditioned but not all the storage areas are of equally high quality. Nevertheless the National Museum is the major national conservation centre, offering teaching and advice throughout the country and training students on three-year degeree courses and with several PhD students.

The Dunhuang *Diamond Sutra*: a challenging problem for scientific conservation techniques

Peter J. Gibbs and Kenneth R. Seddon

The Dunhuang *Diamond Sutra*, the world's oldest, dated, printed book, is undergoing rapid physical deterioration. The following article attempts to analyse the reason for that deterioration, and to propose a possible solution – the nitrate treatment – which may allow this invaluable document to be preserved for future generations.

INTRODUCTION

The history, importance and unique nature of the Dunhuang collection's *Diamond Sutra* have been discussed elsewhere in this volume, and these details will not be repeated here. However, a brief summary of the physical condition of this document forms an essential prerequisite to any discussion of its conservation. Its key physical properties are:

1. The scroll consists of seven sheets
2. Each sheet is 750 × 270 mm (approx)
3. The total length is 5790 mm
4. The colour of the untreated paper is yellow-ochre

Since it was printed in 868 AD, the scroll has been repaired on a number of occasions. The first of these occurred in antiquity: a pre-1025 repair is believed to have been made. After its arrival at the British Museum (1909), there have been at least three attempts at repair. Between 1909 and 1918, the scroll was separated into its component panels, and the original repairs removed. At this time, the frontispiece was washed and probably treated with a chemical oxidizing agent (perhaps $K[MnO_4]$ or $Na[OCl]$). This washing has removed much of the yellow dye from the frontispiece, and also the second panel. The panels were then rejoined, and a lining of heavy Japanese paper was applied with an unknown paste. Since the First World War, the scroll has had further, undocumented linings added. It is undoubtedly true that well-meaning conservation work has caused incalculable damage to the *Sutra*; this is compounded by the lack of any records pre-1960 of the chemical and physical techniques used in this work.

Fig. 1. Detail from the frontispiece of the Dunhuang Diamond Sutra, *as pictured in 1909.*

Fig. 2. Detail from the frontispiece of the Dunhuang Diamond Sutra, *as in Figure 1, but pictured in 1989.*

Fig. 3. Detail from the frontispiece of the Dunhuang Diamond Sutra, *as pictured in 1909.*

Fig. 4. Detail from the frontispiece of the Dunhuang Diamond Sutra, *as in Figure 3, but pictured in 1989.*

Fig. 5. Detail from the frontispiece of the Dunhuang Diamond Sutra, *as pictured in 1909.*

Fig. 6. Detail from the frontispiece of the Dunhuang Diamond Sutra, *as in Figure 5, but pictured in 1989.*

THE CONSERVATION PROBLEMS

The current condition of the paper is that it is brittle, inflexible and distorted. Physical deterioration of the frontispiece has already occurred since its arrival in the British Museum, and this can be strikingly appreciated by comparing key areas of the frontispiece, as it was photographed in 1909, with a recent photograph (1989) taken in the British Library. Comparison of Figures 1, 3 and 5 (all details taken from the 1909 photograph) with Figures 2, 4 and 6 (all details taken from the 1989 photograph) reveals the, mostly irreversible, damage that has occurred in eighty years. As can be seen, significant physical decay has resulted from mounting the scroll, and this is likely to still be occurring. In addition to the irreversible and tragic loss of most of the yellow colour from the frontispiece, it is likely (but unproven) that acid is leaching from the backing paper into the document. The current situation is critical. If action to prevent the chemical and physical damage that is now occurring is not taken within the next decade, the consequences will be tragic.

THE PRACTICAL PROBLEM

There are three important practical, and urgent, aspects to the conservation of the *Diamond Sutra*:

1. It is necessary to remove the scroll from its backing papers, as soon as possible, to prevent further damage occurring.

2. The solvent, which must be used to remove the paste that holds the document to the backing papers, must not remove the dye from the paper.

3. The solvent must not damage the paper, chemically or physically.

Although these problems, at first sight, do not appear to be profound, they are in reality heightened by our lack of scientific knowledge of the system under study.

THE REAL PROBLEMS

As mentioned above, there are very few scientific data existing for any pre-tenth century paper from Dunhuang, and none at all (other than empirical observation) for the *Diamond Sutra*. Our 'knowledge' of this system (it is received wisdom that the document has been dyed with berberine) is based upon hearsay and educated guess-work. We are, in reality, hampered in any attempts to conserve the *Diamond Sutra*, by the following lacunae in our knowledge:

1. We do not know the identity of the yellow dye applied in antiquity.

2. We do not know the identity of the paste applied this century.

There have been, as yet, no scientific measurements made upon the *Diamond Sutra*: any attempts to conserve it without a definitive scientific analysis would be extremely dangerous and foolhardy.

THE NATURE OF BERBERINE

As stated above, the *Diamond Sutra* is dyed yellow. We do not know the identity of the dye, but its probable identity has been deduced, based only on the following circumstantial evidence:

1. The paper is believed to have been dyed with *huangbo* (*Phellodendron amurense*).

2. The active dye within *huangbo* is believed to be berberine (see the following article).

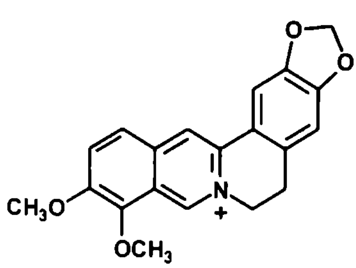
While not providing a sound scientific rationale for a conservation treatment, this does at least provide a basis for assessing the problem faced by conservators. Berberine is a water-soluble dye, but the solvent, which must be used to remove the paste that holds the document to the backing papers, must not remove the dye from the paper. Only water, or even more polar solvents, will remove the paste, but these will all dissolve the berberine. Thus, the problem is as follows: to the best of our knowledge, no solvent exists which will remove the adhesive without dissolving the dye at the same time. This being the case, a chemical solution to this problem must be sought, as a physical solution is not available.

THE CHEMICAL NATURE OF BERBERINE

Berberine is a salt. The most common example of a salt is sodium chloride – common table salt. Salts have two components: positively charged species, known as cations, and negatively charged species, known as anions. Berberine occurs naturally as a berberinium salt of either chloride or sulfate, where berberinium is the cation, and chloride or sulfate are the anions. The structure of the yellow berberinium cation is shown below.

The colour of berberine resides entirely in the cation (a colour centre is known as a chromophore): the anions in berberine, chloride or sulfate, are entirely colourless.

The properties of cations are usually not affected by their anions. Thus the colour of a coloured cation (the chromophore) should not be altered by its anion, and hence the colour of berberine should be independent of the nature of its anion (providing the anion is itself colourless).



The berberinium cation

However, although the spectroscopic and chemical properties of cations are usually not affected by their anions, the solubility of the salt is dramatically altered. It is possible to envisage, therefore, a process whereby berberine is rendered insoluble by exchanging the anion found in nature for another colourless anion. This process would not affect the colour of the dye, but would render it essentially insoluble.

A POTENTIAL SOLUTION: THE NITRATE TREATMENT

Our experiments have shown that, whereas berberinium chloride and berberinium sulfate are very soluble in water, berberinium nitrate is a salt of sparing solubility. Thus, when an aqueous solution of berberinium chloride or sulfate is treated with a saturated solution of sodium nitrate, a dense yellow precipitate is formed, and the mother liquor is effectively decolorized. This precipitate has been fully characterized (including a single-crystal X-ray crystallographic structural determination, performed by Dr P.B. Hitchcock), and is unambiguously berberinium nitrate. The colour of berberinium nitrate is identical to that of natural berberine, and therefore this material fulfils the essential requirements outlined above.

A possible solution to the problem of removing the backing paper from the *Diamond Sutra* is therefore to treat the document with saturated sodium nitrate solution, which would fix the dye in the paper, whilst removing the glue from the backing paper. Observations that support this methodology as a potential treatment include:

1. Treatment of modern papers dyed by berberine with saturated aqueous solutions of sodium nitrate results in the colour being retained in the paper.

2. Control experiments with pure water result in the dye washing out of the paper.

3. The effect of sodium nitrate on cotton-based paper has been studied by Priest and Southgate; initial results from accelerated ageing tests suggest no adverse effects upon the strength of the paper occur.

REMAINING PROBLEMS: *CAVEAT EMPTOR*

Initial results obtained using the nitrate treatment look very promising. However, there are many problems still to be tackled, and many questions still to be answered. In particular:

1. We do not know that the *Diamond Sutra* is coloured yellow by berberine.

2. We do not know that if berberine is present, whether it is the only chromophore present.

3. We do not know the identity of the paste.

4. Scientific tests must be made upon the *Diamond Sutra* if it is to be preserved for future generations.

The last point is particularly important; the need for a scientific study of the Dunhuang *Diamond Sutra* is paramount. A carefully planned study of the document, designed to yield the information that is so essential for its preservation, must start soon.

ACKNOWLEDGEMENTS

We wish to acknowledge the tremendous help and encouragement that we have received from the following British Library personnel: Peter Lawson, Mark Barnard, Frances Wood and Beth McKillop. We are also indebted to Drs Peter Hitchcock (X-ray crystallography) and Ala'a Abdul-Sada (mass spectrometry) of the University of Sussex, and Professor Chris Adams and Drs Jeremy Andrew (confocal microscopy) and Scott Singleton (infrared microscopy) of Unilever Research Port Sunlight Laboratory for their interest and practical assistance with this project. Preliminary work on the nitrate treatment was performed by Miss Fiona Jones (University of Sussex).

The chemical constituents of the *huangbo* dye

Anne-Marie Bremner, Peter J. Gibbs and Kenneth R. Seddon

The dye, *huangbo* (*huang bo*), is believed to be the source of colour in most yellow pre-tenth century Chinese paper. The following article describes the known properties of this dye, and describes the known facts about its chemical constitution. Analytical techniques for detecting its presence on ancient papers are also described.

THE PHELLODENDRON TREE

The *huangbo* dye is derived from an extract of the bark of the Phellodendron cork tree. Phellodendron, a member of the Rutaceae (orange) family, is a small genus of deciduous tree found in north-west China and southern Siberia – a region collectively known as the Amur. The tree comprises two main species *Phellodendron amurense* and *Phellodendron chinense*. The name of the genus is derived from the Greek *phellos* (cork) and *dendron* (tree), giving reference to the soft corky bark of the tree first described by Ruprecht in 1853.

The dried bark is yellow, bitter and fragrant smelling, and has two documented sources in China: *P. amurense* Ruprecht and *P. amurense* var. *sacchaliense* F. Schmidt. Another Chinese variant, *P. amurense* var. *lavelli* Dode is not mentioned as a source of yellow dyes in the literature. There is also a Japanese variant, *P. amurense* var. *Japonicum* Ohwi (known as *kihada* in Japan); the Japanese, too, have used the Phellodendron bark extract as a colourant for sutras and silks for well over a thousand years, and the dye, like the tree, is known as *kihada*.

HUANGBO AS A MEDICINE AND INSECTICIDE

The pharmacological properties of berberine and the other alkaloids found in *huangbo* are well documented, and are still under active investigation. The earliest noted use was stomachic, especially as an antidiarrhoea agent and intestinal antiseptic; it also has a folkloric use as an antifertility remedy. More recent studies have revealed a number of antibacterial, antifungal, antiprotozoal and antiparasitic effects, and *huangbo* has featured as a source of potential anti-cancer and anti-AIDS drugs.

The insecticidal attributes of the dye are perhaps more relevant to the conservation of ancient dyed materials. The bark of all the *amurense* variants, and any materials coloured with the bark extract, possess the antifeedant properties of the alkaloids berberine and palmatine against insects of several genera. A government decree of 671 AD suggests the dyeing of government and religious documents with *huangbo* to prevent 'ageing by insects'.[1] This indicates, but does not prove, that the many yellow documents found in the Cave 17 collection were dyed to protect them from insects. Yellow is also the Buddhist colour of solemnity, which may have given the use of *huangbo* for religious documents an added dimension.

THE TRADITIONAL MANUFACTURE OF *HUANGBO*

The traditional method of extraction of *huangbo* is to boil the bark in water and strain through a cloth sack producing a clear yellow juice. A fifth century treatise on agriculture – 'Important Skills of the Common People'[2] – recommends boiling and straining the dregs of the initial extraction a further three times: the juice produced can be added to the primary extract, increasing the yield up to eight times. It is said that a paper submerged in the high yield juice will have a glossy and even colour.

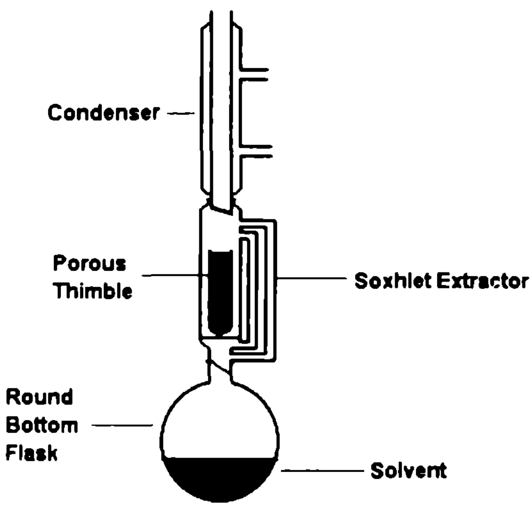


Fig. 1. A Soxhlet extractor

In the laboratory, a typical method of extraction is the Soxhlet extractor (Figure 1); this method mimics the traditional method sufficiently. The solvent (typically water) is heated in the round-bottom flask; the vapour then passes up the side-arms of the Soxhlet extractor to the condenser, and, on condensing, drops onto the powdered bark held in a porous thimble. The solvent, as it fills up the main chamber of the extractor, slowly extracts the soluble components of the bark; and when the chamber is full, the solvent, now containing the extracts, will drop back into the round bottom flask *via* the side-arm. The solvent will heat-up again and evaporate to repeat the process, but, as the extracts do not evaporate, they will remain in the flask. As the solvent repeatedly circulates within the apparatus, it collects the extract and deposits it in the flask where it becomes more and more concentrated.

Obtaining the extract enabled a comparison of some of its chemical and physical properties with those of the alkaloid berberine, which has long been thought of as the principal yellow chromophore in *huangbo*. Figure 2 shows the electronic absorption spectra of both berberinium chloride in water, and the water extract: the overlay clearly shows the dissimilarities between the two, and the marked degree of shift between the comparable peaks was one of the first clues that led us to believe there must be more than one yellow chromophore in the extract.

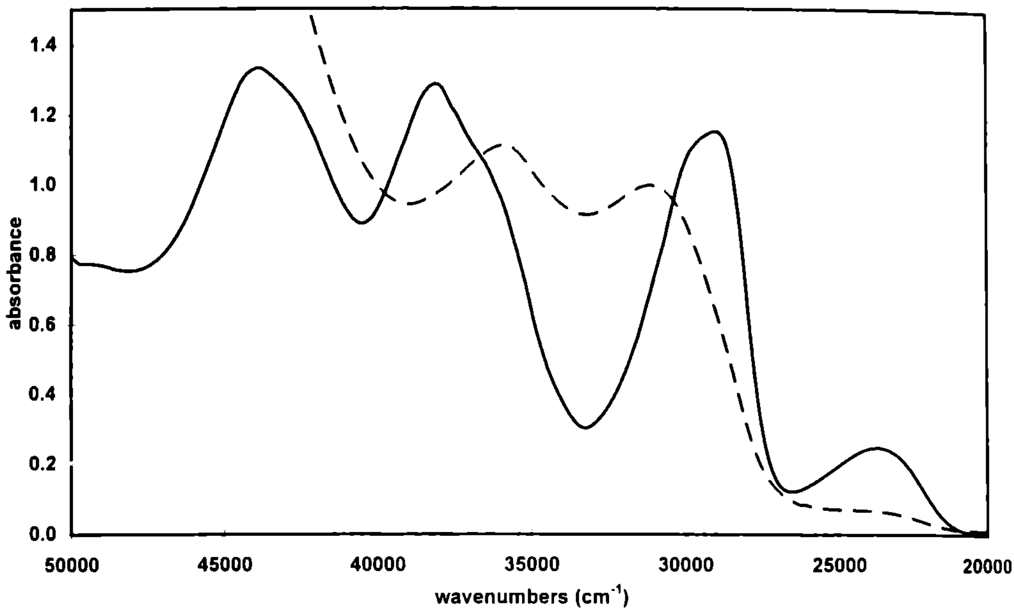


Fig. 2. Electronic absorption spectra overlay of berberinium chloride in water (solid line), and the aqueous extract of the Phellodendron bark (dashed line)

An extensive literature search followed, involving everything that had been written about berberine and the Phellodendron tree in the past twenty-five years. This enabled us to compile a table (Table 1) of all the recorded components of the water extract of the bark. All of these chemicals would be present in both the *huangbo* and *kihada* dyes, and would also be present on the surface and within the fibres of papers and silks coloured with these dyes.

Table 1 shows that, including berberine, there are seven alkaloids in the extract: there are also four flavonol glucosides (large organic molecules containing a sugar group) and four water-soluble polysaccharide (W-SPS) residues. The W-SPS residues are not found individually, but are cross-linked into a complex pattern which, whilst having no effect on the colour of the extract, will considerably heighten its viscosity. Phellamurin, a flavonol glucoside, was mentioned in one article[3] as the second most important chromophore in *huangbo*; this was the only paper, out of hundreds studied, to mention this fact, hence it should be treated with some caution. The alkaloids, however, are the most likely source of any other yellow chromophores in the dye.

Table 1. Identified species within the Phellodendron amurense *bark water extract*

	ALKALOIDS	FLAVONOL GLUCOSIDES	WATER-SOLUBLE POLYSACCHARIDES RESIDUES
P. amurense Rupr.	Berberine Palmatine Jatrorrhizine Phellodendrine Candicine Menisperine Magnoflorine	Phellavin Phellatin Phellamurin Dihydrophelloside	L-rhamnose L-arabinose D-galactose D-galacturonic acid
P. amurense Rupr. var. *sacchaliense* F. Schmidt.	Berberine Palmatine Jatrorrhizine Phellodendrine Candicine Magnoflorine	Phellavin Phellatin Phellamurin Dihydrophelloside	

A Japanese patent from 1989[4] is important as it was the first report to quantify the lesser alkaloids in the *methanol* extract; these are summarized in Figure 3. The chart shows that berberine is the most abundant alkaloid in the bark extract; but it also shows that the abundance of palmatine is about one third of the berberine content.

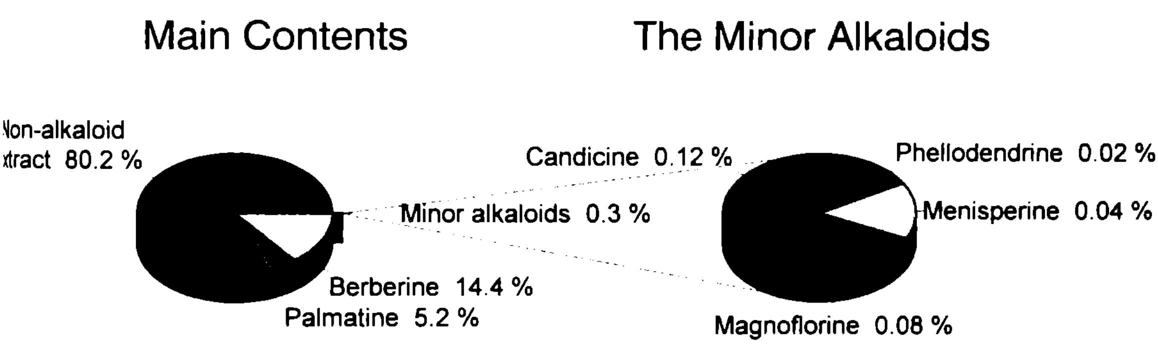


Fig. 3. The alkaloid content (%) of the Phellodendron methanol extract

The chart also shows the relative quantitative insignificance of the other alkaloids, although they should not be ignored as they may have some chemical or physical stabilisation effect on the dye. There was no mention of the alkaloid jatrorrhizine in the patent, hence its absence from the chart.

Table 2 documents what we believe to be the yellow chromophores within *huangbo*: notice that jatrorrhizine, which was not mentioned in the patent,[4] is one of the possible chromophores. It is possible to eliminate the other alkaloids as chromophores as, although their colours have not been documented, their structures reveal whether or not they have any colour.

Table 2. Possible yellow chromophores within the Phellodendron amurense *variants*

	ALKALOIDS	FLAVONOL GLUCOSIDES
P. amurense (all variants)	Berberine Palmatine Jatrorrhizine	Phellamurin

Figure 4a shows a basic organic chain with alternate single and double bonds between the carbons: Figure 4b shows the same chain written in the standard chemical shorthand where the carbons and hydrogens are omitted. The pattern of alternate single and double bonds creates the delocalisation of electrons along the chain; this phenomenon is known as conjugation, and the longer the conjugation of the molecule, the more likely it is to be coloured.

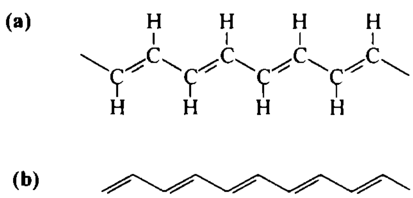


Fig. 4. (a) A conjugated organic chain, and (b) a conjugated organic chain written in chemical shorthand

The structures of the berberinium and palmatinium cations are illustrated in Figure 5. Although the organic chains in the structure are twisted and cross-linked, it is possible to follow an unbroken sequence of fifteen carbon atoms with alternating single and double bonds – a long conjugation which gives both berberine and palmatine their yellow colour (we have samples of both berberine and palmatine, and their colours are very similar – but not identical).

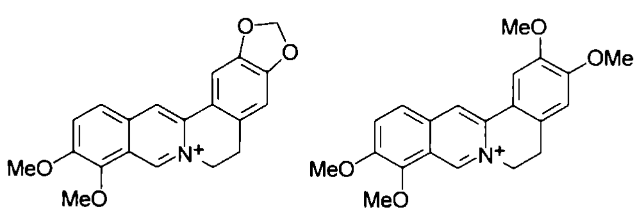


Fig. 5. The berberinium (left) and palmatinium (right) cations

Figure 6 illustrates the structures of palmatine and the other alkaloids present in *huangbo*. The structure of jatrorrhizine is very similar to that of palmatine (and,

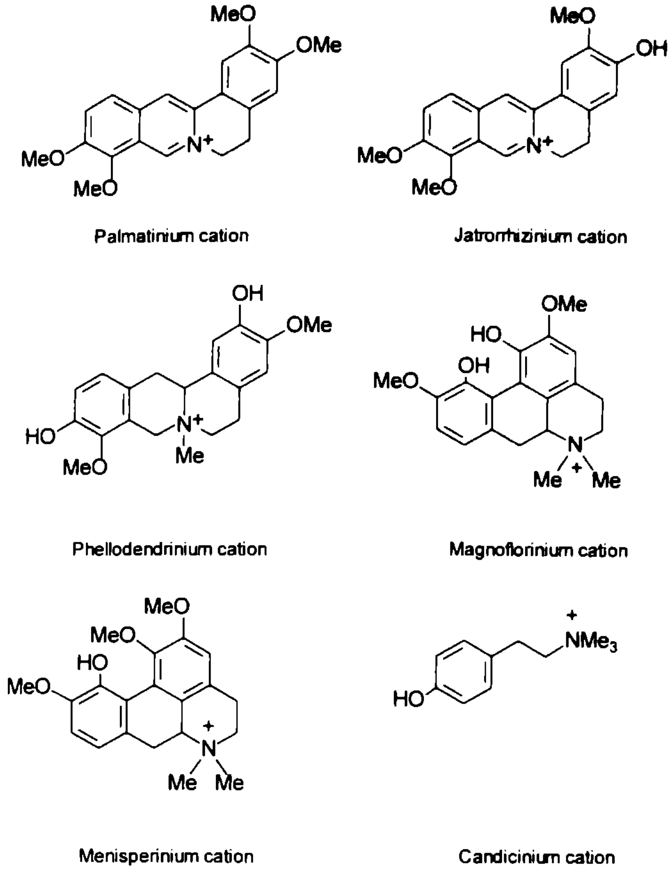


Fig. 6. The palmatinium, jatrorrhizinium, phellodendrinium, magnoflorinium, menisperinium and candicinium cations

indeed, to that of berberine – collectively they are known as the protoberberine alkaloids); it has the same conjugation as berberine and palmatine so that it can be said, with a considerable degree of certainty, that jatrorrhizine is also a yellow compound. Phellodendrine, whilst looking similar to the others mentioned, is lacking the double bonds (the aromaticity) in the second ring system from the left of the figure, hence its conjugation is much shorter than that of berberine, and it is likely to be colourless. The remainder are also colourless: the aporphine alkaloids, magnoflorine and menisperine, have a shorter conjugation than protoberberines, and candicine only possesses the conjugation of the benzene ring.

The subject of conjugation leads to an interesting aside concerning the possible bleaching of the frontispiece of the Dunhuang *Diamond Sutra* to remove a stain. Two of the possible bleaching agents used were potassium manganate(VII) and sodium oxochlorate(I) – more commonly known as potassium permanganate and sodium hypochlorite respectively – both of which are oxidising agents. The reported oxidation products of berberine are shown in Figure 7.[5] In each case the aromaticty of the second ring has been lost, reducing the conjugation and causing colour loss in each product; this may be the cause of the faded colour of the frontispiece compared to the strong yellow ochre of the innermost sheet. Retention of some colour is likely

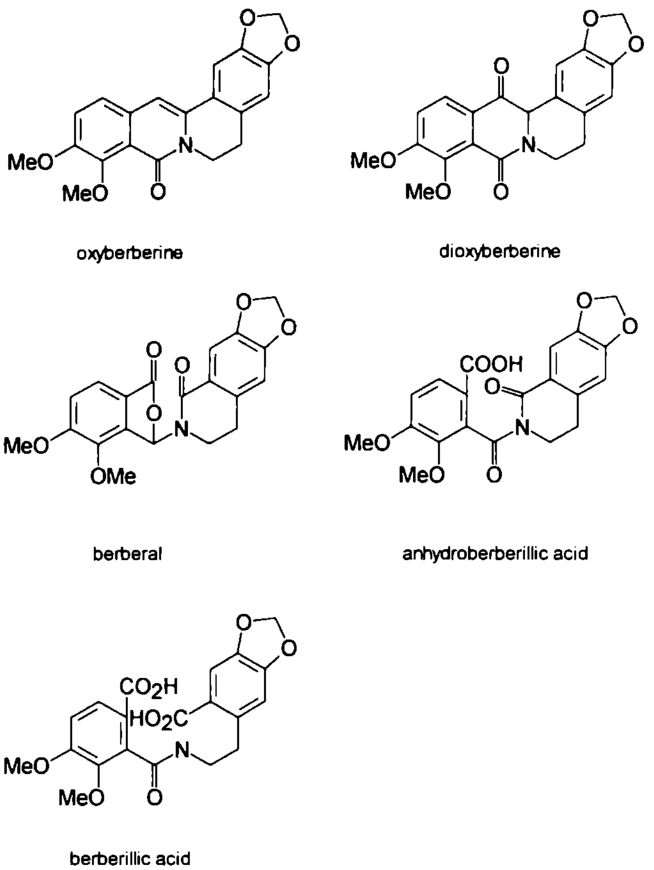


Fig. 7. The oxidation products of berberine: oxyberberine, dioxyberberine, berberal, anhydroberberillic acid and berberillic acid

if the oxidation product is oxyberberine (the result of a mild oxidation) as its conjugation is fairly long; but there will be no colour at all in any of the other products, which range from dioxyberberine (for a fairly mild oxidation) to berberillic acid (for a very strong oxidation); the fact that two of the oxidation products are acids may further compound the problems of the stability of the *Diamond Sutra*'s frontispiece.

PROBLEM I: INCONSISTENCIES IN THE LITERATURE

Within the root bark of the plants, Kunitomo (1962)[6] noted the absence of the aporphine type alkaloids, magnoflorine and menisperine, and, most intriguingly, the total absence of palmatine. Very few alkaloids were reported elsewhere in parts of the phellodendron plants other than the trunk and root bark.

Both the trunk bark and the root bark of the *Phellodendron amurense* variants may have been used in *huangbo*, although it was more likely to have been the trunk bark. Kunitomo's results suggest that even if one was certain that the Amur cork tree is the source of an ancient dye, it is impossible to state without experimentation whether or not a major yellow chromophore, palmatine, is actually present in that dye.

A further predicament is added by the most recent study into the composition of *Phellodendron amurense* variants mentioned earlier. A Japanese patent (1989)[4] concerning the bark's insecticidal attributes, recorded the extraction of *P. amurense* Ruprecht bark with methanol: the results are summarised in Figure 3. A similar extraction of *P. amurense* Ruprecht var. *japonicum* Ohwi – the source of *kihada* – in the same experiment, yielded slightly fewer alkaloids overall, but the composition and proportion of alkaloids in the extract were virtually identical to those of the Chinese variants. A notable absence from the list is jatrorrhizine, which some reports have qualified as the likely third most abundant alkaloid in the dye. The patent fails to mention the compound at all, hence it is difficult to find cause for its absence; it may have been overlooked due to its ineffectiveness as an insecticide, but, in the same way that palmatine is absent in the root bark, jatrorrhizine may have been absent from the unspecified bark region sampled here.

PROBLEM 2: THE NITRATE TREATMENT

The ambiguity of the bark contents also affect the approach to the potential nitrate treatment (see preceding article). In particular, is palmatinium nitrate as insoluble as berberinium nitrate? If this is shown not to be the case, the viability of the treatment must be called into question, as the risk of losing up to one third of the yellow chromophores from the dye when it is treated with the sodium nitrate solution is too great. We also do not know if the lesser alkaloids and other constituents of the dye will respond favourably to the nitrate treatment.

POSSIBLE ANALYTICAL TOOLS

As the literature is unable to qualify, let alone quantify, the exact composition of the bark extract, it is vital to test a sample from any book, manuscript or silk that is put forward for possible treatment; this is the only way to be certain which chemicals are present on the surface and within the fibres of the paper or silk. There are a number of possible analytical tools that should enable us to do this, the major ones are listed below:

1. Electronic Absorption Spectroscopy (UV-VIS)
2. Mass Spectrometry (MS)
3. High Performance Liquid Chromatography (HPLC)
4. Confocal and Infrared Microscopy
5. Electron Microscopy
6. Energy Dispersive Analysis with X-Rays (EDAX)

There is insufficient space here to examine them all in detail. The potential of electron microscopy, energy dispersive analysis with X-rays (EDAX), and electrophoresis, have yet to be extensively investigated, but preliminary results are promising. Electronic absorption spectroscopy, mass spectrometry and high performance liquid chromatography are the techniques which have been most widely used in connection with the Cave 17 material.

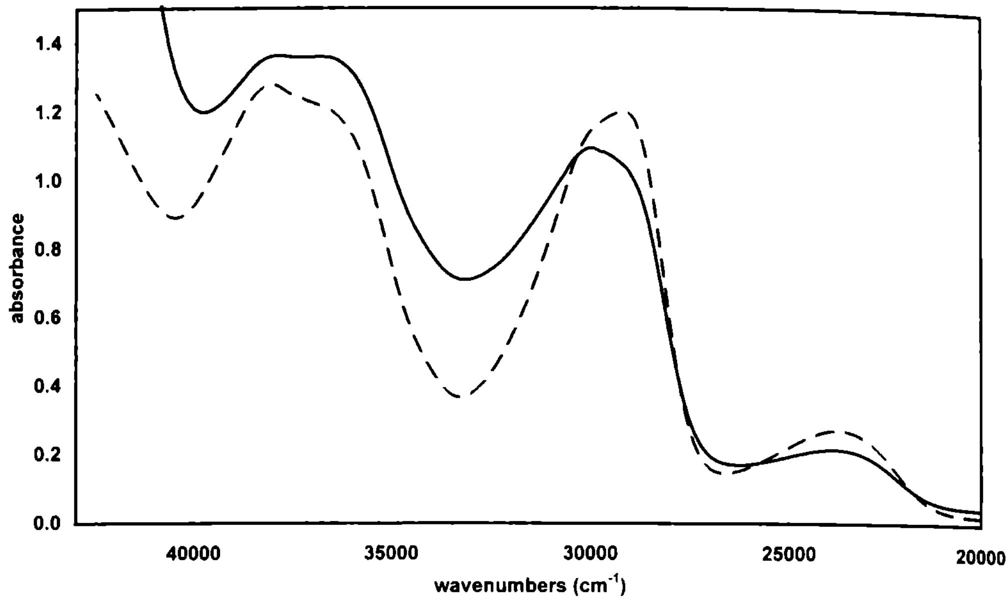


Fig. 8. Electronic absorption spectra overlay of the combined berberinium and palmatinium chlorides (3:1 mix) in water (solid line), and the aqueous extract of the Phellodendron bark (dashed line)

Figure 8 reveals the potential of electronic absorption spectroscopy: the dotted line represents the spectrum of the alkaloids extracted from the *P. amurense* bark, and the unbroken line represents the combined spectra of berberinium and palmatinium chlorides in water. Compared with Figure 2, the similarity between the spectra of the commercially purchased compounds and the extracts obtained from the bark is much closer, although there are still some distinct differences in the peaks and troughs.

Figure 9 represents the mass spectrum of as 3 mm^2 sample of traditional paper dyed with *huangbo* in the traditional way – we believe that this is the first recorded mass spectrum of a dye directly from a paper sample. The peak labelled 336 indicates berberine, and that at 352 indicates palmatine (336 and 352 are the relative molecular masses of the berberinium and palmatinium cations respectively); the relative intensities are in a ratio of about three to one, the same as the ratio indicated in the literature. We believe that with more investigation it will be possible to examine a much smaller sample paper, possibly only 1 mm^2 or less.

Figure 10 illustrates the separation of berberine and palmatine from the *Phellodenron amurense* bark extract by high performance liquid chromatography (HPLC). After attempting several different mobile phases, it was found that, as suggested by a Japanese paper concerning HPLC methods for quaternary alkaloids,[7] a mixture of sodium lauryl sulfate, tartaric acid, methanol and ethanenitrile in the ratio 0.5:49.5:10:40 on a TSK gel, reverse phase, column was successful. There are various types of detectors that could be used in conjunction with the column: the chosen method of detection, here, was an electronic absorption spectrometer, which can only scan one wavelength at a time. The selected wavelength was 345nm, as suggested, as this is a position of a major absorption for both berberine and palmatine (*cf* the electronic absorption spectra in Figure 8).

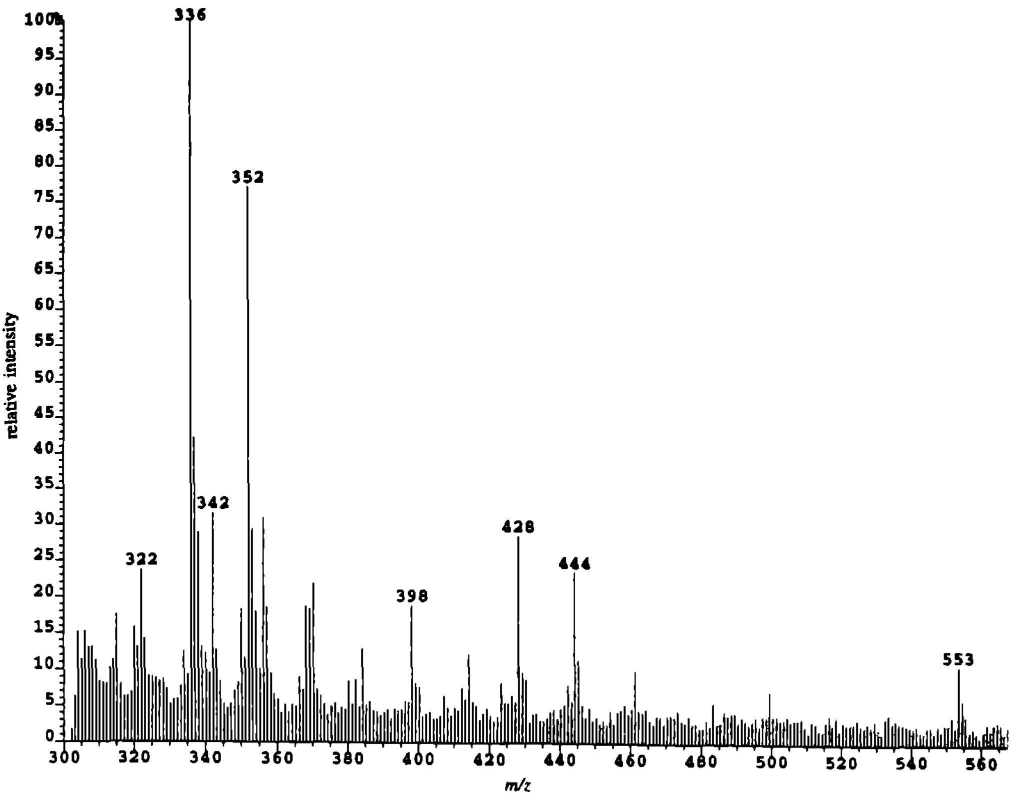


Fig. 9. The mass spectrum of a 3 mm² sample of traditional Japanese paper dyed with huangbo *in the traditional way*

Chromatograms were obtained for palmatinium chloride, berberinium chloride and the traditional extract. The palmatinium chloride chromatogram gave a clear peak with a retention time of around 23 minutes. The berberine peak was slightly less well defined, with a retention time of 26 minutes.

The traditional extract sample gave a few peaks, some of which occurred at quite short retention times at around 1 minute, and also a further two which had very similar retention times to palmatinium chloride and berberinium chloride, since their retention times occurred at 23.4 and 26.0 minutes, respectively.

This was a clear indication of the presence of palmatine in the extract. Not only did this show that palmatine was present, but also that it was present in a significant quantity. It is possible to estimate the quantity of palmatine present from the area underneath the peak: this is estimated at about 30% of the contribution to the colour of the dye.

The HPLC technique drawn from the literature is not ideal. The flow rate of $2\,cm^3\,min^{-1}$ is undesirably high ($1\,cm^3\,min^{-1}$ is preferred), but it is necessary as the retention times are so long; the definition of the peaks is not to the desired resolution, however. Work is now underway to perfect the HPLC separation of the *huangbo* extract, and this extremely sensitive analytical technique is going to be vital for the analysis of ancient paper samples.

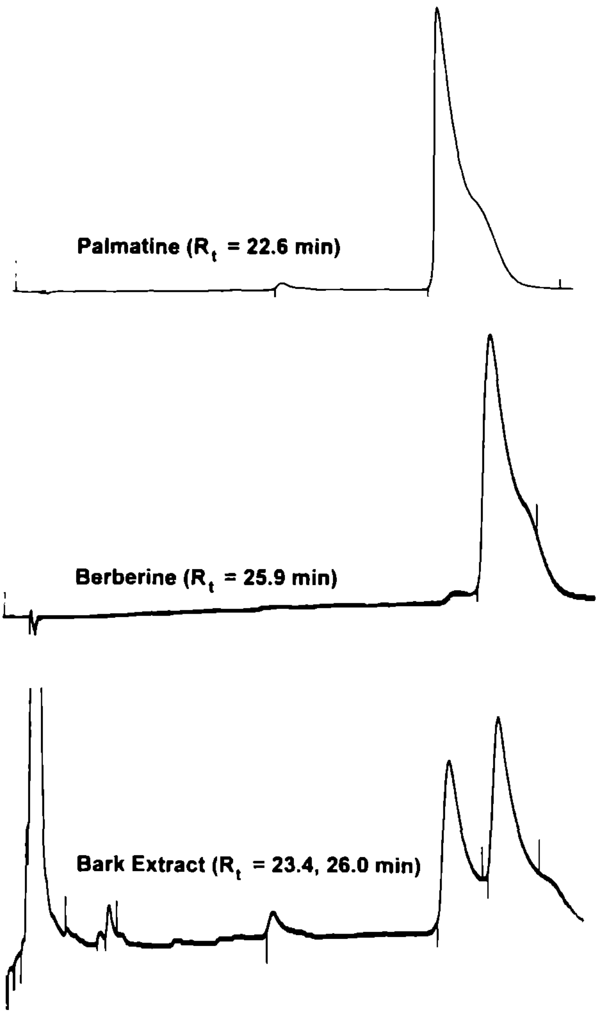


Fig. 10. HPLC chromatograph of palmatine, berberine and the traditional extract

THE IMPORTANCE OF COMPUTATIONAL CHEMISTRY TECHNIQUES

The lesser alkaloids of *huangbo* are very difficult to obtain, and will be very expensive. Palmatine is commercially available, but at a cost of £10 per gram; and whilst it is possible, with modern processes, to do a reasonable amount of chemistry on a gram of substance, much more will be needed to examine, for example, the effects of the nitrate treatment on palmatine. The remainder of the alkaloids in *huangbo* are not commercially available, and will be even more expensive to obtain.

We have a number of powerful computers at our disposal, with the latest molecular modelling packages, such as Spartan and Cerius. These will help to increase the understanding of the chemistry of berberine, palmatine and the lesser alkaloids. Using molecular modelling, it is possible to mimic some of the spectroscopic properties of a compound, and obtain theoretical spectra including electronic absorption spectra. Of course, the theoretical spectra are never identical to the experimental spectra, but there is sometimes sufficient correlation between the calculated spectra and the empirical one to enable important information to be gleaned.

The computers will also enable the investigation of the reactivity of the berberin-ium cation, and, if any crystal structures are obtained for the individual components of *huangbo*, they too can be extensively explored with the Cerius package.

SUMMARY OF THE UNCERTAINITIES IN THE LITERATURE

Finally, it is important to discuss the six questions and/or uncertainities which necessitate the testing of samples from every document to be treated; we believe that the surface composition of the many yellow-dyed papers may vary in each sample due to these uncertainities.

1. Which tree was the source of the dye? It could have been any one of, or a combination from, up to three variants of the *Phellodendron amurense* alone, if it was from this species at all.

2. From which part of the tree did the bark originate? The alkaloid content of the root bark is notably different from that of the trunk bark: the dye could have been extracted from either type of bark, or any combination of the two sources; if this fact is combined with the number of variants in the species, the diversity of the alkaloid content of the potential dyes increases considerably.

3. Which extraction method was used? It was mentioned earlier that the method of extraction was to boil the bark in water. If the water were hot, not boiling, it would still extract an adequate dye, but, depending on the temperature, the composition of the dye is likely to vary as different compounds often extract at distinct rates under specific conditions.

4. How does the differing affinity of the dye's components for the paper affect the surface composition? As the paper is submerged in the dye, the various components of the dye are attracted to its surface giving it colour. If the dye's components have a differing affinity for the paper's surface, this, and the length of time for which the paper is submerged, will determine its surface composition.

5. What if more than one dye were used to achieve the desired effects? Small amounts of a completely different dye could have been added for purely aesthetic reasons; these may have a marked effect on the chemistry of the main dye.

6. How do the constituents of the dye vary over such a long timescale? This is probably the biggest uncertainty: it is relatively simple to explore the chemistry of a modern version of the dye, but there is no way of knowing, without direct analysis, how the components of the dye may have been chemically or physically altered over such a large timescale.

Experimental testing of the surface of the dyed papers is the only way to establish their composition with any certainty.

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The effect of sodium nitrate on cotton-based paper

Derek Priest and M. C. Southgate

Since nitrate ions have been found to act as a fixative for the fugitive phellodendron-based yellow dye (*huangbo*) present in pre-tenth century Chinese papers from Dunhuang, it is important to establish at an early stage whether or not the use of nitrates could affect the paper substrate. Experiments using a standard type of cotton-based paper were carried out to see if sodium nitrate had any adverse effect. Though modern cotton paper is not a perfect substitute for early Chinese paper, the experiments would show effects linked to the cellulosic basis of the paper, free from possible complications due to fillers, sizing agents or other additives commonly found in modern paper.

Although I have read recently that sodium can provoke hydrolysis of cellulose chains, in our experiments, the results were satisfactorily negative.

Solutions of sodium nitrate were applied to chromatography paper, a pure, 100% cotton based paper like laboratory filter paper. A motorised wire-wound bar coater was used to apply the solution of sodium nitrate to the paper. The convenience of the method lies in the ability to ascertain the amount of solution applied, by weight. Ion chromatography was also used to ascertain the amount applied and the results correlated.

The samples were given a rather extreme treatment by being artificially aged at 105 degrees Centigrade for up to twenty-one days. This severe treatment was deliberately chosen to expose any problems. Samples were also exposed to an artifical light source.

Mechanical tests were used to measure the effect on the paper. Fold endurance tests were undertaken. This is not a very precise method of measurement because paper is a statistical material but one often used in conservation because the ageing effect can be picked up very rapidly by measuring fold endurance. Even treatment by water can induce a change in paper structure by relaxation.

Tensile tests were also made. Paper is essentially composed of flattened, criss-crossed wood fibre, forming a bonded fibre network. The mechanical strength of paper arises from a large number of sources: fibre length is a determinant (up to a certain point), the strength of individual fibres, the cross-section of fibres, the area of fibre-length in contact and bonded and the filler. Fibre strength and the bond between fibres are the major factors since the others are affected by and dependent upon these. The long-span tensile test measures the force of the load required to break a strip of paper. The zero span tensile test is made on the edge of a piece of paper and this test demonstrates the fibre strength, breaking the fibres themselves rather than the bonds between them.

There was a very slight decrease in tensile strength with the amount of sodium nitrate added to the paper but the ageing made no difference. There was also a very slight decrease in zero span strength as the paper aged but the presence of the nitrate was not responsible, it was entirely due to thermal effect of ageing. Nitrate has only a very slight effect on the bonding strength of the fibres.

Ageing affects paper colour and reduces brightness but the nitrate did not, even though samples were light-exposed for 120 hours.

In summary, treatment with sodium nitrate caused very little change in mechanical property. Whether or not paper was aged, the presence of sodium nitrate only caused a small loss of strength probably through interfering with the bonds between the fibres. Thermal ageing produced a definite change of colour, independent of the presence of sodium nitrate but exposure to light produced no measurable change in any sample, treated or untreated.

Epilogue: the International Dunhuang Project

Susan Whitfield

The October 1993 Conference was immensely successful and all the papers provoked a considerable amount of discussion. As a result of this, the International Dunhuang Project (IDP) was established and many of the future plans described in my paper, 'The Way Ahead: Compiling a Database of Cave 17 Material' have since been implemented. Instead of giving a copy of this paper here, the following is a summary of the main points arising in the discussion at the conference and how they have been addressed over the past two years through the work of IDP.

MAIN POINTS OF DISCUSSION

In the course of the conference, it became evident that the curators and conservators of Dunhuang and other Central Asian material shared many of the same problems. These can be summarised as follows:

1. *Lack of conservation records:* very important for understanding conservation work carried out in the past that now needs to be reversed.

2. *Chemistry of the manuscripts:* given that there are no detailed conservation records and that previous work has to be undone, it is vital that the current chemical properties of the manuscripts are fully understood before any remedial work is undertaken.

3. *Methods and measurements:* in order to carry out chemical analysis, and then further conservation, well-tested and standard methods and means of measurement are required: these are still lacking. The question of the imprecision of the term 'pure water' used in many papers on the conservation of manuscripts, for example, provoked considerable discussion. It was agreed that it is essental to have well-documented and shared standard methods of working towards purifying water and measuring the result before this term has any meaning. The question of the pH value of paper was also contentious, given that there is, as yet, no adequate device for measuring pH (the existing methods have a very high error range).

4. *The durability of various surrogates:* doubt was raised about the long-term reliability and use of surrogates such as CD-ROMS, and it was agreed that, until long term studies are carried out, microfilm remains the only proven surrogate.

In addition, the geographical disparity of the Dunhuang manuscripts greatly hinders work on the corpus as a whole and comparison between manuscripts in different collections.[1] Relatively poor communication between the holders in the past, especially in the first decades of this century, have resulted in conservation techniques and experience not necessarily being shared and, as the conference papers show, all the collections have suffered to some extent because of this. As a result of the conference in October 1993 it was decided to establish The International Dunhuang Project (IDP) to address these problems, the broad aim of IDP being to promote the study and preservation of the Dunhuang legacy through international cooperation. IDP was duly set up in early 1994 with a small steering committee and a secretariat based at the British Library in London.[2] Its objectives are:

To establish the full extent of the documentary legacy from Dunhuang and other Central Asian sites and to share that information through the development of an international database.

To develop new techniques for the preservation of the original documents through close collaboration with research chemists and paper technologists.

To promote common standards of preservation methods and documentation.

To catalogue the material according to common or compatible standards.

To store the documents in the best possible environment and reduce handling to a minimum.

To stimulate research on the material and increase access through the production of surrogate forms, facsimile publication, microfilm and computer stored images.

The Project newsletter, *IDP News*, carries articles about the various collections of manuscripts and documents from Chinese Central Asia, reports on conservation and science, and news of the Project, visitors and relevant conferences.[3] The second conference was held in Paris in February 1996 and the third (London, 1997) will consider the question of forged Dunhuang manuscripts.

THE DATABASE

One of the primary objectives of IDP is to create a database containing both catalogue information and images of the manuscripts. The Project has been fortunate in attracting the support of the Chiang Ching-Kuo Foundation to carry out the initial stages of the database and input of the Stein non-Buddhist material. It also has the backing of ACI (UK) Ltd, manufacturers of 4th Dimension, the database software. As a result of this, the database has been designed and the input of Stein Chinese material has started along with a comprehensive conservation survey. It is worth here considering the Stein collection as a whole and previous cataloguing work in order to give an idea of the extent of the Project and the need for computerisation.

The British Library holds material acquired by Stein on his three expeditions to Chinese Central Asia between 1900 and 1916, the most famous acquisitions being made during trips to Dunhuang where the mainly Chinese manuscripts of Cave 17 had been discovered a few years previously.[4] But he also collected thousands of Tibetan manuscripts from the same region, Prakrit wooden tablets from Niya and Loulan, and hundreds of written documents in many languages and scripts from the Silk Road ruins along the borders of the Taklamakan desert.

Some of the Chinese and Kharoṣṭhī documents he brought back were published very quickly, and although Giles's catalogue of the Dunhuang manuscripts was not published until the late 1950s by this time numerous studies had come out, mainly by Chinese and Japanese scholars (although there has also been a thriving group of Dunhuang researchers in Paris under the guidance of Professor Drège). Further work and rough translations of the Kharoṣṭhī manuscripts was done by Burrow. Sir Harold Bailey and Reichelt published studies of the Khotanese and Sogdian works and the research of de la Vallée Poussin on the Tibetan Buddhist manuscripts finally reached the press in the 1960s. In addition to these published catalogues the British Library has handlists of the Tangut, Uighur and Eastern Turkic manuscripts in its collections.

But the published catalogues, apart from now being out-of-date, are also all partial. Their authors invariably selected the most complete, most legible and most easily understood of the manuscripts and ignored the remainder. The true size of the Stein collection is probably therefore not widely known. The 7000 Chinese manuscripts from Cave 17 catalogued by Giles represent only half of the total number brought back from Dunhuang. And because the ones omitted are more fragmentary, the task of identifying and cataloguing them will doubtless prove more difficult. Likewise, the 1300 Chinese woodslips catalogued by Chavannes and Maspero represent fewer than half of the total. Not only are there about 2,000 completely uncatalogued fragments, there are also five drawers of woodslip fragments with site marks only. De la Vallée Poussin's selection of under 800 Tibetan documents leaves over 3500 to deal with. The British Library Stein collection therefore totals over 28,000 manuscripts in many physical forms: paper scrolls, concertina-type booklets, sewn booklets, and fragments; woodslips and wooden tablets in various shapes and sizes; silk; and even leather and birch-bark documents.[5] The total number of texts is far greater since many of the manuscripts, especially the scrolls, comprise several different texts, often covering both sides of the paper. And because of the lack of catalogues until recently most of this collection has not been readily available to scholars.

The 7000 manuscripts catalogued by Giles have been available to non-London-based scholars through microfilm or Taiwanese-published reproductions, but many of the former and most of the latter are of poor quality. The catalogued woodslips have also been available outside London as photographs, but research on the remainder of the collection has necessitated a visit to the library itself and even then the uncatalogued manuscripts and the drawers of woodslip fragments are effectively unknown because of the lack of a finding list or catalogue.

Clearly one of the main responsibilities of the curators is to provide some sort of description, even if very brief and tentative, for all the manuscripts in the Stein collection and to make this available to scholars. I have given an outline of the collection in its entirety to illustrate the necessity of further work and the scale of the enterprise. Fortunately the effective lack of access in the area of the Stein Dunhuang manuscripts – the material from Cave 17 – has been largely remedied thanks to the Sichuan People's Publishing House in China – who have produced a facsimile publication of the non-Buddhist documents from Dunhuang – and scholars from the Academy of Social Sciences and the Dunhuang-Turfan Academic Society who have been acting as editors. The work comprises fourteen volumes of photographs with a fifteenth volume containing a Chinese and English index to titles and names.[6] Similar works are being published by Shanghai Ancient Books Publishing House for the collections of Dunhuang manuscripts held in Beijing, Shanghai, St Petersburg and Paris.[7]

Curatorial and conservatorial activity over the past decade has been concentrated on sorting out the 7000 fragments from Cave 17 disregarded by Giles. The majority have been photographed and sewn inside sheets of a stable plastic (Melinex) so that they are easily handlable and both sides of the manuscript are visible. A small number of the larger fragments and scrolls have been treated more traditionally.[8] Volumes nine to fourteen comprise photographs of the previously uncatalogued material. A preliminary catalogue of this material was published in early 1995 by Professor Rong Xinjiang.[9] Although the previously uncatalogued Buddhist material is not included in the these volumes at least it is now available at the British Library, also having been conserved in the same way and Professor Fang Guangchang is working on a catalogue. In addition, invaluable work has been carried out recently on some of the Tibetan, Uighur and Khotanese manuscripts by Drs Takeuchi, Yasin Ashuri and Oktor Skjaervo. Yet much remains to be done and this is where a database will prove invaluable.

AN INTERNATIONAL RESOURCE

The relational database designed since the establishment of IDP carries details of the manuscripts – their conservation history and current condition; the texts – including index terms to both title and content; and a bibliography of related material in all languages. The titles, colophons and dates of the texts are being entered in both Chinese and English. Other language fonts will be added when necessary so that titles and other text quotations can be entered onto the database in the original language. Digitised images have been linked to the database in the trial period and, in the future, the database will contain images of all the manuscripts, some with very high resolution to enable unclear characters and passages to be read more easily. In addition, IDP has set up two other databases holding information of organisations with documents from Central Asia and of scholars working in this field, and will publish 'A Directory of Central Asian Scholars' when the preliminary information has been collected.

The database is intended as an international resource, not only as a catalogue of the British Library Stein collection. It has been designed to hold information on all the Dunhuang and other Central Asia documents. Moreover, it is vital that this information be made as widely available as possible. The long-term plans of IDP therefore include incorporating information and images from other collections and making the database available on-line. International co-operation and funding will be required both in the development stage and later, in the maintenance and continued enhancement of the database, essential to its success.

Museums and libraries are entrusted with the care of international treasures and to fulfill this trust it is vital that they not only preserve the objects but also make them available to all serious scholars. With a carefully designed, easy to use and comprehensive database containing clear images of the materials, there is the opportunity to do this as never before, making the geographical location of the manuscripts almost an irrelevance as they reach an ever increasing audience. This is especially true for these manuscripts from Chinese Central Asia, which include delicate objects that could never be on general display. The International Dunhuang Project is reflective of the resolve of the curators and conservators to increase scholarship and to make these manuscripts genuinely international, a resolve which was solidified at this innovative and exciting conference.

REFERENCES

1 The main collections of Cave 17 manuscripts are in London, Paris, St Petersburg and Beijing. There are considerable holdings in Japan, and other documents scattered among public and private collections elsewhere. The IDP database will also contain details of the collections.

2 A brochure giving details of the Project in English and Chinese is available from Susan Whitfield, The British Library, 197 Blackfriars Road, London SE1 8NG, UK. There is also information on the Internet (http://portico.bl.uk/oioc/dunhuang.html).

3 This is also available from Susan Whitfield and on the Internet, addresses as above.

4 The fourth expedition in 1930 was curtailed by Chinese officialdom. Stein's finds were confiscated and their whereabouts are now unknown. The British Library possesses a set of photographs of the Khotanese documents he discovered at Niya. Wang Jiqing plans to publish an account of the fourth expedition in the near future. Stein visited Cave 17 at Dunhuang in 1907 on his second expedition and returned in 1913 during his third expedition.

5 This does not include the many paintings and drawings also collected by Stein and now held in the British Museum.

6 英藏敦煌文獻(漢文佛經以外部分), (Dunhuang Manuscripts in British Collections (Chinese Texts other than Buddhist Scriptures)), Sichuan renmin chubanshe, Chengdu 1990-, vols 1-(15) . The Leverhulme Trust kindly supported the work at The British Library towards the fifteenth volume.

7 俄羅斯科學院東方研究所聖彼得堡分所藏敦煌文獻 (*Dunhuang Manuscripts Collected in the St Petersburg Institute of Oriental Studies of the Academy of Sciences of Russia*), Shanghai guji chubanshe, Shanghai 1992-.

8 See the paper by Peter Lawson and Mark Barnard in this collection.

9 Rong Xinjiang, 英國圖書館藏敦煌漢文非佛教文獻殘卷目錄 (Catalogue of the Chinese Non-Buddhist Fragments (S.6981-13624) from Dunhuang in the British Library), Xianggang Dunhuang Tulufan yanjiu zhongxin yekan 4 (Hong Kong Dunhuang and Turfan Studies Centre: 4), Shin Wen Feng Printing Co, Taipei 1994.

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