Textiles from the Silk Road in Museum Collections

Scientific Investigations and Conservation Challenges

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Identifying the colorants in archaeological textiles from Central Asia: a long and difficult story

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The Franco-Chinese Archaeological Mission in Xinjiang (directors Corinne Debaine-Francfort and Abduressul Idris) has been excavating archaeological sites along the ancient bed of the Keryia river into the Taklamakan desert. The further into the desert, the more ancient the sites are, dating from the three first centuries CE back to the Bronze Age (c. 2000 BC). The dry environment has allowed the preservation of textiles and elements of clothing, most of which decorated with woven, plaited or embroidered motifs of wool thread dyed different colours. To try and identify the biological sources of the dyes, several field missions have been dedicated to the exploration of the very special natural local environments: one along the southern margin of the Taklamakan desert in 2002; a second one in 2004, specially dedicated to the research and collection of *Porphyrophora* Coccids sources of carminic acid, led by the entomologist specialized in that genus of Coccids, in various parts of Kazakhstan; and a last one in 2013, going up the Keryia river into the Kun Lun mountains.

This presentation will present the range of dye plants and insects that could be collected, the results of the chemical study of their colorants and the results of the dye-analyses of some archaeological textiles, performed by Witold Nowik (C2RMF, Paris) and Lore Troalen (National Museums of Scotland, Edinburgh). The discussion of these results will illustrate the difficulty of the research and will aim at defining ways for overcoming them.

The civilisation of the red thread. Headgear from a looted tomb in the North Cemetery, dated to the Middle to Late Bronze Age (c. 1700 BC and earlier), recently excavated by the Franco-Chinese Archaeological Mission in the Taklamakan desert, Xinjiang, north-west China. © Dominique Cardon/Mission archéologique franco-chinoise au Xinjiang (MAFCX).

A royal shrine from Denmark's Early Medieval Age with oriental silk

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Dyestuff analyses were recently requested in silks from a Royal reliquary shrine in the Cathedral of Odense, which belong to one of the greatest national monuments of Denmark. One of the silks is a yellow pillow with a motif of blue birds and crosses, which is attributed to the reliquary shrine of King Canute the Saint, murdered in 1086 and canonized in 1100. The silk is probably dating about AD 900, it is a samite type, possibly reusing of a chasuble. The pillows pattern has been compared to a group of Sassanid Persian silks that go back to the 700s-900s.

The birds on the pillow case are probably peacocks. Perhaps the design showed peacocks placed on each side of a cross or the Tree of Life. In the iconography of Christian art peacocks are a symbol of immortality and resurrection. The peacock comes from India, where it still lives in the wild today. Motifs with birds were very common in contemporary silk patterns from Central Asia, and the actual bird motifs are thought to come from Sogdiana, the northeastern province of the Central Asian area in northern Iran, Turkmenistan and Kurdistan. The most important city of the province, Samarkand, developed from the 700s onwards as a centre of Islamic culture, and at the same time it was an important station on the Silk Road. The pillow with the birds has been compared with similar silks from the village of Zandan near Tasjkent in Sogdiana.

New dyestuff analyses, special a red dyestuff, sappanwood/brazilwood (*Caesalpinia sappan*), and a yellow dye, which has been determined to be Persian Berries (*Ramnus* family) are interesting, as both the colours are known from silks along the Silk Road. The yellow dye, like saffron, especially, for the earliest written source that describes the assassination of King Canute and his canonization is the account by the English monk Ælnoth who tells us that at the canonization, saffron-yellow silk was among the gifts. Thus the written source from c. 1130 agrees with the scientific pigment analyses done today. Possible the silks were gifts from Canute's widow Adèle, later married to the South Italian Duke Roger of Apulia. As the Christian iconography peacocks symbolize immortality, this symbolic language would certainly have been known to the donor, when the silk pillow was deposited in the Royal reliquary shrine in Odense, Denmark.

Drawing of the yellow pillow with birds from St. Canute's shrine, Odense Cathedral, Denmark. Drawing by Magnus Petersen, 1886.

A Tibetan Tent for the Afterlife - Iconographic Reconstruction and Material Contextualization

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Between the 7th and 9th centuries, the Tibetan production of objects was featured by a combination of iconographic elements that Boris Marshak defined “late baroque style.” Identified as mainly Turko-Iranian and Chinese, these patterns appear also amongst textiles from the Dulan Tibetan royal tombs in the Qinghai, China. In 2014, I had the opportunity to analyze, graphically reconstruct, and contextualize a group of fragments in the China National Silk Museum in Hangzhou that most likely come from the same area. The reconstruction was mainly based on the structure of the compounds, the analysis of fibers and colors, and the detection of every single graphic element. Amongst these, all in weft-faced compound twill (except two), the most important are: a robe with a pair of crossed felines; a long triangular thick fragment with a standing *sēnmurw*; a piece very similar to the robe of the Tibetan ambassador depicted by Yan Liben in the 7th century, in *Emperor Taizong Receiving the Tibetan Envoy* (步辇图, Bùniǎn Tú); and a thick and very damaged fragment, which might be part of a large tent made for the afterlife. The fragment was reconstructed in comparison with textiles preserved in the Abegg Stiftung in Riggisberg, Switzerland, which possibly come from South-West China. In 2017, however, the exhibition “Material Traces: Conserving and Exploring Textiles” at the Abegg, included a panel recalling some of the features of the fragment in Hangzhou, which, today, has permitted me to reevaluate my reconstruction, and also to confirm some of the data previously collected. For the first time, this paper aims to present the material analysis and the iconographic reconstruction process carried on this particular fragment, and the other related fragments.

Reconstruction of a large panel or a tent based on a silk fragment in the China National Silk Museum (silk; weft-faced compound 1/2 S twill with eight colors; 8th-9th cent. Possibly from Qinghai, China or Central Asia).

Late Roman and early Silk Samites from Egypt - Unravelling the thread from the western end of the Silk Road

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In the late 19th century many silken weft-faced compound twills have been discovered in necropolis in Egypt, most notably in Akhmim and Antinoe. The patterned silks have mainly been used as decorations for linen tunics, giving the simple garments a distinct and luxurious feature. The burials where the garments have been found have been dated to 4th-9th centuries AD, but due to their early discovery most of the finds lack a secured context. Nearly all of the silks have been separated from the original garments and are now distributed to museums all over the world, with a remarkable number being in British museums, mainly the Vicoria & Albert Museum and the British Museum.

The PhD project “Complex fabrics from the area of the Roman Empire from late Roman and early Medieval times” aims to give these precious fabrics back some of their context. Located at the University of Bonn, Department of Christian Archaeology, the PhD project investigates western silk samites from more recent and secured archaeological context and compares them to those that have lost their context due to their early discovery. While the recent history of the objects is one part of the research, the main part focuses on the detailed technical analysis of the preserved textiles: The non-invasive visual analysis of yarns, warp and weft proportions, pattern width, steps and weft sequences allows to draw very detailed conclusions on the technique that was employed to produce these weft-faced compound twills.

Microscopic analysis is also used to find irregularities in warp and weft of these finely woven objects. These irregularities tell if there have been “faults” during mounting and/or weaving and therefore give information on the actual weaving process. They can be regarded as an individual signature, and mapping them helps to identify now separated objects that once belonged to the same warp and therefore to the same production unit. This does not only connect pieces now distributed to different museum collections, it also gives information on the economic system of silk samite production in late Roman and early Medieval times.

One-half of a sleeve-panel of woven silk in purple and drab (Inv.-Nr. 303-1887). © V&A London

One of the main goals of this research is to find information on the place of production of these western silk samites and the specialised looms and weavers connected to it. The question whether these fabrics have been produced in or imported to the place of their discovery in Egypt is a point of discussion since their early discovery. Combined with several other methods, such as the analysis of dyestuffs, 14C dating and iconographic analysis, the outcome of the detailed technical analysis helps to trace the origin of these luxurious fabrics.

Silk Road Thangka Textiles from Sven Hedin Collection: Preservation History

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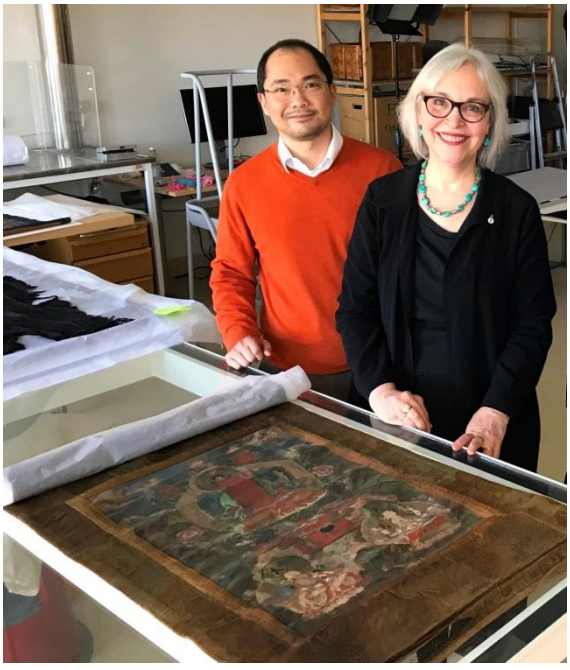
This paper introduces the Silk Road textiles found in the Sven Hedin Collection, preserved in their function of thangka mountings. The history of the collection, and past and current conservation endeavors will be discussed in this richly illustrated presentation.

Thangka mountings contain the history of Silk Road textiles. Textile mountings are often not original to the painting, and can be pieced together with fragments of historic textiles that preserve historic dyes, techniques and patterns. These are tangible examples of rare textile technology methods and materials throughout centuries of Silk Road commerce.

Swedish explorer Sven Hedin collected over 400 thangkas along the Silk Road, with styles and iconography representing various regions of the Tibetan Buddhist world. There has been little attention paid to the collection previously, with some exceptions used within exhibition contexts. This paper will explore how and where Hedin was acquiring the thangkas from, as well as the history of the collection once it was placed into the collection of the Museum of Ethnography, National Museums of World Culture, Sweden.

Working with the professional curatorial and collections management staff, I examined selected thangkas and wrote conservation condition reports, with the use of technical photography, transmitted, UV, infrared, raking and other light sources and scientific tools including a portable microscope. Most of these thangkas had not been seen in decades and had been rolled up in storage. The collection was subject to preservation procedures through the years, including various fumigations, and attempt of fumigation reversal by mechanical means in a specially designed vibration machine.

We look forward to continuation of this preservation endeavour and to further documentation and scientific investigations of this unique collection containing Silk Road textiles from diverse locations and centuries.



Ann Shaftel and Michel Lee with a thangka textile from Sven Hedin collection

The poor wash fastness of indigo dyed threads from a group of Central Asian silk weft-faced compound twill weavings dating from the 6th–9th centuries

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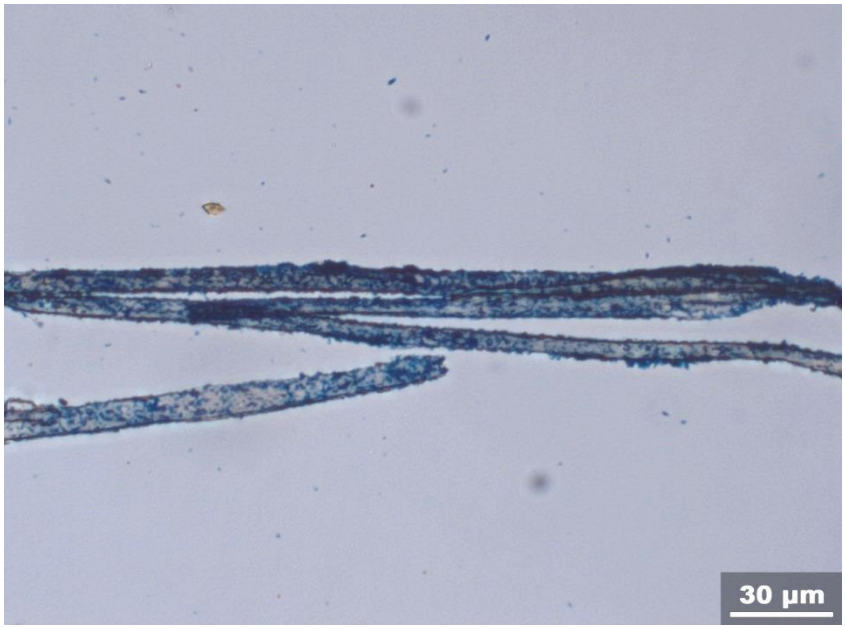
This presentation deals with a group of Central Asian silk weft-faced compound twill (samite) weavings belonging to the Abegg-Stiftung's collection. These objects are archaeological finds radiocarbon-dated to the 6th–9th centuries. The textiles show coloured patterns made of 8 different weft threads, among others light and dark blue.

During the conservation process of one of those textiles, it was noticed that the light and dark blue threads were not wash fast. After having confirmed by analysis that indigo is the implicated colorant, different hypotheses were tested that might explain the surprizing poor water-fastness for indigo.

By performing microscopic observations, it was noted that many small blue particles were distributed on the surface of the fibres, which themselves are reddish. On the contrary, silk fibres dyed with indigo are usually coloured deeply blue.

This difference could be explained by different colouring methods, raising a new question: has the indigo been used as a pigment instead of as a vat dye? In order to better understand the problem, we did further analyses, investigated blue threads and fibres from the whole group of weft-faced compound twill weavings and from textiles experimentally dyed during this project.



Fibres (inv. no. 5682) showing particles on the surface

Wool quality of the carpets from Alan burials of the 8th-10th centuries

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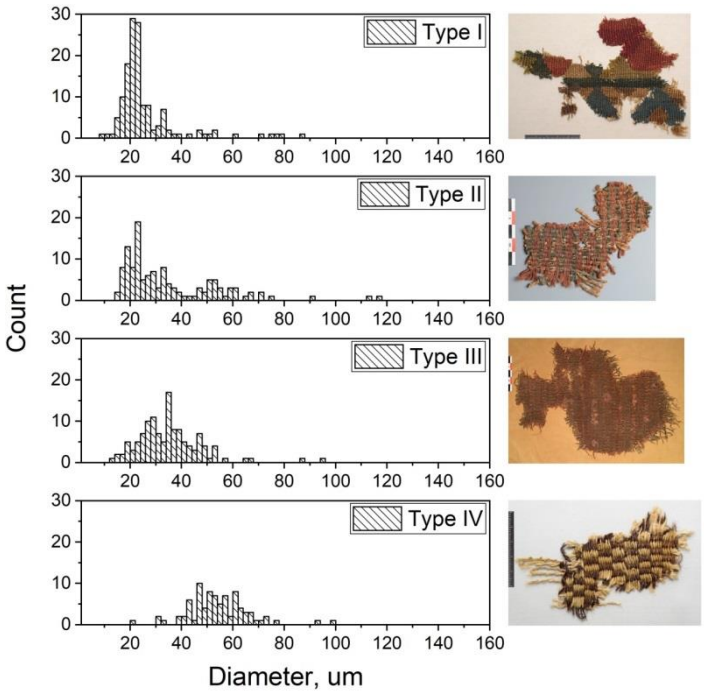
The paper presents the results of the investigation of the production technology and wool quality of nine carpets of four types from the Moshchevaya Balka and Podorvannaya Balka cemeteries in Karachay-Cherkess Republic, north-western Caucasus, Russia. The wool quality measurements of more than 100 fibers were carried out using FEI Versa 3D scanning electron microscope. The weaving and spinning technique and presence of dyes were studied using ultraviolet and infrared photography as well as reflection transformation imaging. For three wool samples AMS dates were obtained covering an interval from the early 8th to the middle 10th century. At this time the northern part of the Silk Road went through this region and trade goods from the West and the East are found in the burials. For burial rituals Alans used a variety of both locally produced and imported wool carpets differing in wool quality and production technology.

The Type I carpets are made of high-quality wool with a low mean and standard deviation values for fiber thickness that is typical for regions with a developed tradition of wool manufacturing like Syria or Egypt. The assortment according to Rast-Eicher varies from AB to D. For polychrome cut-pile carpets (Type II) they used wool of mixed type containing fine fibers, hair and coarse wool were used. The mean and standard deviation values are higher than in Type I, the assortment varies between CD and E. Red colored carpets with cut-pile bands (Type III) are produced from medium quality wool. The typical assortment is D. Although, quality of the wool could have been significantly increased to B-CD by sorting of coarse fibers, that was not done. Local carpets (Type IV) were made of poor quality light and brown wool with assortment E-F and lower. The light fibers were used for dyeing using unstable dyes, while the dark ones were not dyed. The quality of both light and dark fibers varies considerably, even within one item. The wool of local sheep breeds contains large amounts of coarse fibers (in some up to 100%) with a specific distribution. We suggest that this wool was not cut using sheep shears but collected by plucking. Alternatively, coarse goat hairs were used. Both practices are known at the Caucasus and are described in ethnographic records.

This study was supported by the Russian Foundation for Basic Research Project 17-01-00406.



Histograms of the fibers diameter distribution of four types of wool carpets from Alans burials of the 8th-10th centuries.

Behind the Colours: The Historical and Chemical Investigation of Dyes in High Status Chinese Costume and Textiles of the Ming and Qing Dynasties (1368-1911)

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This research pioneers the multi-perspective exploration of dyes in high-status costume and textiles of the Ming and Qing Dynasties using a dual methodological approach of history and chemistry. First, four important historical manuscripts of dye recipes of the Ming and Qing Dynasties were studied for documented evidence of dye sources and dyeing techniques of colour creation in these periods. Then, dyed references made with twenty-two relevant Chinese dyes of assured botanical provenance were analysed by ultra high performance liquid chromatography coupled to a photodiode array detector and mass spectrometer (UHPLC-PDA-MS) to profile the characteristic chemical composition of each dye.

The UHPLC-PDA-MS analytical results provided a unique and reliable reference database to identify dyes in yarns sampled from fifty-one pieces of high-status historical and archaeological textiles of the Ming and Qing Dynasties from eleven collections in China, the UK and Ireland. Dye sources identified in the textiles by chemical analysis were then compared with the four important historical manuscripts of dye recipes to combine material and documentary evidence from primary sources.

This dual methodology research approach gives confidence that just nine natural dyes were common for Ming and Qing Dynasties textiles, and were used according to specific rules to obtain various shades. Synthetic dyes were evident from the late 19th century. These outcomes further the understanding of Chinese textiles and their origin, ownership, date, colour and dyeing methods and inform the role of dyeing in social and global contexts.

Textile dyes commonly used in the Ming and Qing Dynasties, China, and corresponding dyed silk. From left to right, top to bottom: safflower, sappanwood, turmeric, smoketree, pagoda bod, Chinese cork tree, indigo, acorn cup and Chinese gallnut.

Conserving and Displaying Textiles from the Stein Collection at The British Museum: Sakyamuni Preaching on Vulture Peak

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In 1900 a sealed cave filled with scrolls, textiles and other temple objects was discovered at the Buddhist cave temple site of Qian Fo Dong near Dunhuang in Western China. Amongst the items was one of the largest and most complete Buddhist embroideries surviving from the Tang dynasty (618-907 AD). Having been carefully packed away and protected from light for nearly 800 years, the extent of preservation was remarkable. Now known as *Sakyamuni Preaching on Vulture Peak*, the embroidery was brought to the British Museum by the archaeologist Sir Aurel Stein following his second expedition to sites along the Silk Road in 1906-8. At some point before 1914 the embroidery was stitched to a linen backing and mounted on a wooden stretcher. For prolonged periods during most of the early and mid-20th century it was on display in the museum galleries, but has remained largely in storage for the last 40 years. Numerous requests for the loan of the embroidery led to a thorough condition assessment which concluded that the previous treatment, now over a hundred years old, no longer provided adequate support for the textile to travel safely.

Major conservation work was carried out in 2017. The previous restoration backing and support stitching was removed and a new stitched support applied; the wooden stretcher was replaced with a lightweight yet solid support board. Examination of the previous restoration materials showed the fibres to be severely degraded, underpinning the decision to undertake this interventive treatment.

The project provided numerous opportunities for conservators and scientists to collaborate in their investigations into the materiality of the embroidery*. With the hours of close observation required by the treatment, conservators noted details of stitching techniques, underdrawings, trace remains of additional ornamentation and the full extent of historic repairs. Examination under UV light revealed differences in the now-faded dyed embroidery threads, whilst temporary access to the reverse of the embroidery clearly showed the extent of the loss of colour to the front. Collaborating with scientists to identify dyes, and understand their relative light sensitivities, increasingly aids conservators in making decisions regarding recommended light levels and exposure time limits for the display of this and other textiles from the museum's Stein collection.

A detail of Rhand bodhisattva during cleaning of *Sakyamuni Preaching on Vulture Peak.* © The Trustees of the British Museum

The Use of Dyes in Archaeological Textiles of Mogao Grottoes

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The identification of dyes in twenty-five pieces of archaeological textiles, which were discovered in Cave 130 and 122 (Tang dynasty, the 8th century), and the northern area of the Mogao Grottoes (Yuan dynasty, from the 14th century) by archaeologists of the Dunhuang Academy, was carried out by fibre optic reflectance spectroscopy (FORS) and high performance liquid chromatography coupled with ion trap mass spectrometry (HPLC-MS).

FORS examination shows that cork tree, gromwell, madder and indigo were used to dye some of these textiles. The further analysis of dyes was performed to pinpoint the plant sources of natural dyes by HPLC-MS, suggesting that safflower (*Carthamus tinctorius*), sappanwood (*Caesalpinia sappan*), two madder-type plants (*Rubia tinctorum* and *Rubia cordifolia*) and an unknown red dye were used for dyeing red, whereas pagoda tree (*Sophora japonica*), young fustic (*Cotinus coggygria*), grape leaves (*Vitis vinifera*) and huangjing (*Vitex negundo*) were used for dyeing yellow. The latter two yellow dyes have not been reported in Chinese archaeological textiles in previous studies. Ellagic acid, with a small amount of quercetin-O-rhaminoside, was detected in brown textiles, indicating that a tannin-type dye, such as pomegranate (*Punica granatum*), was probably used.

In this presentation, dye analysis of archaeological textiles unearthed in Xinjiang is also briefly included. Some interesting findings are presented here, in particular the identification of insect-based dyes, such as kermes and Polish cochineal, identified in the red yarns of pre-historical textiles of Xinjiang.

The results of our studies suggest that Mogao Grottoes textiles were mostly dyed with Chinese dyes, some of which were obtained from local areas during Tang and Yuan dynasties. However, foreign dyes have been exported to Xinjiang since at least the 3rd century BC. On the other hand, identification of natural dyes on the Silk Road allows textile conservators to select correct materials to repair damaged objects and exhibit them in the galleries safely.

Madder, sppanwood, Amur cork, indigo and Huangjing (Vitex negundo) were identified in the dyed silk banner (collection No. K130: 1), which was unearthed from Cave 130 of Mogao Grottoes.

Investigating Asian colourants in textiles from Dunhuang in the British Museum's collection

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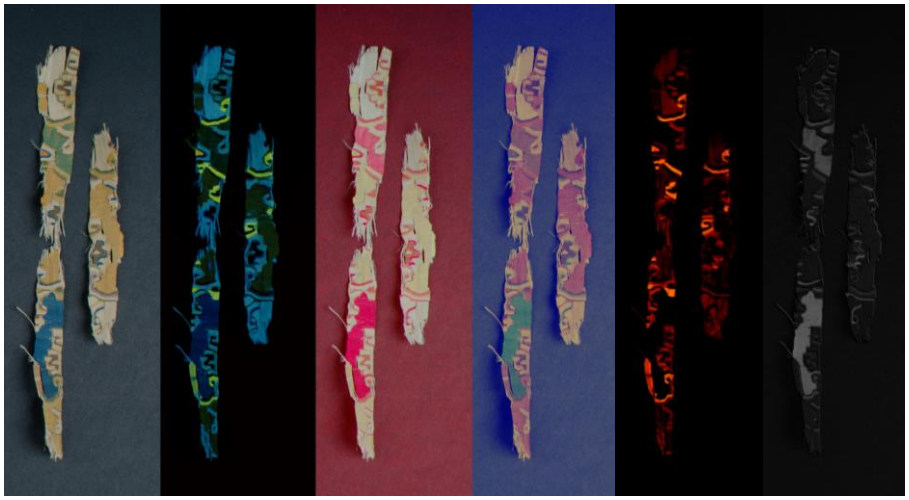
The archaeological complex of Dunhuang is considered a pearl on the Silk Road and the content of 'Cave 17' revolutionised oriental studies. Sealed from the beginning of the 11th century, the cave contained documents, mural and silk paintings and textiles spanning the 6th to the 11th century. These attracted the interest of scholars and archaeologists from around the world. Among them was Sir Aurel Stein who acquired many objects and brought them to the UK in the early 1900s. The textiles, which initially received less attention, consisted of canopies, banners, sutra covers and wrappers, polychrome and monochrome woven silk, clamp-resist dyed silk and embroidered silk.

Scientific investigations of the Dunhuang textiles were largely absent and for this reason a project was started at the British Museum (BM) with the aim of identifying the dye palette used to obtain the remarkable array of colours. Consequently twenty-eight reference specimens of Asian dyes were sourced including unusual materials such as rosewood, rhubarb, dragon's blood, gamboge, violet, *etc*. Silk was dyed following ancient recipes and the reference samples were analysed using colorimetry, multispectral imaging (MSI), fibre optic reflectance spectroscopy (FORS) and high pressure liquid chromatography mass spectrometry (HPLC-MS). All analyses were also repeated on the samples after artificial ageing. A large database of tandem mass spectra of dye molecules was created. Because of the nature of the chosen sources, all classes of organic colourants were included in the database, *i.e.* anthraquinones, naphthoquinones, flavonoids, neoflavonoids, proto-berberines, chalcones, xanthenes, polyphenols, *etc*. Some of the mass spectra are presented here for the first time.

Finally, the HPLC method was used to identify the dyes used in several Dunhuang textiles in the BM collection, including the famous embroidery 'Sakyamuni Preaching on Vulture Peak', one of the largest known embroideries from the Tang dynasty period (618-907 AD). These analyses shed light on most of the dye sources used (safflower, madder, sappanwood, gromwell, berberines, tannins, indigo, *etc.*). They also highlighted the difficulties of identifying some unknown molecules and provided new insights and comparative data on the technologies and skills of Chinese people in the Tang dynasty.



Multispectral images of textile MAS.906-ab from Dunhuang in the British Museum collection. © The Trustees of the British Museum

Identification of silks by protein mass spectrometry

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Bombyx mori is the only completely domesticated species that is commonly known as Chinese silk. There are also a variety of wild silk (non- or semi-domesticated) species of *Saturniidae* family, which have been commercially exploited in Asia and Africa from ancient times, prior to the introduction of domesticated silk [1]. The identification of silks from the archaeological sources has been a controversial subject [2], largely owing to the limitations in conventional methods of fibre analysis that cannot accommodate species-level identification of protein fibres. The techniques of proteomics could elucidate this matter, as it has been already adopted in the analysis of archaeological fibres of mammalian origin [3]. However, due to the difficult nature of the fibroins compare to other fibrous proteins, the subject has been rarely studied and thus a reference database had to be established first.

We have developed a protocol to solubilise modern and archaeological silks and identify their peptide sequences conventional proteomics by high-resolution LC-MS/MS. Seven different species of *Bombyx, Antheraea* and *Samia* silks were solubilised and enzymatically digested, and analysed by nanoLC-MS/MS. The experimental data were de novo analysed using PEAKS software and a silk database consolidated from UniProtKB and NCBInr. The MS/MS results were de novo analysed using PEAKS software using a silk database consolidated from the experimental and computational protein sequences. The results showed that some of the unique amino acid sequences of each fibroin were successfully captured, enabling the species to be differentiated from one another and identified. Further works to examine a range of archaeological silk samples to understand the application limit and profile the degradation mechanism is ongoing, and update from these analyses will also be presented.

[1] Jolly *et al.*(1979) *Non-mulberry silks*, FAO Agricultural Service Bulletin: Rome

[2] Jorgensen, L.B. (2013) Antiquity, 87, 581-88.

[3] Buckley *et al.* (2014) *Journal of Archaeological Science,* 41**,** 631-41; Hollemeyer *et al.* (2008) *Rapid Comm. Mass Spec.,* 22**,** 2751-67; Hollemeyer *et al.* (2012). *Rapid Comm. Mass Spec.,* 26**,** 1735-45; Solazzo *et al*. (2011) Antiquity, 85, 1418-32.

Proteomics characterization of organic metal threads

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The introduction of proteomics to archaeological proteins has brought a new set of techniques to characterize protein fibers and address issues such as techniques of fabrication of textiles and degradation of protein fibers. Recently applied to metal threads, a method for small scale sample extraction and nano liquid chromatography Orbitrap tandem mass spectrometry (nanoLC-Orbitrap MS/MS) analysis was developed to identify the protein substrate of a metal-wrapped thread from a 14th century Italian textile [1].
Organic metal threads were made with an organic substrate, either cellulosic (paper) or proteinaceous (leather, parchment or membranous tissues, often the stomach or intestinal walls of animals) and were a common variety of metal thread in textiles until the 15-16th c. The metal (most frequently gold, silver or alloys) was applied on the organic substrate using either an additional adhesive (bole, glue, gum, or eggs) or the natural exudates of the substrate. Tests on membrane standards using proteomics have determined that collagen peptides were the best markers to identify the animal species of origin, while tissue specific proteins, such as smooth muscle proteins detected in gut tissues, could be used to distinguish between membrane and skin types. Egg or other proteins can also be detected alongside the substrate if used as a binding material [1].
An extensive program for the characterization of membrane metal threads in medieval textiles is being developed at the Museum Conservation Institute. The study of proteinaceous metal threads constitute a very wide topic as the threads were made and/or used in many localities, from Europe to the Middle East, to Central and East Asia. Current results on the proteomics analysis of organic metal threads and applications to Asian textiles will be presented.

Leather metal thread from textile 1862:16, Stralsund Museum, Central Asia or Northern China, 14th century. Image acquired with HIROX KH-8700 3D digital microscope (Hirox-USA, Inc., N.J.), Smithsonian Museum Conservation Institute.

[1] A.K. Popowich, T.P. Cleland, C. Solazzo, Characterization of membrane metal threads by proteomics and analysis of a 14th c. thread from an Italian textile, Journal of Cultural Heritage (2018), in press.

Silk, wild silk and half silk textiles from Palmyra - New scientific approaches

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Silk textiles found in the tower tombs of Palmyra range among the first silk items found in the Roman Empire. Most of these silks are cleary identifyed by translucent fibre microscopy as *Bombyx mori* specimens. However, already Rodolf Pfister pointed out in his first publication about the textiles from Palmyra in 1934 that some of the silk fragments might be imported from India being woven from other silk species *i.e.* fibres produced by different types of butterflies. A third group of silk products highly esteemed in the Roman Empire are so called “half silks“. These products are mentioned by different Roman authors. A few items woven with a silk warp and a woollen weft have been brought to light in Palmyra as well.

A new approach to identify these fibres has been started by the authors in 2018. Considering the fact that extremely few of the original material was available, research methods are limited to micro samples. The paper will present first results using digital microscopy and SEM for longitudinal and cross-section imaging of the fibre, and mass spectrometry for peptide sequencing for species identification.

Balm, traces of silver and unusually behaving indigo dyes on a group of Liao dynasty textiles

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The Abegg-Stiftung owns a collection of Liao Dynasty (907-1125) silk textiles. Among these textiles, a group of costumes and accessories show similarities like same fabrics or decorative elements, the same colour scheme in red and blue, and similar conservation problems. The exact origin is unknown but all items obviously derive from one tomb. The group consists of 13 multi-layered and padded objects: two robes, a jacket, two trousers, two skirts, boots, a headdress, two large ribbons, a pillow and a coverlet. The garments consist of either patterned, both side weft faced samites or complex gauzes with silk embroidery, some with outlines of gild paper thread. All objects have silk paddings and linings. There are balm stains randomly spread in and on all items. The conservation workshop of the Abegg-Stiftung conserved the objects, and in 2007 presented them in a special exhibition.

The conservation problems like consolidation of the gilded hemp paper threads and lacunas within the hardened balm stains were solved. However, there are still open questions asking for further investigation: for example why are these balm stains there at all? For ritual reasons? For practical reasons as pesticide?

Further phenomena present on several medieval Asian textiles in the collection, as well, are on the one hand stains of silver on silk fabrics. How does the silver migrate onto the silk fabrics? On the other hand, the indigo dyed silk threads (weft and embroidery threads) cause within a few days yellowing of cellulosic material, such as silk tissue or blotting paper, when in direct contact with them. Questions to be answered are: Does material degradation or the migration of a component of the dyestuff cause the yellowing of the paper? Are both phenomena documents of special Asian production techniques or care for these precious items? Are these phenomena known in other institutions housing Asian textiles? Are there or have there been attempts to research these topics?

Some analyses on the Abegg-Stiftung's objects took place already: the silver was analysed in 2005 by Susanne Greiff at the Römisch-Germanisches Zentralmuseum, Mainz (G) per EDAX analyses. The analyses of the indigo phenomenon took place in 2003 together with Steven Saverwyns at the KIK/IRPA, Brussels (B) by GC-MS of yellowed paper and reference material. The interpretation of the results in respect to the raised question is still missing though.

Detail of the Liao headdress: left wing from the inner side. Losses in the paper gold embroidery of the dragon and clouds motif. Balm stains along the upper and right edge causing discoloration and loss of silk fabrics. (A. Bayer, Abegg-Stiftung 2006)

Fibre and dyestuff analyses on clothes and accessories from Eastern Central Asia archaeological sites

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Textiles and leather objects with colourful decorations from the archaeological sites of Sampula, Niya, Wupu, Yanghai and Aisikexia'er, situated in the Xinjiang Uyghur Autonomous Region (China), having been analysed by microscopic, spectroscopic, chromatographic and mass spectrometric techniques with regard to the utilized fibre materials and colorants. These studies were performed within the framework of the interdisciplinary Chinese-German research project “Silk Road Fashion: Clothes as a means of communication in the 1st millennium BCE in Eastern Central Asia” [1]. Examined finding sites cover a time span from the end of the 2nd millennium BCE to the 2nd or even 3rd century CE, dating the oldest investigated textile find to 1261 - 1041 cal. BC (with a 95% confidence) [2, 3].

Our aim was to preserve the integrity of the precious objects as far as possible. Thus, non-destructive or minimally invasive techniques were preferred – for instance SEM, SEM-EDX, Raman, IR in ATR mode and diffuse UV–Vis reflectance spectroscopy as well as ambient MS techniques such as ASAP-MS or Flowprobe-ESI-HRMS.

For textile production and dyeing wool, silk and plant-based fibres as well as flavonoid-, indigoid- and anthraquinone-type dyes, obtained from different plants or from scale insects, have been used. Analyses on red and black decorations of leather objects point out that cinnabar and carbon-based black pigments have been exploited for the colourful design.

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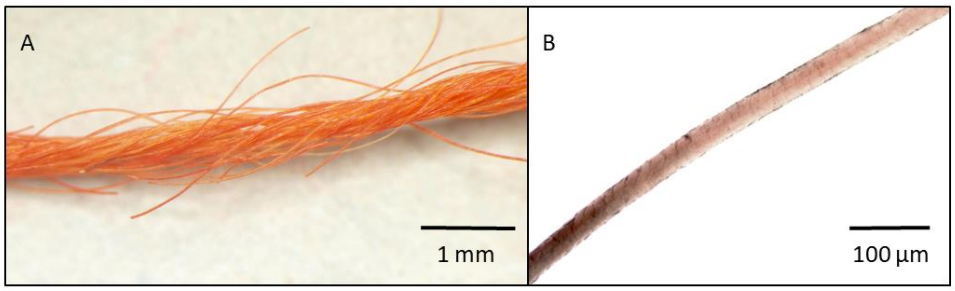

(A) Investigated woolen yarn from a tassel most likely colored with root material originating from plants of the genus Rubia (tomb M157, finding site of Yanghai, Xinjiang, China); (B) optical image of a related fiber showing a scale structure typical for wool.

1. DLR Projektträger: *Silk Road Fashion - Kleidung als Kommunikationsmittel im 1. Jahrtausend v. Chr. in Ostzentralasien* (http://pt-dlr-gsk.de/de/1171.php, 21.05.2018).
2. Kramell, A.; Li, X.; Csuk, R.; Wagner, M.; Goslar, T.; Tarasov, P. E.; Kreusel, N.; Kluge, R. and Wunderlich, C.-H. *Quat. Int.*, **2014**, *348*, 214-223.
3. Kramell, A. E.; Wertmann, P.; Hosner, D.; Kluge, R.; Oehler, F.; Wunderlich, C.-H.; Tarasov, P. E.; Wagner, M. and Csuk, R. *J. Archaeol. Sci. Reports*, **2016**, *10*, 464-473.

Extending the Silk Road to Nepal: Scientific investigations of textiles from Samdzong (5th-7th centuries CE)

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The poster presents the results of textile and dye analyses of cloth remains recovered in Samdzong, Upper Mustang, Nepal. The site consists of ten shaft tombs, dated between the 400-650 CE, cut into a high cliff face at an elevation of 4000 m asl. The dry climate and high altitude favoured the exceptional preservation of organic materials. Digital microscopy, SEM and HPLC-DAD were used to analyse the textile finds. One of the objects recovered from the elite Samdzong 5 tomb complex is composed of wool fabrics to which copper, glass and cloth beads are attached and probably constitutes the remains of a complex decorative headwear, which may have been attached to a gold/silver mask. Two of the textiles are made of degummed silk. There is no evidence for local silk production suggesting that Samdzong was inserted into the long-distance trade network of the Silk Road. Dye analysis permitted identification of a variety of organic dyes, including Indian lac, munjeet, turmeric and knotweed/indigo, as well as inorganic pigment cinnabar. The results indicate that locally produced materials were used in combination with those likely imported from afar, including China and India.

Silk fragment with traces of cinnabar from Samdzong, Nepal

Swastika, a transcultural sign of textile ornamentation between the East and West

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Swastika is a pan-Indian auspicious symbol, whose cruciform is traceable to seals from the Indus civilization. Subsequently, foot-mark of the Buddha called *buddhapāda* was decorated with swastikas and lotus blooms. A wall painting from Khotan, a silk-producing district of the Tarim Basin, represents a bodhisatva's garment decorated with roundels whose main motif is swastika (National Museum, New Delhi). For silk textiles, swastika was patterned with flora and fauna or geometric compositions and reproduced in various forms such as batik, clamp-resist dyed plain weave, samite, and gauze as best exemplified by discoveries from Dunhuang and Astana cemeteries in the Tarim Basin (National Museum; British Museum; Victoria and Albert Museum; Musée Guimet). Their techniques followed either Indian or Chinese traditions.

Of special interest are the Dunhuang gauzes decorated with elaborate lattice patterns, whose diagonal frames consist of a series of swastikas. Parallel composites were woven in figured silks such as samite used as trimmings of woollen robe and stole unearthed from Christian necropolis in Antinoöpolis on the Nile; at least six variants of rhombus=swastika composites were documented (once held by Berlin Kunstgewerbemuseum, but lost during the war). This parallelism is noteworthy since late Roman woollen tunics from Egypt and Nubia were occasionally decorated with merely single swastikas. Presumably, these composites were redesigned from foreign textiles imported from Central Asia and China (for other motifs, see Kosuke Goto, "The Jewelled Lotus: on the sources of ornamental patterns woven in silk samite," *Indo-Asiatische Zeitschrift*, 19, Berlin, 2015, p. 67–76; ibid., "The Celestial Lotus: on the sources of ornamental patterns woven in silk samite," in *Textiles of the Silk Road. Design and Decorative Techniques: From Far East to Europe*, Warsaw, 2016, p. 105-118). Antinoöpolis was connected to Roman seaports on the western coasts of the Red Sea, which harboured ships towards India. This kind of silk samite circulated among Christian communities from the eastern Mediterranean basin to the Latin West. One from a reliquary in the Sens cathedral is woven with rhombus=swastika composites.

Such transcultural strands are indispensable factors to configure the scope of analysis since localization and dating of silk weaving are not established in a definite way. When concrete evidence of production is not given, figured silks should be illuminated from a broad perspective of the Silk Road. One can observe how foreign elements were materialized in weaving; hereafter local characteristics will be clarified.

Drawing showing an ornamental pattern of silk gauze from 'Thousand Buddhas' (Sir Marc Aurel Stein, *Serinda*, Oxford, 1921, IV, pl. CXX).

Scientific Analysis and Technical Study of Three Ancient Egyptian Textiles from the Tomb of Hatnofer and Ramose, Western Thebes, New Kingdom, Dynasty 18, 1550-1295 B.C.

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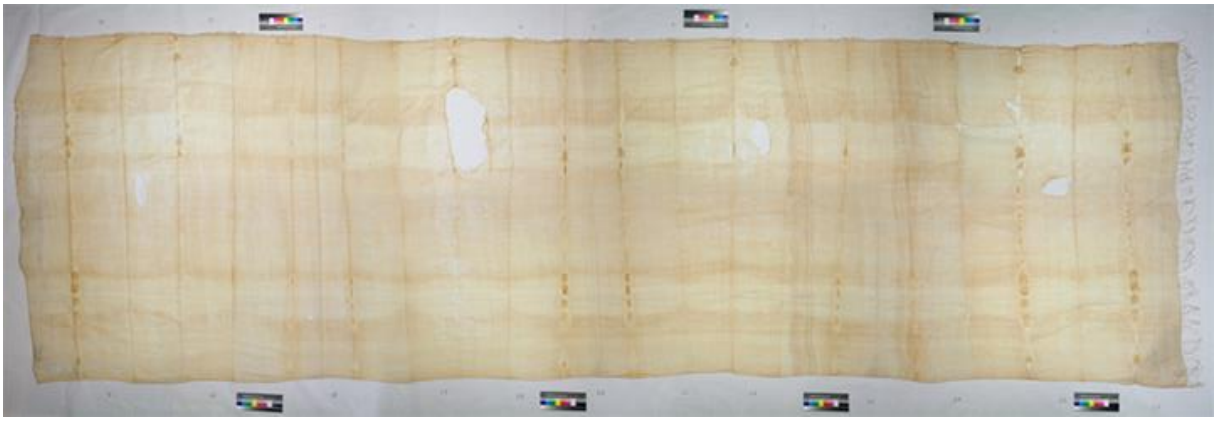
An Egyptian archaeological textile, accessioned in the American Museum of Natural History, Catalog No. 95/2444, from the Tomb of Hatnofer and Ramose, Eighteenth Dynasty (1550-1295 B.C.), Western Thebes was studied along with two other textiles from the same tomb used as comparanda. The Tomb of Hatnofer and Ramose was found intact on January 11, 1936 during a 1935-1936 Egyptian expedition which excavated a hillside in Western Thebes (TT 71) led by William Hayes and Ambrose Lansing of the Egyptian Department at the Metropolitan Museum of Art.

The textile's finely spun fibers, plain-weave balanced structure with selvage fringes and lower edge fringes, and with various weaver's marks, stains, and losses, provide invaluable historical data about finely woven, royal linens of Eighteenth Dynasty Egypt.

The collection is of particular interest; it belonged to a known person from the Eighteenth Dynasty, Hatnofer, who was the mother of Senenmut, one of the most powerful government officials in the reign of the female Queen Pharaoh Hatshepsut. Hatnofer's tomb cache informs us about burials, burial cloths and garments belonging to a prestigious, but not royal, class during a period of extraordinary political and cultural development and achievement for Egypt and for Egyptian women, in particular. During the reign of Queen Pharaoh Hatshepsut, Egypt saw much international expansion with new trade routes. During this important period of Egyptian history, textile production profited immensely from commercial trade, cultural exchange, and growth.

Scientific analysis used for this study include: visual annotations, polarized light microscopy, scanning electron microscopy (including fiber diameter measurements), and carbon-14 dating. Closely examining a textile and its fibers can provide information about the condition of the textile, linen quality, weaving techniques, and the life of the textile itself. While the linen fibers in the Study Textile (Catalog No. 95/2444) and the Comparanda Textile #1 (Catalog No. 95/2443) have been identified, it is still uncertain whether or not the fibers in the Comparanda Textile #2 (Catalog No. 95/2445) are of a different quality linen or of a different plant material which is very similar to linen within the bast fiber family. Further studies would be required to answer this and several other questions that remain.



Dynastic Egyptian textile from the tomb of Hatnofer, Catalogue No. 95/2444 in the American Museum of Natural History collection

Looting of burial sites discovers and challenges conservation of Medieval silk textiles of Mongolian provenance

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Recent textile finds in the nation of Mongolia affirm that people in the northern region were connected to the dynamic East-West silk trade in the medieval period. As Mongolian localities feature seldom in discussions of Silk Road textiles, these carry the potential to enrich our understanding and enjoyment of the collective, transcontinental textile arts portfolio relative to the Mongol conquest. The techniques, materials, and motifs that present— *k'o-ssu*, gold threads, swastikas, and pseudo-Kufic inscriptions, to name a few—raise interesting questions about cultural relationships and commerce. Importantly, they also show from a local perspective how Mongols visually communicated identity; extant descriptions and representations derive from non-Mongol observers.

Unfortunately, it is the looting of burial sites that has lent impetus to the discovery of these textiles. As an example, in July 2017, our team encountered the destruction of a medieval cemetery composed of forty graves. This left us scrambling to recover fragments grave robbers left behind. Climate, geography, the remote location, transportation logistics, and the nascent conservation scene further complicate transfer of the textiles to the museum in Ulaanbaatar. Once there, the issue is compounded by limited conservation resources to stabilize and store these textiles.

Recently, we initiated a holistic approach to restore security of the resting places of the deceased, and to conserve the textiles. Our methods include building textile conservation know-how in the field and museum contexts; archaeological object collection methods and field data analysis; engagement of local nomadic herders; and raising international awareness. Since we are in the early stages, it's too early to evaluate the impact of our approach. Preliminary data show the extent of the looting. In rare instances, community members have relinquished looted silk robes to museum workers, but community engagement efforts may have also inspired more looting.

Nevertheless, documentation emerges as a high-yield conservation priority: archaeological documentation of provenance and context, and conservation examinations that record the textiles' appearance, materials, techniques, and condition. At minimum, systematic documentation will preserve and enable dissemination of the information these textiles hold. At best, it will inform future conservation strategies, and make the textiles available for exhibition and analyses that explore questions for the benefit of humankind. It also evidences the rightful country of origin and the damaged condition of numerous unrecovered textiles that may soon surface via the international antiquities black market.

This textile embellished with gold threads poses unique conservation challenges: It is one of several that NOMAD Science collaborators recovered by sifting moist burial matrices at a looted medieval cemetery in north-central Mongolia. Photo credit: Bayarsaikhan Jamsranjav, National Museum of Mongolia, 2018.

Central Asia textiles in Western collections: two cases studies from San Isidoro Museum (Leon, Spain) and the Victoria and Albert Museum of London

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The silk textiles were one of the most expensive goods in Europe from Antiquity. Many have survived as part of the medieval treasuries in different cathedrals and churches. From the 19th century, they were considered a valuable object for collectors and museums, due to its historical importance, rare materials and early chronology.

The study of these fragile remnants has increased its knowledge through the characterisation of raw materials (fibres and dyes), textile techniques and chronology (through radiocarbon dates).

The poster will present the new data from two case studies. Firstly, two textiles, preserved in the Medieval treasury of San Isidoro of Leon and the Cathedral of Leon (Spain). These textiles are the first ones classified as Central Asian, possibly from Transoxiana or Sogdiana in Spanish collections. Both have been characterised (fibres and dyes), textile technique identified as a compound twill and one has been dated by 14C, between 773-960 cal. AD (Beta – 462331: 1160 ± 30 BP).

The textile in San Isidoro´s Museum is lining the silver casket with the relics of Saint Isidore (c. 560-636 AD). He was Bishop of Seville and is considered one of the Fathers of the Catholic church. In the 11th century, his remains were sent to Leon, by the Muslim king of Seville, as a present for the new kings of Leon. The second textile was found in a tomb in the Cathedral and is linked with the one at Saint Isidore´s casket.

The second case presents an assembly of fragments, one at the Victoria and Albert Museum (London). The fragments are possibly from the same textile and scattered among different European museums. In this case, the textiles are classified differently by the museums, and only the fragment at the Royal Museum of Brussels has been characterised.

The textiles have been classified as Central Asian textiles from 7th to 10th century, the 14C and dyes analyses open questions of these silks, its classification and how the results from dyes analyses, textiles technique and 14C can help to contextualise these fabrics.

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Detail of the textile from San Isidoro´s silver casket (Museo de San Isidoro, León. Photo: Ana Cabrera)

Ancient Textiles Unearthed from the Tombs of the Turkic period in Mongolia

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In this paper, I will show the results of my investigation on techniques and materials of the textiles from the Turkic period (7th century) in Mongolia. The textiles concerned here were found from two Tang style tombs, namely Ulaan Kherem and Zaamar. The tombs presumably belong to the Turkic Allies of the Tang Empire. It is rare to find textiles of the Turkic period in this area. In this presentation, I will report the results of my study aimed to investigate material properties and techniques.

The two Tang style tombs concerned here are located about 170km west of Ulaanbaatar, along the river Tuul. Ulaan kherem tomb has a wall painting approximately dated to the 7th century CE. The date of Zaamar tomb has been identified as 678 year CE, due to the epitaph discovered from the tomb. The textiles presented in this paper were unearthed in 2009 and 2011, and were not previously investigated. These fabrics were used for clothing of the buried bodies, bags and clothes of wooden dolls.

The side and section of fibers were identified by scanning electron microscope. Furthermore, material properties were identified by applying qualitative analysis with the help of energy-dispersive X-ray fluorescence analysis.

As a result of this investigation, I have identified plain weave(平織), twill weave(綾織), warp faces compound twill (綾組織経錦), weft faces compound twill (綾組織緯錦), complex gauze(羅織), gold sticking(印金), and animal fur. And I have also identified the textiles produced in China, Western regions and local regions. Among these, it has become clear that the warp faces compound twill were identical to those found in Tajikistan (Mug Mountain), Tarim Basin (Astana), and Shosoin in Japan. Furthermore, two weft faces compound twill showed the same pattern as the western region textiles excavated from the Tarim Basin (Astana). In addition, I speculated that one of the weft faces compound twill and gold sticking has regional characteristics and it is presumably produced in the surrounding areas of China.

According to these results, we can observe the deep cultural relationship between ancient Mongolia and other regions. All the fabrics found from the tombs were silk. And as a result of studying the animal fur with scanning electron microscope, I have found out that the fur might be of a fox. Furthermore, as a result of analyzing the decoration (gold sticking) using a X-ray fluorescence spectrometers, I have identified that a small amount of silver (Ag) was added to gold (Au). The materials were preserved in a poor condition, therefore, I have placed them into a special container with neutral paper in order to keep them safely.

Warp faces compound twill