

**A TECHNICAL STUDY OF PORTABLE  
TENTH-CENTURY PAINTINGS FROM  
DUNHUANG IN US COLLECTIONS**

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在美收藏十世紀可携式  
敦煌繪畫的科技研究

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# Abstract

This study examines several of the only known extant examples of portable tenth-century Chinese Buddhist paintings from the Mogao Caves, near Dunhuang, People's Republic of China. Although extensive scientific research has been conducted on the wall murals, no comparable analysis has ever been undertaken on the paintings on silk and other textile supports from the Mogao Caves. The findings of this study expand on the established understanding of portable paintings from Dunhuang and identify further lines of enquiry in relation to the pigments, textiles and painting technologies associated with these objects. This study examines paintings in the collections of the Harvard Art Museums, the Museum of Fine Arts, Boston, and the Freer Gallery, Washington, DC, drawing on multiple analytical methods including XRF, FTIR, Raman, AMS, SEM, MALDI and polarizing light microscopy as the first comprehensive and systematic investigation of these important artworks.

# 1 Introduction

## 1.1 Project background

This research project was initiated at the request of Dr. Robert Mowry, Alan J. Dworsky Curator of Chinese Art and head of the Department of Asian Art at the Harvard Art Museums. As rare examples of the early Chinese Buddhist painting that survived within the Mogao Caves at Dunhuang, these two objects, *Maitreya's Paradise* and *Eleven-Headed Guanyin* (see **Figs. 1-2**, below), were chosen for display within the newly refurbished Harvard Art Museums building at 32 Quincy Street, due to re-open in 2013.

During an initial examination of *Eleven-Headed Guanyin* during the summer of 2009, Dr. Mowry noticed unusual and elaborate damask patterning in the upper portions of the blue silk mount material, leading him to question the long-held assumption that the mount was necessarily a recent (twentieth-century) addition. The possibility that the mount could be original to the painting itself, and therefore an example of the almost unknown Chinese mounting practices of the tenth century, provided this project's initial impetus.

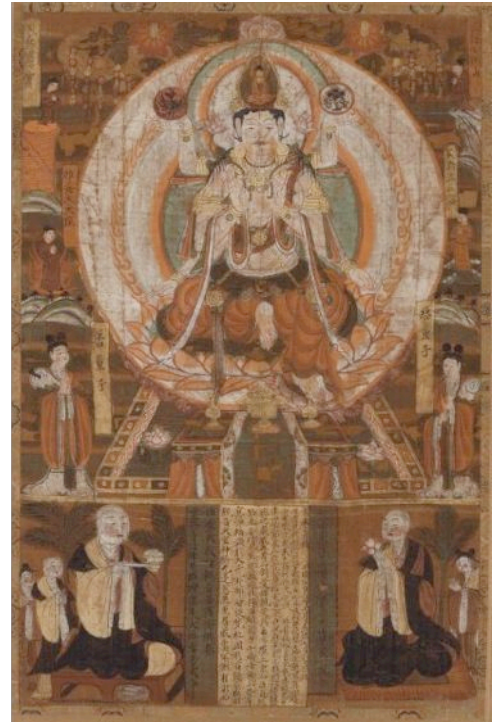


**Fig. 1** *Eleven-Headed Guanyin*, 985 CE.  
Painting on silk. 1943.57.14.



**Fig. 2** *Maitreya's Paradise*, 945 CE.  
Painting on ramie. 1943.54.1.

Following early consultation with colleagues at the Museum of Fine Arts, Boston, and the Freer Gallery, Washington, DC, the project quickly expanded to include an examination of three more portable paintings from Dunhuang, all dating to the tenth century. From the Museum of Fine Arts, *Guanyin as Savior from Perils* (Fig. 3, right) presented the opportunity for further analysis on a painting that had yet to be subjected to a technical examination. The Freer Gallery's *Guanyin of the Water Moon* and *Ksitigarhbha Bodhisattva* (Figs. 4-5, below) have been previously studied in detail, with pigment analysis, by Rutherford Gettens (1900-1974) after he moved from the Fogg Art Museum to the Freer Gallery in 1951.



**Fig. 3** *Guanyin as Savior from Perils*, 975 CE. Painting on silk. 27.570.



**Fig. 4** *Guanyin of the Water Moon*, 968 CE. Painting on silk. F1930.36.



**Fig. 5** *Ksitigarhbha Bodhisattva*, late 10<sup>th</sup> century. Painting on silk. F1935.11.

This technical study, however, expands on pigment analysis to explore two further aspects unique to these paintings: their associated textile supports and mounts, and the manner in which the two elements of paint and textile have come together within these objects to produce distinct styles of Buddhist painting in Chinese Central Asia. A study focusing on textiles and their accompanying painting technology has not previously been undertaken in relation to the portable paintings found at Dunhuang.

## 1.2 The Mogao Caves

In order to properly discuss these paintings and appreciate their significance, a brief outline of the history of the Mogao Caves and the preservation of the paintings at that site is necessary.

The town of Dunhuang, 15 miles from the site of the Mogao Caves, served as an important oasis on the Silk Road, the lengthy network of trade routes that connected Eastern Asia with Europe, from Chang'an (modern Xi'an) in the east to the Mediterranean in the west. Dunhuang's central position between the empires of China, Tibet and Central Asia allowed it to benefit from the fluidity of trade, culture, religion and politics in the region.

According to local legend, the first caves were cut at Mogao in 366 CE, and a process of continuous expansion continued at the site until the fifteenth century, by which time there were 492 cave temples decorated with elaborate murals. Among these many cave temples, one in particular, now designated Cave 17 (or the 'Library Cave'), was filled with manuscripts and paintings before being sealed off in the early eleventh century for reasons that have yet to be conclusively established, and its doorway filled in and painted over.<sup>1</sup>

The basis on which the eleventh century is chosen for the sealing of the cave has been based on the latest dated object found inside, a manuscript from 1002 CE. The earliest dated portable painting on textile to have been discovered there dates from 729 CE, though the majority were painted during the ninth and tenth centuries. Significantly, their timely movement to Cave 17 has produced the oldest surviving collection of Chinese Buddhist paintings on textiles in existence, the remainder presumably falling victim to the numerous political and religious upheavals throughout Buddhist Asia during the period of at least 800 years before Cave 17 was opened by the Taoist monk Wang Yuanlu in 1900 CE, and the first portable paintings dispersed.

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<sup>1</sup> For a thorough examination of the possible reasons for the existence of the 'Library Cave', see Rong, 'The nature of the Dunhuang Library Cave and the reason for its sealing', *Cahiers d'Extrême-Asie*, vol. 11, no. 11 (1999), 247-275.

### 1.3 Perspectives on portable paintings

Given the nature of this rich repository, it is somewhat curious to find that the portable paintings have not yet been the focus of any major technical research in their own right. Some answers may be found in reports on the Mogao Caves from early explorers in the region, and also from what we know about Western perspectives on Asian art from the beginning of the twentieth century. Examining these, it seems that there was a hierarchy at play: the priority was (and has remained) the cave murals themselves (understandably, as they, too, represent the best preserved examples of their kind); next, the manuscripts were the most important portable objects to emerge from Cave 17, prized for their historic and philological value; finally, the portable paintings were swept up with these manuscripts and other items.

This is perhaps best revealed by Paul Pelliot's journal,<sup>2</sup> which he kept throughout his stay at the Mogao Caves during the spring of 1908. Despite spending many pages discussing the finer points of the manuscripts he had procured, he barely mentions the portable paintings, and clearly gives them little real value. His journal entry from 14<sup>th</sup> May, 1908:

*Purchased 38 large paintings from the caves from Wang, for 200 taels, and some wood for a small sum. The paintings are interesting, but unfortunately they are all in the "usual style" of the tenth century, the most static and monotonous period at the caves.*<sup>3</sup>

It is important to remember that these early Western explorers were seeing these materials for the first time, and were primarily historians, archaeologists and geographers rather than art historians. Even then, they had little frame of reference save for European Renaissance and Classical traditions. When the German explorer Albert Von Le Coq (1869-1930) came across examples of Greek-influenced Gandharan art<sup>4</sup> while excavating at Kharakhoja (now in Xinjiang Autonomous Region), he noted that: "The drapery falls in noble lines, not yet degraded by Eastern Asiatic misunderstanding of classic forms."<sup>5</sup>

Furthermore, in these early days of interest in Asian cultures, Western collectors of Chinese art focused largely on objects, specifically the ancient bronzes and jades. It is therefore interesting to contrast these attitudes with those of the Chinese themselves, for in the earliest

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<sup>2</sup> Paul Pelliot (1878-1945) led the second major European expedition to the Mogao Caves in 1908, the year after Sir Aurel Stein's visit.

<sup>3</sup> "Achète au Wang tao 38 grandes peintures provenant de la grotte, pour 200 taëls, plus des bois pour une petite somme. Les peintures sont curieuses, mais malheureusement toutes du «style usuel» du X<sup>e</sup> siècle, de l'époque la plus figée et monotone des grottes." Pelliot, *Carnets de route*, (Paris: Les Indes savants, 2008), 294.

<sup>4</sup> The art of Gandhara, a Buddhist kingdom located in northern Pakistan and eastern Afghanistan until the eleventh century, displays a distinctive mixture of Greek, Persian, and Indian influences.

<sup>5</sup> Hopkirk, *Foreign Devils on the Silk Road* (London: John Murray, 1980), 122.



days of the discovery of Cave 17 around 1900, when the 'Library Cave' was known of only locally, it was the portable paintings that were prized and dispersed as gifts amongst the ruling elite in Gansu Province. Indeed, the transfer of portable paintings to Western collections may in itself have been a cause for the lack of attention paid to them, since despite the foundation of the Dunhuang Academy at Dunhuang in 1984 and their subsequent extensive study of the Mogao Caves site, no portable material remains for Chinese researchers to examine, confining them to relative obscurity in the West.

#### 1.4 Previous research

Previous research on portable paintings has indeed been limited and examination of the paintings for their own sake has been largely from an art historical perspective.

The strongest precedent for technical research on portable paintings from Dunhuang has been set by Rutherford Gettens, who, after carefully analyzing all of the less portable materials that Langdon Warner (1881-1955) managed to bring back to the Fogg Art Museum from Dunhuang in 1924,<sup>6</sup> later created detailed reports on the portable paintings *Guanyin of the Water Moon* and *Ksitigarhbha Bodhisattva* at the Freer Gallery. He also went on to examine portable paintings in the Stein Collection at the British Museum in the early 1970s with Elisabeth West FitzHugh, his colleague at the Freer Gallery.

FitzHugh's work in particular is representative of the previous research carried out on Dunhuang portable paintings. The focus has always remained on the pigments, with FitzHugh's findings contributing towards her chapters on red lead and orpiment in the *Artists' Pigments* publication series as examples of their usage around the world. Other research conducted over the years has merely served as an aside to art historical analysis (such as work carried out by an unknown 'technical chemist' for Arthur Waley's *A Catalogue of Paintings Recovered from Tun-Huang by Sir Aurel Stein* in 1931), or used limited analytical means (such as Suzy Delbourgo's use of x-ray fluorescence spectroscopy to identify pigments on paintings in the Pelliot Collection in 1980),<sup>7</sup> or, indeed, failed to report any analytical method at all (as in work carried out on the Pelliot Collection as recently as 1996).

Not counting the significant and related research on Dunhuang manuscripts and the Mogao Cave murals themselves, the instances listed above represent the entirety of technical research on Dunhuang portable paintings to date.

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<sup>6</sup> For an account of this expedition, see Warner, *The Long Old Road in China* (London: Arrowsmith, 1927).

<sup>7</sup> David Scott notes in his Getty publication *Copper and Bronze in Art* that Delbourgo's identification of atacamite and paratacamite cannot be relied upon since this analysis would only show the presence of copper and chlorine and would not be able to identify the necessary light green salts to confirm identification.

## 1.5 Current research questions

It therefore appears that there is significant scope for the exploration of some basic, yet critical themes in the examination of these paintings:

1. Since the paintings are portable, where have they come from and how were they used?
2. How were the paintings made?
3. What can be learned from their associated textile supports and mounts?
4. Are all the Dunhuang portable paintings in Western collections authentic?

## 1.6 A note on ethics

Anyone interested in the ethical conundrums surrounding Western collections from the Mogao Caves and China at large should firstly consult Sanchita Balachandran's excellent analysis of the First Fogg Expedition to China in her *Research into the Collecting and Conservation History of Chinese Wall Paintings from Dunhuang in the Harvard University Art Museums* (2004). For a wider understanding, James Hopkirk's *Foreign Devils on the Silk Road* (1980) is an excellent historical narrative of the Western expeditions to Chinese Central Asia, while James Cuno's *Who Owns Antiquity?* (2004) provides one current Western museum perspective.

## 2 Object identification

### 2.1 Provenance

Both of the paintings held by the Harvard Art Museums entered the collection as part of the Grenville L. Winthrop bequest of 1943. Winthrop (1864-1943), a Harvard graduate who collected art from many cultures and historical periods, had begun buying and studying Asian art by around the turn of the twentieth century and held a particular interest in China. He acquired both paintings from Kichijiro Tanaka at the New York office of the East Asian antiquities firm Yamanaka & Company; the “Buddhistic painting...from Tun Huang”, *Maitreya's Paradise*, was purchased on February 13<sup>th</sup>, 1933, and *Eleven-Headed Guanyin* reserved for purchase on July 28<sup>th</sup>, 1936.<sup>8</sup>

These paintings represent the only two Chinese paintings in Winthrop's large collection, which is dominated by jade and bronze. It appears that Langdon Warner, leader of the First and Second Fogg Expeditions to China as Fellow of the Fogg Museum for Research in Asia, encouraged the purchase of these items. Referring to *Maitreya's Paradise*, Warner advised: “I believe it to be an immensely important document as the date seems to correspond with A.D. 945 and the thing presumably comes from Tun Huang. I tried hard to get it for the Fogg but Dr. Ross<sup>9</sup> though much interested, could not help at the time and it was then extremely costly.”<sup>10</sup>

By October 1940, a letter from Mr. Tanaka to Winthrop reveals the paintings to already be held at the Fogg Art Museum: “...I visited with Mr. Warner and saw your paintings which are being well taken care of.... As I understood when I visited you, you have decided to let them have them for loan indefinitely, so that the tax can be avoided....”<sup>11</sup> They, along with four thousand other artworks, became part of the Fogg Art Museum's permanent collection after Winthrop's death on January 19<sup>th</sup>, 1943.

Of the three remaining paintings that complete this study, two more were also purchased through identical channels, via Mr. Tanaka at Yamanaka & Company's New York office. *Guanyin as Savior from Perils* at the Museum of Fine Arts, Boston, was purchased in 1927 and features an inscription on its reverse, written in 1907, stating that it had been discovered at Dunhuang in 1899 (that is, the approximate time that Cave 17 was opened by the Taoist priest Wang Yuanlu). This specimen was reportedly submitted to the viceroy of Lan-chou (Gansu

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<sup>8</sup> Grenville Winthrop's account books, Harvard Art Museums Archives.

<sup>9</sup> Dr. Denman Waldo Ross (1853-1935), Professor of Art at Harvard University and a trustee of the Museum of Fine Arts, Boston.

<sup>10</sup> Letter from Langdon Warner to Grenville Winthrop, December 7<sup>th</sup> (year unknown), Arthur M. Sackler Museum (Harvard Art Museums) curatorial files.

<sup>11</sup> Letter from Kichijiro Tanaka to Grenville Winthrop, October 30<sup>th</sup>, 1940. Grenville Winthrop papers, Harvard Art Museums Archives.

Province) before the cave was sealed again until 1907. The painting was then in the collection of Duan Fang (1862-1911), the Manchu governor of Zhili Province (now Hebei) and eminent antiquarian of the late Qing dynasty. As with each of the paintings purchased from Yamanaka & Company, it is unclear how the painting initially entered the collections of the Japanese firm.

While the Freer Gallery's paintings would eventually be purchased from separate dealers, both *Guanyin of the Water Moon* and *Ksitigarbha Bodhisattva* were in 1904 sent by Dunhuang magistrate Wang Zhongan to Ye Changchi (1849-1917), who was education minister for Gansu Province at that time.<sup>12</sup> Holding their respective offices from 1902 to 1906, they knew of the discovery of Cave 17 nearby, where it was reported by Wang Zhongan that many individuals, including local officials and their staff members, had removed numerous paintings and manuscripts. It seems that both paintings remained together until at least 1925, first being obtained by the collector Jiang Ruzao (1876-1954) after Ye Changchi's death in 1917, and subsequently sold by him to persons unknown. It may be noted that, while in Jiang Ruzao's collection, the future Freer Gallery paintings became the first portable paintings to be published in 1919,<sup>13</sup> before being published once again in 1923 after examination by Wang Guowei (1877-1927).<sup>14</sup> *Guanyin of the Water Moon* was purchased by the Freer Gallery from Yamanaka & Company's New York office in 1930 and *Ksitigarbha Bodhisattva* from Tonying & Company, New York, in 1935.<sup>15</sup>

## 2.2 A note on forgeries

Within the research aims of this project, the need is identified to establish the authenticity of portable paintings from Dunhuang in Western collections. Certainly, there has been a strong precedent for forgeries coming out of Dunhuang and Central Asia; when it was discovered that Westerners would be willing to pay ample sums for manuscripts and other archaeological finds from Silk Road sites, this created a thriving market for forgers, particularly in the early twentieth century when Western knowledge of Central Asian cultures was in its infancy. There is no reason to believe that such practices would not extend to paintings and, though the early provenance of each painting has been reported in this study, later provenance and the circumstances of their acquisition by Yamanaka & Company is notably lacking. The study

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<sup>12</sup> Ye Changchi, the late Qing bibliophile and epigrapher, is considered the first to have acknowledged the value of the manuscripts and paintings from Cave 17. Xinjian, 'Ye Changchi Pioneer of Dunhuang Studies', *International Dunhuang Project News*, no. 7 (1997).

<sup>13</sup> Anonymous, *Illustrated Catalogue of Famous Paintings from the Great Collection of the Celebrated Connoisseur of Art, Liang Chang-chü of Foochow*, China: Privately published (1919?), Plates 3A (*Ksitigarbha*) and 3B (*Guanyin*).

<sup>14</sup> Wang Guowei, *Guantang jilin*, Wucheng: Jiang shi Miyunlou (1923), 16:23b-26b (*Ksitigarbha*, F1935.11), and 16:26b-27b (*Guanyin*, F1930.36). Wang Guowei was a pioneer in the field of 'Dunhuangology'.

<sup>15</sup> Abridged provenance notes of Stephen D. Allee, Research Specialist, Chinese Painting and Calligraphy, Freer Gallery of Art and Arthur M. Sackler Gallery, Smithsonian Institution, Washington, DC.

therefore proceeds with this in mind, with an aim to uncovering more information that may, or may not, validate their authenticity.

## 2.3 Art historical descriptions

### 2.3.1 *Eleven-headed Guanyin* (Harvard Art Museums)

This painting on silk, displayed as a hanging scroll with blue silk borders, is dated by inscription to 985 CE. It depicts Guanyin Pusa (Skt. *Bodhisattva Avalokiteśvara*) surrounded by verses from Chapter twenty-five of the Lotus Sutra (*Saddharma Puṇḍarīka Sūtra*). The numerous heads and arms of Guanyin represent his compassion and skilful means to alleviate suffering (his full Chinese name 'Guanshiyin' in itself means 'he who perceives the suffering of the universe'). Around the figure of Guanyin are illustrated various perils from which he saves those with faith, such as fires, physical attack from men and ghosts, falling from heights and imprisonment, accompanied by the corresponding lines of the Sutra.<sup>16</sup> It has been noted that these are rhyming couplets that paraphrase the actual scriptural verse as a mnemonic device,<sup>17</sup> a phenomenon that is also found in the mural paintings of the Mogao Caves.<sup>18</sup> While later Chinese depictions of Guanyin show the Bodhisattva as female, this and other early examples retain the masculine Indian form, a representation that perseveres outside of China to this day.

The inscription identifies the donor at the lower right as Tsung-shou, a son of the principal official at Dunhuang, who dedicated the painting to the monk Yuan-man, appearing above the donor.<sup>19</sup> It has been noted that the calligraphy of the Sutra verses and that of the inscriptions may be by a different hand.<sup>20</sup> The distinctive characters within the Sutra verses display very thin and thick applications of ink within a single stroke, characteristic of the Tang dynasty 'Sutra script' executed with a brush of wide belly with a fine tip.

### 2.3.2 *Maitreya's Paradise* (Harvard Art Museums)

It has been noted by Arthur Waley that the discovery of Maitreya Paradises at Dunhuang is significant, since such representations, though common in Buddhist literature, nowhere else survive in artistic form.<sup>21</sup> Bodhisattva Maitreya (Mílè Púsa in Chinese) is the next Buddha to come after Shakyamuni, the historic Buddha of our age. It is characteristic of depictions of

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<sup>16</sup> Murase, 'Kuan-yin as savior of men: illustration of the twenty-fifth chapter of the Lotus Sutra in Chinese painting', *Artibus Asiae*, vol. 33, no. 1 (1971).

<sup>17</sup> Unpublished correspondence with Hao Sheng, Museum of Fine Arts, Boston.

<sup>18</sup> Unpublished correspondence with Zhao Shengliang, Dunhuang Academy.

<sup>19</sup> Mortimer, *Harvard University Art Museums: A Guide to the Collections* (Cambridge, MA: Harvard University Art Museums, 1986), 30.

<sup>20</sup> Unpublished communication with Hao Sheng.

<sup>21</sup> Waley, *A Catalogue of Paintings Recovered from Tun-Huang by Sir Aurel Stein* (London: British Museum, 1931), xxxix.

Maitreya to find him seated in this manner, with both feet resting on the floor. The paradise of Maitreya is the Tuṣita Heaven, where, according to the Mahayana Buddhist tradition, Shakyamuni also dwelled as a Bodhisattva before being born into this world and gaining complete enlightenment.

The donors displayed at the foot of the composition are dressed in a manner consistent with other tenth century donor paintings from Dunhuang and were a prominent family of that area. The inscription, in exceptional calligraphy, identifies the Li family who dedicated the painting at a time when Buddhism enjoyed enthusiastic support from the region's ruling clan, the Cao family, who themselves commissioned numerous cave temples at Mogao.<sup>22</sup> Ordination ceremonies for a young monk and nun can be seen taking place in each corner below Maitreya.

That the painting is not on silk has led in the past to speculation about what the material might actually be, with cotton, hemp and linen proposed. The painting is in fact on the bast fiber ramie (*Boehmeria nivea*) and mounted within a narrow border of the same material. An old black and white photograph of unknown date and origin<sup>23</sup> clearly shows three straps attached to the upper edge of the border cloth (now lost), presumably for purposes of suspension and similar to other examples that survive in the Stein Collection at the British Museum.

### 2.3.3 *Guanyin as Savior from Perils* (Museum of Fine Arts, Boston)

It was after the eleventh century in China that depictions of Guanyin Pusa evolved from the Indian masculine prototype into a female form. Dated to 975 CE, Guanyin is depicted here in the Indian style, painted for the Lingxiusi temple of the Song Dynasty, one of thirteen in the Dunhuang area.<sup>24</sup> In common with *Eleven-Headed Guanyin*, various perils are depicted around the Bodhisattva, also based on chapter twenty-five of the Lotus Sutra, from which beings are saved by their faith in calling upon Guanyin. The Bodhisattva is shown here seated, a manner of representation that recurs frequently within portable paintings from Dunhuang.

In the two lower corners of the painting, above the nuns depicted beneath, are two young men described in the accompanying cartouches as the 'virtuous boy' and the 'evil boy'. They hold in their arms scrolls recording good and bad deeds. The nun at the lower left has been described as sitting on a Tang-style Buddhist platform, holding a censor in her hands. She is identified by inscription as both the nun Jiejing, from Lingxiusi temple, and artist of this painting, though it is commonly thought that she in fact commissioned the work instead. The

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<sup>22</sup> Sasaguchi, 'A Dated Painting from Tun-Huang in the Fogg Museum', *Archives of Asian Art*, vol. 26 (1972/1973), 28. A member of the Cao family is represented as a donor in *Guanyin of the Water Moon*, described on page 15.

<sup>23</sup> Published in Sasaguchi, 'A Dated Painting from Tun-Huang in the Fogg Museum'.

<sup>24</sup> Teiser, *The Scripture of the Ten Kings* (Honolulu: University of Hawai'i Press, 2003), 230.

nun on the right, Mingjie, is more junior, though both nuns bear the same family name (Li) and may be related.<sup>25</sup>

#### 2.3.4 *Guanyin of the Water Moon* (Freer Gallery of Art)

This painting on silk was remounted by Kinoshita Yokichi<sup>26</sup> at the Freer Gallery in 1931, a common practice for delicate paintings on silk at that time, which often saw them given Japanese border silks before being stretched onto lattice panels.<sup>27</sup> A discussion of the appropriateness of Japanese treatments on Chinese material, still a relevant subject today, is not within the scope of this study, but it is certainly clear that a great deal of valuable information was lost when old mounts were discarded from Dunhuang paintings during their restoration treatment in Western collections during the early twentieth century.<sup>28</sup>

Both the inscription and various attributes, such as the flask and willow branch and the small image of a seated Amitabha Buddha in the headdress, identify the central figure as that of Bodhisattva Guanyin. Again, in this earlier Central Asian depiction, Guanyin retains the masculine appearance of the original Indian rendering of the Bodhisattva.

The chief of the four donors at the foot of the painting is a member of the Cao family, which at the time ruled the independent kingdom of Shazhou, centered on the oasis of Dunhuang, in modern Gansu Province.<sup>29</sup>

#### 2.3.5 *Ksitigarbha Bodhisattva* (Freer Gallery of Art)

This painting on silk, also mounted on a panel, is notably different to the other four paintings featured in this study. A cursory investigation reveals the use of cut gold and a silk of high quality, in addition to a multitude of imagery, iconography and figurative depiction (such as a three-quarter profile) that are not found in any of the paintings previously described.

Bodhisattva Ksitigarbha (Dìzàng Púsà in Chinese) is seen sitting on a rock, as he is sometimes depicted. On his right is the monk Daoming, and on his left is the General of the Five Directions, dressed in military costume. The inscriptions indicate that the painting was

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<sup>25</sup> Tung, *Tales from the Land of Dragons: 1,000 Years of Chinese Painting* (Boston: MFA Publications, 2000), 132.

<sup>26</sup> Kinoshita Yokichi was a Japanese conservator who also worked at the Museum of Fine Arts, Boston. Lee, *The History of Asiatic Department Boston Museum of Fine Arts* (Seton Hall University, 2000), 32.

<sup>27</sup> Paintings within the Stein Collection at the British Museum saw similar treatment at the hands of Japanese conservator Yoshijiro Urushibara, who was retained by the British Museum from 1913 to restore and mount old Chinese paintings, and teach Museum staff traditional Japanese mounting techniques. Itoh, *The Japanese Community in Pre-War Britain* (Richmond, Surrey: Curzon Press, 2001), 115.

<sup>28</sup> Whitfield, *Dunhuang British Museum Mounts: Comparisons of present condition vs. negatives in Library of Hungarian Academy dating from the early twentieth century* (2009), unpublished.

<sup>29</sup> Allee, *Song and Yuan Dynasty Painting and Calligraphy* (Freer Gallery of Art, Washington, DC)  
<<http://www.asia.si.edu/SongYuan/>>

dedicated on the first anniversary of the death of a Khotanese princess, seen kneeling in the lower portion of the painting.<sup>30</sup> Ksitigarbha is primarily revered in East Asian Buddhism and is known for his vow not to enter nirvana until all beings in the hell realms have been released from their torment. Later depictions after the Tang dynasty increasingly show him dressed as a monk, though he continues to carry a wish-fulfilling jewel and monk's staff (in this painting borne by the General of the Five Directions behind).

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<sup>30</sup> Ibid.



## 3 Pigment analysis

### 3.1 Introduction

As discussed in the Introduction, it is the pigments of portable paintings from Dunhuang that have received the most attention since their entry into Western collections early in the twentieth century. But pigment identification is only one aspect of these paintings. Indeed, as those familiar with Chinese and Asian pigments in general can attest, there is not a great deal of variation in their usage over the centuries – studies of very early Chinese materials have identified a small number of pigments that later fell out of use (for example, Han blue<sup>31</sup> and Han purple<sup>32</sup>), but most pigment usage remained fairly regular until the introduction of Western pigments, mostly during the nineteenth century. As can be seen in **Table 1** below, the pigments found are as one would expect from this location and time period.

Nevertheless, some pigments, while seemingly innocuous, may hold the key to some of the fundamental questions posed by this study. In particular, the use of lapis lazuli has raised many interesting questions regarding the origin of these paintings, and the presence of talc grounds (perhaps made from clays of the Dang River that flows past the Mogao Caves), or locally mined atacamite, could also pinpoint and confirm a geographical source for these paintings.

#### 3.1.1 Summary of pigments

Observations of pigment usage are summarized here after examination with x-ray fluorescence spectroscopy (XRF), Raman spectroscopy, Fourier Transform Infrared spectroscopy (FTIR), polarizing light microscopy (PLM), scanning electron microscopy (SEM, backscattered) and matrix-assisted laser desorption ionization mass spectrometry (MALDI). Analysis began with XRF as an indicator of elemental composition.<sup>33</sup> This examination was refined through the use of FTIR and Raman spectroscopy from pigment micro-samples, comparing spectra to the Infrared and Raman Users Group (IRUG) Spectral Database, complemented by PLM, SEM and MALDI, where appropriate. On the more thinly painted silks, layering could only be studied non-destructively with microscopy and infrared reflectography (IRR).

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<sup>31</sup> FitzHugh and Zycherman, 'An Early Man-Made Blue Pigment from China: Barium Copper Silicate', *Studies in Conservation*, vol. 28, no. 1 (1983), 15-23.

<sup>32</sup> FitzHugh and Zycherman, 'A Purple Barium Copper Silicate Pigment from Early China', *Studies in Conservation*, vol. 37, no. 3 (1992), 145-154.

<sup>33</sup> It is important to note that XRF is only a means of elemental analysis and cannot identify compounds. For this reason, it cannot be relied upon solely for the identification of pigments, and will never be able to identify an organic compound.

		<i>Eleven-headed Guanyin</i>	<i>Maitreya's Paradise</i>	<i>Guanyin as Savior from Perils</i>	<i>Guanyin of the Water Moon</i>	<i>Ksitigarbha Bodhisattva</i>
<b>Red</b>	vermilion	x	x		x	x
	hematite		x	x		
	red lead	x				x
<b>Orange</b>	red lead	x	x	x	x	x
<b>Yellow</b>	orpiment	x	x	x	x	x
<b>Green</b>	atacamite	x	x	x		
	malachite			x	x	x
<b>Blue</b>	ultramarine	x	x	x	x	x
	indigo	x		x		
<b>Purple</b>	hematite	x				
<b>Pink</b>	organic red	x		x		
	vermilion				x	
<b>Black</b>	lamp black	x		x	x	
<b>White</b>	lead white	x		x	x	x
	talc		x	x		

**Table 1** Summary of pigments

### 3.1.1.1 Reds, oranges and yellows

These pigments represent those most commonly used throughout Asia before the influx of Western pigments. The reds used range between vermilion (HgS), hematite (Fe<sub>2</sub>O<sub>3</sub>) and red lead (Pb<sub>3</sub>O<sub>4</sub>), sometimes in combinations of all three on a single painting. The oranges are achieved with red lead in every instance, and the yellows with orpiment (As<sub>2</sub>S<sub>3</sub>).

### 3.1.1.2 Greens

Green pigments used on Dunhuang portable paintings are the mineral atacamite (Cu<sub>2</sub>Cl[OH]<sub>3</sub>), naturally occurring as an oxidation product of copper deposits in arid climates, and one instance of the basic copper carbonate malachite (CuCO<sub>3</sub>·Cu[OH]<sub>2</sub>). Atacamite can be synthesized, and its specific characteristics, as found on Dunhuang paintings in this study, are discussed below in Section 3.3.

### 3.1.1.3 Blues

All five paintings examined in this study contained lapis lazuli (natural ultramarine, 3Na<sub>2</sub>O·3Al<sub>2</sub>O<sub>3</sub>·6SiO<sub>2</sub>·2Na<sub>2</sub>S). This is noteworthy, since research by the Dunhuang Academy has found that lapis lazuli fell out of use within the Mogao cave murals by the end of the Tang dynasty (618-907 CE), when it was replaced by the basic copper carbonate azurite (Cu[OH]<sub>2</sub>·2CuCO<sub>3</sub>), far more commonly found in East Asian art. This apparent anomaly is discussed in detail within Section 3.2. The only organic colorant to be definitively identified in this study was indigo (C<sub>16</sub>H<sub>10</sub>N<sub>2</sub>O<sub>2</sub>), detected on the two silk paintings sampled and on the silk mount of *Eleven-Headed Guanyin*.<sup>34</sup>

### 3.1.1.4 Purples and pinks

The use of an organic red colorant can be inferred from microscopic analysis of the painting surface of *Guanyin as Savior from Perils* and *Eleven-headed Guanyin*. Lac dye and madder, both composed of anthraquinone derivatives (C<sub>14</sub>H<sub>8</sub>O<sub>2</sub>), existed in Tang dynasty China. Organics are difficult to analyze due to their thin application (used here as a finishing layer over other pigments) and small sample size.

### 3.1.1.5 Blacks

Lamp black, traditionally a mixture of soot and animal glue, has been identified in two of the five paintings in this study. Lamp black has been used for centuries as the sole black paint

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<sup>34</sup> Gettens may not have been able to detect this organic pigment in his 1954 analysis of the two Freer Gallery silk paintings.

pigment of choice, made from soot by burning wood (often pine) or burning oil at a wick.<sup>35</sup> Sticks of this ink have been excavated from the third century BCE.<sup>36</sup>

#### 3.1.1.6 Whites

The predominant white pigment is lead white, composed of basic lead carbonate ( $2\text{PbCO}_3 \cdot \text{Pb}[\text{OH}]_2$ ). This has been mixed with other pigments to alter hue, and possibly to add body or act as an extender. In *Guanyin as Savior of Perils*, white lead and talc have been applied initially under Bodhisattva Guanyin's body and nimbus in order to brighten and define his image against the surrounding painting. The talc appearing in this painting and *Maitreya's Paradise* may be significant, as it appears to contain distinct impurities of aluminum and iron (when one would expect only magnesium and silicon in talc), which may serve as an indicator of geographical origin. The talc within *Maitreya's Paradise* appears to have been used as a preparatory ground layer (discussed in detail within Section 5).

### 3.2 Lapis lazuli (natural ultramarine), $3\text{Na}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot 2\text{Na}_2\text{S}$

As mentioned earlier, some pigments merit further investigation, and it is interesting to note from **Table 1** that lapis lazuli has been found in each of the five tenth-century paintings within this study. All samples analyzed were of natural origin, as indicated by the weak absorption band in the FTIR spectrum at  $2340\text{ cm}^{-1}$  from encapsulated  $\text{CO}_2$  (see **Fig. 6**).<sup>37</sup> Its presence is compelling because the use of lapis lazuli within the Mogao cave murals – at exactly the same site as the portable paintings were found – became highly restricted or stopped altogether by the end of the Tang dynasty (618-907 CE).<sup>38</sup> Why would this precious pigment be so prevalent on the portable paintings and not the wall murals if they were both painted at the same time and location?

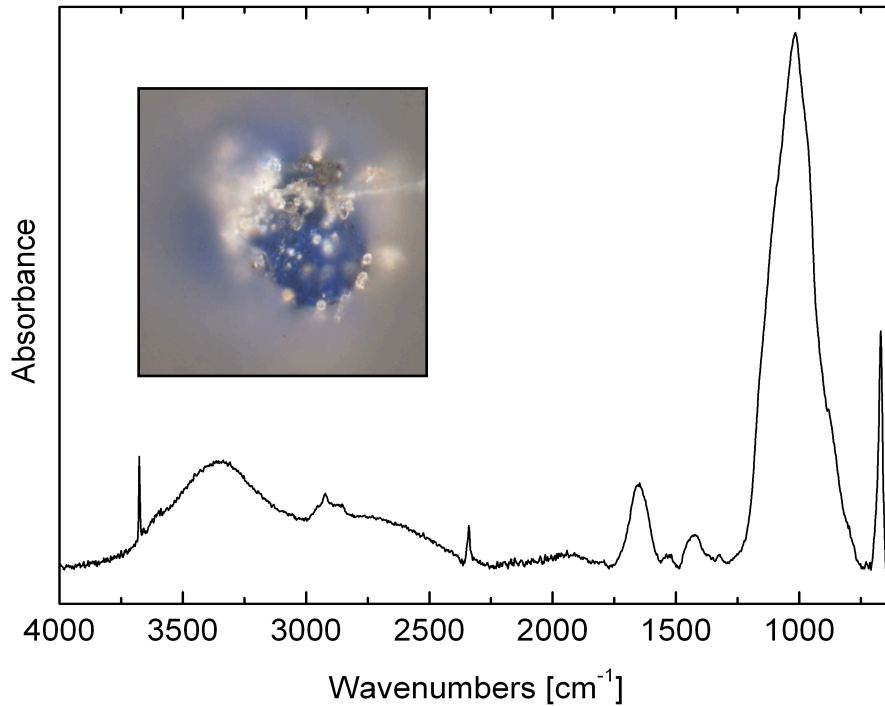
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<sup>35</sup> Swider et al., 'Characterization of Chinese ink in size and surface', *Journal of Cultural Heritage*, vol. 4 (2003), 175.

<sup>36</sup> Tsien, *Paper and Printing*, in Joseph Needham, *Science and Civilisation in China*, vol. 5: Chemistry and Chemical Technology, pt. 1 (Cambridge: Cambridge University Press, 1985), 234.

<sup>37</sup> Smith et al., 'The presence of trapped carbon dioxide in lapis lazuli and its potential use in geo-sourcing natural ultramarine pigment', *Journal of Cultural Heritage*, Vol. 10 (3) (London: Elsevier, July-September 2009), 415-421.

<sup>38</sup> Unpublished personal communication with Dr. Zhao Shengliang, Dunhuang Academy.



**Fig. 6** Lapis lazuli (natural ultramarine) indicated by the weak absorption band in the FTIR spectrum at  $2340\text{ cm}^{-1}$  from encapsulated  $\text{CO}_2$ . Research by the Dunhuang Academy has found that lapis lazuli was replaced with azurite in the cave murals at Mogao by the end of the Tang dynasty.

### 3.2.1 Possible explanations for patterns of lapis lazuli use at Dunhuang

To begin, there are several reasons why the use of lapis lazuli may have declined at Dunhuang during the ninth and tenth centuries. Based on the political and religious turbulence throughout western Central Asia during this period (see Section 3.2.1.1), it seems feasible that trade may have been severely disrupted. It is also possible that trade from that area could have become more heavily involved with European and Near Eastern kingdoms, states which were politically and economically more viable, and less isolated geographically, than Dunhuang. The occupation of the Bactrian lapis lazuli mines at Badakhshan by Muslim Turkic powers brought a very different attitude to art and culture (and, by extension, the mining of precious minerals for pigments), which may have reduced production for a period or allowed known deposits to become depleted.

#### 3.2.1.1 *Historic context: the Islamic influence on the western Silk Road*

The western reaches of the Silk Road of Sogdia and Bactria (modern Kazakhstan and Afghanistan, respectively) were coming under strong Muslim influence from the mid-ninth century onwards, some two hundred years after the introduction of the Islamic religion by Muhammad to the Arabian peninsula during the seventh century CE. The eastward movement of Islam was to have profound effects on both the trade and artistic culture of the regions. Where Buddhist practice was not actively suppressed, figurative art was anathema to the Muslim belief system and naturally dwindled in areas under their influence.



Fig. 7 Ghaznavid and Qarakhanid empires by the mid-tenth century. Image: Berzin Archives.

In 830 CE the Saffarids<sup>39</sup> invaded Kabul and began a militant Muslim occupation of the region. Though later ousted by more moderate rulers, this began a period of intermittent Muslim rule that lasted until full consolidation by the tenth century under the Islamic Turkic kingdoms of the Qarakhanid and Ghaznavid empires (see Fig. 7). The first mosque to be constructed in the Tarim Basin was during the 930s CE at Artuch, now in Tajikistan, just a few hundred miles from the lapis lazuli mines at Badakhshan. The Western Qarakhanids of Kashgar (on the western edge of the Taklamakan desert, opposite Dunhuang at its eastern edge) were the first Turkic tribe officially to adopt the Muslim faith in the late 930s CE.

By the early eleventh century, the Ghaznavid conquest of Gandhara and northwestern India, with its looting and destruction of wealthy Hindu temples and Buddhist monasteries, effectively ended religious travel to and from India along the Silk Road. For centuries, pilgrims had travelled from Central Asia and eastern China to the monasteries of India to meet with Buddhist teachers and bring back religious texts and relics. The last of such visits, by Indian Buddhist practitioners arriving in China, is recorded by Northern Song sources in 1027 and 1036 CE.

<sup>39</sup> The Saffarid dynasty was a Persian empire that extended across south-eastern Iran, south-western Afghanistan and north-western Pakistan and, once fully consolidated, lasted from 861-1003 CE. Frye et al., *The Cambridge History of Iran* (Cambridge: Cambridge University Press, 1975), 121.

### 3.2.1.2 *Early perspectives on lapis lazuli at Dunhuang*

From the earliest days of technical interest in the pigments of Silk Road cave sites, shortly after their discovery, until the middle of the twentieth century, no lapis lazuli had ever been found east of Kizil (now in the Xinjiang Uyghur Autonomous Region of western China). Rutherford Gettens was the first to examine pigments from Dunhuang when he analyzed fragments of Caves 320, 321, 323, 329 and 335, as well as a life-sized sculpture of an Attendant Bodhisattva from Cave 328, after Langdon Warner returned with them from the Mogao Caves in 1924. He failed to find any use of lapis lazuli, but rather found azurite, a basic copper carbonate blue.<sup>40</sup> Even a recent study at the Mogao Caves in 2007 failed to conclusively identify lapis lazuli, despite surveying caves from all periods of Mogao's active use (the fourth to fifteenth centuries).<sup>41</sup>

During Gettens' examination of *Ksitigarbha Bodhisattva* at the Freer Gallery in 1965, he noted that:

*The presence of natural ultramarine in this painting and in 30.36 [Guanyin of the Water Moon] seems to tie in with the presumed Central Asian origin of these paintings. On samples of wall painting from Chinese Turkestan [Kizil]<sup>42</sup> previously examined by the writer, the use of ultramarine and the absence of azurite was noted. It has long been felt that the ultramarine used in paintings of Central Asia probably came from the well-known lapis lazuli mines of Badakhshan, which presumably supplied most of the ultramarine pigment for the early paintings of India, Persia and even Europe. In our experience, ultramarine is very rarely found in paintings from central and eastern China and Japan. The presence of ultramarine would tend to support the Central Asian origins of these paintings.<sup>43</sup>*

Having also found no lapis lazuli on any of the samples brought back from Dunhuang by Langdon Warner, could it be inferred that the portable paintings were painted somewhere other than Dunhuang – that is, further west in Central Asia, nearer to the source of lapis lazuli at Badakhshan (**Fig. 8**)?

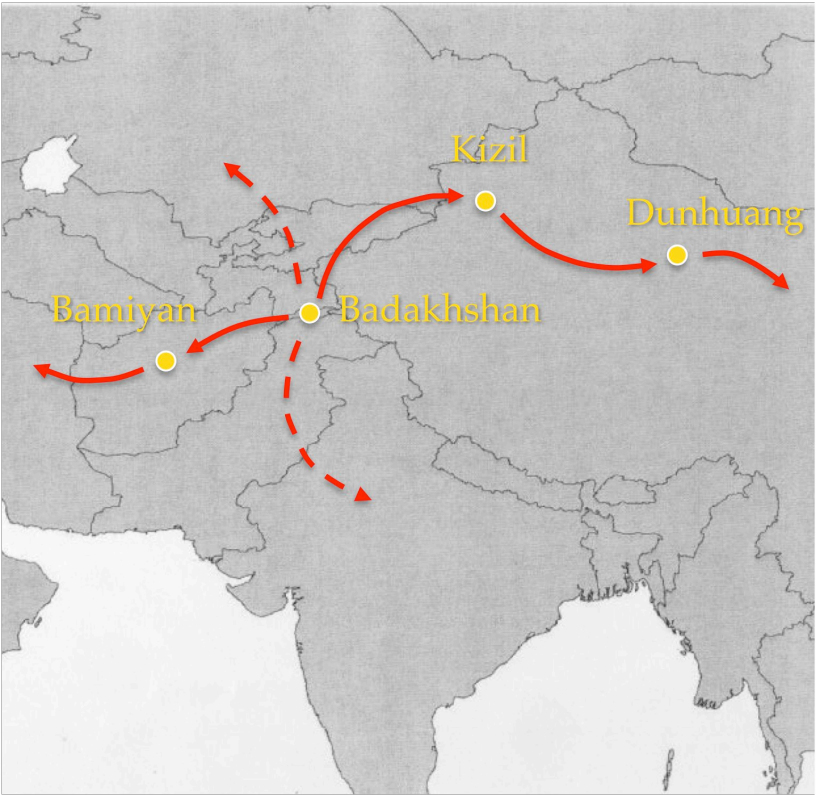
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<sup>40</sup> Gettens' examination of these objects has been well documented and expanded upon within work by Sanchita Balachandran (see Bibliography).

<sup>41</sup> Wang and Fu, 'Summary of painting materials and techniques of the Mogao Grottoes', *Mural Paintings of the Silk Road: Cultural Exchanges between East and West* (London: Archetype Publications, 2007), 112-117.

<sup>42</sup> For a discussion of these findings, please consult: Gettens, 'The Materials in the Wall Paintings from Kizil in Chinese Turkestan', *Technical Studies in the Field of the Fine Arts*, Vol. 6, No. 4 (1938), 281-294.

<sup>43</sup> Gettens, Freer Gallery of Art scientific report, May 5, 1965.



**Fig. 8** Movement of lapis lazuli along trade routes from its source at Badakhshan (in modern Afghanistan). The solid red lines represent the primary east-west trade routes. The Buddhist cave grottoes at Kizil and Bamiyan saw extensive and exclusive use of lapis lazuli in their mural paintings.

3.2.1.3 *Current understanding of lapis lazuli use at Dunhuang*

Lapis lazuli was later identified at Dunhuang<sup>44</sup> and even 1000 miles further to the east at Yungang,<sup>45</sup> contradicting Rutherford Gettens’ belief that its use was confined to Central Asia. Nevertheless, its use in the wall murals of the Mogao Caves seems to have declined rapidly after the seventh century and, in line with Gettens’ observations, is rarely found in East Asia.

Could the lapis deposits have become depleted? To date, there is no evidence to suggest that there was another source of lapis lazuli for Central Asia (or indeed Europe) during this period besides Badakhshan. While large deposits have been found near Lake Baikal in Siberia, this site was not mined until the nineteenth century.<sup>46</sup> If the mines were depleted, it would seem unusual that Marco Polo would take the time to mention it in his travel writings during his journey through Central Asia in 1271, referring to lapis lazuli specifically as a mineral that was

<sup>44</sup> It is worth noting that while researchers at the Dunhuang Academy have published frequently on the use of lapis lazuli at the Mogao Caves, it does not seem that any confirmation of its existence there has yet been published in English.

<sup>45</sup> Piqué, ‘Scientific examination of the sculptural polychromy of Cave 6 at Yungang’, *Conservation of Ancient Sites on the Silk Road: Proceedings of an International Conference on the Conservation of Grotto Sites* (Los Angeles: The Getty Conservation Institute, 1997).

<sup>46</sup> Hurlbut (ed.), *Dana’s Manual of Mineralogy*, (New York: John Wiley and Sons, 1971), 473.



used for the extraction of a blue pigment.<sup>47</sup> Nor probably could the use of lapis lazuli in Europe have peaked during the fourteenth to mid-fifteenth centuries, unless there were supplies from another, unknown source.<sup>48</sup> Lapis lazuli was also used in Persian miniatures of the thirteenth and fourteenth centuries and, of course, in the tenth-century portable paintings from Dunhuang analyzed within this study.

This would seem to rule out depletion of the Badakhshan mines as a whole, but not disruption to mining activities, which could well have occurred during the conquest of the region beginning with the Saffarid invasions of Bactria in the early ninth century. Even without the chaos of warfare and conquest, the Muslim occupation of these regions had a profound impact on the artistic culture of the Silk Road. It is clear that the conquest of Bactria by Muslim forces led to the cessation of mural painting at sites within their sphere of influence, such as Bamiyan in Afghanistan. A characteristic of the occupation of Buddhist kingdoms along the Silk Road was widespread conversion to Islam, though often for purely economic reasons (adherents to Islam paid less tax) rather than through any form of violence. As such, the Islamic doctrinal perspectives on art naturally became dominant. Figurative painting, particularly of figures of spiritual or religious importance, were frowned upon as idolatry. Where Buddhist cave murals and their associated cultural paraphernalia were not actively destroyed, they suffered from benign neglect.

The Muslim presence on the western Silk Road throws into sharp relief the relations between Dunhuang and the nearby oasis of Khotan, or Khoja, further to the west and still Buddhist during the tenth century. Sarah Fraser notes that Khotanese paintings datable to the late tenth century and other sacred objects from that region were found in Cave 17, which may have been brought there by Khotanese fleeing the Qarakhanid invasion (see Section 3.2.1.1).<sup>49</sup> Feeling threatened by the political unrest to the west in Kashgar, Khotanese fear of the pending Islamic aggression against them is thought to be why Cave 17 was originally filled and abandoned, as the monastic community deserted the area. Khotan would fall to the Qarakhanids in 1006 CE.

Given this close relationship between Dunhuang and Khotan, it is possible that Khotan, less than half the distance to the source of lapis lazuli in Badakhshan in relation to Dunhuang, may have supplied the materials and artists that created the Dunhuang portable paintings in this study. There is also another explanation for the use of lapis lazuli on Dunhuang portable paintings when it is not found on murals of the same period: the portable paintings with lapis

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<sup>47</sup> Frampton (ed.), *The Most Noble and Famous Travels of Marco Polo Together with the Travels of Nicolo De Conti* (London: Argonaut Press, 1929).

<sup>48</sup> Plesters, 'Ultramarine blue, natural and artificial', in *Artists' Pigments*, vol. 2 (Oxford: Oxford University Press, 1993), 39.

<sup>49</sup> Fraser, *Performing the Visual* (Stanford: Stanford University Press, 2004), 6.

lazuli pigments may simply have been painted for wealthy clients who wanted the very highest quality materials. The mural paintings in the Mogao Caves painted at the same time were created with less valuable pigments due to the large wall area of the caves, which would have required a far greater volume of pigments than the portable works.<sup>50</sup> Indeed, the difference in scale is certainly vast.<sup>51</sup>

Thus, the portable paintings could indeed have been painted at Dunhuang, but the apparent disruption to the lapis lazuli trade limited its use to smaller scale works after the Tang dynasty. Whether or not Khotanese workshops were responsible for the portable paintings, the lapis lazuli found in them would have had to pass through these western oases to arrive at Dunhuang from Badakhshan.

### 3.3 Atacamite, $\text{Cu}_2\text{Cl}(\text{OH})_3$

Atacamite occurs naturally in the oxidation zones of copper deposits and is the most common copper trihydroxychloride.<sup>52</sup> In her study of the wall murals at the Mogao Caves, Francesca Piqué found atacamite in murals from almost all dynasties and referred to the report of a quarry for atacamite existing in proximity to Dunhuang.<sup>53</sup> It was therefore of great interest to attempt to establish whether the atacamite found on the portable paintings analyzed in this study was mined or synthesized.

Figure 9 shows a representative FTIR spectrum. Within the detection limits of the FTIR, atacamite is the only phase (see inset, **Fig. 9**), and thus is not believed to be an alteration product of an original pigment. The resulting FTIR spectrum contains oxalate peaks at 1360 and 1320 $\text{cm}^{-1}$ , attributable to calcium oxalate and moolooite,<sup>54</sup> a copper oxalate alteration product of atacamite. The relative intensities of the two oxalate peaks indicate there is more calcium than copper oxalate. The source of the oxalates is unclear, although both have been detected in Yuan dynasty wall paintings.<sup>55</sup> In that case, degradation of atacamite particles was apparent in SEM images, a feature not seen in our samples. For wall paintings, fluctuating environmental conditions may exacerbate degradation compared to portable paintings preserved in the relatively stable climate of Cave 17 at Mogao.

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<sup>50</sup> Lapis lazuli was made expensive for several reasons: it was hard to find, came from far away and a great deal of labor was required to mine it due to its hardness.

<sup>51</sup> Unpublished correspondence with Dr. Robert Mowry.

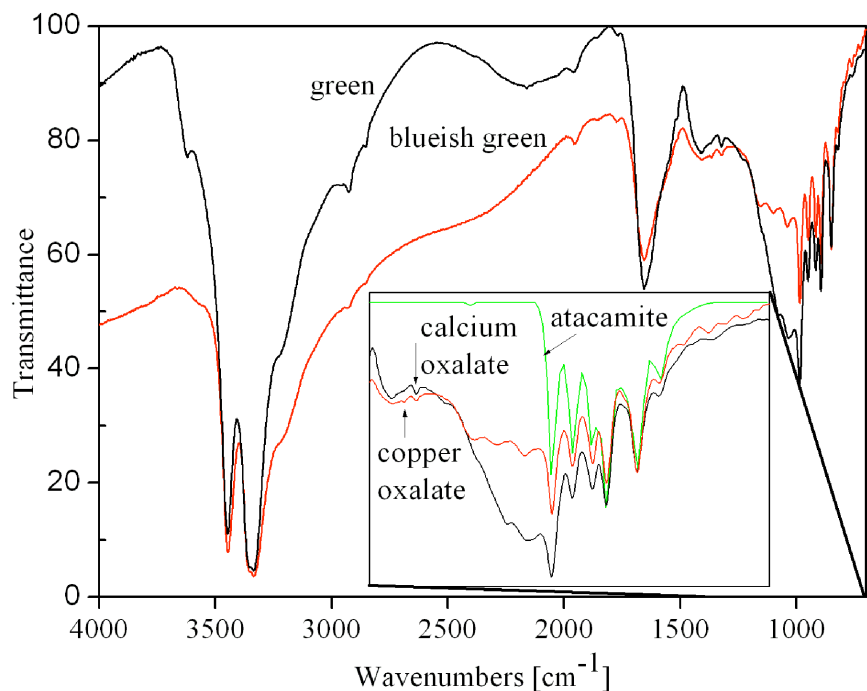
<sup>52</sup> Museum of Fine Arts, Boston, Material Record. < <http://cameo.mfa.org/materials/> > accessed June 12, 2010.

<sup>53</sup> Piqué, *Scientific Examination of the Sculptural Polychromy of Cave 6, Yungang*. Master's thesis. Courtauld Institute of Art, University of London (1992).

<sup>54</sup> Frost et al., 'Raman and FTIR spectroscopy of natural oxalates: Implications for the evidence of life on Mars', *Chinese Science Bulletin* 48, 17 (2003), 1844-1852.

<sup>55</sup> Twilley and Garland, 'Painting materials and deterioration phenomena in a Yuan Dynasty wall painting' in *Scientific Research on the Pictorial Arts of Asia: Proceedings of the Second Forbes Symposium at the Freer Gallery of Art*, ed. P. Jett (London: Archetype Publications, 2005), 109-119.

The source of the atacamite in early Chinese paintings remains an open question,<sup>56</sup> since the mineral can be mined, synthesized, or formed as an alteration product from original pigments. Synthetic atacamite, manufactured from corrosion of bronze (identified by the presence of tin and lead) occurs from the Liao (915-1125 CE)<sup>57</sup> and Yuan (1271-1368 CE)<sup>58</sup> dynasties. SEM analysis shows that the atacamite in this study contains no such detectable elements. Particle morphology can also be a distinguishing feature for synthetic atacamite, as seen on Tang dynasty cave murals.<sup>59</sup> SEM showed the atacamite crystals from these paintings exhibited botryoidal growth patterns (**Fig. 10**) and PLM indicated mixtures of coarse single grain crystals with undular extinction and small clusters of polycrystalline spheres. However, neither of these observations can conclusively identify pigment origin.



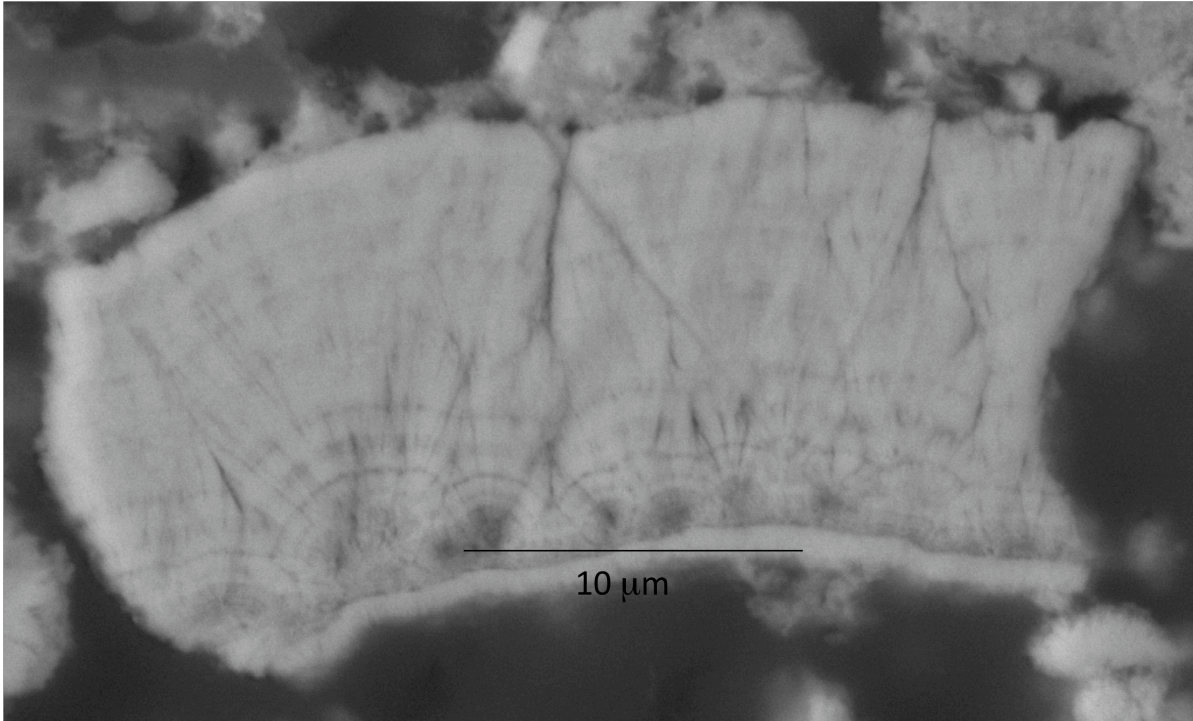
**Fig. 9** FTIR from *Eleven-headed Guanyin* shows atacamite. Two areas of the sample are illustrated (green and blueish green) where oxalate peaks indicate degradation products copper oxalate (1360 cm<sup>-1</sup>) and calcium oxalate (1320 and 1360 cm<sup>-1</sup>) (inset). The relative intensities of the oxalate peaks show copper oxalate in the blueish green and calcium oxalate in both sample areas.

<sup>56</sup> Piqué, 'Scientific examination of the sculptural polychromy of cave 6 and Yungang' in *Conservation of Ancient Sites on the Silk Road: Proceedings of an international conference on the conservation of grotto sites, Los Angeles, October 1993* (Los Angeles: Getty Conservation Institute, 1997), 348-361.

<sup>57</sup> Yong, L., The Palace Museum, personal communication, 2010.

<sup>58</sup> Twilley, J. and Garland, K., 'Painting materials and deterioration phenomena in a Yuan Dynasty wall painting' in *Scientific research on the pictorial arts of Asia* Washington, D.C., 2003, ed. P. Jett (London: Archetype Publications, 2005), 109-119.

<sup>59</sup> Piqué, F., 'Scientific examination of the sculptural polychromy of cave 6 and Yungang', 348-361.



**Fig. 10** A sample of atacamite from *Guanyin as Savior from Perils* displaying botryoidal growth patterns viewed under SEM (backscattered).

### 3.4 Cut gold

Distinctive pieces of cut gold leaf appear on only one painting, *Ksitigarbha Bodhisattva* (**Fig. 11**), but feature in other portable paintings from Dunhuang, dated to the Tang dynasty.<sup>60</sup>

The technique of cut gold is perhaps best known by its Japanese name, *kirigane*, though it is originally a Chinese technique that entered Japan in the sixth century. It is commonly used as a decorative technique in Buddhist artwork, in particular to decorate images of Buddhist deities. Examples have been found on Tang dynasty objects from Turfan (a Silk Road oasis neighboring Dunhuang to the west) and within the mural paintings themselves.<sup>61</sup> Leaves of gold are traditionally placed on a piece of animal skin and cut into fine strips or other shapes using a knife made from bamboo. Using the tips of small brushes, the resulting pieces are then

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<sup>60</sup> Delbourgo, 'Two far eastern artefacts examined by scientific methods', in *International Symposium on the Conservation and Restoration of Cultural Property – Conservation of Far Eastern Art Objects* (Tokyo: Organizing Committee of International Symposium on the Conservation and Restoration of Cultural Property, 1979), 163-179.

<sup>61</sup> Seckel, *The Art of Buddhism* (New York: Greystone Press, 1968).

glued onto the surfaces of wooden Buddhist statues or paintings.<sup>62</sup> It is possible that the presence of cut gold on *Ksitigarbha Bodhisattva* could provide evidence for the age of the painting and merits closer examination.



**Fig. 11** Cut gold additions in the headdress of *Ksitigarbha Bodhisattva* at the Freer Gallery.

### 3.5 Summary

While many of the pigments identified in this study may be considered as standard and anticipated, the isolated location of Dunhuang at the borders of East and Central Asia appears to have produced a compelling new dynamic in the use of lapis lazuli within Central Asian art. Detailed analysis of pigments used in these portable paintings from Dunhuang has also revealed the possibility of further distinguishing characteristics within the pigment selection and composition. These may provide further evidence of geographical ties to the Dunhuang region since, given the portable nature of the paintings, it cannot be assumed that they were necessarily painted at the Mogao Caves prior to their movement to Cave 17.

The most distinguishing feature of these paintings, however, is their associated textile components, which are explored now in the following section.

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<sup>62</sup> Winter, 'Gold in Japanese paintings: a case history involving the Kirikane technique', *Application of Science in Examination of Works of Art* (Boston: Museum of Fine Arts, 1985), 46-54.

## 4 Textile analysis

### 4.1 Introduction

This study is the first time that textile components from Dunhuang portable paintings have been analyzed in detail. An examination of the textile supports and mounts was necessary for several reasons. First, it is the textile components that are unique to these paintings and differentiate them from the cave murals. Second, textile components are in themselves artefacts of paramount historical importance, potentially yielding information about culture and trade well beyond the Mogao Caves. Third, the use of various textiles has influenced the choice of painting technology used to render the painted image, as shall be discussed further in the following section.

A reason why textile components may have been neglected is because most can be clearly identified as silk; those that are obviously not silk have been assumed to be hemp, and these two classifications have endured. As described in this section, these classifications have not always proved accurate and closer examination of the nature of these textile supports reveals further information about the origin and use of these paintings that has hitherto remained unexplored.

A further critical textile component of these paintings are the borders and mounting systems. The tenth century mounts that have survived from the Mogao Caves show some interesting characteristics: sewn mounts, no side mount borders, and mount borders of roughly equal dimensions. They appear to be more closely related to Tibetan *thang-ka* mounts than the traditional Chinese strip mounting technique associated with the secular Chinese literati art of brush and ink. While beyond the scope of this current study, sufficient mounts have survived to significantly inform the history and origins of Chinese mounting practice, and these form an important related area for future research.

### 4.2 Silk

The majority of portable paintings from Dunhuang have been painted on silk and the paintings in this study reinforce that tendency, with four out of five paintings executed on silk supports. Of these four, they can be further divided into coarser and finer silks.<sup>63</sup>

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<sup>63</sup> The use of the terms 'coarse' and 'fine' silks here refers to the overall *quality* (thread count and density) of the woven silk, rather than the thickness of the individual silk threads.

#### 4.2.1 Coarse and recycled silks

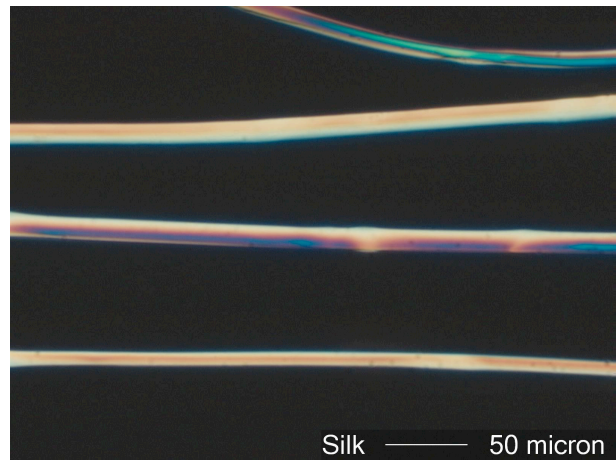
A key characteristic observed in the Dunhuang silk painting supports examined here is the clear evidence of the use of ‘recycled’ silks, that is: silks that were not woven for the purpose of use in paintings. These are part of a set of coarser, loose and uneven woven silks of lower thread count that have been used to paint all three images of the Bodhisattva Guanyin, with *Ksitigarbha Bodhisattva* painted on a finer silk of higher thread count and density.

##### 4.2.1.1 General characteristics

As can be seen from the following photomicrographs (**Figs. 12-13**), silk sampled from the painting support of *Eleven-Headed Guanyin* shows advanced deterioration in the form of embrittlement of the silk fibers. Just as Rutherford Gettens described in his sampling report for *Guanyin of the Water Moon*, the fibers of *Eleven-Headed Guanyin* are partially degraded and fragment easily under the sampling needle.<sup>64</sup> This is also the case for *Guanyin as Savior from Perils*. It is not known whether these degradation characteristics are uniform across all silk samples recovered from Cave 17. Silk paintings can usually be expected to have protein sizing on their surface, in the same manner that paper is sized to prevent ink from bleeding into the substrate, and there is a possibility that animal glue and alum sizing may have had the affect of catalyzing deterioration. This may explain both the darkening of the silk and embrittlement, though it is likely that multiple deterioration factors are involved.



**Fig. 12** Brittle silk fibers from *Eleven-Headed Guanyin* painting support (x400).



**Fig. 13** Unaged silk fibers under polarizing light (x400). Image: MicrolabNW.

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<sup>64</sup> Gettens, Freer Gallery of Art scientific report, June 3, 1957.

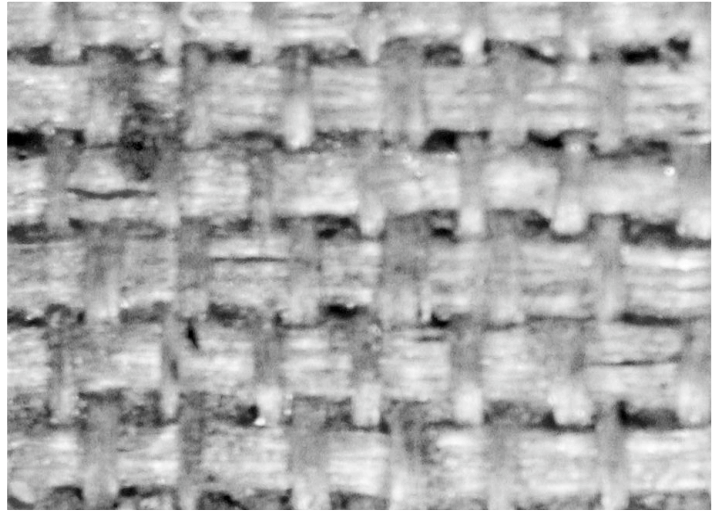
In each painting, the weave of the fabric is quite uneven, which indicates that they were hand-woven. The paintings display a pattern of double warp threads that is a typical signature of the comb used to push weft fibers into place on the loom during weaving. The sericin protein from the silk fibers, combined with any surface sizing on the silk cloth, can also serve to preserve elements of the original weave pattern by inhibiting slippage at thread crossover points (**Fig. 14**). There are numerous breaks and tears in the silk fibers of these paintings and each have a number of repairs in the form of silk patches.

#### 4.2.1.2 *Recycled Silks*

There are two instances of the clear use of recycled or appropriated textiles among the objects discussed in this study. The first is an elaborate damask weave silk, dyed with indigo, that serves as the accompanying mount for *Eleven-headed Guanyin*. While the presence of the *garuda* bird above the Buddha depicted here indicates a later date for the mount, it nevertheless suggests that this fine textile was added to this painting not as a decorative element (the Buddha and other imagery are on their side and practically invisible in normal light, **Fig. 15**) but rather to enhance the painting's spiritual power through the use of a specifically Buddhist garment or ceremonial item of quality and importance.

Radiocarbon dating using accelerated mass spectrometry (AMS, the results are discussed in Section 4.3 below) has now placed this silk as having been manufactured within the eighteenth century, during the Qing dynasty (1644-1912 CE). Despite this, it is worth remembering that if the accepted history of the Mogao Caves is correct, this silk would have been retained for a period of up to 150 years before being transferred to *Eleven-headed Guanyin* as a strip mount after the painting was removed from Cave 17 in the early twentieth century. It is possible that the silk and wood were removed from another scroll that recently had been remounted elsewhere, which could explain the age of the silk and also its distressed, abraded, and soiled surfaces. **Fig. 15** shows the damask image in raking light.





**Fig. 14** Twin warp threads of silk formed by the comb on the silk loom. Twin warp threads were found in 97% of silk paintings examined during a recent study at the Freer Gallery (*Winter, East Asian Paintings*). This photo of *Eleven-Headed Guanyin* has been altered to enhance contrast.

**Fig. 15** Damask weave images within the mounting silk of *Eleven-Headed Guanyin*, revealing a seated Buddha, *garuda* bird and censor.



It can be seen in **Fig. 16** that *Guanyin as Savior from Perils* has been painted on a monochrome weave with a damask diamond pattern. It has been noted that it is characteristic of damask on plain weave silks from Dunhuang that they usually have geometric patterns, such as diamonds, or hexagonal grids.<sup>65</sup>

The re-use of cloth is in fact an important part of the Buddhist tradition. The protocol for monks' robes, the *kāṣāya*, was meant as an emulation of the robes of Shakyamuni Buddha himself. Ideally, the fabric for a *kāṣāya* would be cloth discarded by men and women because of its impurity (which could mean soiled in some way, or used to cover the dead, but also cloth that had been offered or discarded at shrines).<sup>66</sup> Because these pieces of cloth would often be mere scraps (and monks were also not allowed to own quantities of cloth beyond a limited size), the *kāṣāya* was a patchwork, with smaller pieces washed and then sewn together to make a larger robe. Indeed, robes of precisely this type have been found at Dunhuang (Stein Collection, MAS 856), in addition to further examples of damask silks used as painting supports (Stein Collection, MAS.888; V & A: LOAN:STEIN.490), both dating to the Five Dynasties period of the tenth century. Further reasons for the use of recycled silks are discussed below in Section 4.2.3.



**Fig. 16** Damask diamond pattern on a monochrome silk used as the painting support for *Guanyin as Savior from Perils* (Museum of Fine Arts, Boston). The diamond damask pattern is common to many silks recovered from Cave 17.

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<sup>65</sup> Zheng, 'Monochrome woven silk', in *Textiles from Dunhuang in UK Collections* (Shanghai: Donghua University Press, 2006), 60.

<sup>66</sup> Faure, 'The symbolism of the *kāṣāya*', in *Chan Buddhism in Ritual Context* (London: Routledge, 2003), 220.

## 4.2.2 Fine silks

The definition of a 'fine' silk is silk that displays a higher thread count, is in superior condition and may have been made with the intention of being used as a painting support, since such silks appear to lend themselves to this function more effectively than the recycled silks previously described.

### 4.2.2.1 General characteristics

Comparing the plain weave painting supports of coarse and fine silk found in the portable paintings examined here, we find that while both have a similar number of warp threads (80-85/inch, 30-35/cm), the silk of *Ksitigarbha Bodhisattva* is much denser with a *weft* count of 84/inch (32/cm) compared to *Eleven-Headed Guanyin* at 60-65/inch (20-25/cm).

While no date for *Ksitigarbha Bodhisattva* has yet been confirmed, both its support silk and painting style appear similar to the finer silk supports of Dunhuang portable paintings dating from the Tang dynasty found within the Stein collection at the British Museum. Photomicrographs of the silk support of *Ksitigarbha Bodhisattva* taken at the Freer Gallery and then compared to Dunhuang portable paintings in the Pelliot Collection by the Freer Gallery's Pauline Simmons in 1966 revealed that the same type of plain weave silk appeared in thirty-seven of the forty-five Dunhuang portable paintings in the Musée Guimet.<sup>67</sup> In general, it appears that Tang silk supports appear to have a higher thread count, though whether there is a statistically significant variation between Tang and Song dynasty silks requires further study.

## 4.2.3 Explanation for recycled versus fine silks

What could be the reason for the obvious discrepancy between these two standards of silks, found in the same location? It may be a question of period and dynasty, and geographical origin. It is clear that painting style changed frequently at Dunhuang over time, often as a reflection of the local political climate and cultural links to the Chinese empire in the east. In a similar manner, it could be expected that standards in silk production and availability might also fluctuate.

While it has yet to be proven that there is a statistically significant difference between thread counts and densities of Tang silks and those from later dynasties, it has been noted by the authors that there is an observable difference in quality between the silks used for Dunhuang portable paintings during the Five Dynasties and Northern Song period and earlier paintings dated to the Tang dynasty. Accepting this visual difference, we can begin to examine some possible reasons for their contrasting appearance.

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<sup>67</sup> Pope, 1969, Freer file folder, comment 3. Pauline Simmons was Curator in the Department of Far Eastern Art at the Metropolitan Museum of Art, New York, and a leading expert on Chinese textiles.

Firstly, to address the question of difference based on period and dynasty, there are several reasons why the quality of silk (and quality of artistry) may have declined at Dunhuang after the Tang period. In the same way that the finest pigment, lapis lazuli, came from the west along the Silk Road, the finest silks came from the east in imperial China. The plain-weave, densely-woven silks used as painting supports during the Tang dynasty were certainly more suited to the task and were accompanied by a correspondingly more refined painterly style that was influenced by Eastern Chinese rather than Central or South Asian styles. Imperial endorsement of Buddhism at the Tang court in Chang'an, the inclusion of Dunhuang in the Tang empire and strong trade along the Silk Road would have facilitated this refinement.

The weakening and eventual fall of the Tang dynasty provides several reasons why this pattern would have been disrupted. First, the fall of the Tang created a political vacuum in which communication between Dunhuang and the imperial capital broke down (see **Fig. 17**). The lack of security along the Silk Road, formerly provided by Chinese imperial troops, was no longer available. To compound the problem, the later Tang period saw an increase in financial trouble and xenophobia that led to widespread and coordinated repression of Buddhism in Tang China from 845 CE.<sup>68</sup> The destruction was on such a large scale that if the Tang dynasty portable paintings recovered from Dunhuang do indeed represent a Buddhist style of painting from the Tang imperial capital, then they are the last surviving examples. Third, the conflict between Turkic peoples in the west, already mentioned as a possible cause for the disruption of trade in lapis lazuli, had a detrimental impact on Chinese trade to western Central Asia during this period. There are therefore several reasons why trade in silk would have been severely reduced during the Five Dynasties and Northern Song.

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<sup>68</sup> Beckwith, 'The Impact of the Horse and Silk Trade on the Economies of T'ang China and the Uighur Empire: On the Importance of International Commerce in the Early Middle Ages', *Journal of the Economic and Social History of the Orient*, vol. 34, no. 3 (1991), 183-198.



**Fig. 17** Chinese imperial control of Dunhuang. Modified from: Ian Kiu, *Tang Dynasty circa 700 CE*.

The Buddhist Tanguts, who controlled the Dunhuang region by the later tenth century rejected vassalage to the Northern Song dynasty that established itself in Eastern China and ties were stronger with other areas of strong Buddhist influence to the immediate south (Tibet) and west (Khotan). While Khotan was certainly able to produce silk, Chinese silks were always considered superior and remained in demand by the population there. It can thus be seen that, due to its geographical location, Dunhuang was affected by the balance of power in Central Asia; the consequent disruption to trade, in particular, could explain the reliance on re-used silks and the loss of artistic refinement in this isolated area as the region was cut off from the painting academies of imperial China.

Carbon-dating has revealed that the painting support for *Eleven-Headed Guanyin* is at least 150 years older than the dated inscription on the painting, suggesting several possibilities: that silk was highly valued due to its lack of availability; that pieces of recycled silks were valued for their former use as a Buddhist votive or ritual item; that the painting was created earlier and inscribed later.

### 4.3 AMS radiocarbon dating

To directly address the important questions surrounding the age of the mount attached to *Eleven-headed Guanyin* (illustrated in **Fig. 15**), radiocarbon dating using accelerated mass spectrometry (AMS) was requested by the Department of Asian Art at the Harvard Art Museums. Four samples from the painting and mount structure were taken: silk fibers from the mount, fibers from the silk support, and wood shavings from the upper batten and lower batten. Minimum sample weight was 2 mg, and samples were sent to the NSF-Arizona AMS Laboratory at the University of Arizona, Tucson. The painting support was sampled in order to verify that the age of the object matched that provided by the inscription.

Sample ID	Material	d13C	F	14C age BP	Age
001	Silk mount	-22.2	0.9636 +- 0.0079	298 +- 66*	1586-1718 CE
002	Silk support	-22.8	0.8573 +- 0.0090	1,228 +- 85*	637-807 CE
003	Upper batten	-22.9	0.9717 +- 0.0038	231 +- 31	1688-1750 CE
004	Lower batten	-21.6	0.9831 +- 0.0031	137 +- 25	1788-1838 CE

**Table 2** 'Before present' (BP) in radiocarbon dating terms is 1950 CE. The date for the wood corresponds to the date that the tree was felled, though it could have been stored for some time afterwards. The silk would have been woven shortly after being produced by the silk worm and thus carbon dating reflects the actual date of manufacture.

This analysis is the first time that a portable painting from Dunhuang has been dated using AMS. In general, very little carbon dating has been carried out on any material from Cave 17. While AMS analysis is destructive, sample sizes are smaller than one would expect, with only a few short strands of silk ( $\approx 8$  mm) required to achieve the 2 mg minimum sample size. Samples were collected from a variety of locations around the painting support and mount so as to reduce the impact of possible sample contamination and to avoid any aesthetic disturbance.

The dates indicate that the support silk is at least 150 years older than the inscription date. This suggests a possible difference in date between the actual painting and inscription or dedication; or that that silk was highly valuable and may have served multiple purposes before it was 'recycled' and used as a painting support. The mounting silk, though relatively modern, is potentially 200 years older than the date at which the painting was reportedly removed from Cave 17. This indicates that this mounting silk was also used or preserved for a considerable period of time before being applied as a strip mount to *Eleven-headed Guanyin*. At least one of

the wooden battens can be associated with the mounting silk by age, indicating that both silk and batten components could have been used to mount another painting before 1900 CE.

In retrospect, a more complete understanding of the painting's mount history would have been obtained if the lining papers from the strip lining had also been sampled, possibly pinpointing a date for remounting; however, cost restrictions prevented a more thorough analysis of the painting components using AMS.

## 4.4 Ramie and bast fibers

### 4.4.1 Characteristics

The most common response to the presence of a bast fiber used as a painting support is one based on economic factors: bast fiber cloth was cheaper than silk. In recent work on the textile collections at the British Museum, British Library and Victoria & Albert Museum it was felt that "hemp is a much cheaper material than silk and subsequently would have suited the commission from a less wealthy donor".<sup>69</sup>

The painting surface of a bast fiber cloth is distinctive (**Fig. 19**). Like paintings on raw cotton found in Central Asian Buddhist art (**Fig. 18**), the surface is sufficiently coarse to require a preparation 'ground' layer of white pigment in order to fill the large interstices between the threads and create a more uniform surface to receive colored pigments. In the case of *Maitreya's Paradise* this ground layer is formed from talc and calcite. An in-depth discussion of the painting technology associated with these supports takes place in the following section.



**Fig. 18** *Double-Sided Buddhist Temple Banner*, 9<sup>th</sup>-10<sup>th</sup> centuries. Painting on raw cotton. 1934.133 (Harvard Art Museums).

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<sup>69</sup> Persson, *Dunhuang Textiles in UK Collections*, 41.



**Figs. 19-20** At left is *Maitreya's Paradise*, on ramie. At right, *Eleven-Headed Guanyin* on silk. Both images x12.6 magnification, highlighting the different surface qualities.

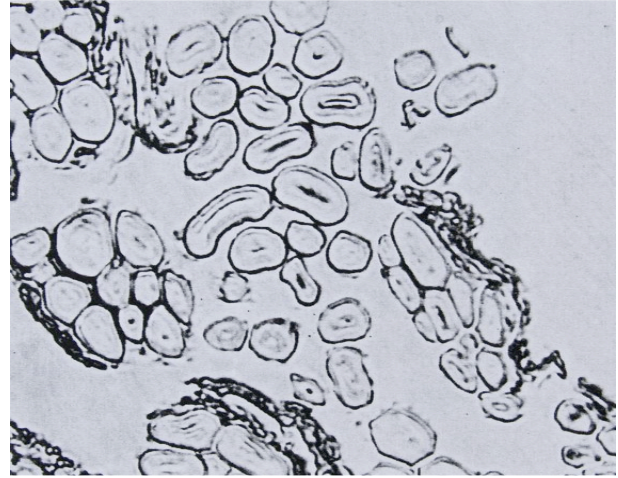
## 4.4.2 Fiber identification

### 4.4.2.1 Fiber cross-section

Bast fibers, which include hemp, flax, ramie and mulberry, are exceptionally difficult to differentiate as longitudinal samples under the polarizing microscope. In many instances, a cross-section is required in order to view the fiber end-on, where structural differences can then be observed.

A sample cross-section was prepared with the assistance of Meredith Montague, Textile Conservator at the Museum of Fine Arts, Boston. This technique involved placing the sample taken from *Maitreya's Paradise* into a bundle of pink polyester thread (a thread of completely different character to the sample bast fiber) and the bundle drawn into the center of a wine cork on a sewing needle. The cork was then thinly sliced across its width with a scalpel to produce round discs of cork containing cross sections of the fiber bundle, with the bast fiber at its center (see **Fig. 23** below).





**Fig. 21** Top left, ramie control. Note dark lumen, radial striations and angularity. Image: The Textile Institute.

**Fig. 22** Top right, hemp control. Image: The Textile Institute.

**Fig. 23** Lower left, sample from *Maitreya's Paradise*, with dark lumen, radial striations and angularity characteristic of ramie.

#### 4.4.2.2 Red plate test

As a further means of differentiating between hemp and ramie, a red plate test was carried out with the polarizing microscope. Fibers exhibit a different color shift from blue to yellow as they are rotated 90° on the microscope stage. An 's-twist' fiber such as ramie will display a color shift in the opposite direction to a 'z-twist' fiber such as hemp.<sup>70</sup> Controls were used to establish the expected color shift direction for each fiber, and the identification of the fiber was confirmed as ramie.

#### 4.4.2.3 Problems of identification

Due to the great difficulties in identifying bast fibers from purely visual observation, it is not surprising to find that some confusion has arisen surrounding the identification of painting supports other than silk recovered from Cave 17. As one example, the curatorial records for

<sup>70</sup> Elgar et al. 'A Technical Study of the *Hokkedo konpon mandara*', *Scientific Research on the Pictorial Arts of Asia: Proceedings of the Second Forbes Symposium at the Freer Gallery of Art* (2005), 3.

*Maitreya's Paradise* at the Harvard Art Museums have labelled the support as cotton, hemp and even silk over the 65 years since it entered the collection. A publication on the painting guessed linen (flax) for their particular identification.<sup>71</sup> Of course, none of these assumptions were correct.

Because of the time and effort involved in a definitive identification, some institutions appear to have held to one bast fiber, hemp, as a generic term for non-silk supports in the case of portable paintings from Dunhuang. A search of the British Museum's collections accessible through its Collection Database search engine, for example, will find 351 items that have been identified as hemp, including the non-silk portable paintings from Dunhuang in the Stein Collection. A search for ramie objects will yield 179 results from the Museum's collections, none of them Dunhuang materials, but mostly attributed to the indigenous tribes of Taiwan.

In many cases, only a focused study or strong precedent for the use of a certain fiber has produced a confident identification in any collection. That ramie has been in use for over 5,000 years throughout China suggests the possibility of its presence in other portable paintings from Dunhuang.<sup>72</sup> Furthermore, ramie has been identified in Tibetan manuscripts from Cave 17 held in the British Library, suggesting that *Maitreya's Paradise* is not an anomaly.<sup>73</sup> Ramie has also been identified as the support for the *Hokkedo konpon mandara*, a 12th-century painting from Japan thought to be heavily influenced by Chinese styles of Buddhist painting, at the Museum of Fine Arts, Boston.<sup>74</sup>

Even in a full survey of the Dunhuang textiles from the Second Stein Expedition held at British Museum, British Library and Victoria & Albert Museum there is no mention of ramie.<sup>75</sup> Silk, hemp, wool and cotton are instead identified. The findings of this study suggest that non-silk portable paintings from Dunhuang may merit closer examination.

#### 4.5 Ramie versus silk

The common perception of the choice of bast fiber supports for Dunhuang portable paintings is in economic terms – hemp and ramie were cheaper than silk. There are several pieces of evidence that challenge this assumption.

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<sup>71</sup> Sasaguchi, 'A Dated Painting from Tun-Huang in the Fogg Museum', *Archives of Asian Art*, vol. 26 (1972/1973), 26-49.

<sup>72</sup> The earliest recovered ramie artefact from China was found at Wuxing in the north of Zhejiang Province dating to the 3<sup>rd</sup> millennium BCE. Kuhn, *Textile Technology, Spinning and Reeling*, in Joseph Needham, *Science and Civilisation in China*, vol. 5: Chemistry and Chemical Technology, pt. 9 (Cambridge: Cambridge University Press, 1988), 30.

<sup>73</sup> Helman-Wazny, *Fibre Analysis of Dunhuang Documents in the British Library* (International Dunhuang Project, 2008) <[idp.bl.uk/pages/archives\\_papers.a4d](http://idp.bl.uk/pages/archives_papers.a4d)> accessed June 13, 2010.

<sup>74</sup> Elgar et al. 'A Technical Study of the *Hokkedo konpon mandara*'.

<sup>75</sup> Zhao, *Textiles from Dunhuang in UK Collections* (Shanghai: Donghua University Press, 2007).

First, *Maitreya's Paradise*, painted on ramie, displays a higher standard of artistry than the paintings on silk examined in this study, including the use of lapis lazuli in relative abundance; the calligraphy, also, has been noted by experts to be of a high standard.<sup>76</sup> This is not necessarily compelling, the savings from purchasing a painting on cheaper bast fiber may have allowed for greater investment in the standard of painting. Nevertheless, it is interesting to note perceptions of ramie cloth during and after this period in China. The *Nung Sang Chi Yao* (1273 CE) noted that, because ramie fabrics were pliable, strong, clean and white, they fetched a price double or more than that of ordinary fabrics.<sup>77</sup> It has also been recorded that the loom for weaving ramie was the same as for weaving cotton,<sup>78</sup> the only other non-silk fiber to have been conclusively identified as used for Buddhist portable artefacts along the Silk Road.<sup>79</sup>

#### 4.5.1 Non-silk supports throughout Asia

It is important to remember that in many Asian cultures, non-silk paintings may not have been the cheaper option, but rather the norm. Painting technologies developed to suit the availability of indigenous sources of fibers for supports. In India, where Buddhist wall murals also existed, cloth fabric was a very common support for painting (known as *pata*) before the arrival of paper technology in the twelfth century, and was still used for large-format works after that time. Early banner paintings from Nepal (*prabha*) were executed on cloth supports similar to the Tibetan *thang-ka* (usually cotton), and both of these styles of cloth paintings feature sewn mounts, rather than the strip mounting with paste practiced in East Asia. Early photographic evidence shows that paintings currently in the Stein Collection featured sewn mounts before being remounted on arrival at the British Museum.<sup>80</sup>

Dunhuang's central location within Asia and its standing as a critical oasis on the Silk Road insured that the locality was exposed to a great diversity of cultural influence. Until the eleventh century, when the Muslim invasions drove Buddhism from India and disrupted the western Silk Road, there was a steady traffic of Buddhist monks to and from China and India, adding a further spiritual and cultural dimension to the purely economic trade that Dunhuang facilitated (indeed, a fabric of a palm-leaf manuscript of an Indian drama of the second century CE was even found at Turfan).<sup>81</sup> Dunhuang was often in closer proximity to the Tibetan empire than it was to the Chinese and was occupied by the Tibetans between 781-847 CE.

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<sup>76</sup> Unpublished correspondence with Hao Sheng, Museum of Fine Arts, Boston.

<sup>77</sup> *Nung Sang Chi Yao*, ch. 2 (1273 CE), 11a in Kuhn, *Textile Technology, Spinning and Reeling*, 38.

<sup>78</sup> *Thien Kung Khai Wu*, ch. *shang* (1637 CE), 44b-45a in Kuhn, *Textile Technology, Spinning and Reeling*, 37.

<sup>79</sup> See 1934.133, a banner painting on raw cotton in the Harvard Art Museums found at Turfan on page 39.

<sup>80</sup> Whitfield, *Dunhuang British Museum Mounts: Comparisons of present condition vs. negatives in Library of Hungarian Academy dating from the early twentieth century* (2009), unpublished.

<sup>81</sup> Agrawal, *Conservation of Manuscripts and Paintings of South-east Asia* (London: Butterworths, 1979), 1.

Chinese art in the form of portable paintings, as it survives today, is restricted to silk and paper; Chinese painting technology has developed to suit these materials, as has Chinese mounting practice. Rather than seeing bast fiber supports only as a cheaper form of silk, they appear to offer valuable information regarding the convergence of other cultural and artistic styles at Dunhuang. Because paintings on cotton and bast fiber are not associated with any other surviving Chinese painting style, their use and related painting technology suggest non-Chinese cultural origins that impressed their influence on the art of the Dunhuang region, or, as mentioned earlier, the paintings themselves may have been brought to Dunhuang. The evidence for painting workshops, suggesting an economic dynamic in the production of portable paintings, is discussed in the following section.

## 5 Painting technology

### 5.1 Introduction

A discussion of painting technology in this context is essentially an examination of how the pigments and supports that have already been described interact. In particular, we are exploring the manner in which painting technology has been adapted to suit different forms of painting support. Some characteristics of the painting process will be described, in order to produce a clearer understanding of how, and possibly why, these paintings were made.

### 5.2 Workshop process

The dominant influence on the tenth-century painting technique employed on portable paintings from Dunhuang is a workshop practice, in evidence from several marked characteristics on the paintings examined in this study and additional documentation from Cave 17. The variety of painting found at the Mogao Caves and elsewhere on the western Silk Road predates the literati painting of China, when art and painting came to be practiced purely for its own sake, instead of serving religious or economic ends. The paintings at the Buddhist sites along the Silk Road are functional religious works, designed for spiritual contemplation and inspiration, or as a means of gaining merit through their painting or patronage.<sup>82</sup> Donors therefore formed an important part of the dynamic of all these paintings, and the painters themselves often worked only for payment in food and not strictly for profit.<sup>83</sup> The painter, donor and monastery essentially came together to form an economy around the execution of these paintings, and their later restoration.<sup>84</sup>

#### 5.2.1 Underdrawing

All four paintings dated by inscription to the tenth century that were examined in this study displayed evidence of underdrawing. This was observed using infrared reflectography and imagery from *Guanyin as Savior from Perils* is illustrated in Figures 24-25.

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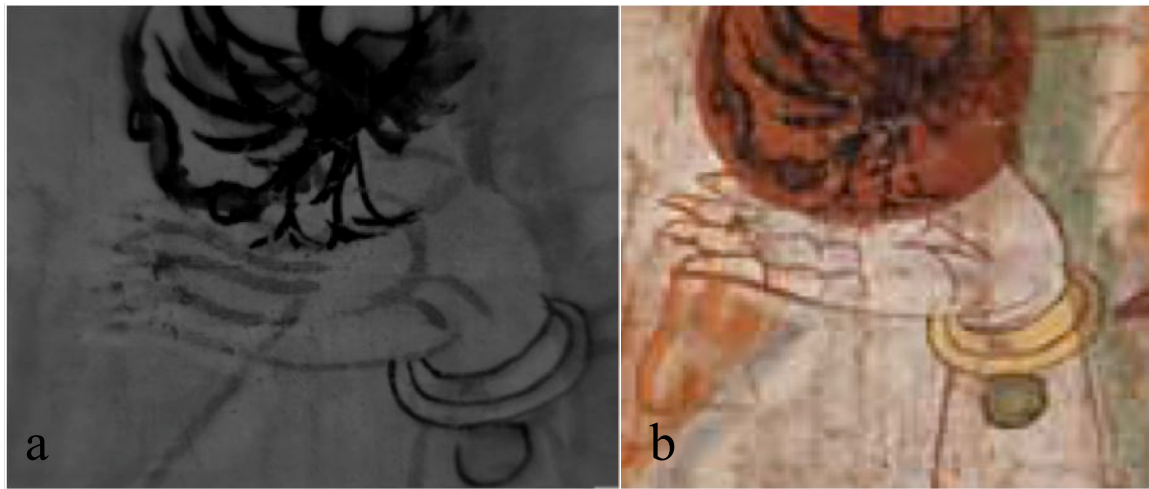
<sup>82</sup> Russell-Smith, *Uygur Patronage in Dunhuang: Regional Art Centres on the Northern Silk Road in the Tenth and Eleventh Centuries* (Leiden: Koninklijke Brill NV, 2005), 135.

<sup>83</sup> The donation of food for feasts and Buddhist festivals was a common occurrence at Dunhuang and served as one of the principal means by which the lay and monastic communities would engage with one another. Whitfield, *The Silk Road: Trade, Travel, War and Faith* (London: British Library, 2004), 282.

<sup>84</sup> The findings of this study corroborate work by Sarah Fraser on the workshop practices of Dunhuang and the surrounding regions in Fraser, *Performing the Visual* (Stanford: Stanford University Press, 2004).



Fig. 24a-25a Left, infrared reflectography as light applications of ink. Fig. 24b-25b Right, normal illumination.



The lines are roughly applied with a dilute ink solution, implying a broad pattern of guidelines rather than a studious process of copying. The application of underdrawing introduces the multi-step process associated with workshop work, still in practice for the execution of Buddhist paintings in Himalayan Buddhist cultures. Its presence also raises the possibility of multiple artists at work with a hierarchy of painting master and students. In Tibetan *thang-ka* painting, for example, the novice student will often prepare the support, others draw the outline, fill in color and apply finishing touches, while the master may only insert the eyes as the final step.<sup>85</sup> In the case of Dunhaung portable paintings, we also find calligraphic inscriptions (discussed in Section 5.2.3).

<sup>85</sup> Jackson and Jackson, *Tibetan Thangka Painting: Methods and Materials* (London: Serindia Publications, 1984).

## 5.2.2 Layering

In stark contrast to the painting style found on Tang dynasty portable paintings from Dunhuang, which feature subtle brush and ink work suggesting a precursor to the monochrome literati painting that would emerge in China in the eleventh century, tenth-century portable paintings from the Five Dynasties and Northern Song feature thick, opaque and layered pigments. Intensity of hue is controlled either by thickness of the paint layer or by combinations of paint layers, usually a color pigment applied over lead white. This is further evidence of a simple and prescriptive painting technique akin to a workshop practice with potentially several hands at work, probably creating identical, multiple images in rapid succession.

Below we have an example of these methods employed in the painting of *Guanyin as Savior from Perils* (**Fig. 26**). Here the body of the Bodhisattva is painted over a ground layer of lead white to add luminescence and bring the figure forward from his surroundings. Colored pigments are then applied. In the detail we can see two 'shades' of green atacamite. The first, on the left, has been applied on top of the white, which appears beneath cracks in the green. The darker green to the right has been achieved simply by adding another layer of the same pigment of identical hue over the top of the first layer. In a similar manner, the orange red lead on the right has been applied over the top of a red iron oxide layer. On an added note, the copper-based atacamite reveals itself beneath a layer of yellow orpiment by displaying a degradation reaction with sulfur contained within the yellow pigment.



**Fig. 26** Layered pigment application technique used to paint *Guanyin as Savior from Perils*.

### 5.2.3 Inscriptions

It is a notable characteristic of many of the paintings in the Stein Collection that they contain empty painted enclosures for inscriptions, left blank while other paintings, such as those in this study, contain numerous details of the date of the painting, the subject matter and the identity of multiple donors. Others have been modestly filled in with a disproportionately small and noncommittal descriptor, such as, simply, *guanyin pusa*.<sup>86</sup> This behavior indicates that such an inscription was probably added much later, without any real knowledge of the painting's meaning or provenance. These empty cartouches are also evidence of a workshop painting practice that produced multiples of any given subject matter. They suggest that paintings may have been purchased already painted, and their inscriptions added later according to the identity of a would-be donor. This begs the question of whether the dated inscriptions identify the date that the actual painted image was created, or the date of purchase or donation, and could explain the lengthy time lag between the age of the silk used to paint *Eleven-Headed Guanyin* and the date of the inscription (see Section 4.3).

Where inscriptions do appear, it seems likely that the calligraphy was added by someone other than the artist. In *Eleven-headed Guanyin*, the sutra verses have been painted by a different hand using a different brush, and different character style to the donor inscription below. In *Maitreya's Paradise*, the quality of the calligraphy in the inscription is very high. The ability to write calligraphy, revealing a relatively high level of literacy, separates this activity from the less intellectual activity of painting, which at this period of time remained simply a service rather than a means of self-expression.<sup>87</sup>

### 5.2.4 Further evidence at the Caves

Painting workshops are also thought to have existed at Dunhuang based on surviving artists' preparatory works recovered from Cave 17. These workshops served the purpose of decorating the caves, an institution launched by the Cao family who ruled Dunhuang after the fall of the Tang dynasty in 907 CE.<sup>88</sup> Manuscripts discovered at Turfan, west of Dunhuang, such as a shoe in tomb 153 (72TAM153: 29, 30) made from the discarded draft of a work register of artisans and painters, identifies the existence of a painting master (a *huashi*).<sup>89</sup> This reveals a hierarchy in the execution of paintings at Turfan, where a master would be supervising those who assisted him, around thirty-five people in the case of this manuscript.

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<sup>86</sup> Bodhisattva Avalokiteśvara.

<sup>87</sup> Cassidy (ed.), *Iconography at the Crossroads* (Princeton: Princeton University Press, 1993), 8-9.

<sup>88</sup> Fraser, *Performing the Visual* (Stanford: Stanford University Press, 2004), 4.

<sup>89</sup> Dien, 'The Inventory Lists of Tomb 86TAM386 at Astana, Turfan', *The Journal of East Asian Archaeology*, vol. 4 (2002), 183-200.



In documents recovered by Paul Pelliot from Cave 17 in 1908, they suggest that a formal painting academy could have existed at Dunhuang from around 930 CE. One document (no. 2032, 939 CE) records the interactions of a temple representative and academy member who reportedly painted a door to one of the caves. The same document mentions a significant payment of millet made to another.<sup>90</sup> As ever, geopolitical factors probably played a large role in the establishment of a painting academy and workshops in the Dunhuang area. While the Tang dynasty had seen the beginnings of painting academies around imperial China, which would later flourish during the Song dynasty,<sup>91</sup> the withdrawal of government patronage as the Tang dynasty declined necessitated local action to maintain and develop the infrastructure of Buddhist painting, which provided significant socio-economic cohesion between local government, and the lay and monastic Buddhist communities.

Nevertheless, the primary stakeholders involved in the creation and use of portable paintings were lay practitioners of Buddhism. Painting was a service and ranked below the study of Buddhist scripture that was associated with the higher levels of literacy enjoyed by most monks and nuns. This made it unlikely that monks would have formed part of any painting workshop, particularly as workshops took payment for their services. Since an ordained monk or nun would not have their own individual possessions, the paintings would either have belonged to the monastery as a whole or been used by lay practitioners as a point of focus in their practice. Requiring the support of the lay community, monasteries have always devoted effort to accommodating lay practitioners, and it is likely that sections of monasteries would have been set aside for their use, as they often are today.

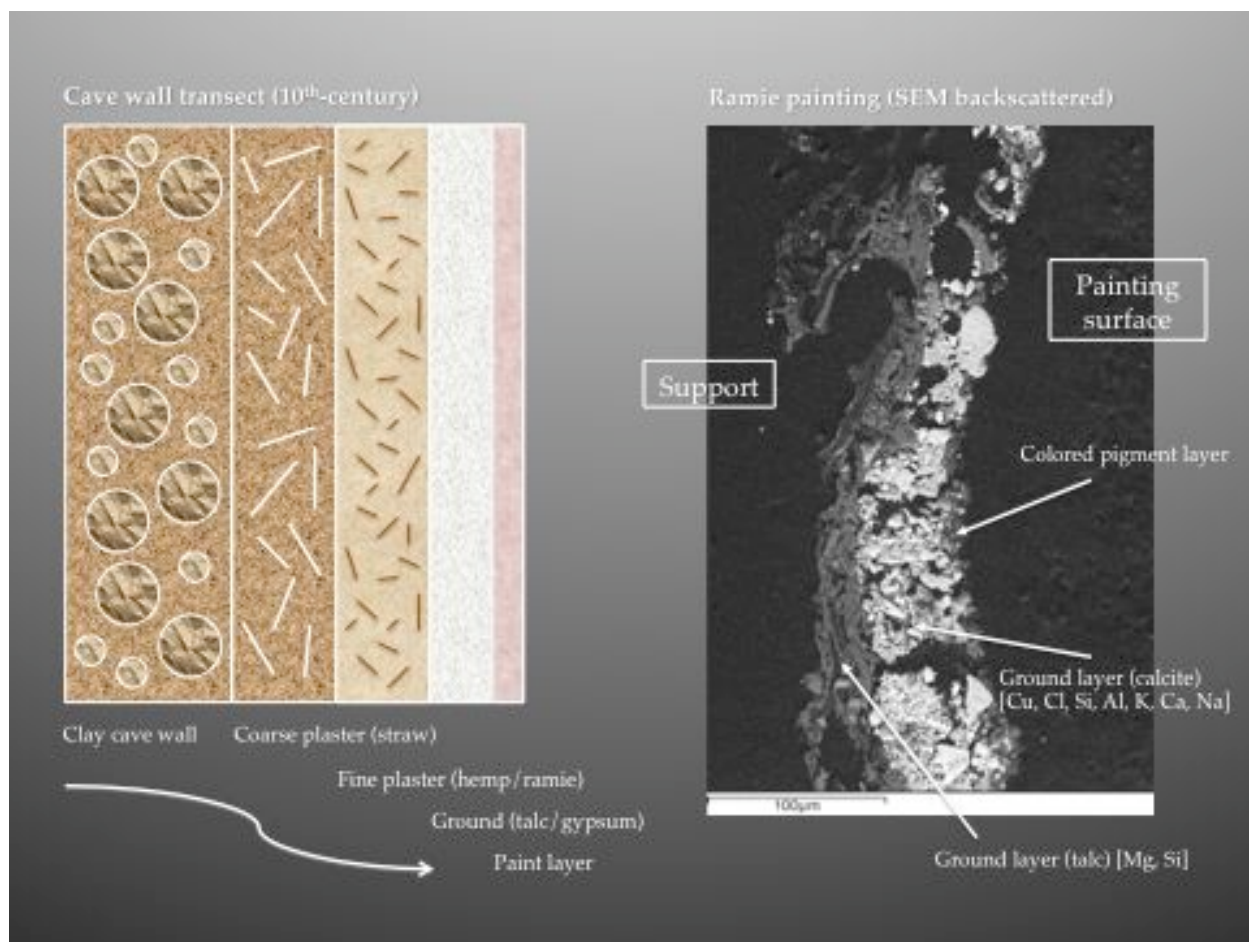
### 5.3 Comparison to wall mural technique

It has been pointed out by Jacques Giès, Director of the Musée Guimet (which holds the Pelliot Collection), that there is a striking resemblance between the portable paintings on bast fiber and the Mogao wall murals themselves. One similarity lies in their physical construction. Compare the two images in **Fig. 27** below.

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<sup>90</sup> Fraser, *Performing the Visual* (Stanford: Stanford University Press, 2004), 24.

<sup>91</sup> Lin, *The Art of Chinese Painting*, trans. Y. Xinjian (Beijing: China Interncontinental Press, 2006), 84.



**Fig. 27** Cave wall transect (tenth century) from Mogao compared to a painting cross-section from *Maitreya's Paradise* (SEM, backscattered). Transect image based on research by Wang and Fu (2007).

We see a very similar layering of mineral conglomerate, painting pigment and, importantly, a layer of bast fibers used to reinforce the initial preparatory layers of the mural paintings. Indeed, the process of constructing the painting surfaces are so similar that it is as though the cave wall had been transferred to cloth. The ceilings of many of the caves were painted in imitation of textile canopies,<sup>92</sup> and it seems reasonable that a reverse of this thought process could also have occurred, that is: painting the cave murals onto cloth as portable paintings.

Giès' observations imply that a scenario may have existed where the painting technology used in the caves was transferred directly to portable paintings, with bast fiber supports used for the reason that they provided, in large part, the support for the cave murals themselves. If such a direct correlation existed, then it is possible that the portable paintings could have been executed by the same artisans responsible for the cave murals. It has been

<sup>92</sup> Gray, *Buddhist Cave Paintings at Tun-huang* (Chicago: University of Chicago Press, 1959), 36.

noted that this method of incorporating bast fiber and clay with a finishing layer has also been employed as a traditional technique for house construction in the Dunhuang region.<sup>93</sup>

There is also a distinct *visual* affinity between cave mural paintings from the western Silk Road and portable paintings on bast fiber. A wall fragment from Kizil at the Museum of Fine Arts, Boston (23.253) reveals this striking similarity, with straw or other similar fibers visible just below the pigment layers. The pigment and ground layer together are not more substantial than one would find on a portable painting on cloth.

## **5.4 Adjustment to painting style: eighth to tenth centuries**

### 5.4.1 Adjustment according to surface

The main conclusion drawn from a comparison of the different painting techniques represented in Dunhuang portable paintings is that the method of painting was adapted to suit the physical nature of the supports in use. There is also a distinct shift in style over the centuries, from a refined brush and ink technique lacking evidence of any prescriptive workshop practice that corresponds to the use of high quality, densely woven silks, giving way to the heavy, opaque pigments and prescribed forms executed on lower quality silks and bast fiber supports after the Tang dynasty.

### 5.4.2 Adjustment according to cultural influence

In examining pigments, supports and painting style, each seems to have been influenced by the isolation of Dunhuang at the decline and fall of the Tang dynasty. As contact with the Tang capital at Chang'an weakened in conjunction with declining imperial sponsorship of the arts and Buddhism, culminating in the wholesale suppression of Buddhism in China, the Dunhuang region was forced to continue with the resources it had available. Without artistic input from eastern China, influence from the south and west became stronger where cultural and economic links were strongest. The occupation of Dunhuang by the Tibetan imperial army from 781-847 CE and the alliance between Dunhuang and Khotan until the fall of the latter to the Quarakhanids in 1006 CE are two obvious examples.

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<sup>93</sup> Unpublished correspondence with Zhao Shengliang, Dunhuang Academy.

## 6 Conclusions

### 6.1 General conclusions

This project examined a group of paintings that, while truly unique in the history of painting in Asia, had yet to receive a comprehensive technical examination of their various components. This project could not begin to answer all of the questions posed by these paintings, but it has become clear that much can be gained from a closer investigation of portable paintings from Cave 17 regarding the story of art and culture at Dunhuang, and the wider socio-economic history of the Silk Road.

While it has been noted that pigment analysis formed the focus of the few technical studies of Dunhuang portable paintings to date, this study has now pinpointed three pigments in particular that have the potential to reveal a great deal about the story of painting in the Dunhuang region. The use of lapis lazuli on portable paintings is inconsistent with its absence on the mural paintings of the same period (discussed extensively in Section 3.2) and may serve as an indicator of the economic and political turbulence that ended the most prosperous phase in the history of the Silk Road. Also, two further pigments have the potential to serve as geographic indicators: analysis of atacamite found in this study indicates that the pigment was likely mined, rather than synthesized, and has the potential to be traced to a source. Talc deposits, found throughout these paintings, is certainly a topic for further research, as it may be possible to compare samples from these paintings with material from the walls of the Mogao Caves themselves, confirming local production of these portable paintings.

This study also explored new areas of research surrounding Dunhuang portable paintings and recognized the importance of their associated textile components. For the first time, textile components were sampled, identified and dated conclusively. Sampling of the non-silk painting *Maitreya's Paradise* revealed the use of ramie fibers, which until now have never before been associated with Dunhuang portable paintings. The presence of ramie fibers in manuscripts also recovered from Cave 17 suggests that its use may be widespread. The radiocarbon dating of *Eleven-Headed Guanyin* also represents the first use of this form of analysis on a Dunhuang portable painting. Given the legacy of forgery that surrounds Central Asian collections throughout the world, this is a very promising tool that may be able to put to rest much of these lingering concerns.

The findings of this research project also support some key areas of recent art historical scholarship surrounding Dunhuang and the Mogao Caves. There are numerous indications, for example, of underdrawing and prescriptive painting techniques in tenth century Dunhuang portable paintings that reinforce Sarah Fraser's research on workshop painting in the

Dunhuang region. The changing style of painting during the Five Dynasties and Northern Song period also appears to confirm Dunhuang's relative isolation and stronger links with non-Chinese Buddhist kingdoms after the fall of the Tang dynasty. The apparent corresponding change in the quality of silk used as painting supports after the Tang dynasty also raises questions about the manufacture and supply of silk throughout Central Asia at this time.

This project represents part of a continuum of research at the Harvard Art Museums. The Harvard Museums have for almost one hundred years been one of the world's leading institutions in Dunhuang research. In 1924, Langdon Warner went to great lengths to bring artifacts from Dunhuang to the Fogg Art Museum for research and study; subsequently, Rutherford Gettens became one of the first in the world to carry out analytical work on objects from Dunhuang, continuing to analyze Dunhuang material at the Freer Gallery of Art and British Museum until his death in 1974. Further research has continued in recent years. Sanchita Balachandran, who re-examined Warner's mural fragments and the history of Dunhuang research at Harvard during her Straus fellowship, was awarded a Baird Fellowship to continue this work. The new history of the Straus Center by Francesca Bewer, *A Laboratory for Art: Harvard's Fogg Museum and the Emergence of Conservation in America, 1900-1950*, also examines the importance of the technical examination of Dunhuang materials in the Harvard collections.

## 6.2 Further research

Due to the age of the objects examined in this study, there are often more resulting questions than answers. As such, there is a great deal of further research that could be done.

As discussed throughout this current study, the textiles associated with Dunhuang portable paintings are particularly compelling. To begin, it would be helpful to establish whether there is a statistically significant difference between the thread counts and densities of Tang silk supports and later Five Dynasties and Northern Song support silks. At a glance, it appears that Dunhuang was forced to rely on locally available and recycled materials after the decline and fall of the Tang dynasty. This would also fit with the changing nature of the painting style in the area, and the paucity of other precious substances, such as lapis lazuli, noted in this study.

Further work is needed to verify such inferences, but a large body of data is already available in the form of Zhao Feng's survey of Dunhuang textiles in the UK. His research includes thread counts that can be tabulated and analyzed in order to establish whether additional work might be fruitful. Zhao Feng did not include the portable paintings on textiles in the Stein Collection within his study and this has formed the core of a successful proposal to continue this line of research with further funding from the Harvard Art Museums in the form of a Baird Fellowship. In addition to the portable paintings that are catalogued within the

British Museum's collections, there remains the possibility that discarded original mounts may still exist, lost during the restoration campaign the Stein Collection underwent upon its arrival at the Museum in the early twentieth century. In addition to establishing a possible pattern in the quality of silks available at Dunhuang after the Tang dynasty, original mounts would tell an important story of the history of early mounting in China, before the rise of literati art and its associated mounting practices.

In a different vein, there is a notable lack of information regarding the acquisition of these portable paintings now in US collections by the Japanese firm Yamanaka & Company. Four of the five paintings in this study were sold by one man, Mr. Tanaka, long after most portable paintings from Dunhuang had been dispersed throughout the globe. In order to discover the details of their acquisition, it would likely be necessary to consult the Yamanaka & Company archives held in Japan. This creates problems for the non-Japanese speaker and highlights one of the main barriers to a more effective understanding of Dunhuang material, which is one of language. It is clear, for example, that the richest sources of information about textiles at Dunhuang are the lists of assets owned by temples there (from offerings, donations and so on), and surviving manuscripts that could be consulted in order to check the nature of the manufacture and use of portable paintings on textiles. For this reason, it is hoped that further work will be carried out in conjunction with the Dunhuang Academy on portable paintings, whereby the Western scholar would benefit from the deep historical and cultural understanding of the Academy's scholars, while in turn placing Chinese colleagues in contact with art from China that has hitherto remained inaccessible to them in the West.

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