A Palette for a Prince: The Colours in the Shahnamah *for Muhammad Juki*

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Abstract

The Shahnamah *(RAS 239) copied for the Timurid prince, Muhammad Juki (1402–1445) in Herat, has long been considered one of the finest surviving, illustrated Timurid manuscripts. It was presented to the RAS in 1834 by Lieutenant Colonel Doyle (1787–1848), but attracted little scholarly attention until Barbara Brend published her monograph in 2010. The manuscript contains 31 exquisite miniature paintings, two of which (fol. 430v and fol. 531r) were added later during the Mughal period (1526–1761). This article will examine the sumptuous, jewel-like colours employed to depict scenes from the epic and the metals, pigments, and dyes from which they were derived. Precious metals and organic colours made from plants such as indigo and lac extracted from female insects are examined in detail: the methods of their production and extraction, the techniques used for their application, their commercial value, and the prestige they afforded their patrons all contribute to an understanding of what constituted the miniature painters' palette in the Timurid period.*

Keywords: *Shahnamah*; Persian miniature painting; Timurid; lac; indigo; gold; silver; pigments; colours

The *Shahnamah* made for Muhammad Juki is one of the great treasures of the Royal Asiatic Society in London.[1] The manuscript was copied in Herat for the prince Muhammad Juki (1402–1445), fourth son of the Timurid ruler Shah Rukh (r. 1405–1447). Muhammad Juki died before it was completed, and the unfinished manuscript seems to have accompanied Babur, founder of the Mughal dynasty, when he moved to northern India in 1526, as his seal, along with those of successive Mughal rulers, is found on folio 536v. The manuscript contains 31 illustrations that Barbara Brend described as being 'of strikingly great beauty not only for their colour and design, but also for their narrative verve and range of feeling'.[2] Barbara

[1]Royal Asiatic Society, Persian Ms 239. The entire manuscript has been digitised at https://royalasiaticcollections.org/ras-persian-239-shahnamah-of-firdausi-of-muhammad-juki/, (accessed 27 April 2022). The digital version available at https://cudl.lib.cam.ac.uk/view/MS-RAS-00239-00001/591 (accessed 27 April 2022) also offers a convenient platform that allows viewers to jump back and forth between individual images.

[2]B. Brend, *Muhammad Juki's Shahnamah of Firdausi* (London, 2010), p. 1.

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Brend, who has devoted much of her life to the study of illustrated Persian manuscripts, made a particular examination of this codex which was published by the Society in 2010.[3] The monograph contains much insightful information on the history, codicology, and paintings of this *Shahnamah*, and in writing this tribute to Barbara Brend and her scholarship, I hope to contribute to its study by shedding light on the question of the colours used by the artists as well as the technique of their application. This article interprets the results of chemical and other technical analysis in light of what is known about the historic trade in these colours, as well as discussing other information such as prices and prestige accrued.

A number of methods have been applied to analyse the pigments and dyes used to paint the illustrations in the Juki *Shahnamah*. Years ago, when I conserved the miniatures in this manuscript, I was permitted to use only non-invasive microscopic methods, as well as the 'new' technique of spectral wavelength analysis for identifying the colours.[4] With these methods, it was possible to identify the various blues (though not the *mixes* using blue) as well as which of the colours were inorganic pigments (made from rocks and minerals) and which were organic colours (made from plants and animals). These methods, however, did not permit identification of the organic colours nor did they provide much information on the pigments. One exception was the pigment orpiment, the yellow tri-sulphide of arsenic, which can usually be identified using a microscope because it has pronounced striations across even the smallest particle. In addition, we can suppose that any green colour damaging the support is likely to contain copper, although, in fact, a number of copper-containing pigments are used in manuscript painting.

More recently in 2019 and 2020, I worked with Professor Maurizio Aceto to analyse the manuscript once more, using new and highly sensitive analytical machinery and non-invasive techniques such as UV-visible diffuse reflectance spectrophotometry with optic fibres (FORS) and spectrofluorimetry.[5] The new analysis unexpectedly identified the female insect lac as the main red organic colour used by every 'hand' as identified by Barbara Brend in her monograph.[6] Only recently have researchers been able to distinguish between lac and other insect reds, and as a result we have begun to recognise lac as one of the main red organic colours used for painting in many Persian and Indian manuscripts beginning as early as the fifteenth century. The results of the recent analysis of the Juki *Shahnamah* were also revealing in identifying the frequent use of indigo, not only for blues but also for many mixtures, including greens, greys, purples, and all shades of each of these colours. Although many other pigments and organic colours have been identified in the Juki *Shahnamah*, this article examines lac and indigo in more depth as well as the ways in which gold and silver metals have been employed throughout the manuscript.

[3]Ibid.

[4]The flaking and powdering pigments were consolidated in 1993. Consolidation is the process of applying a dilute adhesive so as to adhere particles to each other and to the substrate. Closely monitoring the process through a microscope, the chosen adhesive—Selianski (purest grade) isinglass made from the swim-bladder of the sturgeon fish—was applied using a 000 brush.

[5]All of the analysis of lac and indigo cited in this article was carried out in cooperation with Professor Maurizio Aceto, Università degli Studi del Piemonte Orientale, Alessandria, Italy.

[6]Brend distinguished the work of seven hands (Painters A–G): Brend, *Muhammad Juki's Shahnamah*, pp. 189–190.

§1 Lac

Lac is the distinctive red organic colour used to paint purple, lilac, and red. It features in most of the Juki miniatures and was used by all the different hands for different details. For example, in the miniature 'Tahminah comes to Rustam' (Figure 1), the artist used lac to paint the textiles on Rustam's red-purple pillow and his blue-purple mattress. Lac was also used for the red and purple flowers in 'Firdausi encounters the court poets of Ghazna' (fol. 7r), for the lilac backgrounds in 'The fortress of Gang Dizh attacked with mines' (fol. 223r), and even for the horses' red and burgundy armour in 'Gushtasp in battle with Arjasp at Balkh' (fol. 270r–269v). In such a prestigious Persian manuscript, the red might well have been made from Armenian cochineal (*Porphyrophora hamelii*) or from the equally expensive and prestigious kermes (*Kermes vermilio*), imported from the Mediterranean and long traded along the Silk Roads. Analysis proved the contrary: in every case the organic red colour, and all its shades, was made from female insects imported from India and known as 'lac'.[7]

Lac is the resinous excrescence developed by the scale insect *Coccus lacca*. A native of India, it is also found in tropical and subtropical areas of Southeast Asia. The most common species is the *Kerria lacca*. There are two species of lac in India: *Kusumi* and *Rangini*.[8]

For thousands of years, the female lac insect has been used to produce scarlet-red, pink, lilac-purple, and every shade in-between. An ancient dyestuff, it was recorded in the earliest mythological and religious scriptures from India. In the Vedic period (*circa* 1500–1100 BCE), it was known as *laksha* (Sanskrit: *lākṣā*), and the collection of hymns known as the *Atharvaveda* described the lac insect as 'sister of the gods' and 'healer of wounds'.[9] The *Mahabharata*, the epic poem compiled between the third century BCE and the third century CE, mentioned using lac in building a palace, and the Vinaya Buddhist texts detailed how lac was extracted and how to dye with it.[10] Later, the Greeks and Romans used it for dyeing and painting.[11]

Lac was also used widely for medical purposes. Ayuvedic texts recommended lac to treat obesity, dropsy, and chronic fevers, especially following childbirth.[12] Both Arabic and Persian doctors, from Abu Mansur Muwaffaq ibn ʿAli al-Harawi (d. 976) and Avicenna (980–1037) to Ibn al-Baytar (1197–1248), recommended taking lac internally for complaints such as dropsy and liver problems.[13]

Lac was extensively traded from India to the West. The *Periplus of the Erythraean Sea*, a first-century CE Greek text describing the sea routes from Egypt, noted that traders transported lac dye from India to Adulis (modern Zula) on the African coast of the Red Sea.[14] Documents from the Cairo Geniza, an archive found in the Ben Ezra synagogue

[7]For another recent identification of lac, see Kristine Rose Beers, 'Investigating the palette of the Ruzbihan Qur'an', in E. J. Wright, *Lapis and Gold: Exploring Chester Beatty's Ruzbihan Qur'an* (London, 2018), pp. 246–263.

[8]For a full account of species from India and Southeast Asia, see R. A. Donkin, 'The insect dyes of Western and West-Central Asia', *Anthropos* 72 (1977), pp. 864–865; A. Mohanasunderam, M. Monobrullah, K. K. Sharma, S. C. Meena and R. Ramani, *Lac Insect and Associated Fauna* (Ranchi, 2016).

[9]S. Mahdihassan, 'Lac as a drug in the Athara-Veda and its identity', *Hamdard Medius* 23 (1980), pp. 106–132.

[10]M. Roy, 'Dyes in ancient and medieval India', *Indian Journal of the History of Sciences* 13 (1978), pp. 83–112.

[11]It has recently been identified on a third-century BCE Hellenistic wine jug from Puglia in Italy: see J. Dyer, 'The identification of lac as a pigment in ancient Greek polychromy: the case of a Hellenistic oinochoe from Canosa di Puglia', *Dyes and Pigments* 149 (2018), pp. 122–132.

[12]D. Cardon, *Natural Dyes: Sources, Tradition, Technology and Science* (London, 2007), pp. 664–665.

[13]D. Cardon, *Le Monde des Tinctures Naturelles* (Paris, 2003), p. 515.

[14]L. Casson, *The Periplus Maris Erythraei* (Princeton, 1989), Introduction, p. 18; translation, p. 55.

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Figure 1. 'Tahminah comes to Rustam' (detail), *Shahnamah* of Muhammad Juki, Royal Asiatic Society, Ms 239, fol. 56v. Source: Courtesy of the Royal Asiatic Society.

in Fustat (Old Cairo), showed that medieval Jewish traders from Egypt and Libya imported lac from Gujarat and other ports in southwest India. From there, it was shipped either via the Persian Gulf to Persia or via Yemen to Cairo.[15] From Cairo, lac traders travelled across North Africa to Spain, where lac was considered so precious that in 1267 King Alfonso X 'the Wise' decreed that it could be used only by the royal dye works.[16] The identification of lac in prestigious Spanish and Portuguese textiles and manuscripts dating from the Romanesque period onwards attests to the flourishing Arab and Jewish trade networks during this period. Other medieval maps of trade routes show that goods were also shipped from Gujarat via Muscat, Sohar (a port on Oman's north coast), and the islands of Qeshm, Hormuz, and Qish to Siraf on the south coast of Iran. From there, these imports went overland either to Shiraz or to Basra via al-Ubullah. This shipping route was the most likely way that lac arrived

[15]S. D. Goitein, *Letters of Medieval Jewish Traders* (Princeton, NJ, 1973); S. Moosvi, 'India's sea trade with Iran in medieval times', *Proceedings of the Indian History Congress* 70 (2009–10), pp. 240–251.

[16]Cardon, *Natural Dyes Sources*, p. 664.

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in Persia. Lac imported to Venice from Calicut and Cambay was expensive: in 1409 the price had risen to double that of imported brazilwood.[17]

In addition to its uses as a medicine and a dye for textiles, lac was especially important in various aspects of Islamic book production.[18] In his section on making coloured ink, the Zirid prince Ibn Badis (d. 1061) recorded that the best one was made by mixing one-and-a-half ounces of powdered lac with gallnut, tamarisk water, and gum arabic.[19] Writing in 1433, Simi Nishapuri, a librarian at the Timurid court in Mashhad and an expert in the arts of the book, reported that paper dyed with lac was extremely good and could not be faulted.[20] Gum lac was also used as a floatation additive for marbling paper.[21]

Lac was most valuable in book production as paint, in all of its shades. It was used for both the bright pink and the dark and dense scarlet red in a Qurʾan manuscript copied by Muhammad ibn ʿAbdallah ibn ʿAli ibn Gattus in 1213 at Valencia in Andalusia (Cairo, Dar al-Kutub, Rasid 196).[22] As in textile dyeing, lac would have been reserved for high-status manuscripts made in the region.[23] Aceto and I identified lac in a seventeenth-century Ottoman manuscript, where it is used for the beautiful lilac shade of the costumes (Figure 2).

In addition to the fifteenth-century copy of the *Shahnamah* for Muhammad Juki produced in Herat, we also found lac in several other Persian manuscripts, including a fifteenth-century copy of the *Shahnamah* from Shiraz (Cambridge University Library, Or. 420); a mid-fifteenth century copy of the *Shahnamah* with Nizami's *Khamsah* in the margins, attributed to Western India (Manchester, John Rylands Library, Persian 9); and almost all the miniatures in a copy of the *Shahnamah* dated 1635 in the University of Iowa (Figure 3).

Preparing lac for use in painting is an elaborate process.[24] About 18 months before the lac insects are born, the new host tree is prepared by pruning it, so that there is abundant fresh sap for food by the time the new-born insects are transferred to it. Cultivation begins when a farmer ties a broodlac (a stick covered in pregnant females whose eggs are ready to hatch; see

[17]A. Leix, 'Medieval dye markets in Europe', *CIBA Review* 10 (1938), pp. 324–329. From the thirteenth century onwards, lac was imported to Europe, where it was widely used for textile dyeing, painting, and polychromy, as well as for manuscript painting and for colouring tawed skin book covers. By the fourteenth century the Venetians and Genovese, the main traders for all European destinations, purchased it in Constantinople, the principal trading base of the time.

[18]For example, in his *Kitab al-Nabat* the great Persian polymath Abu Hanifa al-Dinawari (d. 896) described using lac to dye leathers and skins: see R. Pfister, 'Matériaux pour servir au classement des textiles égyptiens postérieurs à la conquête arabe', *Revue des Arts Asiatiques* 10.2 (1936), p. 6.

[19]M. Levey, 'Mediaeval Arabic bookmaking and its relation to early chemistry and pharmacology', *Transactions of the American Philosophical Society*, n. s. 52.4 (1962), pp. 19–20.

[20]W. M. Thackston, 'Treatise on calligraphic arts: a disquisition on paper, colors, inks and pens by Simi of Nishapur', in *Intellectual Studies on Islam: Essays Written in Honor of Martin B. Dickson, Professor of Persian Studies, Princeton University*, (eds) M. M. Mazzaoui and V. Moreen (Salt Lake City, 1990), p. 220.

[21]Y. Porter, *Painters, Paintings and Books: An Essay on Indo-Persian Technical Literature, 12–19th Centuries* (New Delhi, 1994), p. 48.

[22]I owe this information to the team of Maria João Melo, Department of Conservation and Restoration Requimte, Faculty of Science and Technology, Campus Caparica, Monte de Caparica, Portugal.

[23]C. Porter, 'Color analysis and the roles of economics, geography and tradition in the artist's choice of colors for manuscript painting', in *And Diverse Are Their Hues: Color in Islamic Art and Culture*, (eds) J. Bloom and S. Blair (New Haven and London, 2011), p. 220.

[24]In January and February 2019, I travelled to Ranchi, Jharkhand, India, to study the cultivation and processing of lac, as well as how it was brought to market. I am grateful to Dr R. Ramani, ex-director of the ICAR-Indian Institute of Natural Resins and Gums (INRG), as well as the scientific team at the Institute. My thanks also to Miho Kitagawa of the Lac Study Group in Japan, and to Mr Singh, Nidhi Agarwal, and Penny Jewel, who made possible my visits to the tribal areas.

Figure 2. Miniatures of sultans and public officers, Ottoman Empire, *circa* 1690, John Rylands Turkish Ms 2. Source: Courtesy of John Rylands Library, University of Manchester.

Figure 4), to a new host tree to be infested (inoculated). The farmers know that the time for transfer is imminent when yellow spots show on the females, indicating they are about to give birth. At this stage, the broodlac is full of liquid that provides food for the young, both male and female, until they exit the mother's body and feed instead on the sap of the new host tree.

Twenty-one days later, when all the young have exited the lac cell, the sticklac (the branch with the dead mother's body in the resinous coating) is untied from the new host tree and removed so that the lac (and the dead mothers) can be scraped off. Since each female gives birth to between 300 and 1,000 young (depending on the species), thousands of young lac insects colonize the new host tree. The young insects' mouthparts pierce and suck the sap from the tree. Once the females begin to suck the sap, they never move again (Figure 5), but during these few days the males continue to move and mate. The males quickly die (within two to three days of emerging from the pupa) and only the (fertilized) females remain on the new branch. A day or so after settling, the females begin to secrete lac resin encasing the insect which increases in size as it matures.

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Figure 3. *Shahnamah*, University of Iowa, Ms F522sh, detail, fol. 395a. Source: Courtesy of University of Iowa Libraries, Special Collections.

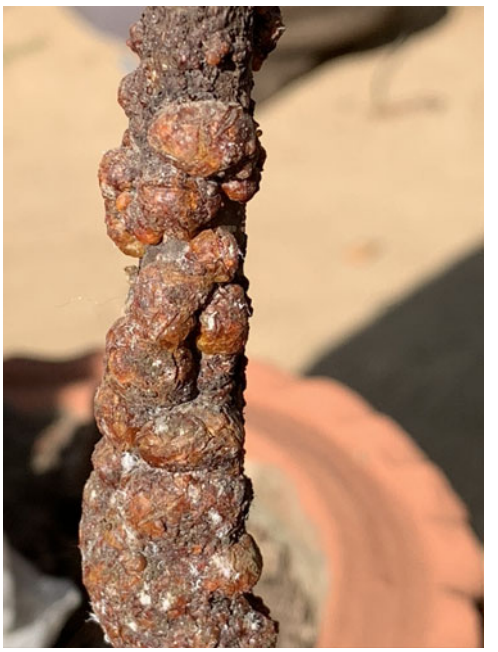

Figure 4. Broodlac: eggs about to hatch. Source: Photo by Cheryl Porter.

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Figure 5. Young 'crawlers' mating and feeding on the new host branch. Source: Photo by Cheryl Porter.

After mating, the female produces more resin as the sap is chemically altered in the female insect's body so as to completely envelop the insect while she continues to feed. When exposed to the air, the extruded substance turns into a gradually hardening resinous material that covers the insects and the twig like a sleeve. Inside the protective cover the females provide the bright red fluid that feeds the eggs, which continue to grow under the resinous cover. When the young insect is fully grown, it pierces a hole in the sack, leaving the empty cell and the dead mother in the lac. The cycle then repeats.

The coated branches of the host trees (Figure 6), with the dead mother and the resin, are cut and taken away to another place where the sticklac is scraped off with a knife. The harvested sticklac, which at this stage contains about 10 per cent of real dyestuff, is crushed and sieved to remove impurities, and the sieved material is then cleaned and purified. A small percentage (about 7 per cent) is usable to make the lac dye. The rest of the product is refined for making waxes and resin.

§2 Indigo

All three blues used by medieval Persian painters—lapis lazuli, azurite, and indigo—were easily available, as attested by their frequent use in Persian painting, both pure and in mixtures such as indigo and lapis for light and dark blues, and indigo mixed with lac for purples and lilacs. Mixing the various blues with other colours, both organic and inorganic, produced browns, greys, and especially greens, a common feature in Persian manuscript

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Figure 6. Kusum tree, the main tree used to host the lac insects throughout the Ranchi-Nankum area, Jharkhand, India. Source: Photo by Cheryl Porter.

painting. Persian artists much admired pistachio green and used indigo to achieve this favoured colour. There is also a long tradition of indigo-dyed textile production in Persia, and many recipes detail the traditional use of indigo in manuscript production for dyeing

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paper, colouring leather, book covers, marbling, making inks, and painting borders, as well as miniature painting.[25]

Minerals for the two blue pigments were mined nearby: lapis in Badakhshan (a region comprising parts of what is now northeast Afghanistan, eastern Tajikistan, and the Tashkurgan county in China) and azurite, a basic copper carbonate, in central Iran and elsewhere. The organic blue, indigo from the plant *indigofera*, was imported but also available locally. Some indigo likely came together with lac and other spices and medicines from India and southeast Asia, shipped from Indian ports such as Cambay in Gujarat (the largest entrepôt for indigo) to the port of Basra.[26] Although indigo had long been imported from India, where it was known as *nil* or *nila*, Persia also produced its own extremely high-quality indigo in Kabul and also in Kirman in southeast Persia.[27]

Indigo is made from the leaves of indigotin-bearing plants. In Europe, this was the woad plant (*Isatsis tinctoria*), but even before the Greeks and Romans, another blue was known to have existed in Asia. In Europe, the colour was known as *indikon* or *indicum* ('the Indian dyestuff') and highly regarded ('the colour of kings and the king of colour'). Although there are numerous plant sources for indigo, the main source in Asia was—and still is—the *indigofera spp*.

Whatever the source, the blue colour is not obtained by simply crushing the leaves, but by soaking them in water to extract the colourless indoxyl. The leaves are then removed and oxygen added by vigorous beating, until a bright blue foam appears. Indigo pigment subsequently precipitates into a blue, clay-like paste, which dries to the durable (and easily transportable) pigment. To make a fermentation dye vat, powdered indigo pigment is stirred into warm water made alkaline with substances such as lime and added reducing agents [28] to feed the bacteria unique to indigo. When the vat reduces (becomes anoxic), it loses its blueness and becomes greeny/yellow, with a coppery dark blue scum of oxidised indigo on the surface. The vat is then ready for dyeing—cloth or yarn dipped in an indigo vat emerges as a yellowy green colour and slowly turns blue on contact with air.

For painting, oxidised foam on the vat surface was sometimes used but generally manuscript and other painters used extracted pigment. Ground indigo can be added to a binder (for example, gum Arabic or egg white) and used like other pigments.

A good place to begin the discussion of the use of indigo in the Juki manuscript is the story Barbara Brend recounts of the derisory sum that Firdausi felt his patron Mahmud of Ghazni had paid him for composing the *Shahnamah*. Later, regretting his lack of generosity, Mahmud sent a camel caravan of indigo 'which, however, entered the town by one gate as Firdausi's body was carried out another'.[29] The story is deeply ironic, given how much indigo occurs in the paintings of the Juki *Shahnamah*. It also serves to demonstrate that

[25]Porter, *Painters, Paintings and Books*, pp. 41–42 and 64.
[26]J. Balfour-Paul, *Indigo in the Arab World* (Richmond, 1997), p. 23.
[27]Ibid., p. 24.
[28]Various substances are traditionally added to adjust the pH of the vat and to promote fermentation. In India, these may include a fructose source, such as dates or tamarind, as well as lime, lumps of chalk, and soda ash, among other substances.
[29]Brend, *Muhammad Juki's Shahnamah*, p. 8.

indigo, although nowhere near as costly or prestigious as the pigment made from lapis, was nevertheless a relatively expensive material.

Indigo is found throughout the Juki *Shahnamah*, both as a pure blue and in mixtures in both miniature paintings and borders. It was used for a number of the blues, for the black water, and for a surprising number of the mixtures. Together with lapis, it formed the dark blues. It is combined with red ochre to make a purple-brown, with red lead to make a red-orange for the fruit on trees, and with lac for lilac-purple backgrounds and textiles. It was frequently used for the green colours, combined mostly with orpiment, but also with yellow plant dyes. In mixing it with a number of yellows, both organic and inorganic, the artist has been able to achieve a wide range of green hues. Green pigments are very rare in nature. The medieval artists knew very well that copper greens frequently damaged the support. They were also incompatible with a number of pigments. One advantage of indigo-based greens is that they are completely inert and can be safely painted with no ill effect to the support or surrounding pigments.

Aceto and I have identified indigo in the Juki *Shahnameh* in miniatures by hands B and C (as defined by Barbara Brend) as well as those by the later Moghul painter(s).[30] On the folio depicting the 'Portrait of the infant Rustam shown to Sam' (fol. 30v), it has been used to paint the light blue sky (Figure 7). In addition, it has been mixed with lapis to form the paint of the dark blue textile on the same folio. The reddish-brown of the fruit on the trees in the same miniature shows a most unusual combination of red lead and indigo.

The painting of 'The paladins in the snow' (fol. 243r), also attributed to hand B, displays much indigo throughout the surface, including the background, the stream, and the clothing (Figure 8). Indigo blue does not sparkle or shine like a mineral blue, but is flatter and duller. Perhaps it is fitting, then, that the artist chose to use so much of the blue indigo in this beautiful but gently foreboding image, as the colour blue was often associated with mourning. The ninth-century ʿAbbasid litterateur Ibn al-Washshaʾ recorded that blue and black were the colours worn by bereaved women and those in trouble.[31] Literary and visual sources tell us that this association continued into the Timurid period. The residents of Samarqand wore blue and black garments to mourn Timur's son Jahangir,[32] and a funeral procession in a manuscript of ʿAttar's *Mantiq al-Tayr* dated 1487 shows several bereaved onlookers in blue robes who wail and rend their garments as they accompany the coffin.[33] One of the gravediggers in the scene wears a blue robe as well. The besotted lover Majnun is typically dressed in blue, as the colour of mourning, in Persian manuscript paintings.[34]

[30]Two miniatures were added to the manuscript in Mughal India: 'Talhand dies during the battle against his brother' (fol. 430v) and 'Yazdagird hides in a mill' (fol. 531r); see Brend, *Muhammad Juki's Shahnamah*, pp. 148–162 for a discussion of the manuscript's sojourn in India.

[31]Balfour-Paul, *Indigo*, p. 167 and note 102 citing Abu Tayyib Muhammad al-Washshaʾ, *Kitab al-Muwashshaʾ*, (ed.) R. E. Brunnow (Leiden, 1886), pp. 126–127.

[32]L. Golombek, 'The draped universe of Islam', in *Content and Context of Visual Arts in the Islamic World*, (ed.) P. P. Soucek (University Park and London, 1988), p. 29 and note 26, citing Sharaf al-Din Yazdi, *Zafarnamah* (Tehran, 1957–58), Vol. 1, p. 199; Balfour-Paul, *Indigo*, p. 167 and note 103.

[33]New York, Metropolitan Museum of Art, 63.210.35; available at https://www.metmuseum.org/art/collection/search/451730?searchField=All&sortBy=Relevance&ft=mantiq+al-tayr&offset=0&rpp=20&pos=5 (accessed 27 April 2022).

[34]J. Scott Meisami, 'I guess that's why they call it the blues: depictions of Majnun in illustrated manuscripts', in *And Diverse Are Their Hues*, (eds) Bloom and Blair, pp. 120–151.

Figure 7. 'Portrait of the infant Rustam shown to Sam', *Shahnamah* of Muhammad Juki, Royal Asiatic Society, Ms 239, fol. 30v. Source: Courtesy of the Royal Asiatic Society.

The painting of 'The paladins in the snow' (Figure 8) also displays unusual combinations using indigo: indigo and red ochre for the light purple-brown background, and indigo with an organic (plant) yellow for the dark rich green textile of the clothing for the man on the

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Figure 8. Detail from 'The paladins in the snow', *Shahnamah* of Muhammad Juki, Royal Asiatic Society, Ms 239, fol. 243r. Source: Courtesy of the Royal Asiatic Society.

left. Of equal interest is the identification of indigo as the dark grey of the stream at the foot of this miniature. Water is usually painted with silver in Persian manuscripts, but here it is not. It has no reflectance, no light coming from it, but is dark and dead.

§3 Gold and silver

Befitting a courtly manuscript, the artists of the Juki *Shahnamah* used precious metals to enhance the paintings. Two forms of gold were available to Persian painters: leaf and paint (sometimes called 'shell gold'). The earliest sources for preparing gold ink and paint described amalgamating gold powder with mercury. Recipes 54 and 71 from the Leyden Papyrus, a document transcribed in the third century CE from earlier copies, mentioned using metal mercury to prepare gold paint.[35] Another method used in medieval times involved putting gold paste into a cloth or wash-leather and squeezing out the excess mercury so that the amalgam became hard and brittle enough to grind into powder.[36] The tenth-century Yemeni scholar al-Hamdani also noted the use of mercury for refining gold in his treatise on precious metals.[37] Analysis also shows that gilding techniques, which had developed in Antiquity, were still frequently used in al-Andalus between the

[35]E. R. Caley, 'The Leyden Papyrus X: an English translation with brief notes', *Journal of Chemical Education* 3.10 (1926), p. 1157, §54: 'Preparation of liquid gold. Soft leaves of gold: pulverise with mercury in a mortar; and employ them in writing, after the manner of black ink', 71.

[36]D. Thompson, *The Materials and Techniques of Medieval Painting* (New York, 1956), p. 194.

[37]J. W. Allan, *Persian Metal Technology, 700–1300* (London, 1979), p. 7.

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tenth and twelfth centuries, primarily because mercury was available locally.[38] In later times, however, the mercury amalgam was replaced by grinding the leaf with honey, gum, or salt and then washing away these additions with water, a technique still used in Turkey and the Indian subcontinent.[39]

For such a prestigious manuscript, the Juki *Shahnamah* displays a rather restrained use of gold, almost exclusively gold paint. Gold is employed for the sky in paintings attributed to three artists: 'Ruhham attacks the sorcerer Bazur' (fol. 135r; Figure 9) by hand A; 'The div Akvan lifts the sleeping Rustam' (fol. 165v) and 'Gushtasp plays polo before the Qaysar' (fol. 252r) by hand C; and 'Isfandiyar slain by Rustam' (fol. 296r) by hand D.

In general, when gold is used for painting in the Juki *Shahnamah*, whether for the sky, architectural features, trees, crowns, or even fire, it is a single hue. To paint the metal armour in this manuscript, however, the artists used two shades: one greenish and one more yellow. They juxtaposed different hues to show strips of metal, one joined to the other, and indicate the method of fabricating armour (see Figure 9).

Although many Islamic manuscripts juxtapose gold of different hues (or play off leaf and paint), the shift towards the use of two (or more) contrasting hues of gold became prominent in fifteenth-century Turkoman painting.[40] The various shades of greenish and reddish gold result from additional elements of silver and copper, respectively. Native gold almost always contains silver in amounts varying between 5 and 50 per cent. The higher the silver content, the greener the hue. When gold is red or rose-coloured, as for example in a late sixteenth-century Mughal Qur'an manuscript in the Chester Beatty Library (Ms Is 1547), one can be sure that the copper has been added, since natural copper content rarely exceeds 1 per cent.[41]

Another method of enhancing gold paint is by pricking and punching, enabling the flat metal surface to catch and reflect light at different angles and adding depth, definition, and complexity to the surface of the painting. The painters of the Juki added pricking to indicate the riveting of the metals, as in 'Isfandiyar slain by Rustam' (fol. 296r). They used the technique not only for soldiers' armour ('Rustam rescues Bizhan from the pit', fol. 180r), but also for the protective covering of the horses ('Farud shoots Zarasp', fol. 119v).

The technique of pricking and punching has been identified in manuscripts produced in the 1350s and 1360s at Shiraz in southwest Iran.[42] The same technique occurs in European manuscripts much earlier, at least from the 1230s, although it did not become common until the early 1400s.[43] A particularly interesting use of punching occurs in the late sixteenth-century Persian Qur'an manuscript in the Chester Beatty Library (Ms Is 1547) where the black letters are outlined in gold ink, with tiny punch marks evenly placed in the gold to reflect the light in a subtle but effective way.[44] The real beauty of the punched letters

[38]J. B. Martin, 'Islamic gilding technology: written sources and scientific analyses', in *Art Technology, Sources and Methods*, (ed.) S. Kroustallis (London, 2008), pp. 119–126.

[39]This technique is still used, with gum in Turkey and with honey in India. For a useful explanation of this technique, see Anita Chowdry on preparing 'shell gold': https://anitachowdry.wordpress.com/2015/05/27/preparing-shell-gold/ (accessed 27 April 2022).

[40]Wright, *Lapis and Gold*, p. 242.

[41]For the Mughal Qur'an manuscript, see A. J. Arberry, *The Koran Illuminated* (Dublin, 1967), no. 163, p. 50.

[42]E. Wright, *The Look of the Book: Manuscript Production in Shiraz, 1303–1452* (Washington DC, 2012), p. 58.

[43]N. Morgan, 'Painting with gold and silver', in *Colour: The Art and Science of Illuminated Manuscripts*, (ed.) S. Panayotova (London, 2016.)

[44]Arberry, *The Koran Illuminated*, p. 50.

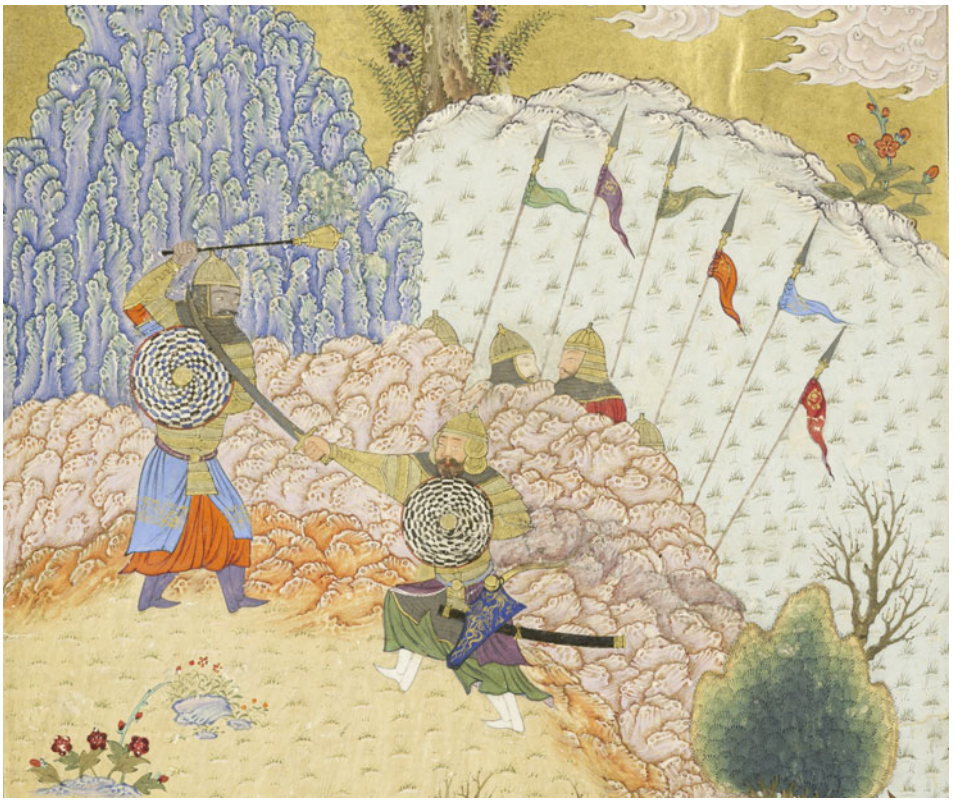

Figure 9. Detail from 'Ruhham attacks the sorcerer Bazur', *Shahnamah* of Muhammad Juki, Royal Asiatic Society, Ms 239, fol. 135r. Source: Courtesy of the Royal Asiatic Society.

can be appreciated only when studying the unpunched letters, which seem quite ordinary in comparison.

Silver is found throughout the Juki *Shahnamah*. Since silver often oxidises to form a dark grey or even a black layer, it is often impossible to tell whether the silver was applied in the form of leaf or paint or even painted in black. In manuscripts made in the Islamic lands, painters frequently used silver to depict armour and metal implements as well as water. It seems strange that artists would choose a metal that they knew would almost certainly blacken over time. How long this process takes depends on various factors, including the metal's reaction to other pigments and dyes around it, how often the book was opened, how polluted the atmosphere was, and the purity of the metal itself. Most certainly, the use of the precious metal to depict specific objects and water was simply accepted as a convention, and the inevitable blackening accepted as part of that convention, since silver would have likely retained its colour at least during the presentation of the manuscript and perhaps for many years afterwards. Nevertheless, when looking at water in rivers, ponds, lakes, and deep sea, it is clear that very often it is *not* blue (or green) at all. It is almost always dark in colour, sometimes nearly black, and often darkly reflective, exactly the way artists in the Islamic lands had

painted it. Moreover, water in these manuscripts is portrayed much more realistically than in medieval European painting, which typically had blue wavy lines.[45]

Insects, plants, stones, minerals, and precious metals, many of them expensive imports, were used to paint the Juki *Shahnamah*. Thus, in addition to the beauty, narrative verve, and range of feeling that Barbara Brend noted in the manuscript, we can say that the colours are composed of the most precious and expensive pigments, dyes, and valuable metals that display the technical skill of the artists and the wide range of materials accessible at the Timurid court.

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[45]Indian manuscripts almost always use tin, especially to depict water, and much else besides. For further discussion, see C. Porter, 'The use of metals in Islamic manuscripts', in *The Making of Islamic Art. Studies in Honour of Sheila Blair and Jonathan Bloom*, (ed.) R. Hillenbrand (Edinburgh, 2021) pp. 160–179.

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