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# Going Beyond Appearances

## Examination of Hidden Paint Layers in a *Gulistan* of Sa'di from the Freer Gallery of Art

*Elisabetta Polidori,  
Emily K. Jacobson, and  
Blythe McCarthy*

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## ABSTRACT

Polidori, Elisabetta, Emily K. Jacobson, and Blythe McCarthy. Going Beyond Appearances: Examination of Hidden Paint Layers in a *Gulistan* of Sa'di from the Freer Gallery of Art. *Smithsonian Contributions to Museum Conservation*, number 8, vi + 40 pages, 42 figures, 2019. — Among the many manuscripts at the Freer Gallery of Art is a lavishly illuminated copy of the *Gulistan* of Sa'di (F1998.5). This manuscript was transcribed in an elegant nasta'liq script by renowned calligrapher Sultan 'Ali Mashhadi in Herāt (present-day Afghanistan) in 1468, but much of its history is unknown. The text includes six paintings that were added in the seventeenth century during the reign of Mughal emperor Shah Jahan in India. Stains on the versos of the painted pages provide tantalizing traces of the existence of earlier illustrations underneath the Mughal ones. A technical study incorporating infrared and ultraviolet imaging, X-ray computed radiography, and targeted pigment analyses has revealed new information about these preexisting paintings. The size of the figures and the intermediate changes to the compositions suggest there were several working phases for the manuscript. A revised chronology now includes these phases and further enriches our understanding of this complex manuscript. From a technical standpoint, this research highlights both the challenges and undeniable potential of imaging technology for the study of Islamic manuscript paintings, many of which have been reworked at various times in their history.

*Cover image:* Detail of *A Prince Riding* by Mughal artist Balchand from the Freer Gallery of Art's *Gulistan* of Sa'di (F1998.5.65).

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# Contents

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LIST OF FIGURES	<b>v</b>
INTRODUCTION	<b>1</b>
THE FREER <i>GULISTAN</i> : DESCRIPTION AND HISTORIC PROVENANCE	<b>1</b>
SCIENTIFIC EXAMINATION OF THE <i>GULISTAN</i> PAINTINGS	<b>6</b>
Methods	<b>6</b>
Results	<b>9</b>
Discussion	<b>20</b>
CONCLUSIONS	<b>31</b>
ACKNOWLEDGMENTS	<b>33</b>
CHRONOLOGY	<b>35</b>
NOTES	<b>37</b>
BIBLIOGRAPHY	<b>39</b>



# Figures

---

1. Paintings in the <i>Gulistan</i> of Sa'di. India, Mughal dynasty, circa 1645	2
2. Colophon on folio 105a	3
3. Illuminated borders on folio 6b	4
4. Inscriptions on folio 1a	5
5. <i>Sa'di in the Rose Garden</i> by Govardhan on folio 6a	6
6. Discoloration on <i>Sa'di in the Rose Garden</i>	7
7. Water stains on folio 7b	7
8. Multispectral examination of the Freer <i>Gulistan</i>	8
9. Tracing of original paint overlaid on <i>A Prince Riding</i> by Balchand on folio 65a	9
10. <i>Galen Watching a Dispute</i> by Payag on folio 60b	10
11. Pigment offset on folio 61a from <i>Galen Watching a Dispute</i>	11
12. <i>Sa'di in the Rose Garden</i> by Govardhan on folio 6a	12
13. Computed radiograph of <i>Sa'di in the Rose Garden</i>	12
14. Reflected infrared image of <i>Sa'di in the Rose Garden</i>	13
15. Digital reconstruction of the earlier painting underneath <i>Sa'di in the Rose Garden</i>	13
16. <i>The Prophet and the Persian Physician</i> by Abid on folio 46b	14
17. Transmitted infrared image of <i>The Prophet and the Persian Physician</i>	15
18. Digital reconstruction of the earlier painting underneath <i>The Prophet and the Persian Physician</i>	15
19. <i>Galen Watching a Dispute</i> by Payag on folio 60b	16
20. Computed radiograph of <i>Galen Watching a Dispute</i>	16
21. Transmitted infrared image of <i>Galen Watching a Dispute</i>	17
22. Digital reconstruction of the earlier painting underneath <i>Galen Watching a Dispute</i>	17
23. <i>A Prince Riding</i> by Balchand on folio 65a	18
24. Discoloration on the reverse of <i>A Prince Riding</i>	19
25. Transmitted infrared image of <i>A Prince Riding</i>	20
26. Reflected infrared image of <i>A Prince Riding</i>	20
27. Computed radiograph of <i>A Prince Riding</i>	21
28. Digital reconstruction of the earlier painting underneath <i>A Prince Riding</i>	21

29. <i>The Qazi of Hamadan in a Drunken State</i> by Lalchand on folio 74a	22
30. Discoloration on the reverse of <i>The Qazi of Hamadan in a Drunken State</i>	22
31. Computed radiograph of <i>The Qazi of Hamadan in a Drunken State</i>	23
32. Digital reconstruction of the earlier painting underneath <i>The Qazi of Hamadan in a Drunken State</i>	23
33. <i>Sa'di's Companion Frightened by the Tribes from the Hills</i> by Murad on folio 85b	24
34. Discoloration on the reverse of <i>Sa'di's Companion Frightened by the Tribes from the Hills</i>	24
35. Details in visible light and transmitted infrared light of <i>Sa'di's Companion Frightened by the Tribes from the Hills</i>	25
36. Digital reconstruction of the earlier painting underneath <i>Sa'di's Companion Frightened by the Tribes from the Hills</i>	25
37. <i>The Coronation of Sultan Husayn Mirza</i> , attributed to Mansur. Historic Iran (present-day Afghanistan), Herāt, Timurid dynasty, circa 1469	26
38. <i>The Two Wrestlers</i> , attributed to Shah-Mozaffar. Historic Iran (present-day Afghanistan), Herāt, Timurid dynasty, circa 1486	27
39. <i>Timur Hunting</i> , from a <i>Zafarnama (Book of Victories)</i> of Sharaf al-Din Ali Yazdi. Iran, Shiraz, Timurid dynasty, circa 1436	28
40. Folio from a <i>Shahnama (Book of Kings)</i> of Firdawsi. Iran, Gilan, Aq Qoyunlu dynasty, Turkmen period, 1493–1494	29
41. Folio from <i>Mihr u Mushtari (The Sun and Jupiter)</i> of 'Assar. Iran, Shiraz, Aq Qoyunlu dynasty, Turkmen period, 1477	30
<i>Unnumbered</i>	
Detail of illuminated border on folio 6b	40

# Going Beyond Appearances

## Examination of Hidden Paint Layers in a *Gulistan* of Sa‘di from the Freer Gallery of Art

Elisabetta Polidori,<sup>1</sup> Emily K. Jacobson,<sup>2\*</sup> and Blythe McCarthy<sup>2</sup>

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### INTRODUCTION

The collection of Persian and Indian manuscripts at the Freer Gallery of Art, Smithsonian Institution, is one of the finest in the world. Among its many gems is a lavishly illuminated copy of the *Gulistan* of Sa‘di. Given its exceptional artistic quality, this manuscript stands as a major achievement in the arts of the book, yet much of its complex history remains unknown.

The manuscript was transcribed by the most celebrated calligrapher of his time, Sultan ‘Ali Mashhadi, in Herāt, present-day Afghanistan, in 1468. Written in an elegant nasta‘liq script, the text includes six full-page miniatures, which were executed in India in the seventeenth century during the reign of Mughal emperor Shah Jahan (reigned 1628–1657; Figure 1).

Brown stains caused by the degradation of copper-based pigments are present on the verso of the folios with paintings. Such areas of discoloration do not match the visible paint layer, providing tantalizing traces of the existence of earlier illustrations below the Mughal ones. In this work, a thorough imaging campaign, undertaken to reveal as much as possible of the previous compositions, and targeted pigment analyses are discussed in the context of the history of the manuscript.<sup>1</sup> This technical work reveals that the history of the *Gulistan* and its paintings is more complicated than previously thought.

### THE FREER *GULISTAN*: DESCRIPTION AND HISTORIC PROVENANCE

The *Gulistan*, meaning “rose garden,” is one of the greatest works of Persian literature. Composed by Shaykh Sa‘di Shirazi and completed in 1258, this text was copied countless times and provided inspiration for many pictorial representations in illuminated manuscripts from the Persianate world.

The *Gulistan* is conceived as a collection of moralizing stories and anecdotes, dealing with virtually every major issue and challenge faced by mankind. The prose, written in an elegant, colorful, and terse style, is interspersed with verses in a variety of meters used to comment on the narrative and draw a moral from it.

The Freer copy of the *Gulistan* is a relatively small manuscript (25.4 × 16.5 × 2.5 cm), bound in a gilt-stamped green leather binding. Several leaves with illuminations and paintings, one singleton and six bifolios, are no longer part of the text

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FIGURE 1. The Mughal paintings in the *Gulistan* of Sa'di. India, Mughal dynasty, circa 1645. Opaque watercolor, ink, and gold on paper. Gift of the Art and History Trust in honor of Ezzat-Malek Soudavar. Freer Gallery of Art, Smithsonian Institution, F1998.5.



block and are housed separately inside window mats. The manuscript comprises a total of 105 folios and is complete, with the exception of folio number 4, which was separated at the beginning of the twentieth century and is now part of the Keir Collection, currently on long-term loan to the Dallas Museum of Art.<sup>2</sup>

The Freer *Gulistan* is very important from both artistic and historical perspectives, as it is the product of three royal workshops operating under the Timurid<sup>3</sup> and Safavid<sup>4</sup> dynasties in Iran and under the Mughal<sup>5</sup> dynasty in India. The co-existence in this manuscript of multiple historic layers makes it possible to study not only the artistic canons promoted in the royal ateliers during these different periods but also their interaction.<sup>6</sup> Of great importance to this end is the presence in the manuscript itself of direct documentary evidence regarding production and ownership history.

According to the colophon (Figure 2), the text was transcribed by renowned calligrapher Sultan ‘Ali Mashhadi in 1468 in Herāt, situated in modern-day Afghanistan, during the reign of Sultan Abu Sa‘id Mirza (reigned 1451–1469).<sup>7</sup>

The current borders are not contemporary to the calligraphic work. Although most of them are decorated with gold flecks with a technique called *zarafshan*, 16 bear lavish illuminations. The decorations, depicting legendary birds (*simurgh*) and animals jumping or locked in combat in a configuration called *girift-o giri* (“give and take”; Figure 3), stand out for their exquisite quality; on stylistic basis, Abolala Soudavar has suggested that they were executed by Aqa Mirak in the 1540s. A close confidant of the second ruler of the Safavid Empire, Shah Tahmasp (reigned 1524–1576), and a leading artist of his court in Tabriz in northwestern modern-day Iran, Aqa Mirak participated in a number of important projects within the royal workshop, such as the execution of deluxe copies of the *Shahnama* and of the *Khamasa* by Nizami. Mirak’s fame was so high he was mentioned in the treatise *The Canons of Painting* by the head of the royal atelier of Shah Abbas, Sadeqi Beyg Afshar.<sup>8</sup>

At some point the manuscript must have traveled to India and entered the Mughal royal library<sup>9</sup> because an inscription on a flyleaf (Figure 4) recounts that the third Mughal emperor Akbar (reigned 1556–1605) donated the manuscript to his commander in chief, Mun‘im Khan, in 1568.<sup>10</sup> The inscription describes the book with five paintings—one less than the current number.

Additional inscriptions on the same flyleaf document the subsequent history of the manuscript.<sup>11</sup> The *Gulistan* entered the Mughal royal collection again during the reign of Jahangir (reigned 1605–1627),<sup>12</sup> suggesting that although precious manuscripts were given as tokens of appreciation to members of the governing elite, they were largely treated as temporary gifts or loans, which were at times returned.<sup>13</sup> Shah Jahan<sup>14</sup> (reigned 1628–1658) and his daughter Jahanara Begum<sup>15</sup> are also listed among the owners of the *Gulistan*.

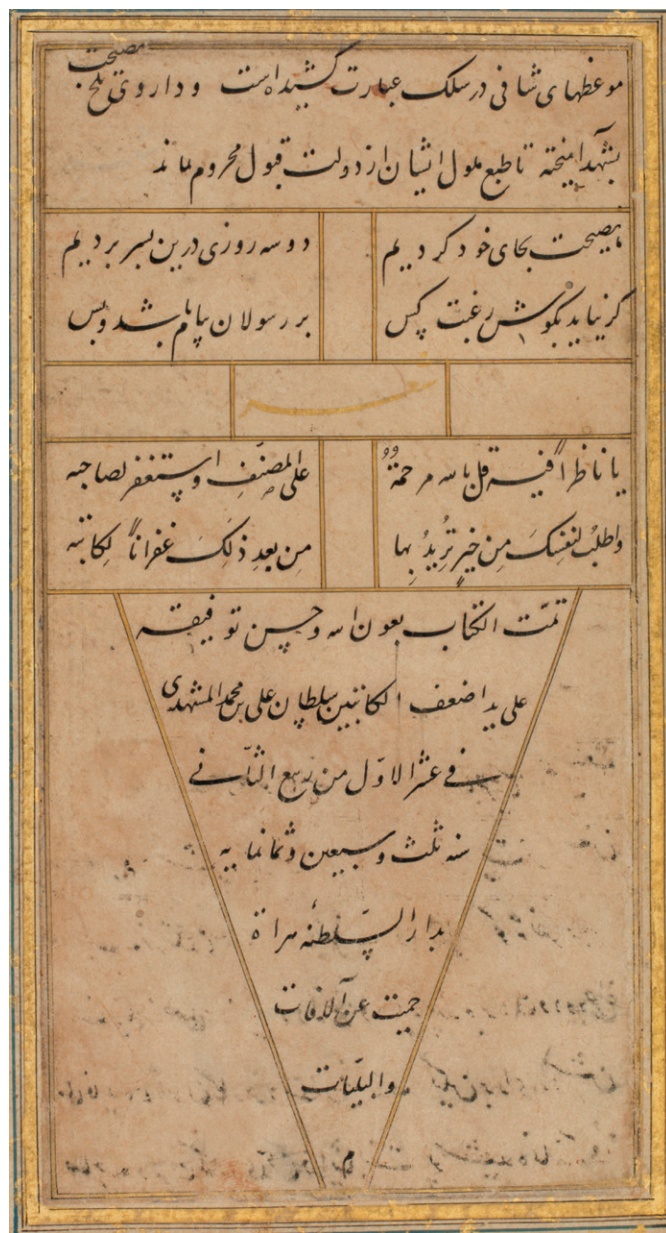


FIGURE 2. Colophon, folio 105a, the *Gulistan* of Sa‘di, F1998.5.105. The colophon gives information about the calligrapher and date of execution.

A critical phase in the history of the manuscript is the execution of new paintings over the preexisting ones by the leading artists of the court of Shah Jahan—Govardhan, Abid, Payag, Balchand, Lalchand, and Murad—whose names were noted as small inscriptions<sup>16</sup> next to or within the images;<sup>17</sup> a date of execution of circa 1645 has been proposed on stylistic grounds.<sup>18</sup> The Mughal paintings number six, one more than in the pictorial cycle described by





FIGURE 3. Folio 6b, the *Gulistan* of Sa'di, F1998.5.6. The illuminated borders have been attributed to Aqa Mirak.



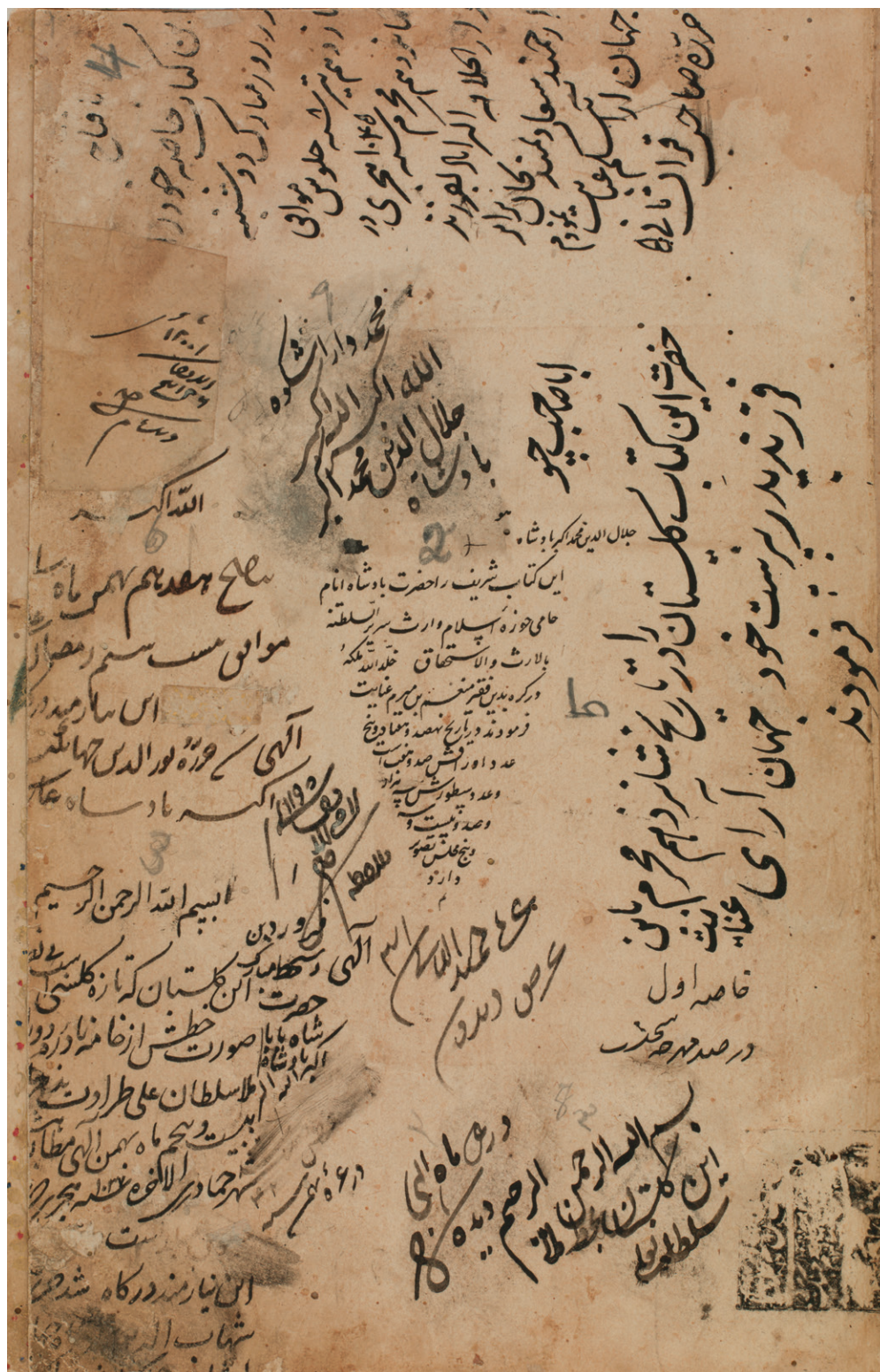


FIGURE 4. Folio 1a, the *Gulistan* of Sa'di, F1998.5.1. These inscriptions give important information about the owners and the history of the manuscript.



Mun'im Khan. Since the text is complete, it has so far been assumed that an illustration that had been planned for in the Timurid time period was never executed and that one of the six Mughal artists worked on a blank folio rather than on a preexistent paint layer.

As mentioned, shadows of the original illustrations of the *Gulistan* are visible on the opposite sides of the Mughal paintings as dark stains caused by the degradation of copper-containing pigments. Ubiquitous in Persian and Indian art, these pigments are fairly unstable, and in humid environments they can interact chemically with the cellulose support, causing its discoloration and embrittlement.<sup>19</sup> Like an echo from the past, these outlines of discoloration provide the viewer with a vague, yet tantalizing, idea of the earlier paintings, which are characterized by considerably larger figures compared to their Mughal counterparts. The only exception is *Sa'di in the Rose Garden* by Govardhan (folio 6a);<sup>20</sup> in this folio, the green areas of paint on the recto are consistent with the discoloration on the verso, leading to a preliminary assumption that this painting was added to the pictorial cycle in 1645 and that no Timurid version existed underneath (Figures 5, 6).

The circumstances that led to the repainting campaign are unknown; according to Stuart Cary Welch, it was carried out to remedy the damage caused by a fire that broke out in the royal palace in 1644 and almost took the life of princess Jahanara.<sup>21</sup> A set of water stains, visible on the top fore-edge corner of each folio, could be evidence of this fire. However, these stains are contained within the margins and do not extend into the central area of the folios, where the paintings are located; it therefore seems unlikely that the original illustrations were damaged on this occasion.

A second group of water stains runs across the text area of each folio throughout the manuscript. Given that their trace ends abruptly at the joint with the Safavid margins, this additional water accident cannot be linked to the alleged fire and must have occurred before the addition of the new borders in the 1540s (Figure 7). The dark coloration of these stains, which suggests prolonged exposure of the paper to water, and their position over areas of painting and writing point to a much more serious accident than the one previously mentioned. Several areas of the carbon black ink calligraphy were solubilized, and the illustrations' paint layer became critically soft by exposure to water, as indicated by the presence of offset paint on the pages that faced the paintings when they were still bound in the text block.

It remains debatable whether the original illustrations were painted over because they were damaged. Rather than having a practical purpose, the repainting campaign might have had a symbolic one, namely, asserting the Mughal ownership on the Timurid manuscript and contextually emphasizing the artistic skill reached in pictorial representation by Mughal painters.<sup>22</sup>



FIGURE 5. *Sa'di in the Rose Garden* by Govardhan on folio 6a of the *Gulistan* of Sa'di, F1998.5.6.

## SCIENTIFIC EXAMINATION OF THE *GULISTAN* PAINTINGS

### METHODS

Only noninvasive techniques were used in the scientific investigation of the *Gulistan* paintings. High-resolution imaging was carried out at the National Postal Museum, Smithsonian Institution, using a video spectral comparator (VSC 6000)





FIGURE 6. Folio 6b, the *Gulistan* of Sa'di, F1998.5.6. Discoloration on the reverse of Sa'di in the *Rose Garden* by Govardhan. The image has been rotated horizontally for the sake of comparison.

manufactured by Foster + Freeman.<sup>23</sup> This device consists of a main unit outfitted with several light sources and a camera, connected to a personal computer (Figure 8). It provided the ability to perform a wide range of examination techniques and to take a large number of images with the same spatial registration and resolution, which can easily be compared and overlapped. The VSC 6000 was used to examine the paintings under incident, raking, and transmitted light. Wavelength

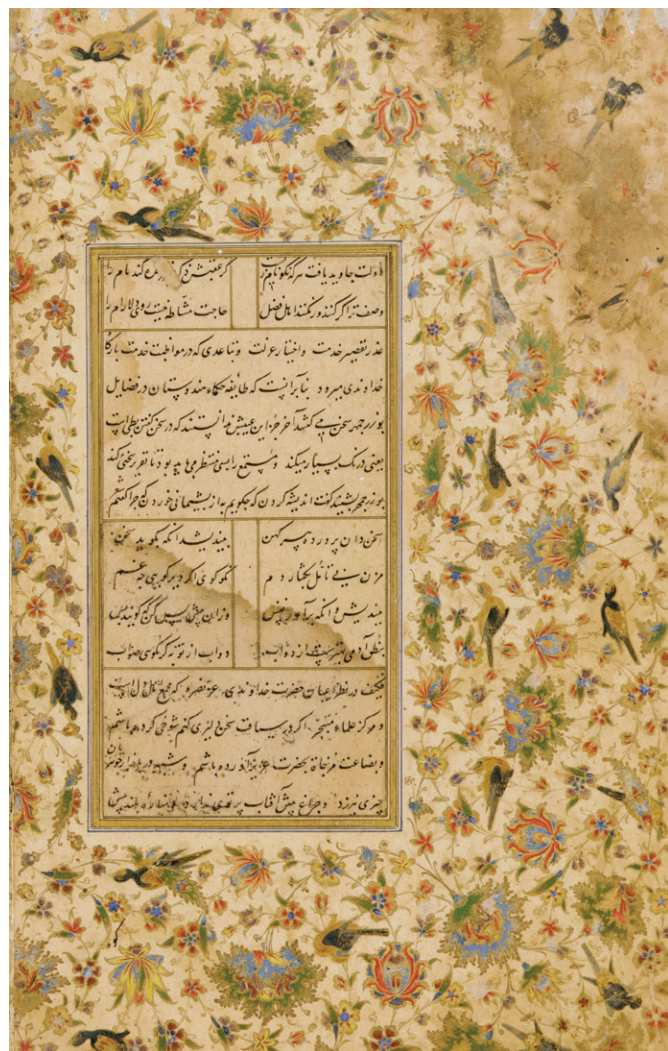


FIGURE 7. Folio 7b, the *Gulistan* of Sa'di, F1998.5.7. Folio 7b shows water stains in the calligraphy section, as well as in the upper right corner of the borders. These stains are not contemporaneous; rather, they were caused by two separate water incidents that occurred at different points in time.

bands generated by a combination of filters on the camera and multiple light sources spanning from 254 nm in the ultraviolet (UV) to 1,000 nm in the infrared (IR) were used.<sup>24</sup>

Near-infrared radiation—in the region of the electromagnetic spectrum between 700 and 1,000 nm—proved extremely useful for the purposes of this research. Near-infrared radiation is characterized by lower energy and higher wavelength than visible light and can penetrate many pigments commonly used in paintings, whereas it is absorbed by carbon-based substances, often employed in underdrawings, and copper-based pigments. In reflected IR imaging,<sup>25</sup>





FIGURE 8. Elisabetta Polidori performs multispectral imaging of one of the Freer's *Gulistan* paintings at the National Postal Museum.

each painting was illuminated from the front with a halogen lamp,<sup>26</sup> and the near-infrared radiation reflected back from the surface was captured with the camera outfitted with a 1,000 nm long-pass filter.

Transmitted IR imaging was the technique that yielded the most information. Operating in a way very similar to reflected IR imaging, the camera captures the near-infrared radiation transmitted through a painting illuminated from the back rather than from the front.

The VSC 6000 also has the ability to produce UVA-induced visible fluorescence, a phenomenon which occurs when a material absorbs radiation in the region of the electromagnetic spectrum between 315 and 400 nm and reemits it in the visible region. This technique corroborated some of the findings obtained with IR radiation by providing information about pigment distribution in the various paint layers. For example, Indian yellow and madder lake, two organic pigments frequently found in Mughal art, can fluoresce strongly when irradiated with a UVA source, whereas copper-based pigments absorb the radiation and thus appear dark under the same conditions.

Selected areas of the paintings were also more closely investigated with multispectral imaging. By using broadband illumination<sup>27</sup> and a 40 nm band-pass filter<sup>28</sup> while moving in

steps of a few nanometers, an image may be acquired wherein each pixel can represent any region of the spectrum between 400 and 1,000 nm.

In addition to the multispectral imaging, computed radiography (CR)<sup>29</sup> using a GE Inspection Technologies ISO-VOLT Titan X-ray source and GE Rhythm detection system was performed on the paintings in the Department of Conservation and Scientific Research of the Freer Gallery of Art and Arthur M. Sackler Gallery.<sup>30</sup> Although X-rays can penetrate through many paint layers, they are absorbed by elements with a high atomic number, such as lead and other heavy metals. Therefore, areas painted with white lead, red lead, gold, and similarly dense substances appear lighter in color. The level of penetration is also a function of the thickness of the layer; thus, areas that are more thickly painted appear lighter than areas painted sparingly with the same material.

Once the imaging campaign was completed, the images obtained from each artwork were overlapped using a raster graphic editor (Adobe Photoshop), and sections of vestigial paint, which could be identified with the various techniques, were digitally traced on an overlay. Areas of the Mughal illustrations where the presence of a preexisting pictorial layer had been positively identified were then analyzed with X-ray fluorescence spectroscopy (XRF),<sup>31</sup> a noninvasive elemental



FIGURE 9. A Prince Riding on folio 65a of the *Gulistan* of Sa'di, F1998.5.65. The tracing of original paint (in red) found through imaging was digitally overlapped on the painting by Balchand in preparation for XRF analysis.

technique that reveals the presence, in a material, of chemical elements with medium and high atomic numbers. The outline produced in Photoshop was essential to accurately locate vestigial areas in relation to the Mughal compositions (Figure 9). Interpretation of the results from this spectroscopic analysis was complicated by the fact that Persian and Mughal painting materials are inherently similar. Therefore, the presence of vestigial paint could be confirmed from an analytical standpoint only when the chemical elements detected by the instrument were clearly inconsistent with the estimated composition of the paint visible on the surface. For example, in *The Prophet and the Persian Physician* attributed to Abid (folio 46b), XRF measurements on the light

green paint just below the *Prophet* figure detected copper, lead, and mercury. The first two elements are consistent with a copper-based green pigment mixed with white lead. Mercury, however, is typically associated with either vermilion or cinnabar, both red mercuric sulfides. Given that no red pigment is visible in this area, its presence in an underlying paint layer must be assumed.

Additional information was gathered from areas of off-set paint visible on the pages that used to face the paintings when they were still bound in the text block.<sup>32</sup> This offset does not match the Mughal paintings and therefore must have originated from the earlier depictions (Figures 10, 11). Even though their extent varies considerably, these areas of paint offset provide interesting information about the original palette and, in the case of the folio that used to face *Galen Watching a Dispute*, offer a glimpse of the original composition.

Finally, information obtained from visual examination, the imaging campaign, and scientific analyses was combined in Photoshop, leading to the digital reconstruction of sections of the original paintings. Although based on a scientific investigation, the interpretation of such information remains to some extent subjective. These reconstructions should therefore be seen as tools to further the research, rather than its end point.

## RESULTS

The findings from imaging and analysis of all six paintings will be presented here, although the techniques that yielded no meaningful results will be omitted. With the exception of *The Prophet and the Persian Physician* (folio 46b), residues of preexisting paintings underneath the visible ones seem rather scant. It is important to note that the practice of repainting was common in Mughal times, and preexisting illustrations could be intentionally wiped off, scraped, or otherwise removed to accommodate new compositions.<sup>33</sup>

The examination of *Sa'di in the Rose Garden* by Govardhan (folio 6a) led to the discovery of very interesting information (Figure 12). Computed radiography revealed the presence of a kneeling figure with extended arms (Figure 13) beneath Sa'di's companion on the left-hand side of the composition. This area appears red in transmitted visible light, as does an object—likely a turban—located to the left of the head of Sa'di. In reflected IR the tree on the left appears thicker, and the base of a second, shorter shrub can be identified in the upper right quadrant (Figure 14). Even though the information is not exhaustive, the sections of the earlier painting that could be reconstructed appear remarkably different from the Mughal composition (Figure 15).

In *The Prophet and the Persian Physician* attributed to Abid (folio 46b), large areas of underlying paint are visible through the losses of the uppermost layer, particularly in the blue background of the architecture, in the doorway on the right-hand side of the composition, and in the light green





FIGURE 10. *Galen Watching a Dispute* by Payag on folio 60b of the *Gulistan* of Sa'di, F1998.5.60.



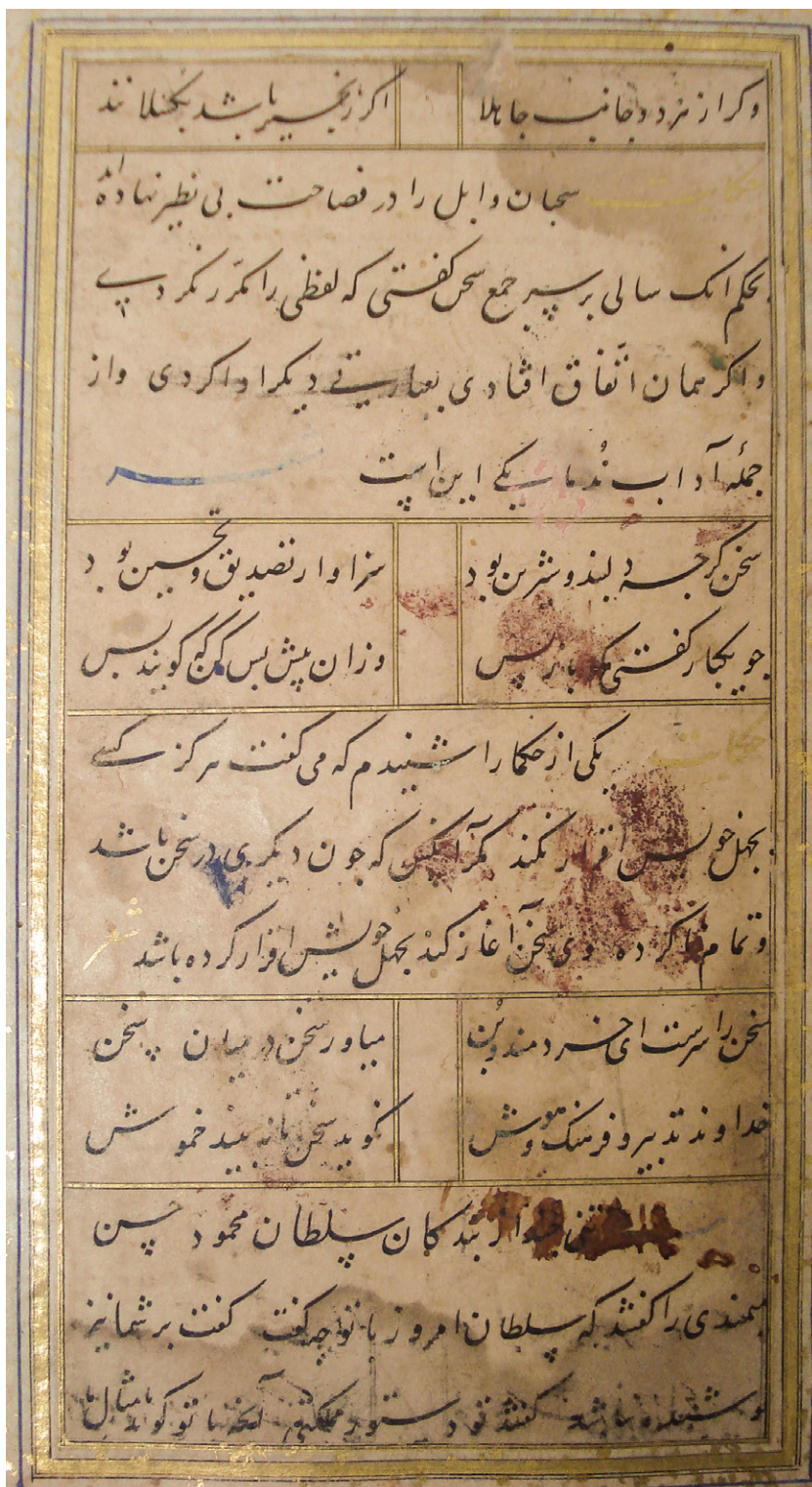


FIGURE 11. Folio 61a, the *Gulistan* of Sa'di, F1998.5.61. The paint on this page does not match the color of the pigments or the shape of the figures of the painting on the facing page (*Galen Watching a Dispute*) and therefore must have transferred from the original illustration.





FIGURE 12. *Sa'di in the Rose Garden* by Govardhan on folio 6a of the *Gulistan* of Sa'di, F1998.5.6.



FIGURE 13. The computed radiograph of *Sa'di in the Rose Garden* reveals a kneeling figure on the left, which does not appear in the current painting.

area in the foreground (Figure 16). Examination with transmitted IR radiation uncovered a dark outline in the lower right quadrant of the image suggestive of a kneeling figure and a footstool in the lower center (Figure 17). As previously mentioned, XRF measurements in this area revealed mercury, gold, and silver, along with the more predictable presence of copper and lead. Further examination with a combination of transmitted visible and transmitted IR radiation uncovered an orange background with red geometrical patterns dotted

with green stars. By digitally combining all this information in Photoshop, it was possible to reconstruct areas of the earlier painting (Figure 18).

Vestiges of the Timurid original under *Galen Watching a Dispute* (folio 60b) by Payag were rather difficult to detect (Figure 19). A head and a drapery are visible in the computed radiograph to the left of the figure of Galen (Figure 20), in the upper right quadrant of the image. The size of



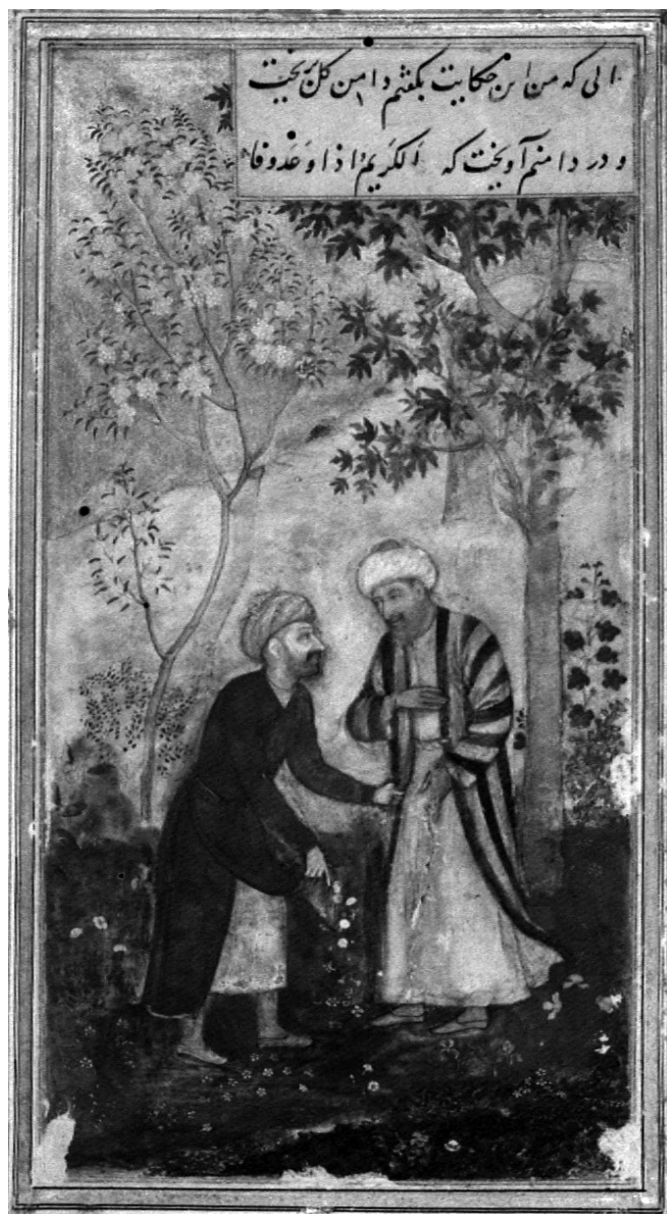


FIGURE 14. The reflected IR image of *Sa'di in the Rose Garden* shows that the tree on the left was originally thicker and that there was a second, shorter shrub in the upper right.

these details, coupled with the extent of the discoloration on the opposite side of the painting and the distribution of paint offset on folio 61a, suggests much larger figures than the ones in the Mughal version. Transmitted IR revealed that the profile of the mountain was originally lower and ran uninterruptedly across the image (Figure 21), whereas XRF measurements above this region identified the presence of gold, indicating that the sky area was previously gilded. The digital



FIGURE 15. Digital reconstruction of sections of the earlier painting underneath *Sa'di in the Rose Garden*.

representation obtained appears notably different from the Mughal illustration (Figure 22).

In the case of *A Prince Riding* by Balchand (folio 65a), the discoloration on the painting's reverse once again hints at larger earlier figures (Figures 23, 24). Examination with transmitted IR confirmed this hypothesis by revealing with striking clarity the torso and headpiece of the preexisting prince (Figure 25). The XRF measurements performed in these areas led to the identification of both gold and silver





FIGURE 16. *The Prophet and the Persian Physician* by Abid on folio 46b of the *Gulistan* of Sa'di, F1998.5.46.





FIGURE 17. The transmitted IR image of *The Prophet and the Persian Physician* revealed a dark outline in the lower right suggestive of a kneeling figure, a footstool in the lower center, and a background dotted with stars.

on the headpiece and arsenic in the central region of the vest, suggesting the use of orpiment; gold was again detected in the sky. Reflected IR revealed the presence of a third headpiece related to the figure of the prince: a turban with feathers very similar in iconography to the one in the Mughal painting and located slightly to the left of it (Figure 26). Given its close resemblance to the visible paint layer, this element is not part of the original painting, but it should be dated at a later time.

Additional information was obtained with computed radiography. Specifically, a much sturdier tree trunk was depicted on the left-hand side of the composition in lieu of the Mughal shrub, and the horse was taller and had a more static stance, with both front legs firmly planted (Figure 27). The lying figure also appeared larger, as well as more horizontal, and paint offset on folio 66a suggests that it was dressed in



FIGURE 18. Digital reconstruction of sections of the earlier painting underneath *The Prophet and the Persian Physician*.

blue. By combining this information it was possible to digitally generate a hypothetical representation of the painting underneath the work by Balchand (Figure 28).

*The Qazi of Hamadan in a Drunken State* (folio 74a) by Lalchand is the only painting executed on a secondary layer of paper that was pasted overall on the original folio, most likely to provide strength to a support that already in Mughal time must have become brittle and degraded (Figures 29, 30). Staining on the reverse side of the painting and results from the imaging techniques again indicate a larger scale of the original figures, which were arranged in a fashion similar to



FIGURE 19. *Galen Watching a Dispute* by Payag on folio 60b of the *Gulistan* of Sa'di, F1998.5.60.



FIGURE 20. The computed radiograph of *Galen Watching a Dispute* shows a head and a drapery to the left of the figure of Galen (the figure in the upper right).

the Mughal version. An elaborate headpiece, probably belonging to the Timurid version of the sultan, is distinguishable in the top center of the composition in the computed radiograph (Figure 31). According to targeted XRF measurements, this element was executed in both gold and silver. Surprisingly, a second profile was revealed by computed radiography to the left of the head of the Mughal sultan; it appears to be unrelated to the mentioned headpiece, indicating the presence of two distinct versions of the sultan below the visible

one: an earlier version of much larger size and a second version very similar in iconography to the Mughal painting. An arm extended toward the center of the folio could belong to either one of such versions. Finally, a candle, a plate, and a toppled wine vessel are clearly visible in the central region of the painting in the computed radiograph. In this case as well, the revealed information was used to produce a tentative representation of the earlier painting (Figure 32).





FIGURE 21. The transmitted IR image of *Galen Watching a Dispute* reveals that the profile of the mountain was originally lower and ran uninterrupted across the image.

Examination of *Sa'di's Companion Frightened by the Tribes from the Hills* by Murad (folio 85b) also led to intriguing discoveries. The outline of the earlier versions of Sa'di and his companion is clearly discernible on the painting's reverse (Figures 33, 34). The presence of small areas of discoloration throughout the folio suggests that the mountain was originally interspersed with mounds of grass, a common pictorial feature in the Timurid time period. Such



- |   |  |
|---|--|
| <span style="display: inline-block; width: 15px; height: 15px; background-color: red; margin-right: 5px;"></span> <b>Red paint</b><br>(Traces of red paint visible on corresponding areas on folio 61 recto)    | <span style="display: inline-block; width: 15px; height: 15px; background-color: blue; margin-right: 5px;"></span> <b>Blue paint</b><br>(Traces of blue paint visible on corresponding areas on folio 61 recto)    |
| <span style="display: inline-block; width: 15px; height: 15px; background-color: pink; margin-right: 5px;"></span> <b>Pink paint</b><br>(Traces of pink paint visible on corresponding areas on folio 61 recto) | <span style="display: inline-block; width: 15px; height: 15px; background-color: brown; margin-right: 5px;"></span> <b>Brown paint</b><br>(Traces of brown paint visible on corresponding areas on folio 61 recto) |
| <span style="display: inline-block; width: 15px; height: 15px; background-color: gold; margin-right: 5px;"></span> <b>Gold</b><br>(Au revealed by XRF in this area)   | <span style="display: inline-block; width: 15px; height: 15px; background-color: green; margin-right: 5px;"></span> <b>Areas very discolored on verso</b><br>related to the earlier painting                       |

FIGURE 22. Digital reconstruction of sections of the earlier painting underneath *Galen Watching a Dispute*.

spots are also visible in areas of paper on the recto corresponding to the two tribesmen. It seems unlikely that secondary compositional elements such as these bushes would have been painted before the figures. Instead, it seems more plausible that these figures either were not included in the first composition or were depicted in a different location. A possible answer comes from the transmitted IR image; here, the profile of the mountain appears lower, and the upper quadrants are filled with two rounded shapes. It is tempting to interpret these shapes as figures peering at the scene in the foreground, an iconography common in the Timurid time period. Examination with transmitted IR revealed further differences from the paint layer visible in this region;





FIGURE 23. A Prince Riding by Balchand on folio 65a of the *Gulistan* of Sa'di, F1998.5.65.



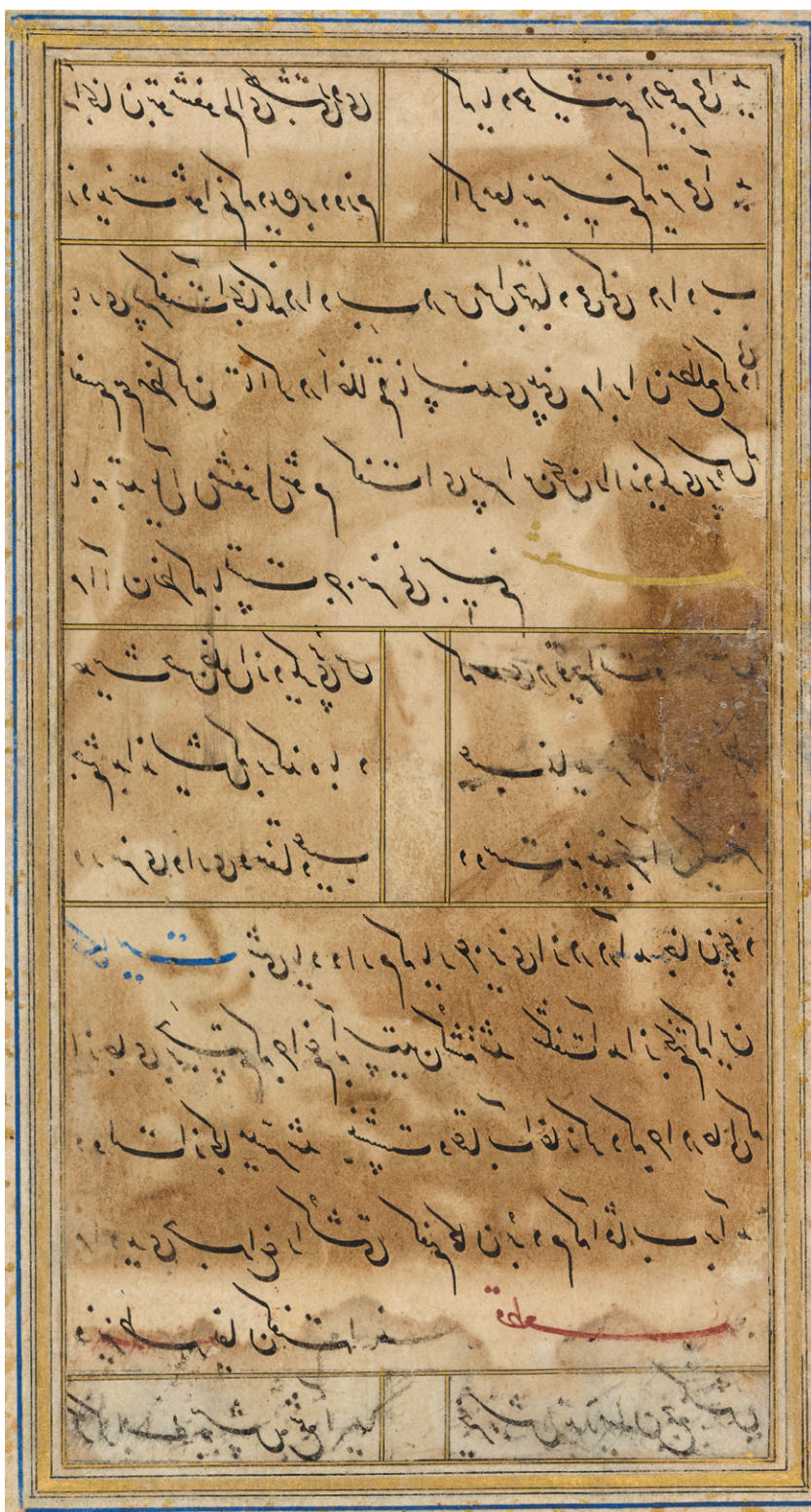


FIGURE 24. Folio 65b, the *Gulistan* of Sa'di, F1998.5.65. Discoloration on the reverse of the painting by Balchand shows the larger figure on a horse. The image has been rotated horizontally for the sake of comparison.





FIGURE 25. The transmitted IR image of *A Prince Riding* reveals with striking clarity the torso and headpiece of the preexisting prince.

namely, the savage in the top center seems to wear a turban and a long piece of garment reaching to just above the knee, whereas his companion seems to hold a sword rather than a stick (Figure 35). Considering the overall similarity to the current composition, it seems appropriate to place this additional intervention chronologically closer to the Mughal rather than the Timurid painting. Results from XRF measurements in the region in the center top indicate that the sky was painted in gold and silver. Like for the previous



FIGURE 26. A detail from the reflected IR image of *A Prince Riding* reveals a large preexisting headpiece as well as feathers on a turban slightly to the left of the smaller one in the existing painting.

illustrations, evidence of original paint was digitally combined, producing an image notably different from the visible one (Figure 36).

#### DISCUSSION

Given the novel and complex nature of the information obtained on the Freer *Gulistan*, the discussion is organized in three sections. The first section focuses on the stylistic features of the original illustrations. The second section centers on the number of paintings present in the *Gulistan* before the Mughal intervention. The final section is about the discovery of an additional vestigial paint layer very closely related to the Mughal illustrations in three paintings.

First, the stylistic features of the original illustrations were likely executed shortly after the text was copied in 1468. There are two main differences between the original and the visible paintings. The elemental analyses performed indicate that in half of the earlier compositions, the sky was golden, rather than blue. The application of gold paint or leaf in the sky is a common artistic convention in Islamic art and cannot be used to narrow down the execution from a chronological or geographical standpoint. The second, and more significant, difference is the larger size of the original figures, which, when visible, cover the majority of the available paper surface. This stylistic trait is unusual for Timurid paintings made in Herāt in the second half of the fifteenth

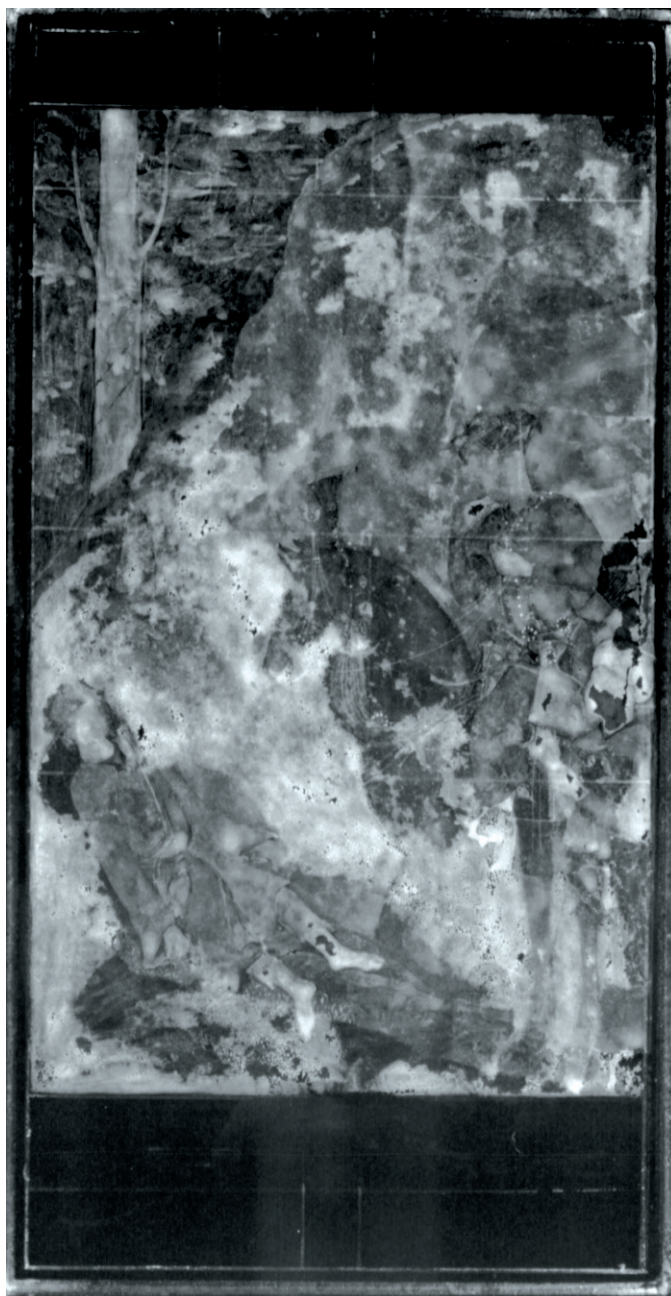


FIGURE 27. The computed radiograph of *A Prince Riding* shows the tree trunk at the left was taller and thicker and that the horse was larger and had both front legs firmly planted on the ground.

century.<sup>34</sup> As Sultan ‘Ali Mashhadi completed the *Gulistan* under the reign of Abu Sa‘id, Abolala Soudavar has proposed that these earlier compositions might have been executed by Mansur, one of the ruler’s court painters in Herāt.<sup>35</sup> Unfortunately, the art historical investigation is hindered by the scarcity of surviving examples from the reign of Abu



FIGURE 28. Digital reconstruction of sections of the earlier painting underneath *A Prince Riding*.

Sa‘id to compare with the vestigial paint layers of the Freer *Gulistan*, and only one work has been attributed to Mansur so far, *The Coronation of Sultan Husayn Mirza* (Figure 37). However, the large size of the earlier figures in the *Gulistan* differs considerably from the style of this painting, which is characterized by a heightened taste for miniaturization. Comparison with the small scale of the figures in another illustration attributed to the son of Mansur, Shah-Mozaffar, is possibly even more striking (Figure 38).<sup>36</sup> It belongs to





FIGURE 29. *The Qazi of Hamadan in a Drunken State* by Lalchand on folio 74a of the *Gulistan* of Sa'di, F1998.5.74.

another *Gulistan*, executed 20 years later and also copied in Herāt by Sultan 'Ali Mashhadi.

The original *Gulistan* paintings recall instead earlier Timurid works from Shiraz executed under the governorates of Ibrahim Sultan (reigned 1423–1435) and his son Abd Allah (reigned 1435–1447), such as *Timur Hunting*, dated 1436 (Figure 39), from a *Zafarnama* (Book of Victories) of Sharaf al-Din Ali Yazdi, and the paintings in the so-called Ibrahim Sultan Anthology in the Museum für Islamische



FIGURE 30. Folio 74b, the *Gulistan* of Sa'di, F1998.5.74. Discoloration on the reverse of the painting by Lalchand shows the figures from the earlier painting. The image has been rotated horizontally for the sake of comparison.

Kunst, Staatliche Museen zu Berlin (accession number I. 4628). They also bring to mind some contemporary Turkman images produced in western Iran (Figures 40, 41).<sup>37</sup>

A substantiated interpretation of these stylistic features is still not possible as information about the preexisting paintings remains too scarce. However, Simon Rettig has suggested that the earlier illustrations may be by an artist who





FIGURE 31. The computed radiograph of *The Qazi of Hamadan in a Drunken State* reveals a turban on the sleeping figure as well as a candle, plate, and toppled wine vessel from the original painting.

trained or actually worked in western Iran—more specifically, in Shiraz, the capital of Fars, which was at the time one of the main centers for manuscript production, or in Yazd, where during the late fifteenth century several manuscripts containing paintings with large figures were executed.<sup>38</sup>

Following the death of Timurid ruler Shahrukh in 1447, the western region of the Timurid Empire fell under the rule of the Turkman Qara Qoyunlu dynasty,<sup>39</sup> with its capital at



FIGURE 32. Digital reconstruction of sections of the earlier painting underneath *The Qazi of Hamadan in a Drunken State*.

Tabriz. The dynasty further extended its dominion to Shiraz and southern and eastern Iran from 1453 to 1467. Under the reign of Sultan Jahan Shah (reigned 1439–1467) and his son Pir Budaq, who was first governor of Shiraz until 1460 and then of Baghdad, the arts of the book flourished:<sup>40</sup> Pir Budaq indeed gathered around him numerous peripatetic practitioners of the arts of the book, who followed him from Shiraz to Baghdad. The death of Pir Budaq in 1466 signaled the decline of Baghdad as an important center of manuscript production, forcing artists to migrate to other regions of Iran in search of new patrons. As one of the most highly refined fifteenth-century cultural centers, Herāt may certainly have attracted many western Iranian artists, and it seems possible that the earlier illustrations in the *Gulistan* were executed at this juncture. Documentary information related to artists of the book moving from western Iran





FIGURE 33. Sa'di's *Companion Frightened by the Tribes from the Hills* by Murad on folio 85b of the *Gulistan* of Sa'di, F1998.5.85.

to Herāt between 1450 and 1500 is currently lacking, and the original paintings in the Freer *Gulistan* might represent evidence of such a phenomenon. Contrasting sharply with paintings by Behzad, they also seem to point to the existence of several levels of production in Herāt under Abu Sa'id and Sultan Husayn.

Second, as previously mentioned, upon receiving it in 1568, Mun'im Khan described the manuscript as having five illustrations, yet vestigial paint was discovered underneath all



FIGURE 34. Folio 85a, the *Gulistan* of Sa'di, F1998.5.85. Discoloration on the reverse of the painting by Murad reveals the outlines of the larger original figures. The image has been rotated horizontally for the sake of comparison.

six paintings. Either we assume that he committed a mistake and accounted for one less painting than what was actually present in the volume, or the book was left unfinished in Timurid time and was completed with a sixth image sometime between 1568 and 1645. Although there is still no conclusive evidence to determine which composition was added at a later date, the available information points to the image





FIGURE 35. *Sa'di's Companion Frightened by the Tribes from the Hills*, the *Gulistan* of Sa'di. (Top) Detail in incident visible light. (Bottom) Detail in transmitted IR light.

under Govardhan's painting (folio 6a). There is no sign in the underlying paint layer of the large figures that characterize the other earlier depictions. Rather, the figure of Sa'di's companion visible in the computed radiograph seems well proportioned compared to the overall size of the image. The original painting under *The Prophet and the Persian Physician* (folio 46b) also lacks evidence of preexisting large figures. However, the decoration of the architecture, consisting of green stars on an orange and red background, was a common design for tiles in Iran, suggesting it was part of the original paint layer.



Areas discolored on verso (related to the earlier painting) Blue paint (Traces of blue paint visible on corresponding areas on folio 86 recto)  
Gold and silver (Au and Ag revealed by XRF in this area)

FIGURE 36. Digital reconstruction of sections of the earlier painting underneath *Sa'di's Companion Frightened by the Tribes from the Hills*.

In summary, it seems plausible that sometime after 1568 the pictorial cycle was completed with the execution of a painting on folio 6a and that this painting was then covered by Govardhan with an image of *Sa'di in the Rose Garden* circa 1645, at the same time the other five compositions were repainted by artists of the court of Shah Jahan.

Third, three paintings contained an additional vestigial paint layer very closely related to the Mughal illustrations, namely, the turban discovered to the left of the headpiece of the prince in folio 65b, the profile of the sultan in *The Qazi of Hamadan in a Drunken State* (folio 74a), and the different



FIGURE 37. *The Coronation of Sultan Husayn Mirza*, attributed to Mansur. Historic Iran (present-day Afghanistan), Herāt, Timurid dynasty, circa 1469. Opaque watercolor, ink, and gold on paper. Arthur M. Sackler Gallery, Smithsonian Institution, Art and History Collection, LTS1995.2.26.





FIGURE 38. *The Two Wrestlers*, attributed to Shah-Mozaffar, from a *Gulistan* of Sa'di. Historic Iran (present-day Afghanistan), Herāt, Timurid dynasty, circa 1486. Opaque watercolor, ink, and gold on paper. Arthur M. Sackler Gallery, Smithsonian Institution, Art and History Collection, LTS1995.2.31.





FIGURE 39. *Timur Hunting*, from a *Zafarnama* (Book of Victories) of Sharaf al-Din Ali Yazdi. Iran, Shiraz, Timurid dynasty, circa 1436. Opaque watercolor, ink, and gold on paper. Arthur M. Sackler Gallery, Smithsonian Institution, Art and History Collection, LTS1995.2.17.





FIGURE 40. Folio from a *Shahnama* (Book of Kings) of Firdawsi. Iran, Gilan, Aq Qoyunlu dynasty, Turkmen period, 1493–1494. Opaque watercolor, ink, and gold on paper. Arthur M. Sackler Gallery, Smithsonian Institution, Henri Vever Collection, S1986.172.





FIGURE 41. Folio from *Mihir u Mushtari* (*The Sun and Jupiter*) of 'Assar. Iran, Shiraz, Aq Qoyunlu dynasty, Turkmen period, 1477. Opaque watercolor, ink, and gold on paper. Freer Gallery of Art, Smithsonian Institution, F1949.3.



attributes displayed by the figures in the central region of *Sa'di's Companion Frightened by the Tribes from the Hills* (folio 85b). Although these details might be pentimenti, or sections of a preparatory drawing, they could also indicate another intermediate phase of repainting, possibly contemporary with the first version of *Sa'di in the Rose Garden*. More research is needed before a well-informed theory can be proposed.

## CONCLUSIONS

Results from the examination and analyses add to the sheer beauty and complexity of the Freer's *Gulistan* of Sa'di, a masterpiece of the Islamic arts of literature, calligraphy, and painting. The research led to the following discoveries:

- Earlier depictions were present before the execution of the visible pictorial cycle in Mughal time, but their remnants seem scarce.
- The uncommonly large size of the figures in at least four of the earlier paintings points to an artist from western Iran.
- The presence of previous paint layers underneath all six paintings, rather than only five, adds an important work-

ing phase to the history of the *Gulistan* whose implications are yet to be fully understood.

- Additional changes in composition were revealed during examination, suggesting the existence of more phases in the execution of the paintings than what was previously thought.

From a technical standpoint, multispectral imaging technology was successful in revealing hidden paint layers under the visible *Gulistan* illustrations; among the implemented techniques, transmitted IR imaging proved particularly insightful.

Given the layered structure of the paintings and the inherent similarity between materials used in Timurid and Mughal times, interpreting results from both imaging and analytical techniques proved challenging. The ability to examine the objects under multiple wavelengths, coupled with computed radiography and a targeted use of XRF, made it possible to overcome these limitations and formulate a tentative chronology.

The examination and analysis of the Freer *Gulistan* have provided insights into its creation and subsequent history, and hopefully, continued collaborative research by curators, conservators, and scientists will further enrich our understanding of these still elusive paintings.





# Acknowledgments

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**W**e owe the successful completion of this project to the many people who helped us along the way with their generosity of time and knowledge; first and foremost, Massumeh Farhad, Interim Deputy Director for Collections and Research, Chief Curator, and The Ebrahimi Family Curator of Persian, Arab, and Turkish Art, Freer|Sackler (FLS); Simon Rettig, Assistant Curator of Islamic Art, FLS; Debra Diamond, Curator of South and Southeast Asian Art, FLS; Lamia Balafrej, Smithsonian Predoctoral History of Art Fellow; Stacy Bowe, Conservation and Scientific Research Department Assistant, FLS; Tom Lera, Research Coordinator, National Postal Museum; Owen Lang, Senior Applications Specialist, Foster + Freeman; Nancy Hacskaylo, Visual Information Specialist, FLS; and Neil Greentree, Photographer, FLS.





# Chronology

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Circa 1209–1210	Poet and prose writer Shaikh Sa‘di Shirazi is born in Shiraz
1258	Sa‘di finishes writing the <i>Gulistan</i> in Shiraz
1451–1469	Reign of Timurid ruler Sultan Abu Sa‘id Mirza
1468	Calligrapher Sultan ‘Ali Mashhadi completes a copy of the <i>Gulistan</i> by Sa‘di in Herāt. At least five paintings are added to the <i>Gulistan</i> shortly after, perhaps by painters from Western Iran
Between 1468 and 1540	Water damage occurs and remains visible as staining within the paintings and text
1469	Timurid ruler Sultan Abu Sa‘id is defeated by Uzun Hasan, the Aq Qoyunlu Turkman ruler of western Iran, and shortly afterward is killed
1524–1576	Reign of the Safavid ruler Shah Tahmasp
1540s	Borders attributed to painter Aqa Mirak are added to the manuscript
1544	Mughal emperor Humayun in exile at the Safavid court of Shah Tahmasp
1556–1605	Reign of the Mughal emperor Akbar the Great
1568	Akbar donates the <i>Gulistan</i> to his commander in chief, Mun‘im Khan, who described it as having five paintings
Between 1568 and circa 1645	Possibly, a sixth painting is added to the <i>Gulistan</i> on folio 6a underneath the painting <i>Sa‘di in the Rose Garden</i> by Govardhan
1605–1627	Reign of the Mughal ruler Shah Jahangir. The <i>Gulistan</i> returns to the Royal collection.
1628–1658	Reign of the Mughal ruler Shah Jahan
1644	Alleged fire breaks out in the royal palace, damaging the <i>Gulistan</i> , however the damage is only found in the borders.
Circa 1645	Execution of six paintings over the preexisting ones by the leading artists of the court of Shah Jahan: Abid, Payag, Balchand, Lalchand, Murad, and Govardhan





# Notes

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1. This research project was undertaken during a 2011 Smithsonian Postgraduate Conservation Fellowship in paper conservation in the Department of Conservation and Scientific Research at the Freer Gallery of Art and Arthur M. Sackler Gallery.
2. B. W. Robinson, Ernst J. Grube, G. M. Meredith-Owens, and R.W. Skelton, *Islamic Painting and the Arts of the Book* (London: Faber and Faber, 1976), chapter no. III.219 (page 181) and color plate 23. Folio number 4 is decorated with fine illuminations but has no paintings.
3. The Timurid dynasty was a Sunni Muslim power of Turko-Mongol lineage, established by Timur in 1370 and ending in 1507. At the peak of its power, the empire comprised Iran, Transoxiana (corresponding approximately to modern-day Uzbekistan, Tajikistan, southern Kyrgyzstan, and southwest Kazakhstan), the Caucasus region and parts of modern-day Turkey, Syria, Iraq, and Kuwait. At the beginning of the fifteenth century, Herāt was the capital of the arts of the book in the Islamic world, and the schools of miniature painting of Tabriz and Shiraz also flourished.
4. The Safavid dynasty was a Shi'a Muslim power that ruled Persia from 1501 to 1736. Its territory comprised modern-day Iran and parts of Iraq, Syria, Turkey, Armenia, Georgia, Russia, Azerbaijan, Turkmenistan, Afghanistan, and Pakistan. The capital of the empire was first Tabriz, then Qazvin, and, finally, Isfahan.
5. The Mughal dynasty was a Muslim dynasty of Turko-Mongol origin that controlled large parts of the Indian subcontinent from 1526 to 1857. Its first ruler, Babur, claimed to descend from both Timur, founder of the Timurid Empire, and Genghis Khan, founder of the Mongol Empire.
6. This manuscript is not unique in having been reworked multiple times. Both Persian and Mughal cultures placed paramount importance on the written word and granted calligraphy the highest status among all art forms. Ownership of illuminated manuscripts was therefore highly valued, and the extensive modifications these objects often underwent upon changing hands were motivated not only by artistic considerations but also by symbolic and political ones. See D. J. Roxburgh, "The Study of Painting and the Arts of the Book," *Muqarnas*, 17 (2000): 10–12.
7. A. Soudavar, *Art of the Persian Courts* (New York: Rizzoli, 1992), 332: "The book was completed by the help of God and with his good success at the hand of the least of the copyists, Sultan-Ali, son of Muhammad of Mashhad, during the first ten days of Rabi' II of the year 873 [1468–1469] at the capital Herat — may it be protected from disaster and catastrophe." (Quote translation by Wheeler M. Thackston.)
8. M. B. Dickson and S. C. Welch, *The Houghton Shahnameh* (Cambridge, Mass.: Harvard University Press, 1982), 264–265. See also Y. Porter, "From the 'Theory of the Two Qalams' to the 'Seven Principles of Painting': Theory, Terminology, and Practice in Persian Classical Painting," *Muqarnas*, 17 (2000): 109–118.
9. Abolala Soudavar advanced a very compelling hypothesis to explain the entry of the *Gulistan* in the Mughal library. The manuscript might have been a gift from Shah Tahmasp to the second Mughal emperor, Humayun (reigned 1530–1540, 1555–1556), who was in exile at the Safavid court in 1544. Humayun was the great-grandnephew of the Timurid sultan Abu Sa'id, during whose reign the manuscript was executed. As such, the gift of the manuscript would have represented an homage reconnecting the Mughal ruler to his Turko-Mongol ancestors. Shah Tahmasp might have commissioned Aqa Mirak to elaborate the margins on this occasion, with the intent not only to embellish the Timurid manuscript but also to leave a lasting record of the Safavid ownership on its pages before donating it to Humayun. See A. Soudavar, "Between the Safavid and the Mughals: Art and Artists in Transition," *Iran*, 37 (1999): 49–50.
10. Soudavar, *Art of the Persian Courts*, 332: "This noble book was given by his majesty the emperor of mankind, protector of the realm of Islam, inheritor of the throne of the sultanate by birth and right — may God prolong his rule — to this miserable one, Mon'em b. Miram, in Kara on the date 975 [1567–1568]. Number of folios, 107; number of lines, 3123; and five illustrations." (Quote translation by Wheeler Thackston.)
11. For all the inscriptions, see also J. Seyller, "The Inspection and Valuation of Manuscripts in the Imperial Mughal Library," *Artibus Asiae*, 57, nos. 3–4 (1997): 287–288.

12. Soudavar, *Art of the Persian Courts*, 333: "On the 17th of Bahman, regnal year 1, corresponding to 3 Ramazan, [this book entered the library of] this petitioner of the divine court. Written by Nuroddin Jahangir, son of Akbar Padshah-e Ghazi." (Quote translation by Wheeler M. Thackston.)
13. Soudavar, *Art of the Persian Courts*, 334.
14. Soudavar, *Art of the Persian Courts*, 333: "This Golestan, which is a verdant garden, without equal, the calligraphy of which is from the pen of the rarity of the age Molla Soltan-Ali, [entered the library of] this petitioner of the divine court, on the 25th of Bahman, corresponding to the 8th of Jomada II 1037, which is my accession. Written by Shahab-oddin Mohammad Shah Jahan." (Quote translation by Wheeler M. Thackston.)
15. Soudavar, *Art of the Persian Courts*, 333–334: "I gave this book of my own personal property, on Monday the 11 of Tir, regnal year 8, corresponding to 16 Moharran 1045 [1635–1636], in Akbarabad, to my dear felicitous child, precious as my soul, Jahanara Beygom. Written by Saheb Qeran II [Shah Jahan]." Also, "Aba Sahebjiu ["Dear Daddy"]. His Majesty gave this Golestan to this father-loving Jahanara, on 16 Moharran." (Quote translations by Wheeler M. Thackston.)
16. The inscriptions include the following: on folio 6 recto, in the margin, "Govardhan"; on folio 60 verso, on the cloak of Galen, "Work of Payag"; on folio 65 recto, beneath the horse, "Work of Balchand"; on folio 74 recto, at the bottom in white, "Work of Lalchand"; on folio 85 recto, on the rock, "Work of the slave Murad." The inscription on folio 46 verso, at the bottom, is badly flaked and only partially legible: "Nadiruzzaman-i Jahangiri . . . Aqa Riza . . ." However, it seems to follow the known formula for inscriptions by Abid. See M. C. Beach, *The Imperial Image: Paintings for the Mughal Court*, rev. and expanded ed. (Washington, D.C.: Freer Gallery of Art and Arthur M. Sackler Gallery, Smithsonian Institution, 2012), 94–97.
17. All the inscriptions are located within the images and were likely appended by the artists themselves. The only exception is the inscription in the work by Govardhan, which is visible on the margin below the painting and might have been added later. Often, artists in Mughal India did not sign their works, but someone in the workshop, like the chief painter in the atelier or another individual, such as a librarian, ascribed such works to them. See J. Seyller, "Scribal Notes on Mughal Manuscript Illustrations," *Artibus Asiae*, 48, nos. 3–4 (1987): 247–277.
18. Soudavar, *Art of the Persian Courts*, 334.
19. See G. Banik, "Scientific Studies for Explaining Copper Corrosion in Graphic Art Works," *Das Papier*, 36, no. 9 (1982): 438–448, and K. Ahn et al., "Investigation of the Stabilization of Verdigris-Containing Rag Paper by Wet Chemical Treatments," *Heritage Science*, 2 (2014): 12, <https://doi.org/10.1186/2050-7445-2-12>, for further information on the reaction between cellulose and pigments containing copper.
20. For the titles of the paintings we referred to Soudavar, *Art of the Persian Courts*.
21. S. C. Welch, *India: Art and Culture, 1300–1900* (New York: Metropolitan Museum of Art, 1985), 242.
22. See Soudavar, "Between the Safavid and the Mughals," 50.
23. For another study on the materials and techniques of Islamic manuscripts using a Foster + Freeman video spectral comparator (VSC 8000), see P. Knipe et al., "Materials and Techniques of Islamic Manuscripts," *Heritage Science*, 6 (2018): 55, <https://doi.org/10.1186/s40494-018-0217-y>.
24. The VSC 6000 is designed for forensic investigation of questioned documents; therefore, some of its characteristics are not ideal for the examination of artworks. In many modalities, the filters can be applied only on the camera and not on the light source. This design results in an increase of the temperature (T) and a decrease of the relative humidity (RH) in the microenvironment of the main unit, as well as levels of light exposure that are, in many cases, above the limits recommended for light-sensitive artworks. Several precautions were implemented to ensure the safety of the works during examination, including constant monitoring of the fluctuations of T and RH with a thermohygrometer, mounting the works on a four-ply mat to avoid direct contact with the platform, using a small fan to generate a very gentle but constant flow of air around the objects, and strictly keeping the examination time to the minimum. Newer VSC models incorporate LED lights, which may help to alleviate some of these problems.
25. As described in J. Warda et al., *The AIC Guide to Digital Photography and Conservation Documentation*, 2nd ed. (Washington, D.C.: American Institute for Conservation of Historic and Artistic Works, 2011), reflected IR imaging is made in the 700–1,000 nm range and should not be confused with infrared reflectography, which is undertaken in the 1,000–25,000 nm range.
26. Philips Brilliantline Halogen 12V 20w 4000h.
27. Halogen lamp, Philips 24V 250 W ELC 13163.
28. This filter is a continuous band-pass interference filter, that is, an optical filter that is able to transmit certain wavelengths and reflect others while maintaining a near zero coefficient of absorption.
29. In computed radiography, a flexible phosphor imaging plate is used to capture the X-rays instead of conventional photographic film. After exposure, the imaging plate is run through a special scanner that converts the information into a digital image.
30. Computed radiographs of all paintings were taken at 30 Kv, 5  $\mu$ A, for 1.3 minutes.
31. X-ray fluorescence spectroscopy was performed using an Omega 5 Museum and Industrial Object Analyzer, a modified Spectrace 6000 spectrometer with data acquisition and control. Measurements were performed either in air for 100 s live time or in helium for 60 s live time. The X-ray beam of the instrument covered a surface of approximately 2 mm<sup>2</sup>.
32. Folio 5b, which used to be adjacent to *Sa'di in the Rose Garden* by Govardhan (folio 6a), is the only leaf where no paint offset is visible. The text areas of this folio, however, are not original: compared to the other text panels, the paper looks brighter, and there are no water stains. Also, the calligraphy on both recto and verso was executed with thicker and larger strokes. It is not yet possible to establish why and when this folio was reworked.
33. Soudavar, *Art of the Persian Courts*, 334. See also L. E. Parodi et al., "Tracing the History of a Mughal Album Page in the Los Angeles County Museum of Art," *Asianart.com*, 8 March 2010, <http://www.asianart.com/articles/mughal/index.html> (accessed 15 July 2012).
34. Massumeh Farhad, chief curator and The Ebrahimi Family Curator of Persian, Arab, and Turkish Art, Freer/Sackler, personal communication.
35. Soudavar, *Art of the Persian Courts*, note 17, 122.
36. See B. Brend, *Perspectives on Persian Painting: Illustrations to Amir Khusrav's Khamsah* (London: Routledge Curzon, 2003), 171.
37. See D. Roxburgh, "'Many a Wish Has Turned to Dust': Pir Budaq and the Formation of Turkmen Arts of the Book," in *Envisioning Islamic Art and Architecture: Essays in Honor of Renata Holod*, ed. D. J. Roxburgh (Boston: Brill, 2014), note 2, 176.
38. See B. Brend, *Perspectives on Persian Painting*, 115–116 and subsequent plates 44 (p. 135) and 45 (p. 140).
39. Qara Qoyunlu, also called Black Sheep Turkmen, were a Turkic Shi'a tribal federation that ruled over modern-day Azerbaijan, Armenia, and Iraq from about 1375 to 1468.
40. For manuscript production under Pir Budaq, see D. Roxburgh, "'Many a Wish Has Turned to Dust,'" 175–222.



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Detail of illuminated border, attributed to Aqa Mirak, from folio 6b, the *Gulistan* of Sa'di, F1998.5.6. (See Figure 3 for full folio.)



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