

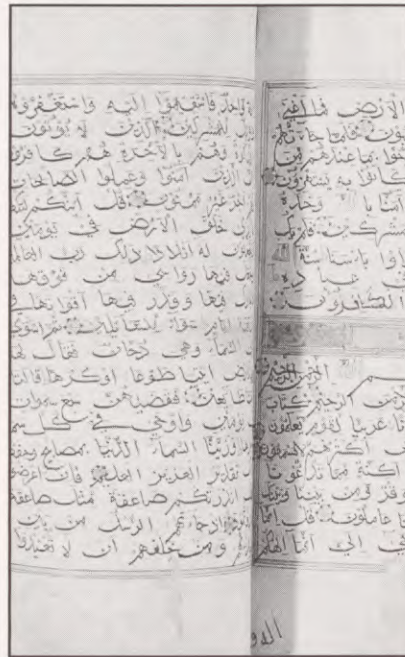
# SCIENCE IN THE SERVICE OF RELIGION AND ART

## ANALYSIS OF PIGMENTS IN MIDDLE EASTERN MANUSCRIPTS

BY **Robyn Sloggett, Angela Kerry** AND **Kerry Nugent**

**T**HE LINK BETWEEN THE UNIVERSITY of Melbourne Library at the end of the 20th century and an 11th century Arabic recipe for black ink which employs myrtle, water, nails, pomegranate rinds, Syrian mulberry juice and iron sulfate<sup>1</sup> may not at first be obvious. It becomes a little more obvious when seen in the context of the Library's Middle Eastern Manuscript Collection, housed in the Baillieu Library. These manuscripts offer a wealth of information on eastern book production and the trade of such manuscripts between the east and west. It is through this trade, with a history spanning centuries, certainly before the European settlement of Australia, that the Middle Eastern manuscript collection in the Library owes its existence.

The cultural collections of the University of Melbourne present a treasure trove for researchers. As the University approaches its 150th anniversary its rich cultural assets serve not only to support and define the University's research and teaching, they also reflect the interest of academic departments and of relationships of the University to donors, alumni and key Australian identities. The Baillieu Library houses a number of world class collections, as well as individual items



15th century Qur'an. (MUL 3, Middle Eastern Manuscript collection, University of Melbourne Library Collection.)

which are of world significance. The good management of these collections is central to the Library's vision.

In 1994 the Curator of Rare Books, Merete Smith, opened a metal cabinet in the Rare Book stacks of the Library, and discovered over 175 Middle Eastern manuscripts. Realising their importance

and cognisant of the fact that the collection could not be properly studied until it was stabilised, Merete contacted the University of Melbourne Conservation Service in order to assess and advise on the conservation needs of the collection. A report on the condition of the collection was prepared, and the Library provided funds to individually box the items.

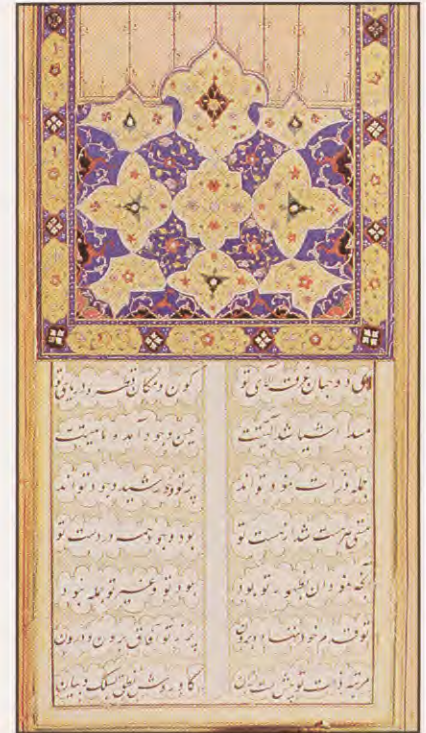
The collection was established in the 1960s for teaching and research purposes by Professor Emeritus John Bowman, Professor of the Middle Eastern Studies at the University of Melbourne. He acquired the manuscripts from Mr Reynolds, a dealer at Luzacs in Bloomsbury in London. Luzacs purchased books and manuscripts from a range of sources, a major one being Mr Ellis, Keeper of Arabic Manuscripts at the British Museum. Mr Ellis, according to Professor Bowman, had often acquired manuscripts from individuals who brought them to him in his capacity of Keeper. Mr Ellis had a private collection of these manuscripts which were then sold on to Mr Reynolds. Professor Bowman had similarly developed a collection of Persian manuscripts, from the same source, for the University of Leeds while he was employed there prior to emigrating to Australia. Consequently, the Baillieu Library collection has

parallels in content with both the British Museum and the University of Leeds collections of middle eastern manuscripts.

There is a broad range of geographical origins, dates, texts and calligraphy represented by the manuscripts in the University Library's collection. There is a catalogue of the collection but the accuracy of much of this information is in doubt. Many of the attributions require confirmation and further investigation.<sup>2</sup> There is much work to be done on the manuscripts to establish more accurate information on the texts, their origin and their dates. It is clear from the specialists who have examined the manuscripts that the collection is rich and valuable. The manuscripts are important as objects in themselves and as tools for research into areas such as pigment usage, eastern bookbinding traditions, eastern religious and secular texts and calligraphy.

The collection contains Qurans and related texts, books of poetry, astrology, mathematics, logic dictionaries, grammar, Christian prayer books, biographies and books of sayings. There are Turkish, Persian, Arabic, Syriac, Sanskrit, Urdu and Ethiopic manuscripts. They cover Christian oriental texts, works from the Ottoman Empire, the Moghuls and the Indian Raj. While some of this material is in original bindings, much has been rebound and repaired as it was used, passed on and traded. The collection is therefore a rich source of examples of oriental binding and mending techniques, as well as providing an excellent survey of middle eastern paper types and calligraphy.

In 1995 an Australian Research Council research project was undertaken to investigate the pigment usage in selected manuscripts in the collection. This project was developed between the Library, the Conservation Service and the School of Physics. As part of an earlier investigation, Lois Mathieson from the Conservation Service and Kerry Nugent from the School of Physics had



Leaves in a 17th century manuscript in Persian. (MUL 17, Middle Eastern Manuscript collection, University of Melbourne Library.)

identified the usefulness of raman for examining cultural material.<sup>3</sup> Raman is a particularly important and useful tool for the analysis of artworks because it is a non-invasive method of achieving accurate results in pigment analysis. Pigment analysis using raman produces a spectrum of a particular chosen particle within the pigment. This spectrum is then compared to the spectrum of known pigments. This technique is particularly suitable for analysing the pigments used in manuscript production because it does not require a physical sample to be taken.

In the initial stage of the project five manuscripts were chosen for analysis. They are, as currently catalogued:

- **MUL 3**, a small Quran from the 15th century AD.
- **MUL 17**, a 17th century Arabic text comprising two separate manuscripts: "The One Hundred Sayings of Ali" written by Schah Mahmoud Nichpouri and translated into Persian

by Tachid-ed-Din Vatwab, and "A description of the pilgrimage to Mecca" with "plans and illuminations by Nezani".

- **MUL 86**, a Persian manuscript — Hadiqua of Sana I, A Sufi poem copied in the 16th century by Ali Husaini Imad.
- **MUL 87**, a Persian manuscript, the 15th Diwan Assafi.
- **MUL 134**, a northern Indian manuscript of the love story of Kamrup and Kamlata from the 18th century.

Lapis lazuli, also known as natural ultramarine, was the most prevalent of the blue pigments in manuscripts tested and is found in all the manuscripts except for MUL 134. Much of the lapis used in middle eastern book production originated from Afghanistan. Lapis lazuli is a complex silicate of sodium and aluminium, containing sulphur radicals.

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The stone is crushed or broken by heating and cooling. It is usually mixed with lead white to make it appear blue.<sup>4</sup>

Three blue particles in the dome on folio 69v of MUL 17 indicated lapis lazuli, with two exhibiting slightly irregular lapis lazuli peaks. The indication of artificial ultramarine in a second sample from this area requires further examination, indicating a post-1830 date for the manuscript or restoration of that area (which is not evident). The violet colour of the dome indicated a mixture containing small amounts of lapis lazuli with red particles in a lead white matrix. Lapis was also found in the green leaves and brown trucks of these illustrations. It was identified in the *unwan*<sup>5</sup> pages of MULs 3 and 17 (in the blue and in the violet area) and MUL 87.

In MUL 3 all the samples of other colours were adulterated with the lapis suggesting that the same brush, palette knife or grinder was used in the preparation and application of the pigments. Indigo was found in the deeper blues of the *unwan* of MUL 87 while lapis was found in the lighter blue sections. Seven sections of blue of the *unwan* of MUL 134 were tested but none of the spectra were identifiable and they did not resemble lapis.

While lapis lazuli was the most common blue particle used azurite and indigo were also found. Indigo is a vegetable colouring agent produced from plants of the *Indigofera* genus in China and India. Synthetic indigo was produced from the 1880s and from 1900 the synthetic product replaced the organic.<sup>6</sup> Azurite is a basic copper compound (similar to malachite another copper compound pigment). It is prepared through a process of grinding, washing, levigation and flotation.<sup>7</sup> Azurite was found in the *unwan* page of MUL 17 (also containing lapis). Indigo was identified in MUL 86 and on the *unwan* page of MUL 87, mixed with lapis to achieve a deeper blue.

Dry process vermilion, also known



10th century Persian manuscript. (MUL 86, Middle Eastern Manuscript collection, University of Melbourne Library.)

as cinnibar, was produced in China where it was manufactured by heating mercuric acid and sulphur together to form mercuric sulphide. It is used extensively in both eastern and western manuscripts. The mid range blue/red colour was identified as vermilion of page 279 of MUL 3, MUL 17 in the building illustrations, palm leaves (with lapis, orpiment and a white which was probably a calcium carbonate) and brown tree trunks (with orpiment and lapis).<sup>8</sup> It was also used in MUL 86 and in an orange petal of MUL 87 in a more finely ground form than any of the other manuscripts examined. In the *unwan* of MUL 134 the four areas of red all exhibited high luminescence, one indicated vermilion but it appeared to be highly bound in a resinous medium. The resinous nature of the red is similar to that seen in the other manuscripts. None of the greens gave a good spectra. The orange red petal (in the blue and red flower) indicated vermilion which was much more finely ground than in other manuscripts studied to date.

There were other reds and oranges of MUL 3 which were not identified other than as organic pigments which may be *realgar*.<sup>9</sup> In MUL 17 a red was sampled from the border of folio 69v, it appears as a waxy red similar to the orange in MUL 3, and may be *realgar*. *Realgar* was used in the building illustrations of MUL 17. In MUL 7 a pigment with the spectrum of *realgar* but showing an extra peak was found. It is possible that this extra peak was formed by a drying agent.

A non-oxide form of red lead was found in MUL 86. Red lead is an artificial lead tetroxide pigment produced by heating white lead at approximately 480°C.<sup>10</sup> It was used in Byzantium and began to appear in Persia in the 14th century.<sup>11</sup> It produces a bright orange colour in paintings which is common in many Persian manuscripts in particular.

Haematite is a natural anhydrous ferric oxide. Haematite was identified in the riders and horses of MUL 87, sometimes mixed with yellow lead monoxide or massicot or strengthened with a resinous red. It was also seen in a brown deer in MUL 87 and possibly in the *unwan* of MUL 17 mixed with charcoal to produce a darker colour. Two other pages on MUL 134 were tested, one with an illustration of riders and horses, and another with a deer and tiger (see inside front cover of this journal). On these pages the orange/red and red tones indicated haematite or haematite mixed with yellow lead monoxide or massicot. The dark red stripe on the saddle also indicated haematite, but it appeared to have been strengthened using a resinous red. Areas of brown indicated haematite, although one area on a brown horse appeared to have been strengthened with a bituminous material similar to tar.<sup>12</sup>

Generally difficulties were experienced in gaining a spectrum with several of green and yellow pigments and materials with a binding agent. These pigments often fluoresced highly. Alternative methods of identification will need to be employed to identify these pigments.

Orpiment is prevalent in paintings from Iran, Turkey, Iraq, Persia and the Himalayas in this period but not so commonly used in India. Orpiment was used in the decorative borders, palm leaves and trucks and in the *unwan*<sup>13</sup> of MUL 17, in MUL 86 and the *unwan* of MUL 87.<sup>14</sup>

In the *unwan* of MUL 87 a spectra could not be achieved with the green pigments indicating that this was probably an ink and the medium was blocking the spectra. The green particles were analysed on this page and on a page with illustrations of horses but the spectra were not definitive. It is possible that the green comes from a mixture of orpiment and indigo, and the red appeared to be resinous perhaps madder.<sup>15</sup> Similarly, in MULs 17 and 134 the greens did not give good spectra although malachite was identified in MUL 17. Malachite is a basic copper carbonate and was readily available through the east in this period. Greens were also formed from a combination of pigments, for example the palm leaves of MUL 17 proved to comprise a complex mixture of red (vermilion), blue (which was a mixture of orpiment and lapis lazuli) and yellow (orpiment and a white which was probably a calcium carbonate as lead white was not indicated). The combination of orpiment and indigo to form green was written about in early sources one of the earliest being Ibn Badis in the 11th century.<sup>16</sup>

Several of the yellows sampled did not give good spectra, particularly in MULs 87 and 134. In MUL 134 two yellows were tested and appeared as a highly fluorescent colour probably Indian Yellow. Indian yellow was introduced into India in the 15th century and then appears to have been used exclusively in the region from the 16th century.<sup>17</sup> Indian yellow is produced from the urine of cows fed on mango leaves.

The white pigments in all the manuscripts tested proved the most difficult to register spectra. Some of the whites were, however, able to be identified, if not with complete certainty. In



Persian manuscript. (MUL 87, Middle Eastern Manuscript collection, University of Melbourne Library.)

MUL 17 the white in the *unwan* was identified as lead white. In MUL 134 two white samples indicated gypsum, a calcium dihydrate sulphate, and a further sample appeared to be lead white. Lead white, produced through heating lead and treated with vinegar, is extensively used in paintings in the east from the 15th century.<sup>18</sup>

The black pigments in MUL 134 appeared to be charcoal, known as lamp black. In MUL 17 the red on the tower illustration registered as vermilion with black particles which were probably carbon from the manufacturing process.

A purple from page 45r in MUL 17 was analysed. Although it appeared as a strong, consistent colour there was too much fluorescence to produce a reading, an indication of a strong organic material. The purple in pages with the illustrations of horses in MUL 134 was unable to be identified except that it gave the appearance of a resinous

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## NOTES

1. Martin Levey, Miroslav Krek and Husni Haddad, "Some Notes on the Chemical Technology in an Eleventh Century Arabic Work on Bookbinding" *Isis* v. 47. 1956, pp. 239–243.
2. Guy Petherbridge, co-author of *Islamic Bindings and Bookmaking* with Gulnar Bosch and John Carswell, Syed Mohamad Albukhary, Director of Musium Kesenian Islam, and Dr Brian Lewis, the University of Leeds, have all examined the collection and commented on the depth and breadth of the items contained in it. Dr Lewis spent six weeks cataloguing the collection and completed an analysis of its contents. Unfortunately he died on his return to Leeds and his research report has not been found.
3. L. Mathieson and K. Nugent, "Raman Laser Microprobe Spectroscopy and the Analysis of Materials from Oil Paintings", *AICCM Bulletin*. 17 (1,2) 1996, pp. 51–60.
4. For further information on eastern preparation of lapis lazuli and other pigments see Bukhari, Y.K. "Pigments", *Marg*, XVO, 2, March 1963, supplement p.ii-iii, P. Laurie. "The Pigments and Medium", *A Survey of Persian Art*, volume 5, A. A. Pope and P. Ackerman, 1977, pp.1918–1920 and M. Levey, "The Manufacture of Inks, Liqs, Erasure Fluids, and Glues — A Preliminary Survey in Arabic Chemical Technology", *Chymia*, VII, 1961, pp. 57–73.
5. An *unwan* is the symmetrical design/illumination of the upper half of the folio at the beginning of the manuscript. A full page illumination is called a sarlah. See B. Gray, *The Arts of the Book in Central Asia 14th–16th Centuries*, Colorado, 1979, p. 36 ff.
6. R. J. Gettens and G. L. Stout, *Painting Materials*, Toronto and London, 1966, p.120.




Manuscript from Northern India, left, a leaf, and right, the cover. (MUL 134, Middle Eastern Manuscript collection, University of Melbourne Library.)

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material and the purple pink of the mountains appeared to consist of a resin with ochre.

Work on the manuscripts is ongoing. In 1998 a working group was established to publish the manuscripts on the internet to encourage international scholarly comment on the texts and

calligraphy. There is much work to be done in researching areas of the book production of collection such as book-binding, the paper usage and further analysis of the pigments used. It is anticipated that further research will also be undertaken on the texts and calligraphy of the manuscripts of this significant collection. ■



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7. Gettens and Stout, 1966, p.95.
8. Orpiment is a sulphide of arsenic, closely related to realgar, was used widely in the east in this period and possibly came from the Black Sea, Armenia and Iraq. For the origins and uses of orpiment in eastern manuscripts see Fitzhugh, 1988, p. 427.
9. *Realgar* is a natural sulphide of arsenic and its name is apparently derived from the Arabic *Rahj al ghar* meaning powder of the mine. Gettens and Stout, 1966, p.152.
10. See Gettens and Stout, 1966, pp.152–153 and E. W. Fitzhugh, "Study of Pigments on Selected Paintings from the Vever Collection", *An Annotated and Illustrated Checklist of the Vever Collection*, Washington, 1988, p. 425 ff.
11. See Laurie, 1977, p.1918.
12. In this area ochre was also identified.
13. Three areas of yellow were examined on this page. While two were identified as orpiment there was a yellow particle in the blue area which gave an indication of being haematite.
14. Other yellow pigment of MUL 87 were tests but the spectra produced was not definitive.
15. It was very similar to the resinous red in MUL 3.
16. Levey, 1961, pp. 57–73.
17. Fitzhugh, 1988, p.428.
18. See Fitzhugh, 1988, p. 425 ff and Laurie, 1977, p. 1918.

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