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Raman spectroscopy analysis of pigments on 16–17th c. Persian manuscripts

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ABSTRACT

The palette of four Persian manuscripts of the 16th and 17th centuries were established by Raman microscopy to include lazurite, red lead, vermilion, orpiment, a carbon-based black, lead white, malachite, haematite, indigo, carmine and pararealgar. The first five pigments were identified on all four manuscripts, as previously found for other Islamic manuscripts of this period. The findings were compared with information available in treatises on Persian painting techniques. Red lead, although identified on all of the manuscripts analysed in this study as the main red pigment, is seldom mentioned in the literature. Two unusual pigments were also identified: the intermediate phase between realgar and pararealgar in the manuscript *Timur namah*, and carmine in the manuscript *Shah namah*. Although the established palette comprises few pigments, it was found that the illuminations were enhanced by the use of pigment mixtures, the components of which could be identified by Raman microscopy.

1. Introduction

The Victoria and Albert Museum (V&A) holds a rich collection of illuminated oriental manuscripts covering different geographical locations and historical periods, the vast collection including some of the most significant works of Persian literature. The manuscripts selected for analysis are examples of the skill of the Safavid dynasty of Persia (1501–1732), where the art of calligraphy, illumination and binding reached its apogee. Many rulers of this dynasty were major art patrons and some of them were artists themselves, such as Shah Thamasp (1529–1576), the son of the founder of the dynasty (Shah Ismail I), who was both a calligrapher and a designer [1].

In order to explore the palette of pigments used during this period of Persian art, four illuminated Persian manuscripts from the 16th and 17th centuries were selected. Two of them are epic poems: *Timur namah* (Book of Timur) which tells the story of Timur, the founder of the Timurid dynasty (1370–1405), and *Shah namah* (Book of Kings), the history in 16,000 verses of the Pre-Islamic Persian Kings. The other two manuscripts are books of poetry: *Layla we Majnun*, Nizami (1141–1209), the famous adaptation of a Middle Eastern love story, and *Diwan Anvari*, the collected poems of the Persian poet Anvari (1126–1189).

Very few scientific studies of the pigments used on Persian illuminated manuscripts have yet been made. Raman microscopy (RM) is a particularly appropriate technique since it allows the *in situ* analysis of artefacts in a non-destructive way and is now widely used to identify pigments on manuscripts [2–5]. The data obtained are essentially immune to interference from other pigments, due to the high spatial (ca. 1 μm) and high spectral (ca. 1 cm^{-1}) resolution of the instrumentation. Most inorganic materials and a limited range of organic ones can be identified in this way. However interference from fluorescent binders, especially heavily bound ones, may lead to difficulties in identification.

By establishing a palette for the manuscripts analysed, a comparison can be drawn between the pigments employed and those referred to in two Persian treatises on painting that have been translated into English. The first is the *Gulistan-I Hunan* (Rose Garden of Art), an appendix to a text written by Qadi Ahmad, in c. 1608, [6] and the second is *Qanun us-Suvar* (Canons of Painting) by Sadiqi Bek, a royal painter from the 16th century [7]. Both were written in what is now Iran. Purinton and Watters [8] in 1991 compared information about the materials used in Persian painting obtained through scientific analyses with that available in the literature on Persian painting techniques. They examined nineteen Persian paintings dating from the 15th to the 17th centuries by energy-dispersive X-ray fluorescence analysis (XRF), complemented by X-ray diffraction (XRD) and polarised light microscopy (PLM). The palette of this period was found to consist mostly of mixtures of pigments to achieve a variety of different colours. Several more recent studies using RM as the main analytical technique for pigment and binder analyses have contributed further to our knowledge of the

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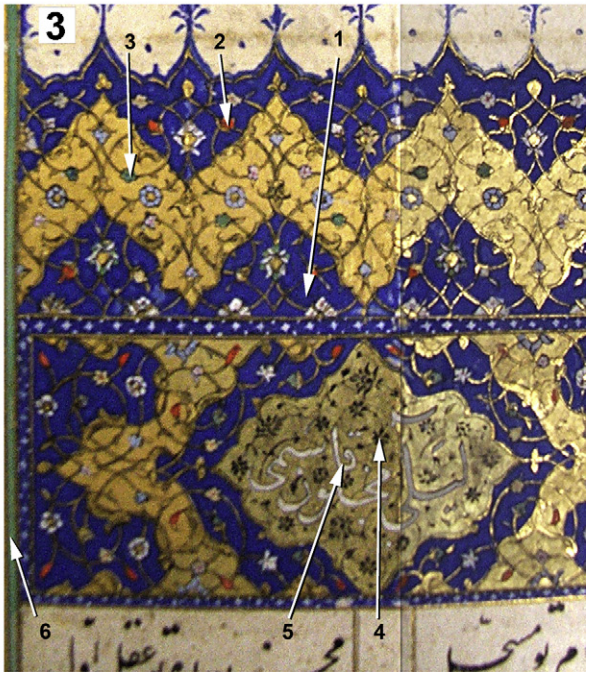

Figs. 1–3. **(1)** Double-page frontispiece from the manuscript *Timur Namah* (MSL/1876/699). Locations of the Raman analyses are indicated numerically. **(2)** *Unwan* from the manuscript *Timur Namah* (MSL/1876/699). Locations of the Raman analyses are indicated numerically. **(3)** *Unwan* from the manuscript *Layla we Majnum* (MSL/1885/359). Locations of the Raman analyses are indicated numerically.