PAOLA RICCIARDI, JOHN K. DELANEY, LISHA D. GLINSMAN, MATHIEU THOURY, AND MICHELLE FACINI

A Comprehensive In-Situ Approach for the Analysis of Illuminated Manuscripts and Drawings: Exploring the Synergy between Imaging Spectroscopy, FORS, XRF, and High-Resolution Multispectral Infrared Reflectography

ABSTRACT

This study will describe the combination of high fidelity, site-specific methods (FORS and XRF) with the mapping capability of imaging spectroscopy, to provide improved in situ mapping and identification of pigments in fragile and light-sensitive works of art. These analytical techniques have been combined predominantly to study oil paintings. Due to the very limited ability to sample fragile works of art, development of in situ analytical techniques is important. The experimental setup in use at the National Gallery of Art in Washington, DC combines the mapping and diagnostic capabilities of both reflectance and luminescence imaging spectroscopy with the specificity of more traditional analytical in situ methods such as FORS and XRF. This combination allows comprehensive non-invasive studies of different kinds of works of art. The relatively low cost imaging apparatus ($10K) consists of a Si-CCD camera, a color-corrected lens, a set of 12 narrow-band filters (400–950 nm), and black/white standards for calibration to reflectance values. Operating at low light levels (200 lux), this system was used to identify and map the primary pigments in works on paper[1] and illuminated manuscripts[2]. Additionally, a high spatial resolution (280 dpi) and high sensitivity multispectral infrared reflectography camera, with a custom lens, allows imaging works of art in three spectral bands between 1000 and 2500 nm with extremely low light levels (20–50 lux), thereby facilitating the identification of thin underdrawing lines. Results will be presented regarding a few 14th- and 15th-century illuminated leaves, including *Praying Prophet* painted by Lorenzo Monaco in Florence around 1413. The palette used to paint this leaf is extremely rich and mainly consists of lead white, ultramarine, red lead, vermillion, red and yellow organic dyes, lead-tin yellow, brown earths, and mosaic gold. The green color has been obtained by mixing azurite and massicot, and the gold leaf is laid over a ground prepared with gypsum and a red earth. The presence of specific absorption bands in some of the NIR reflectance spectra suggests the use of egg tempera as a binder in some areas of the miniature, while other areas seem to have been painted using either gum Arabic or egg glair. High-resolution infrared reflectograms show limited underdrawing in ink, mainly in the pink foliage and in areas of the prophet's robe where the folds have not been painted exactly over the drawn lines; the presence of more extensive underdrawing cannot be excluded. Additionally, the page has been ruled and the music notes seem to have been outlined, probably with a metalpoint stylus. This methodology combining analytical techniques has been shown to also be useful in the study of watercolors, gouache and metalpoint drawings.

NOTES

1. Delaney, J. K., et al., Mark Rothko's early works on paper: a technical analysis of modern materials, Poster presented at AIC 38th Annual Meeting, Milwaukee, 2010
2. Delaney, J. K., et al., Application of imaging spectroscopy to the study of illuminated manuscripts, Poster presented at AIC 37th Annual Meeting, Los Angeles, 2009

PAOLA RICCIARDI
National Gallery of Art
Washington, DC
pr364@cam.ac.uk

JOHN K. DELANEY
National Gallery of Art
Washington, DC
j-delaney@nga.gov

LISHA D. GLINSMAN
National Gallery of Art
Washington, DC

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MATHIEU THOURY
National Gallery of Art
Washington, DC

MICHELLE FACINI
National Gallery of Art
Washington, DC