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Introduction:

The Emerson-White Hours (MS Typ 443-443.1, Houghton Library, Harvard University), is a book of hours and missal produced in Valenciennes, Bruges, and Ghent in the late 1470s or early 1480s. There are seven full-page miniatures (many more have been removed), fourteen historiated borders, twenty-eight historiated initials, and twenty-four calendar illustrations in tempera and gold. Text pages have shell gold trompe-l'oeil borders. The illuminators include Simon Marmion, the Master of the Houghton Miniatures (named for this manuscript), the Master of the Dresden Prayer Book, and one of the Ghent Associates. The goal of analysis was to determine if identification of palettes supported previous stylistic attributions.

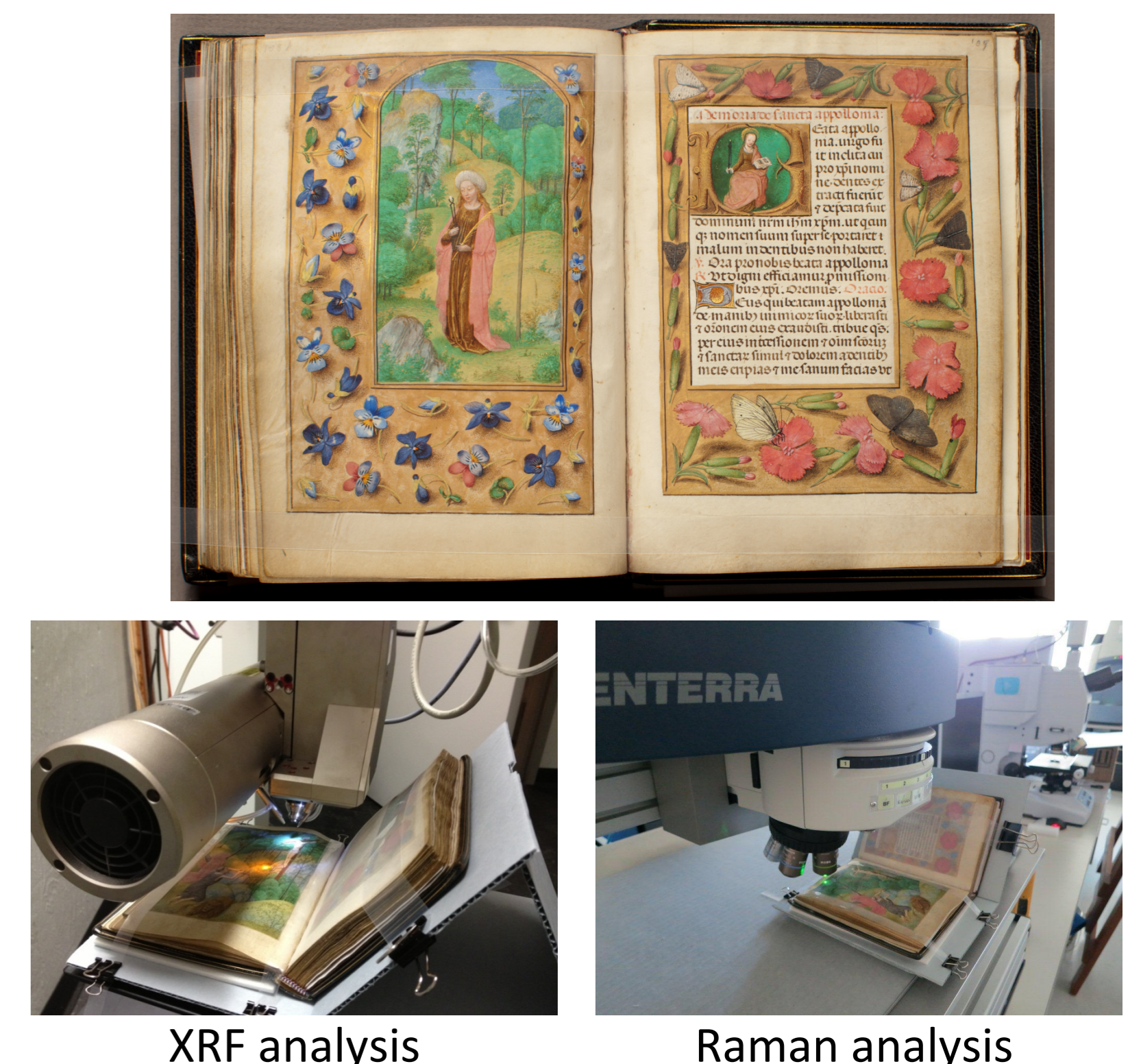
Here, we focus on the illuminations attributed to Simon Marmion and the Houghton Master and demonstrate that technical analysis can support attributions by identifying differences in the artists' pigment preferences, pigment blending, and overall technique of paint application, specifically how the artist renders shadows.

Experimental:

The **X-ray fluorescence spectroscopy** unit is a Bruker Artax with a Silicon Drift Detector. The settings for these measurements were: 600 microAmperes, 50 kiloVolts, 60 seconds collection time without filters. The helium purge was used to aid in detection of light elements.

The **Raman spectrometer** is a Bruker Optics Senterra dispersive Raman microscope with an Olympus BX51M microscope (20x, 50x objectives were used). The Raman spectrometer is equipped with 532, 633 and 785 nm excitation laser sources, used on 2mW, 2mW and 10mW settings, respectively. Certain pigments are more easily detected with specific wavelength lasers, therefore a combination of these 3 lasers was used in this study. Spectra were compared with reference libraries on the Opus software.

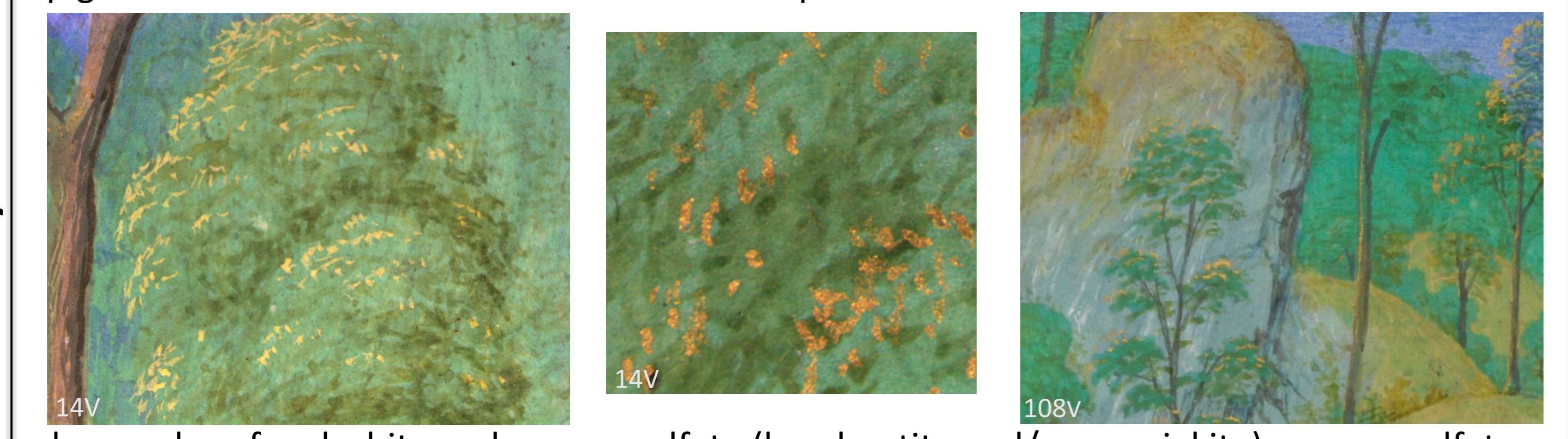
Infrared digital photographs, capable of detection up to ~1.1 microns, and **Infrared reflectograms**, 1.5-1.8 microns, revealed no notable underdrawing. **Transmitted light images** revealing overall paint application were taken with a fibre optic light sheet (LuminousFilm) placed beneath the illumination and captured with a Canon EOS digital camera mounted on a copy stand.



Illuminations Attributed to Simon Marmion



distinctive palette of lime green, green-yellow, organic red, brown · uniform color fields with defined borders · overall transparency achieved with thin media application and pigments of low lead content · overall vertical paint strokes



base color of malachite and copper sulfate (brochantite and/or posnjakite) · copper sulfate greens not identified in palette of the Houghton Master · leaf detail achieved with dark green glaze, lead tin yellow type I, shell gold · distinctive green-yellow contains lead tin yellow type I, likely an organic yellow with iron oxides



grey tone of the rocks painted with azurite and outlined with indigo for shadow definition · thin paint layer and subtle modulation in paint application

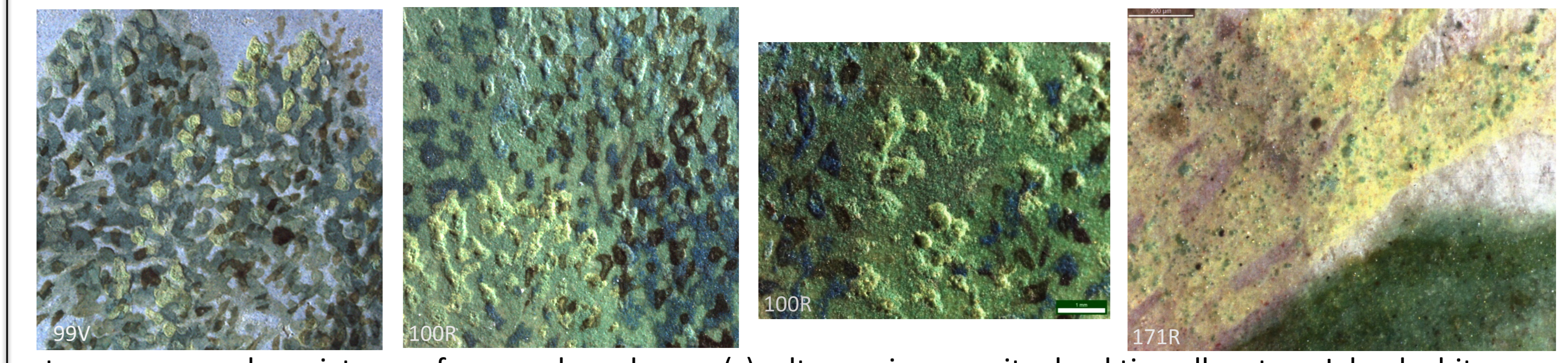


preference for organic red · red robe (14V) and red cape (108V) are similar mixtures of lead white with a calcium-based substrate for the organic red · vermilion used sparingly to paint red streaks of blood and with lead white for flesh tones · red lead not detected · short strokes of blue, likely indigo, or brown as final layer in face to create shadow

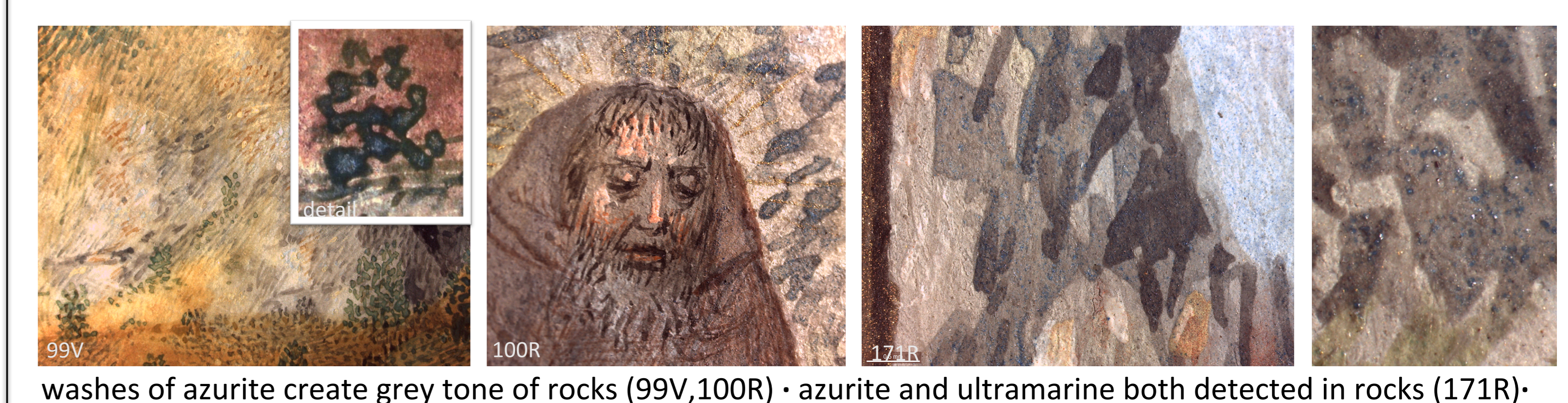
Illuminations Attributed to The Houghton Master



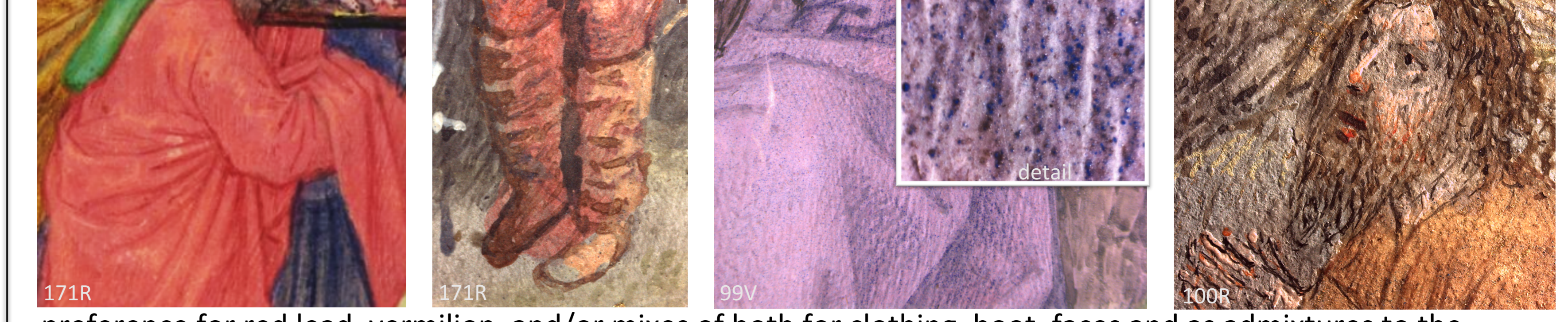
broad color palette · colors and base shapes blended and overlapped · media applied fairly wet with pooled media, often cracked · pigment selection contains higher lead content than those used by Marmion · multi-directional brush strokes



trees are complex mixtures of copper-based green(s), ultramarine, azurite, lead tin yellow type I, lead white · indigo is also detected in trees (99V) · layered, thick, staccato paint application · sophisticated blending and wide distribution of pigment particle size



washes of azurite create grey tone of rocks (99V, 100R) · azurite and ultramarine both detected in rocks (171R) · likely use of black pigment · wash application with large particles of azurite pooling along the tide line · unlike Marmion, Houghton Master did not use indigo to create greys in rocks



preference for red lead, vermilion, and/or mixes of both for clothing, boot, faces and as admixtures to the landscape · organic reds likely used with ultramarine to make lavender color (99R) · organic reds not typically used alone, except in pink robe (171R) · shadows in faces created by dark tone first, with highlights added on top - the reverse of Marmion's sequence

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Conclusion:

The previous stylistic attributions of the illuminations were supported by pigment identification, in conjunction with visual observation enhanced by magnification and transmitted light. Marmion and the Houghton Master preferred different pigments (greens, reds, and the blues used for greys and shadows), and differed in pigment blending and the sequence and manner of pigment application. Going forward, analyses of greys, browns and other neutral tones may provide discriminating insight into the attribution of artists with similar artistic styles.