Supplementary Information: Additional Figures and Tables

Multi-Modal, Non-Invasive Investigation of Modern Colorants on Three Early Modern Prints by Maria Sibylla Merian

Olivia Dill[1], Marc Vermeulen[1], Alicia McGeachy[1] and Marc Walton[1,*]

[1]Northwestern University, Art Institute of Chicago Center for Scientific Studies in the Arts
[*]Correspondence: marc.walton@northwestern.edu

Table S1. Parameters for MA-XRF scans of each print

Point	Pixel Size	Dwell Time	Voltage	Current
Plate 9	1.0 mm	0.2 s	40kV	1.250 A
Plate 54	0.8 mm	0.2s	40kV	1.250 A
Plate 55	0.8 mm	0.2 s	40 kV	1.250 A

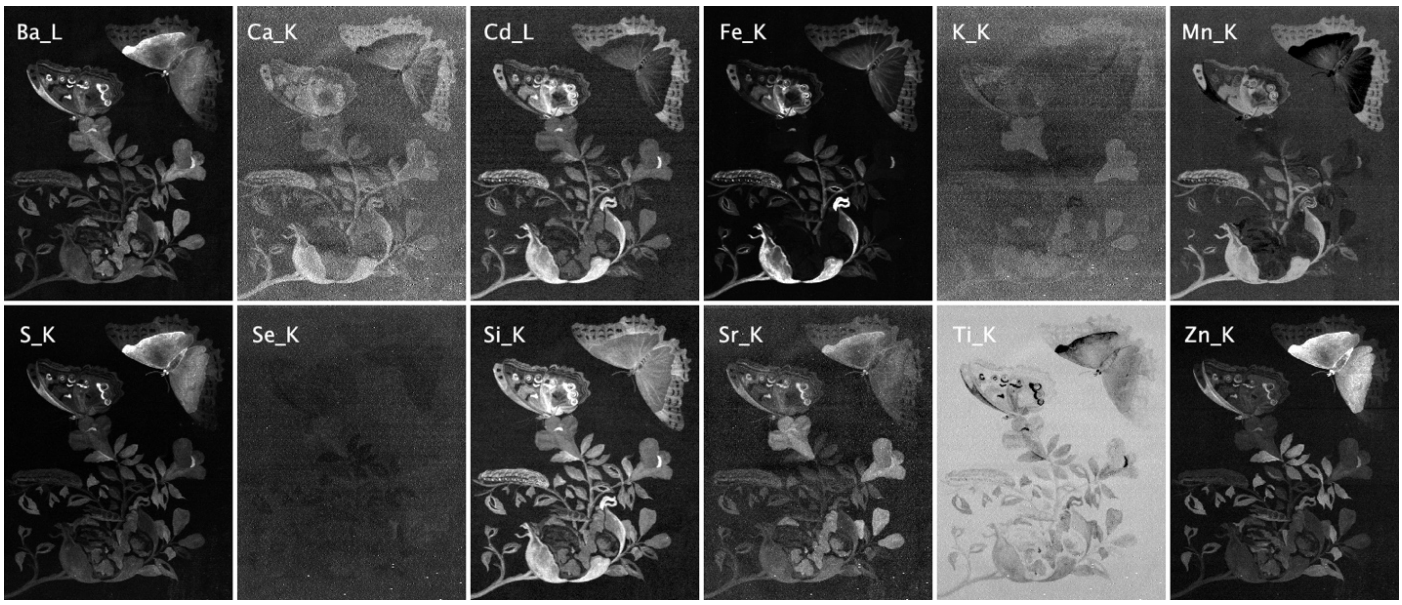

Figure S1. Elemental maps resulting from MA-XRF scan of plate 9.

Table S2. Results of XRF point analysis for plate 9. Elements marked with an asterisk are found in the mat. Those in italics are found in the paper. Elemental distributions suggest the use of cadmium-based yellow and reds, barium-rich red, Prussian blue, brown umber, lithopone, and iron oxide yellow.

Point	Color	Elements Present	Pigment identification
01	Brown	*Ca*, Ti*,K, As, Cu, Si, Ni* Fe, S, Zn, Mn, Ba, Cd	Mat and/or paper Umber (iron oxide + manganese oxide), lithopone (barium sulfate + zinc sulfide)
02	Light blue	*Ca*, Fe*, K, As, Co, Si, Cu, Mn, Ni, Ti** Zn, S, Ba	Mat and/or paper Lithopone (barium sulfate + zinc sulfide), unidentified organic pigment?
03	Dark Blue	*Ca* Ti* K, As, Co, Ba, Cu, Ni, Mn, Si* Fe, Zn, S, Ba	Paper and/or mat Prussian blue Organic pigments with lithopone substrate in mixture with Prussian blue
04	Green	*Ti*, Ca*, Fe*, K, As, Co, Cu, Mn, Ni, Ba, Si* Zn, S	Mat and/or paper Unidentified organic pigment, zinc sulfide and/or lithopone (barium sulfate + zinc sulfide)
05	Green	*Ca*,K, As, Co, Mn, Cu, Si, Ni, Ti** Fe, Zn, S , Ba	Mat and/or paper Iron oxide and/or Prussian blue, lithopone (barium sulfate + zinc sulfide)
06	Yellow	*K, Ca*, As, Sr, Mn, Cu, Ni, Si, Ti*,* Fe, Ba, S, Cd, Zn	Mat and/or paper Iron oxide, lithopone (barium sulfate + zinc sulfide), cadmium-based pigment
07	Dark Red	*Ca*, Fe*, K, As, Co, Mn, Cu, Ti*, Ni, Si* , Zn, S, Ba	Mat and/or paper Iron oxide, lithopone (barium sulfate + zinc sulfide),
08	Mint Green	*Ca*, Fe*, K, As, Co, Cu, Mn, Ni, Si, Ti** Zn, S, Ba	Mat and/or paper Unidentified organic pigment, lithopone (barium sulfate + zinc sulfide)
09	Red	*Ca*, K, As, Cu, Si, Ni, Co?, Ti*,* Fe, Ba, S, Zn, Mn	Mat and/or paper Iron oxide and/or umber (iron oxide + manganese oxide), lithopone (barium sulfate + zinc sulfide)
10	Pink	*Ca*, K, Fe*, As, Co, Cu, Zn, Mn, Ni, Si* Ti, S	Mat and/or paper Unidentified organic pigment, titanium white?
11	Dark Blue	*K, As, Zn, Co, Cu, Mn, Ni, Si, Ba, Ca*, Ti** Fe, S	Mat and/or paper Prussian blue
12	Light Green	*Ca*, K, As, Co, Mn, Cu, Si, Ni, Ti** Zn, Fe, S, Ba	Mat and/or paper Iron-oxide and/or Prussian blue, lithopone (barium sulfate + zinc sulfide)
13	Dark Green	*Ca*, K, Co, Cu, As, Mn, Ni, Si, Ti*,* Fe, Zn, S, Ba	Mat and/or paper Iron oxide and/or Prussian blue, lithopone (barium sulfate + zinc sulfide)

14	Dark Yellow Green	*Ca, K, As, Mn, Cu, Si, Ni, Ti** Fe, Zn, S, Cd, Ba	Mat and/or paper Iron oxide and/or Prussian blue, lithopone (barium sulfate + zinc sulfide), cadmium-based pigment
15	Red	*Ca*, K, Fe*, As, Co, Cu, Si, Ni, Mn, Ti** S, Ba, Cd	Mat and/or paper Barium sulfate, cadmium-based pigment
16	Paper	*Ca, Ti, Fe, K, Co, As, Cu, Mn, S, Ba, Si, Ni*	
17	Mat	Ca*, Ti*, Fe*	

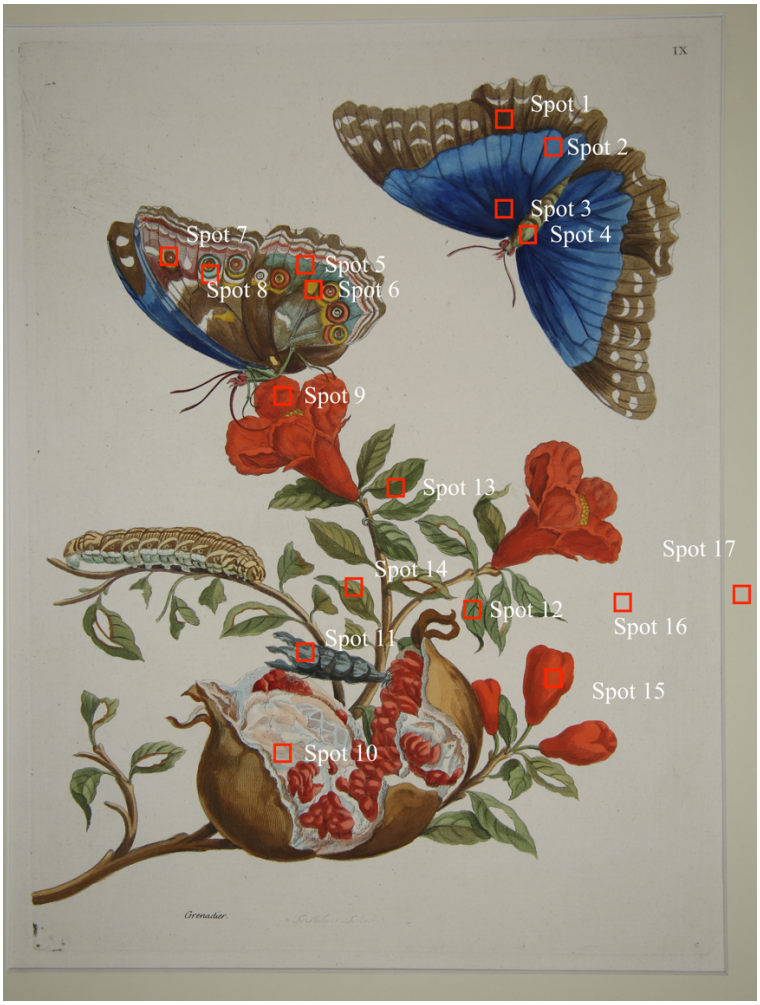

Figure S2. Sample locations for XRF point analysis of plate 9.

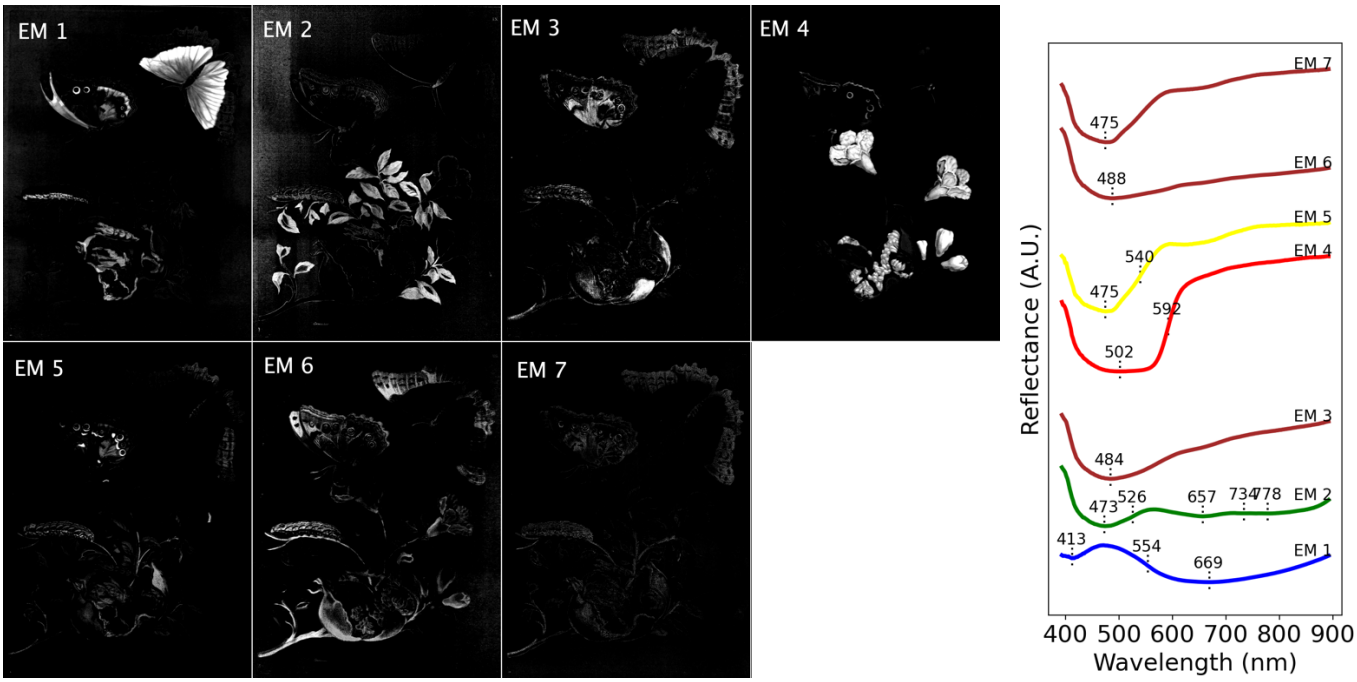

Figure S3. Endmember maps resulting from hyperspsectral imaging for plate 9 (left) and associated reflectance spectra (right). Inflection points and local absorption maxima have been annotated in reflectance spectra.

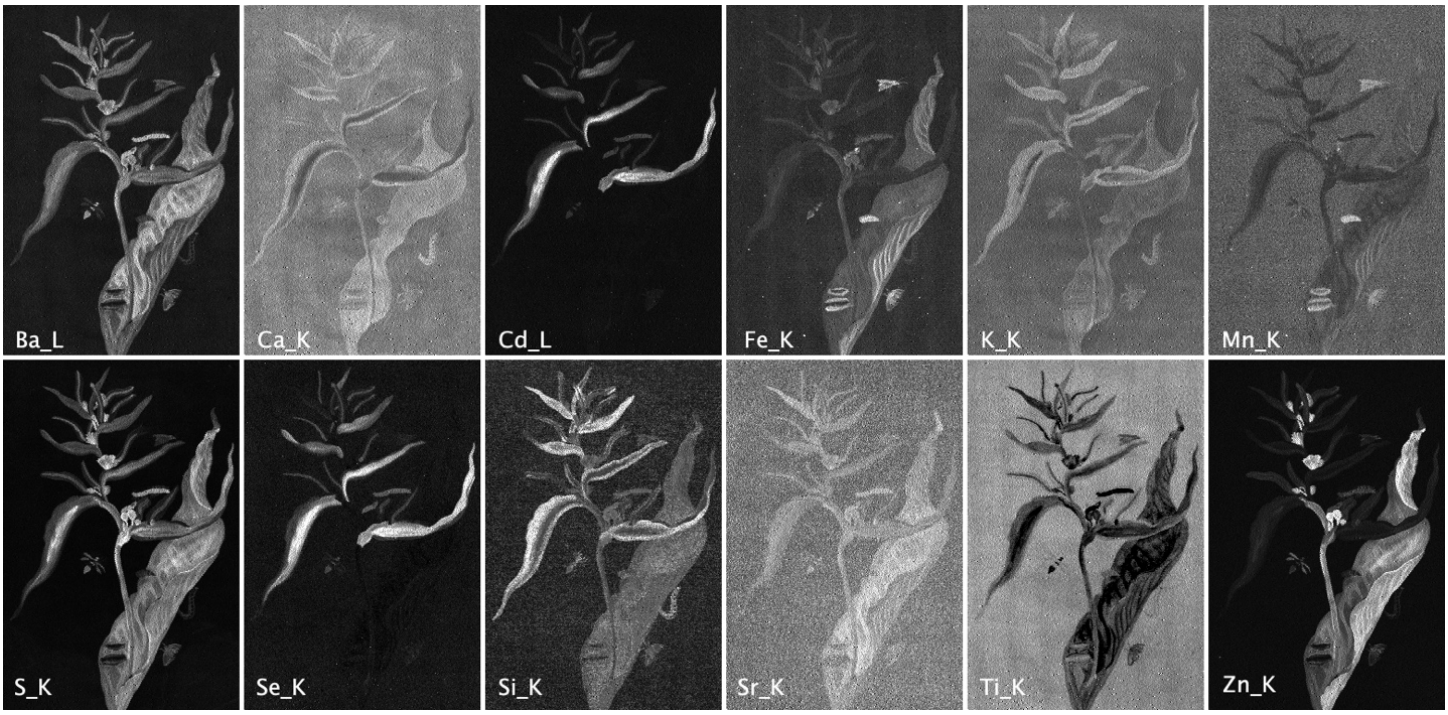

Figure S4. Elemental maps resulting from MA-XRF scan of plate 54.

Table S3. Results of XRF point analysis for plate 54. Elements marked with an asterisk are found in the mat. Those in italics are found in the paper. Data was corrupted for spot 1 and spot 2 so they are not included here. Elemental distributions suggest the use of Prussian blue, brown umber, lithopone, and cadmium-based yellow.

Point	Color	Elements Present	Pigment identification
03	Green-Blue	*Ca, Fe, K, As, Co, Cu, Mn, Ni, Si, Ti*, Zn, S, Ba	Mat and/or paper Unidentified organic pigment, lithopone (barium sulfate + zinc sulfide)
04	Light Green	*Ca*, K, As, Co, Cu, Si, Mn, Ni*, *Ti** Zn, Fe, S, Ba	Mat and/or paper Prussian blue and/or iron oxide, lithopone (barium sulfate + zinc sulfide)
05	Dark Green	*K, As, Co, Cu, Si, Mn, Ni*, *Ca*, Ti** Zn, S, Fe, Ba	Mat and/or paper Prussian blue and/or iron oxide, lithopone (barium sulfate + zinc sulfide)
06	Brown	*Ti*, K, As, Cu, Si, Co, Ni*, Ca* Fe, Mn, Zn, S, Ba	Mat and/or paper Iron oxide and/or umber (iron oxide + manganese oxide), lithopone (barium sulfate + zinc sulfide)
07	Pink	*Ti*, Ca*, Fe*, Ba, K, Si, As, Co, Mn, Cu, Ni S, Zn*	Mat and/or paper Unidentified organic pigment, zinc white or lithopone (barium sulfate + zinc sulfide)
08	Yellow	*Ca*, K, As, Co, Mn, Cu, Sr, Ni, Si, Ti* Zn, S, Fe, Cd, Ba*	Mat and/or paper Cadmium-based pigment, lithopone (barium sulfate + zinc sulfide)
09	Paper	*Ca, Ti, K, As, Fe, Co, S, Si, Mn, Cu, Ni*	
10	Mat	Ca*, Ti*, Fe*	

Figure S5 Sample locations for XRF point analysis of plate 54. An additional point was measured outside the frame on the print's mat.

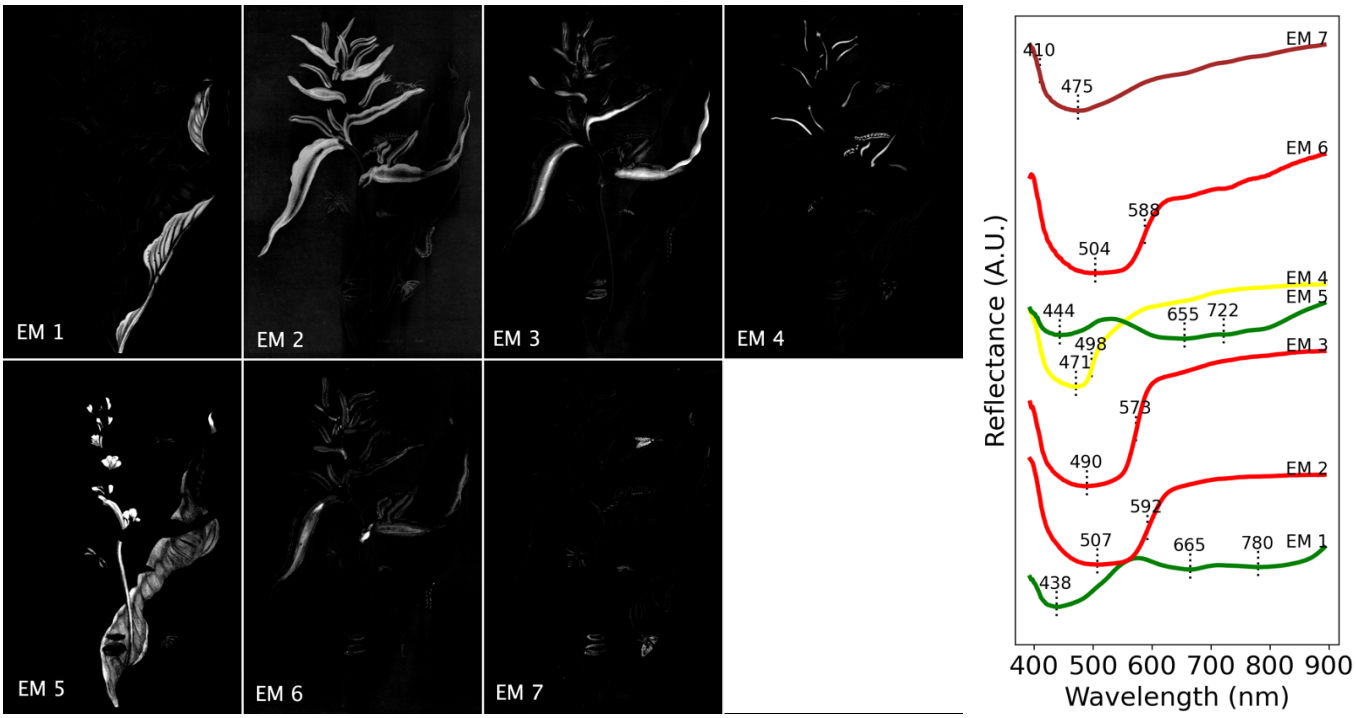

Figure S6. Endmember maps resulting from hyperspsectral imaging for plate 54 (left) and associated reflectance spectra (right). Inflection points and local absorption maxima have been annotated in reflectance spectra.

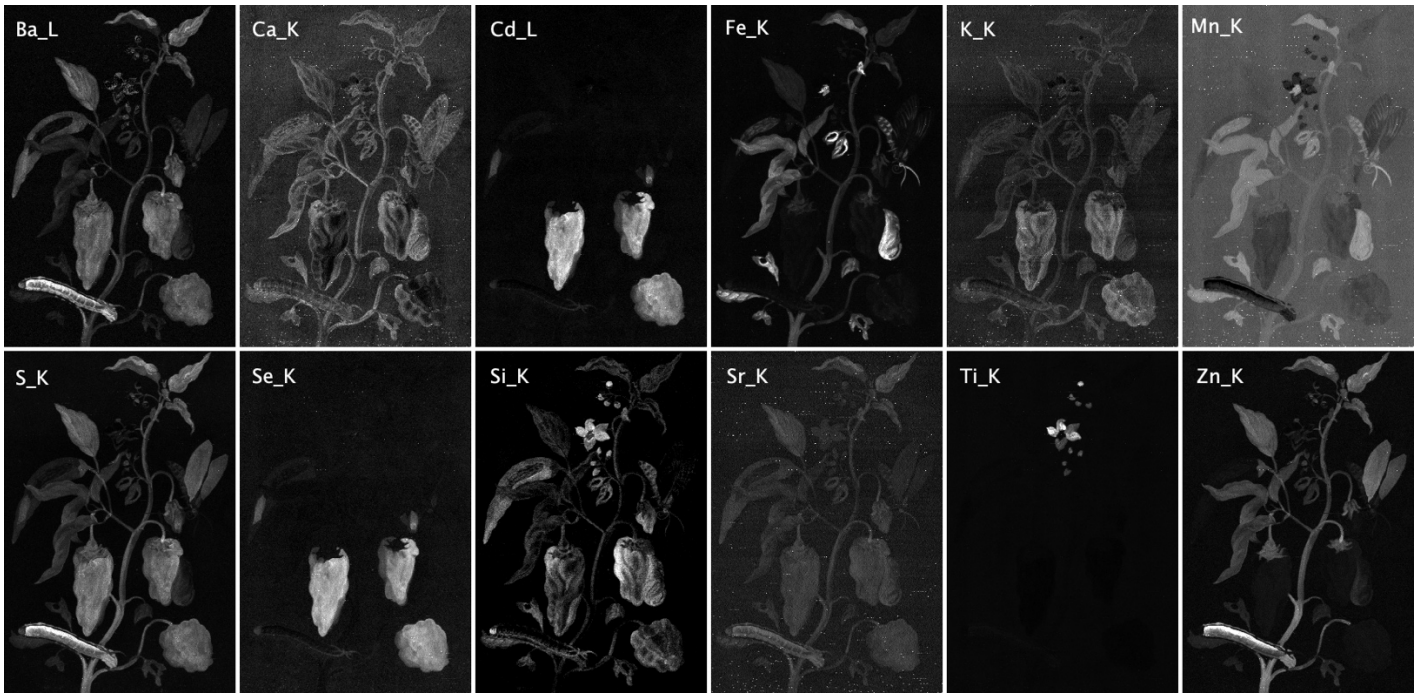

Figure S7. Elemental maps resulting from MA-XRF scan of plate 55.

Table S4. Results of XRF point analysis for plate 55. . Elements marked with an asterisk are found in the mat. Those in italics are found in the paper. Elemental distributions suggest the use of cadmium red, lithopone, cadmium-based yellow, and brown umber.

Point	Color	Elements Present	Pigment identification
01	Dark green	Ca* *Cu, Mn, As, K* Fe, Zn, Ba, S, Si	Mat Paper Prussian blue + iron oxide? Organic pigments with lithopone substrate in mixture with Prussian blue and/or iron oxide?
02	Light blue	Ca*, Fe* *K, As, Cu, K, Mn* Ti, Zn, Si, S	Mat Paper Organic pigment?
03	Yellow-green	Ca*, Ti*, P*, *K, Cu, As* Fe, Zn, S, Si, Mn, Ba	Mat Paper Prussian blue + iron oxide? Organic pigments with lithopone substrate in mixture with Prussian blue and/or iron oxide?
04	Red	Ca*, Ti*, P*, Fe* *Mn, Cu, As* Cd, Ba, Se, S, Si, Zn (?)	Mat Paper Cadmium red, Organic red on a barium sulfate substrate
05	Brown	Ca*, Ti*, P* *K, Cu, As* Fe, Mn, Ba, Zn, S, Si	Mat Paper Iron oxide, umber-type
06	Light green	Ca*, Ti*, P*, *K, Cu, As, Mn* Fe, Zn, S, Ba	Mat Paper Prussian blue + iron oxide?, Organic pigments with lithopone substrate in mixture with Prussian blue and/or iron oxide?
07	White	Ca*, P*, Fe* K, Cu, As, Mn Ti, Si	Mat Paper Titanium white
08	Yellow	Ca*, Ti*, P* K, Cu, As, Mn, S Fe	Mat Paper Iron oxide
09	Black	Ca*, Fe* K, As, Cu, K, Mn Zn, S, Si, Ba, Fe	Mat Paper Unknown black
10	Light green	Ca*, Fe*, P* K, Mn, Cu, As S, Ba, Zn,	Mat Paper Organic pigments with lithopone substrate?
11	Paper	(Ca*), (Ti*), (Fe*), (P*) S, K, Cu, As, Mn	Mat Paper
12	Mat	Ca*, Ti*, Fe*, P*	Mat
13	Dark red	Ca*, Ti*, P*, Fe* Mn, Cu, As	Mat Paper

		Cd, S, Se Si, P, K, Ba,	Cadmium red Organic red?
14	Dark red	Ca*, Ti*, P*, Fe* Mn, Cu, As Si, P, K, Ba,	Mat Paper Organic red?
15	Dark green	Ca*, P* Cu, As, K Fe, Zn, S, Si, Mn	Mat Paper Prussian blue + iron oxide? Organic pigments with lithopone substrate in mixture with Prussian blue and/or iron oxide?

Figure S8. Sample locations for XRF point analysis of plate 55.

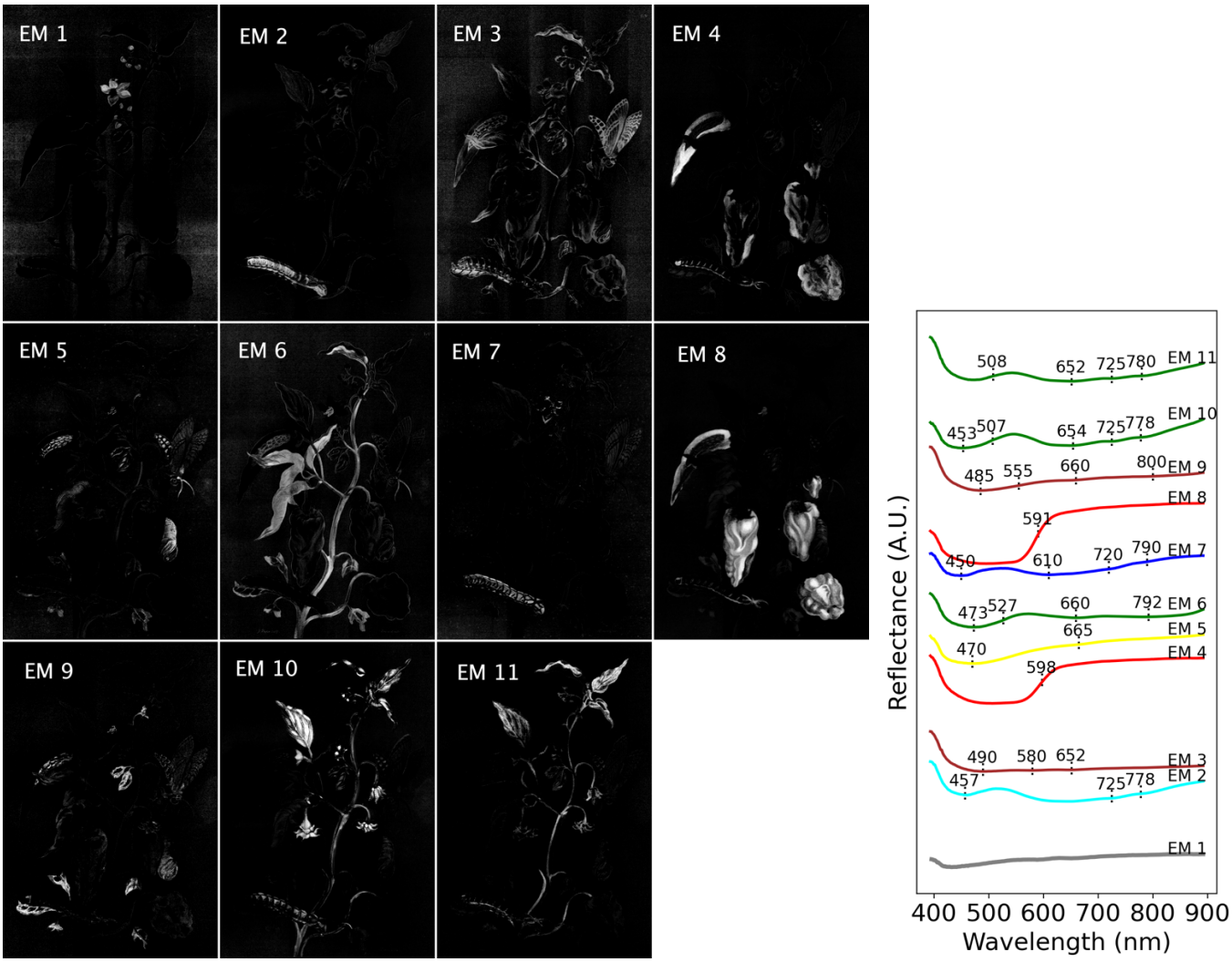

Figure S9. Endmember maps resulting from hyperspsectral imaging for plate 55 (left) and associated reflectance spectra (right). Inflection points and local absorption maxima have been annotated in reflectance spectra.