Multiscale X-ray Fluorescence Mapping Complemented by Raman Spectroscopy for Pigment Analysis of a 15th Century Breton Manuscript

Khachatur V. Manukyan[*], Benjamin J. Guerin, Edward J. Stech, Ani Aprahamian, Michael Wiescher

Nuclear Science Laboratory, Department of Physics, University of Notre Dame,

Notre Dame, Indiana 46556, United States

David T. Gura

Department of Rare Books and Special Collections, Hesburgh Library, University of Notre Dame,

Notre Dame, Indiana 46556, United States

Zachary D. Schultz

Department of Chemistry and Biochemistry, University of Notre Dame,

Notre Dame, IN 46556

[†] *Nuclear Science Laboratory, Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556, United States*

[‡] *Department of Rare Books and Special Collections, Hesburgh Library, University of Notre Dame, Notre Dame, Indiana 46556, United States*

[§] *Department of Chemistry and Biochemistry, University of Notre Dame, Notre Dame, IN 46556*

Electronic Supplementary Information

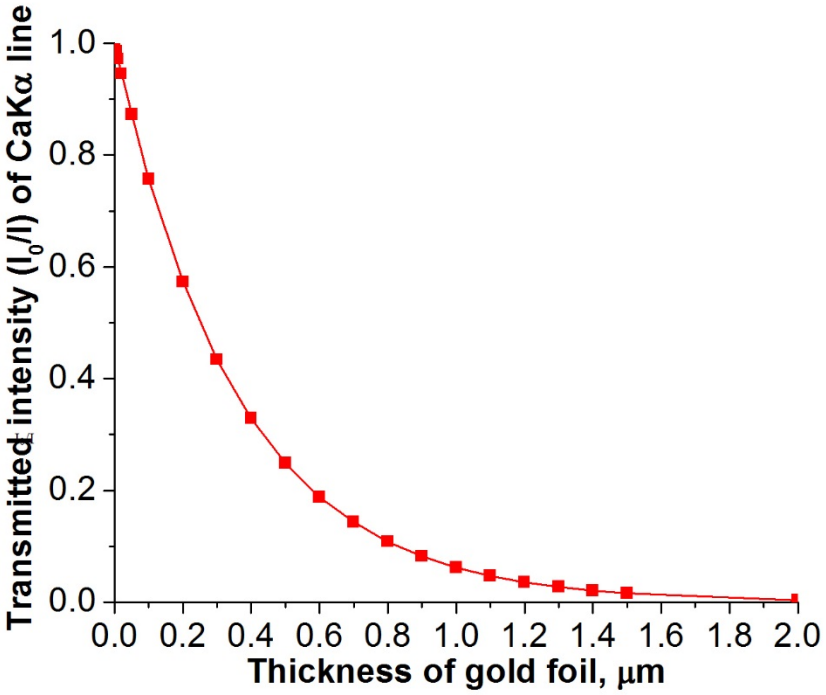

Figure S1 Dependence of I_0/I for CaKα line on gold foil thickness

Table S1 Quantified elemental composition of marked areas in Figure 2B

Element	Atomic %	
	Marked areas in Fig. 2B	
	1	*2*
CaK	1.87	20.72
BaL	0.85	4.83
FeK	0.60	3.88
CuK	96.21	68.38
HgL	0.00	0.45
PbL	0.47	1.74

Table S2 Quantified elemental composition of marked areas in Figure 3A

Element	Atomic %					
	Marked areas in Fig. 3A					
	1	*2*	*3*	*4*	*5*	*6*
CaK	2.75	52.14	51.30	2.14	86.68	93.43
FeK	0.23	5.13	4.72	0.97	1.81	2.16
CuK	0.36	3.20	3.05	0.12	1.17	0.72
HgL	0.24	7.02	18.81	96.22	0.00	0.00
PbL	96.43	32.52	22.12	0.55	10.34	3.69

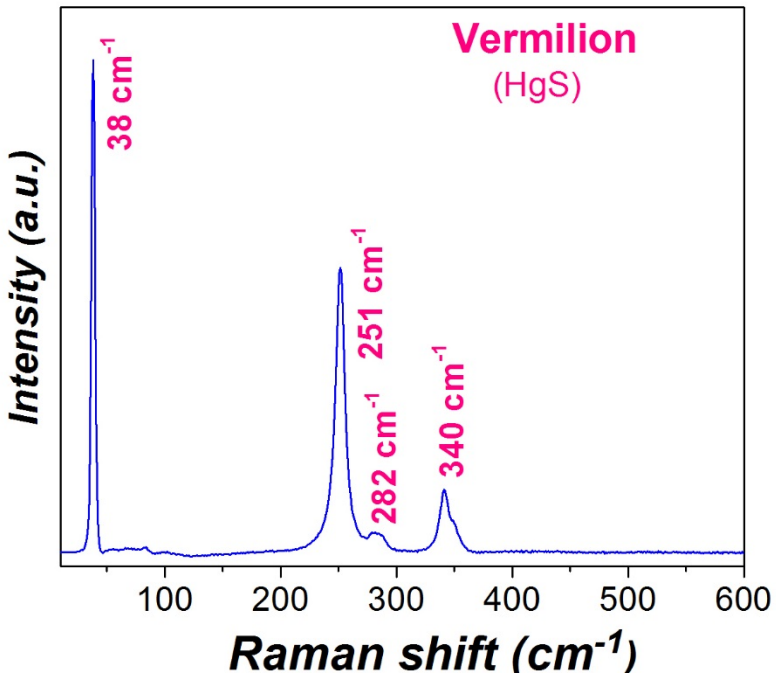

Figure S2 Raman spectrum taken from red letters in Figure 3A

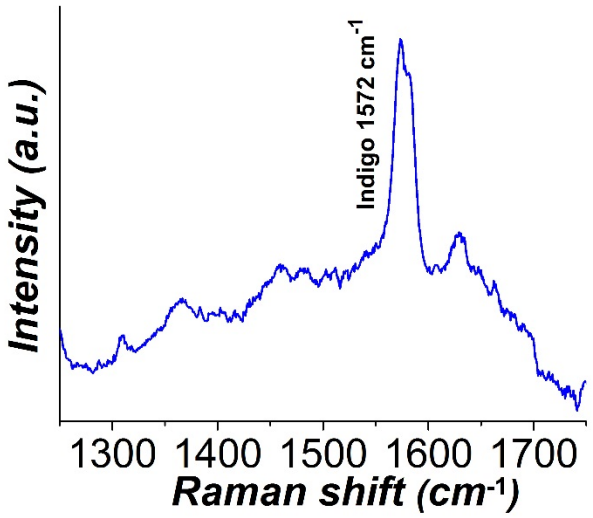

Figure S3 Raman spectrum taken from a large red-yellow particles marked as [1] in Figure 4A

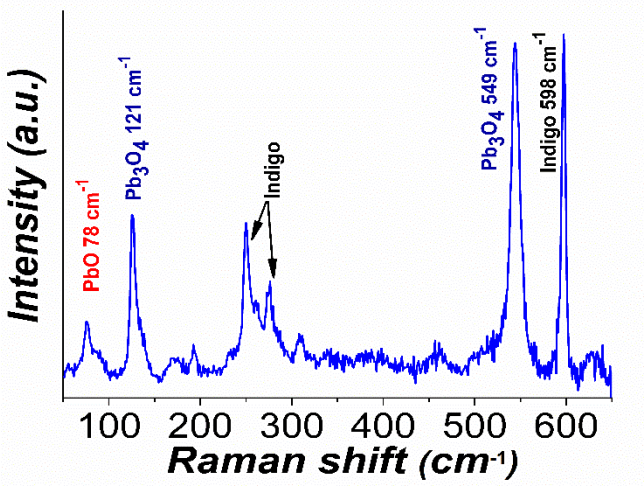

Figure S4 Raman spectrum taken from dark green area marked as [4] in Figure 4A

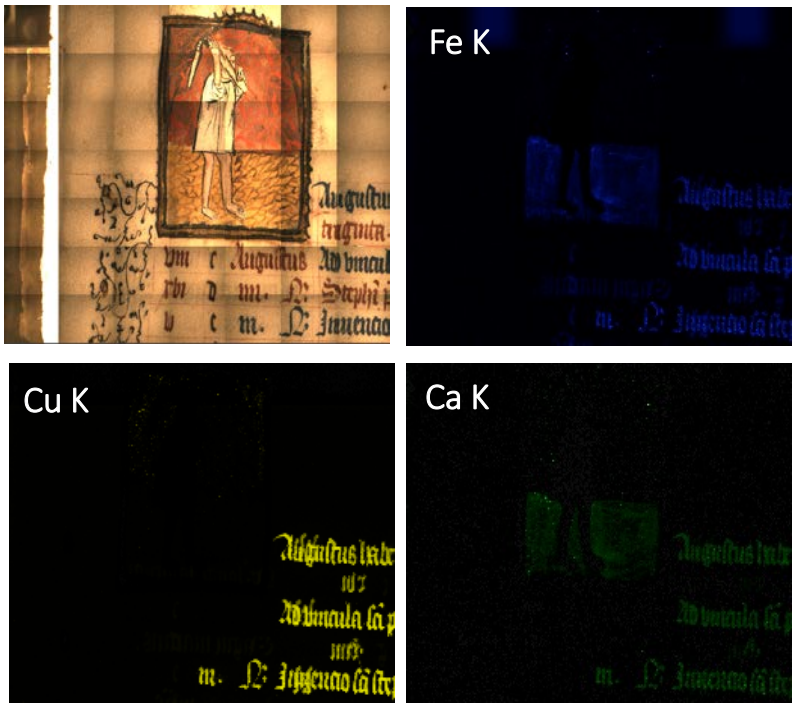

Figure S5 μ-XRF mapping of inks

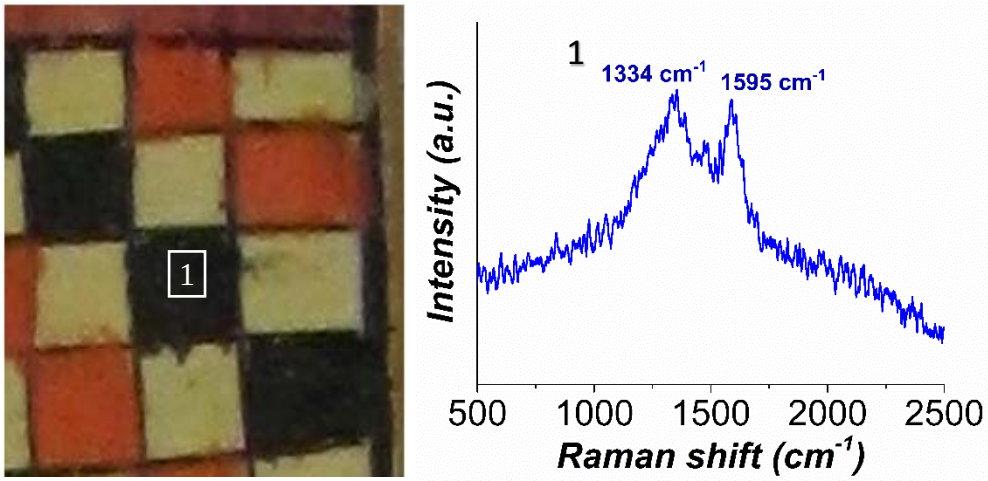

Figure S6 Raman spectrum of black carbon-based pigment