Analysis and Investigation of a Brown Ground Layer from North Italy in the Seventeenth Century

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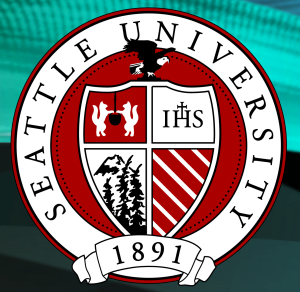
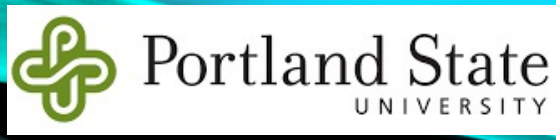




THE PORTRAIT OF BARON IGNAZIO DE PIZZIS

- A Swagger portrait
  - A full-body painting with extra emphasis and detail placed on the clothing of the model.
- Dimensions: 83.75” x 51.75” inches
- Painted by Carlo Ceresa
- Uses a brown-beige ground layer

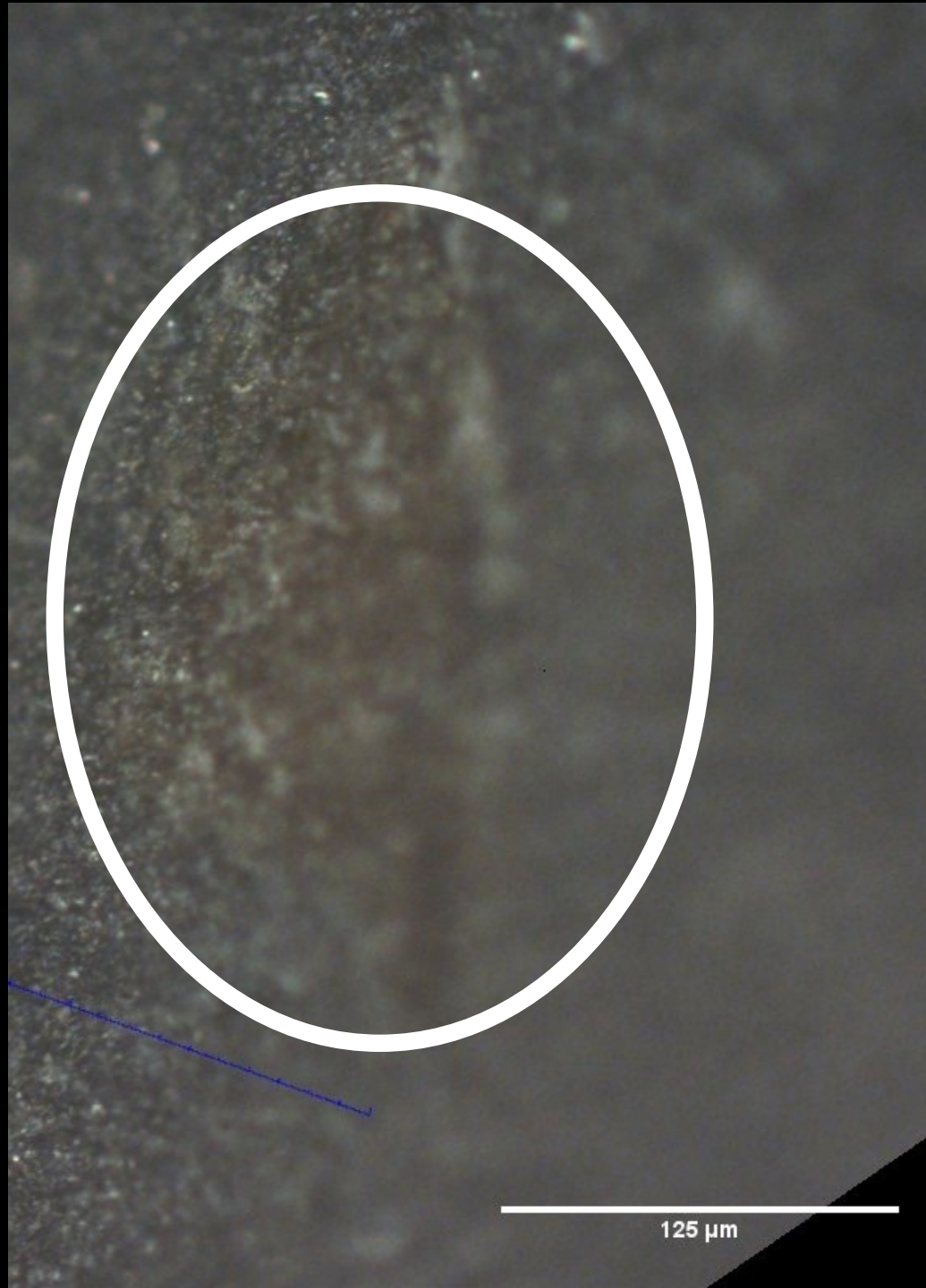
CARLO CERESA (1609-1679)

- Trained and worked near Bergamo, Italy, a northern city.[1]
- Known for his portraits and religious artwork, such as portraits for chapels and altar restoration.[2]
- Otherwise, much is unknown about his life.

[1]Langmuir, E. Palazzo Moroni and Accademia Carrara. *The Burlington Magazine* **1983**, *125*, 782-783+785.
[2]Vertova, L. Additions to Carlo Ceresa. *The Burlington Magazine* **1995**, *137*, 599-607.

GROUND LAYERS OF PAINTING

- The ground is the layer used to prepare a support or canvas for painting.
- The ground layer can affect the colors and tones of art.[3]
  - A white ground layer is often preferred due to high contrast with other colors.
- Right: A cross section of the ground layer of "The Portrait of Baron Ignazio de Pizzis" encased in Bioplastic



[3]Ground. *The National Gallery*. https://www.nationalgallery.org.uk/paintings/glossary/ground.

PROJECT GOAL

To investigate the composition of the Portrait of Baron Ignazio de Pizzis, specifically the blue paints and ground layer.

The bigger goal: to learn more about the brown ground layer used in the portrait, as well as connecting it to a larger historical context.

Analytical Methods

Infrared Reflectography and Infrared False Color

- Easy method of detecting compositional differences in the portrait.
- Uses heat lamps which emit IR waves to measure IR reflection by the materials on the painting.

Raman Spectroscopy

- Uses Raman scattering to identify molecules in the paints.
- Uses a high intensity laser to knock off incident light and measure the Raman scattering.
- All samples were measured at 50x magnification.

X-Ray Fluorescence

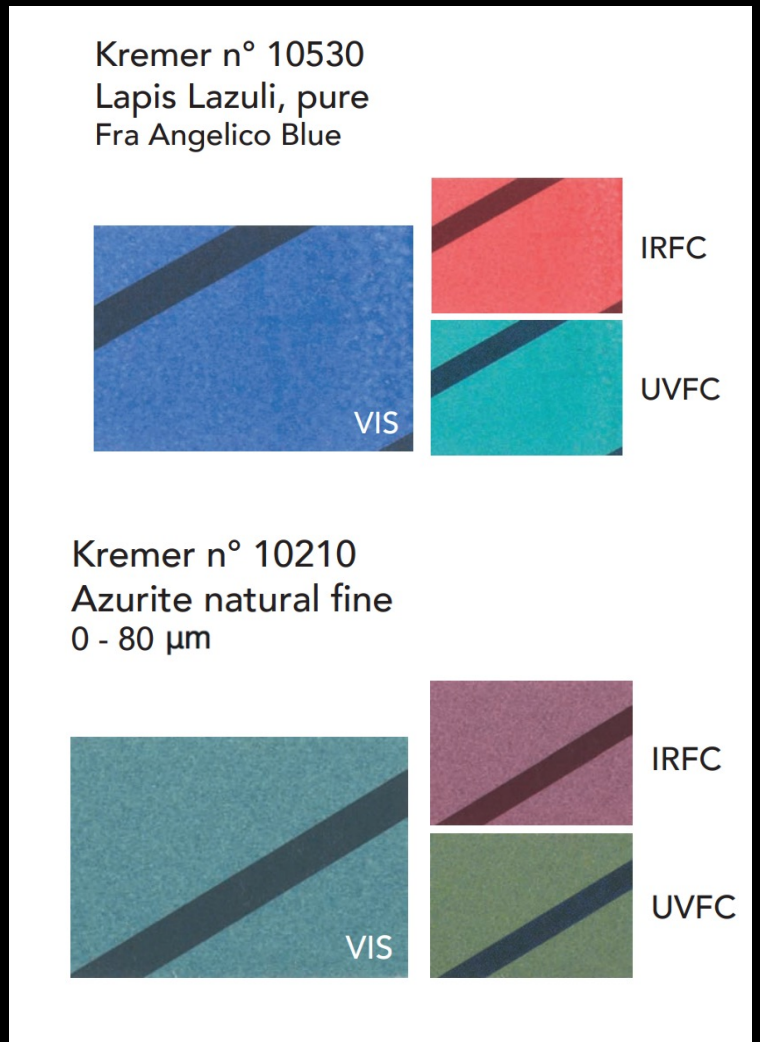
- Detects elements in the paint and ground layers of the portrait.
- Measures fluorescence released when orbitals relax after having a core electron knocked off.
- Spectra were taken at 40kV, 7.6 μA, and a live time of 60 seconds.

IRR

- We can see a black and white image of the portrait with different tones of gray, representing differences in IR absorption.
- The area around the head is shaded similarly to the background of the portrait, despite being a part of the drapes.

IRFC

IRFC database references taken from:
Boust, C.; Wohlgelmuth, A. HistoricalPigments_BLUE_170920: Pigments under UV and IR radiations, in *Scientific imaging for cultural heritage*, ISSN 2609-780X, 18/08/2017, copa.hypotheses.org/552.

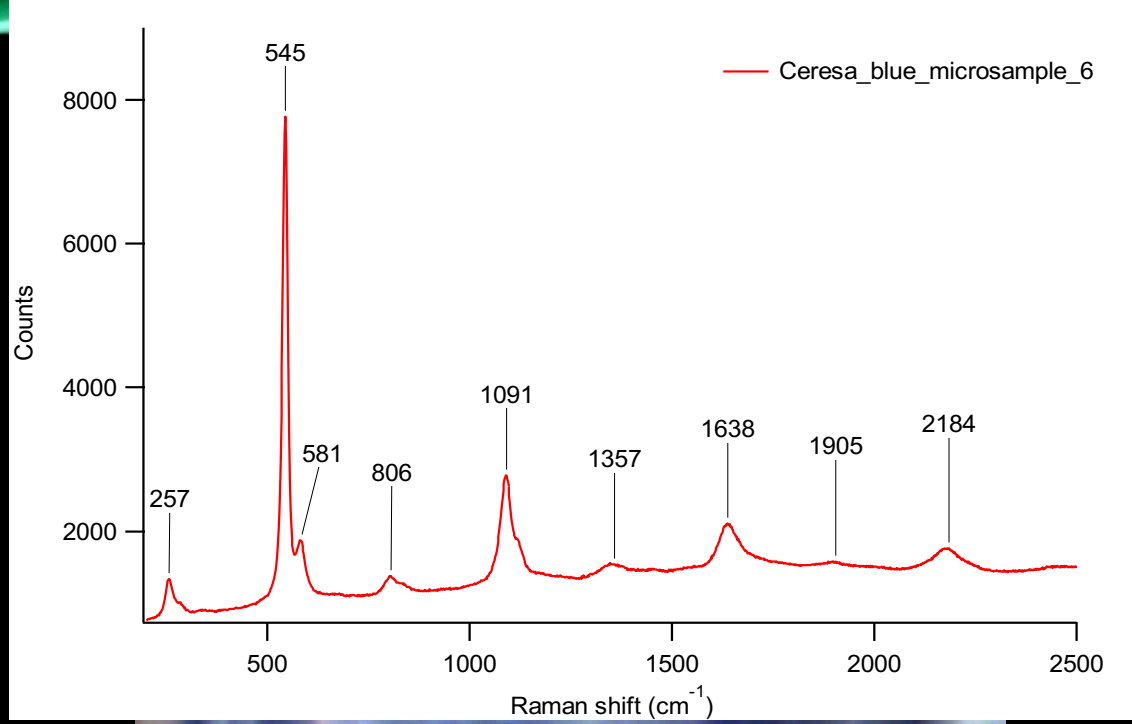


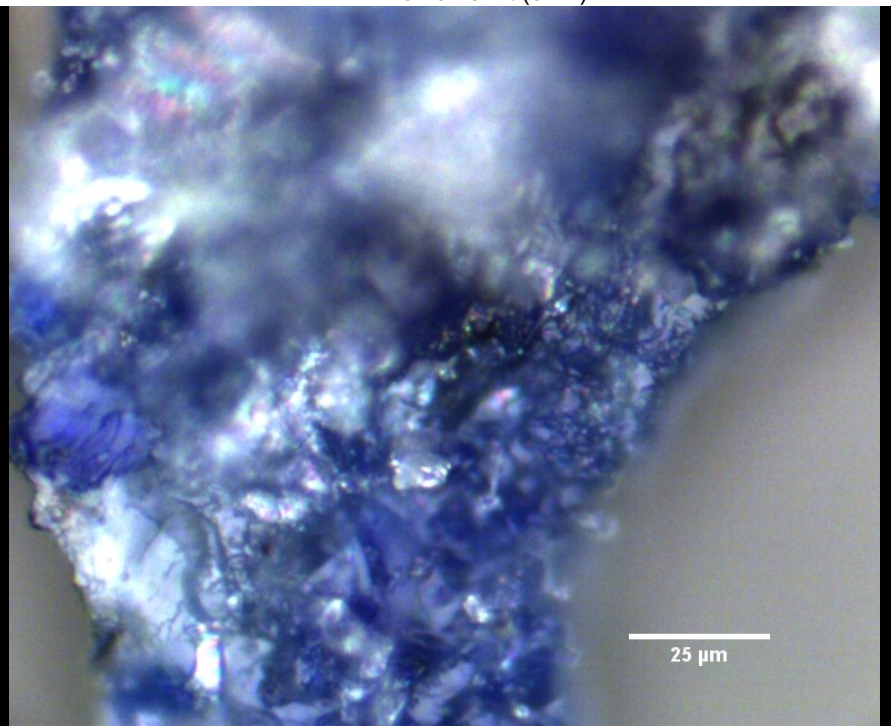
RAMAN MICROSCOPY

- Top: The Raman spectra produced by analyzing a pigment sample of the blue trim of the armor with a 532 nm laser and at 25% intensity.

- Down: Image of the pigment sample being analyzed.

- The Raman spectrum for the blue sample is nearly identical to spectra in literature for lapis lazuli, with strong peaks at 545 and 1091 cm^{-1}.[4]

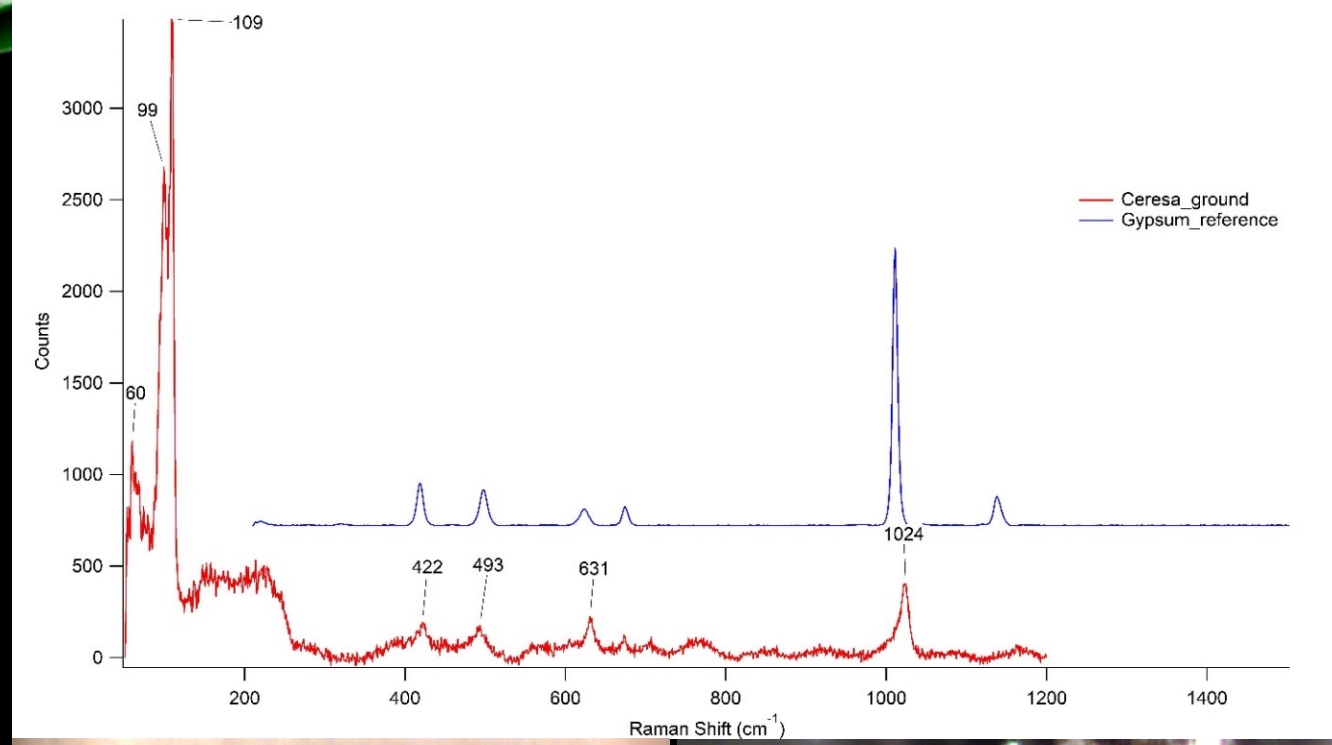


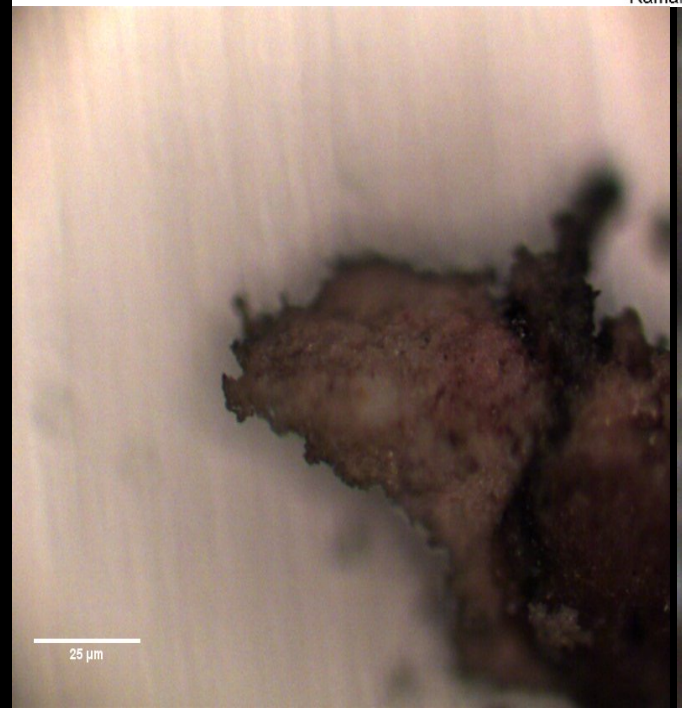


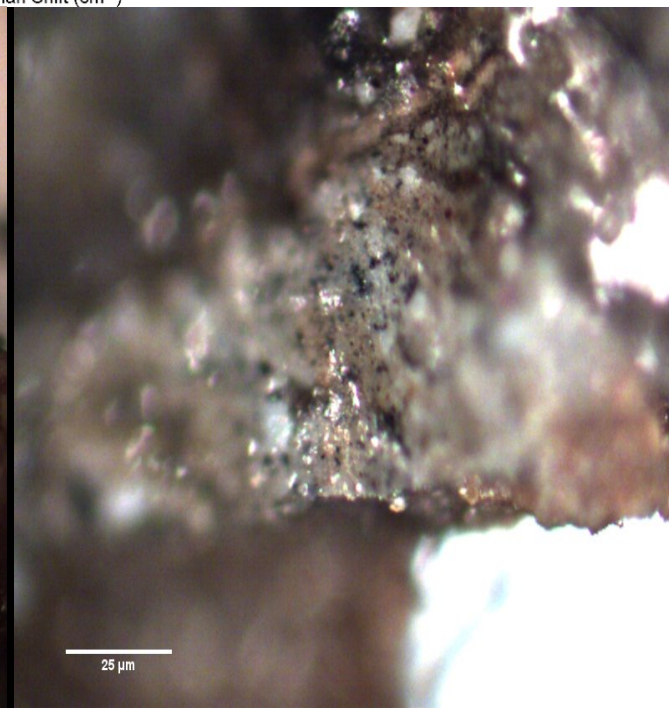
[4]González-Cabrera, M.; Arjonilla, P.; Domínguez-Vidal, A.; Ayora-Cañada, M.J. Natural or synthetic? Simultaneous Raman/luminescence hyperspectral microimaging for the fast distinction of ultramarine pigments. *Dyes Pigm.* **2020**, *178*, 108349

RAMAN MICROSCOPY (CONT.)

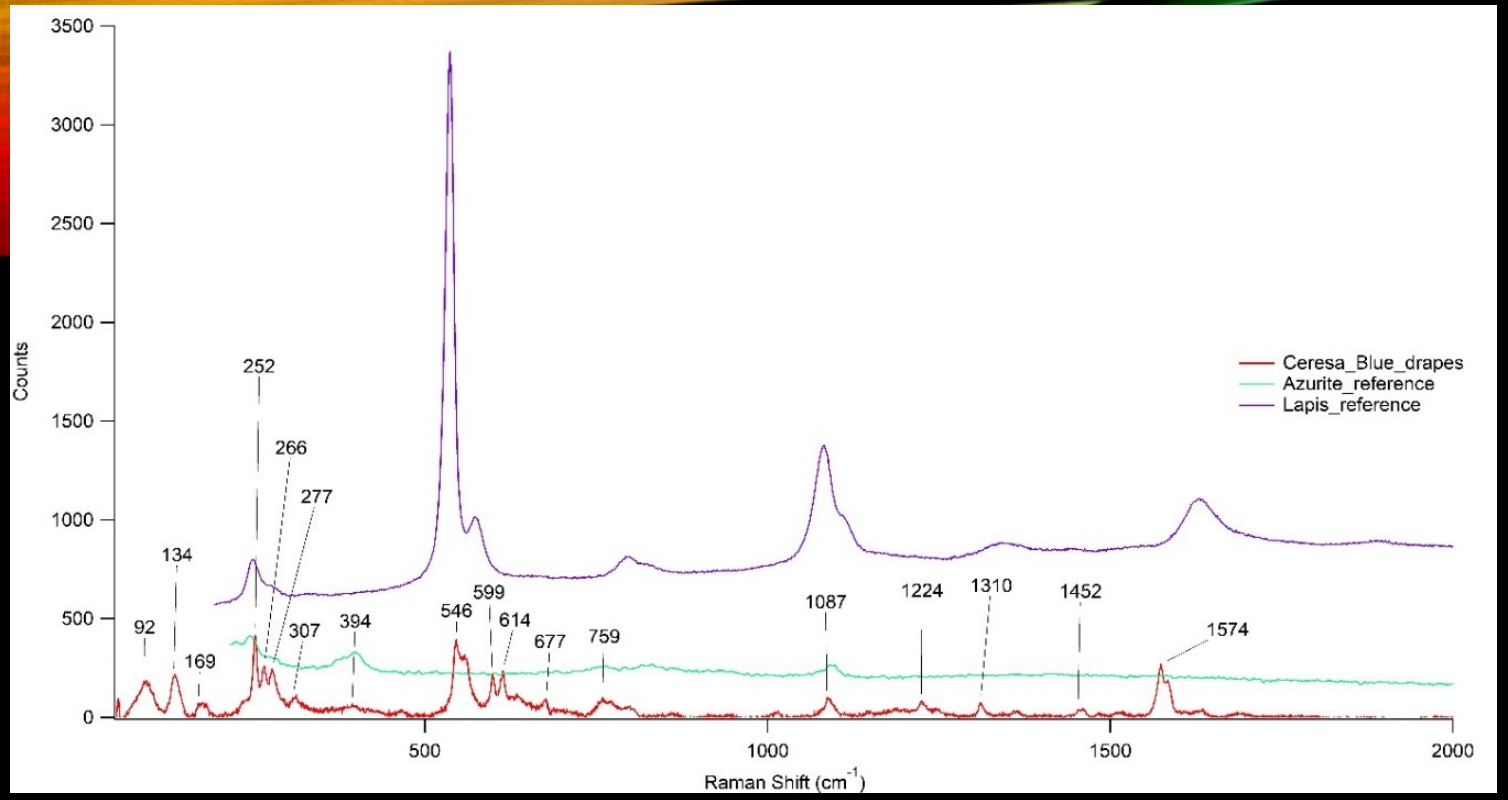
- Top: Raman spectrum of the ground layer at 785 nm & 50% intensity with a reference spectrum of gypsum.[5]
- Bottom Left: Region where Raman was applied.
- Bottom Right: Image of a different region of ground layer that produced no spectrum.
- SERS was attempted on the ground layer but failed due to fluorescence.

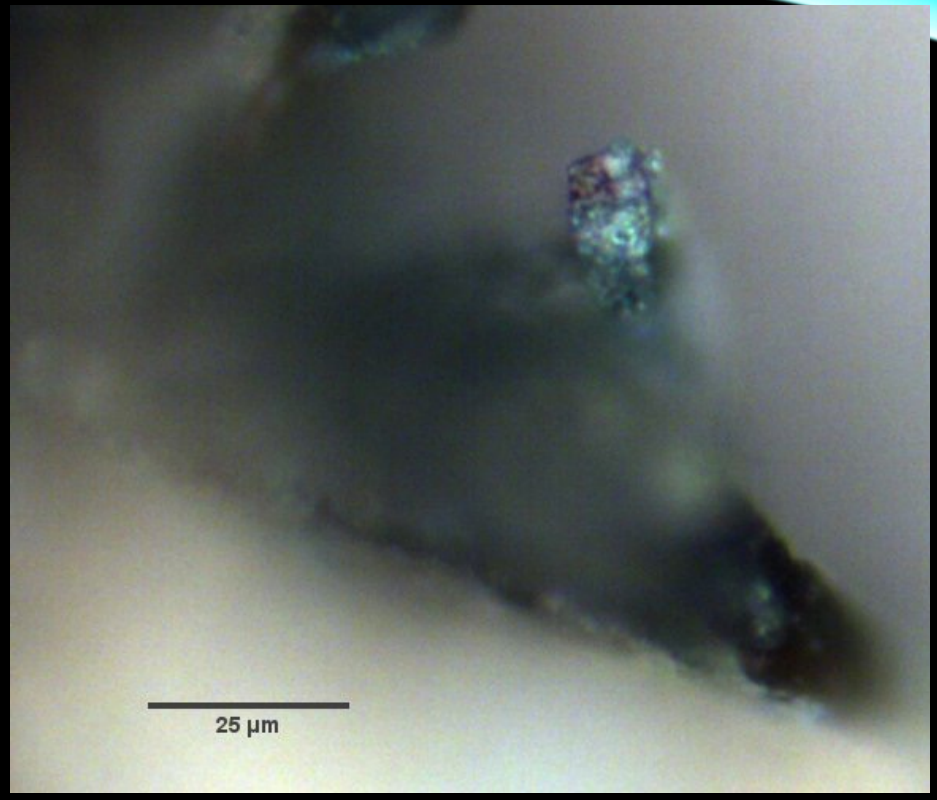






[5]RRUFF database. Berlin, Germany 2015. http://rruff.info/ X050099/display=default/ (accessed August 11, 2021).

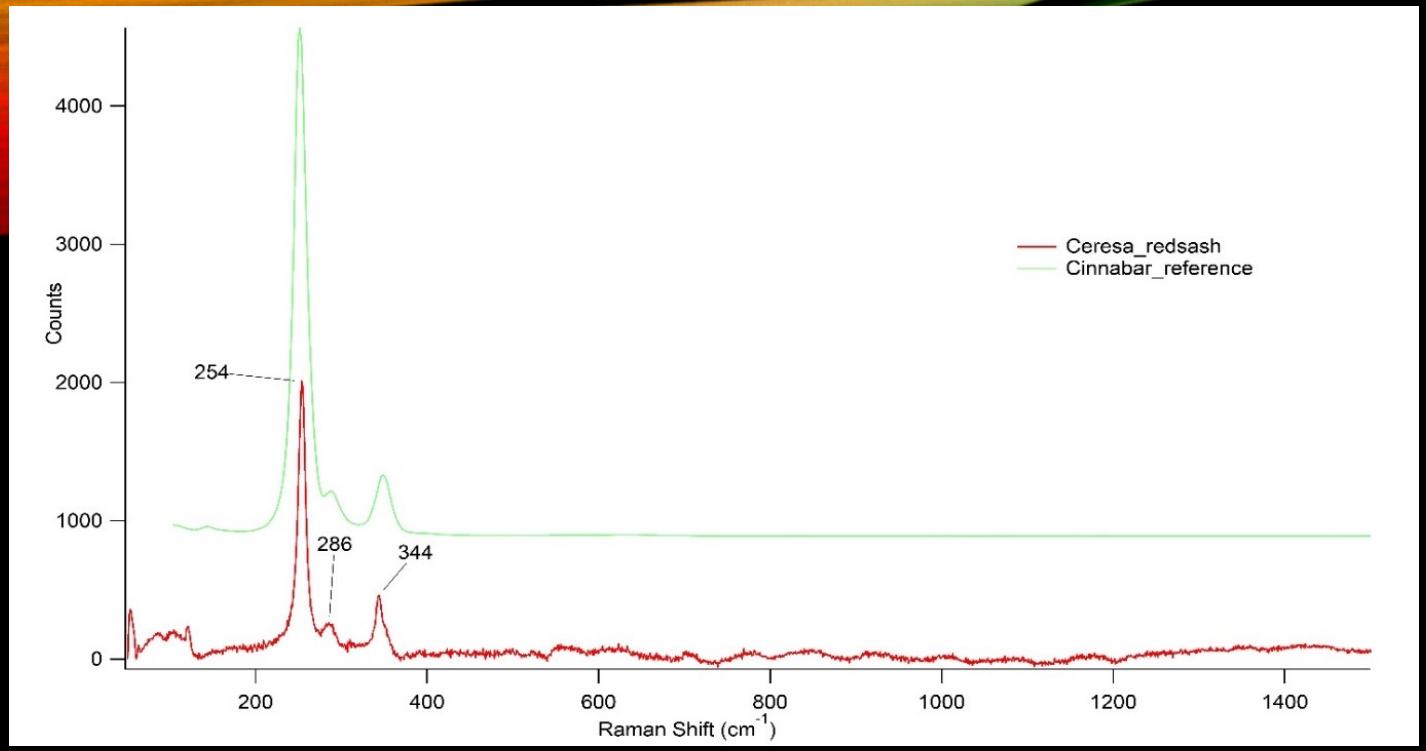


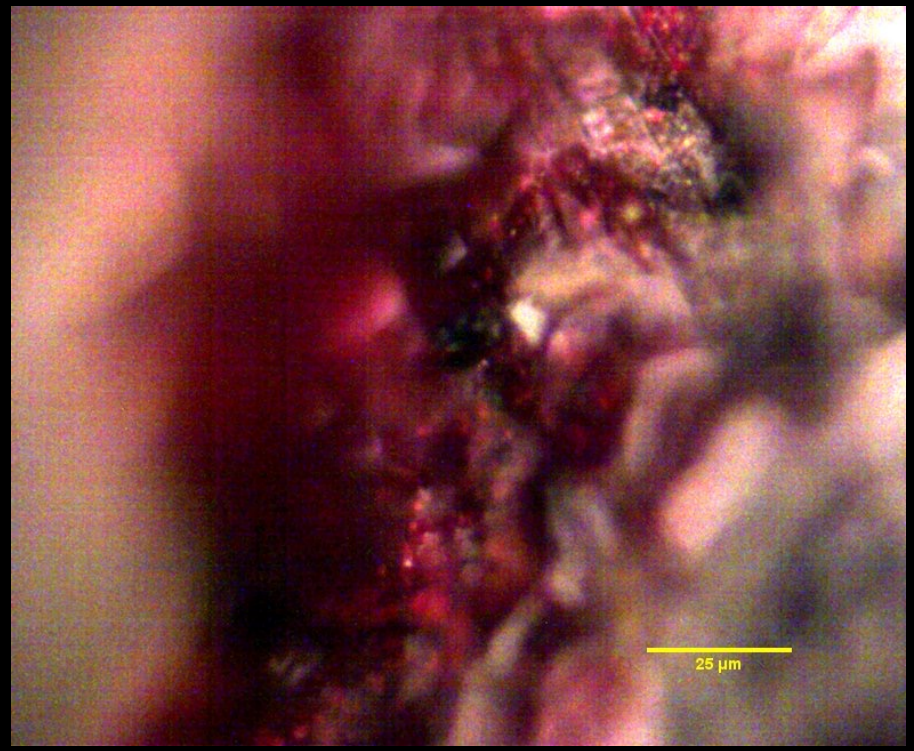


RAMAN MICROSCOPY (CONT.)

- Top: The Raman spectrum of a cross section of the drapery with baseline correction taken at 785 nm and 10% intensity. A lazurite and azurite[6] spectrum are superimposed onto the spectrum for comparison.
- Bottom: Image of the cross section of the drapes where Raman analysis was applied.

[6]RRUFF database. Berlin, Germany 2015. http://rruff.info/R050638/display=default/ (accessed August 11, 2021).





RAMAN MICROSCOPY (CONT.)

- Left: the Raman spectrum of a cross section of the red sash was taken at 785 nm and10% intensity with baseline correction. A cinnabar reference spectrum[7] is superimposed on the spectrum.
- Right: The image of the region of Raman analysis with its contrast enhanced by 1.00%

[7]RRUFF database. Berlin, Germany 2015. http://rruff.info/ R050072/display=default/ (accessed August 11, 2021).

XRF FILTER AND REGIONS

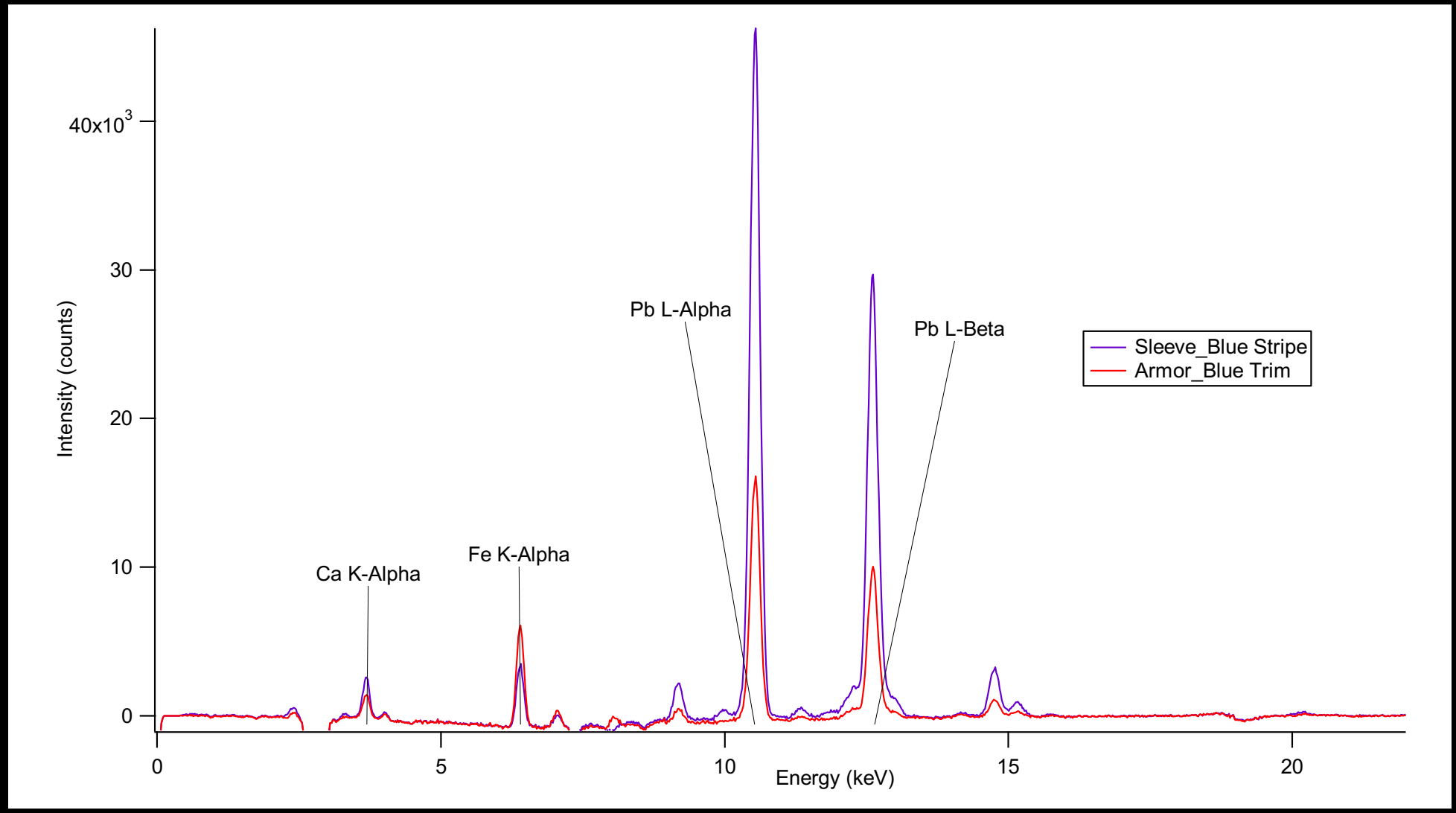
An example of XRF setup with the tracer and the portrait.

XRF Filter	Location							
	blue trim	drapes	left iris	Sleeve (ground)	Sleeve (blue stripe)	pink plume	shoe sole	sash
No filter	x				x			
Blue filter	x	x	x	x		x	x	
Red filter					x			x

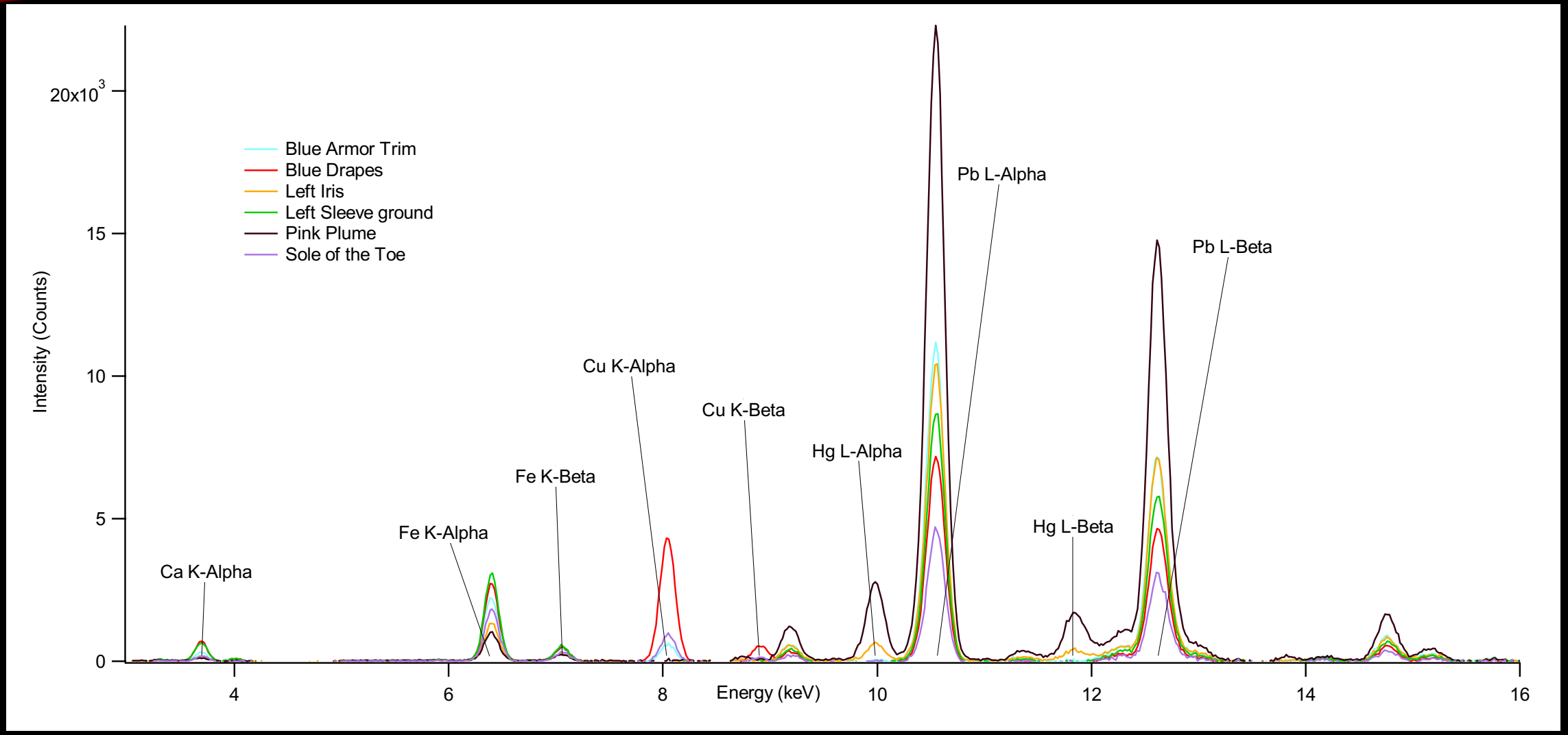
Due to a limitation of time, not every region was able to be analyzed with XRF with each filter used. The tracer has a working distance of a centimeter.

Blue Filter = 1 mil of titanium
Red Filter = 12 mil aluminum, 1 mil of titanium, 1 mil of copper

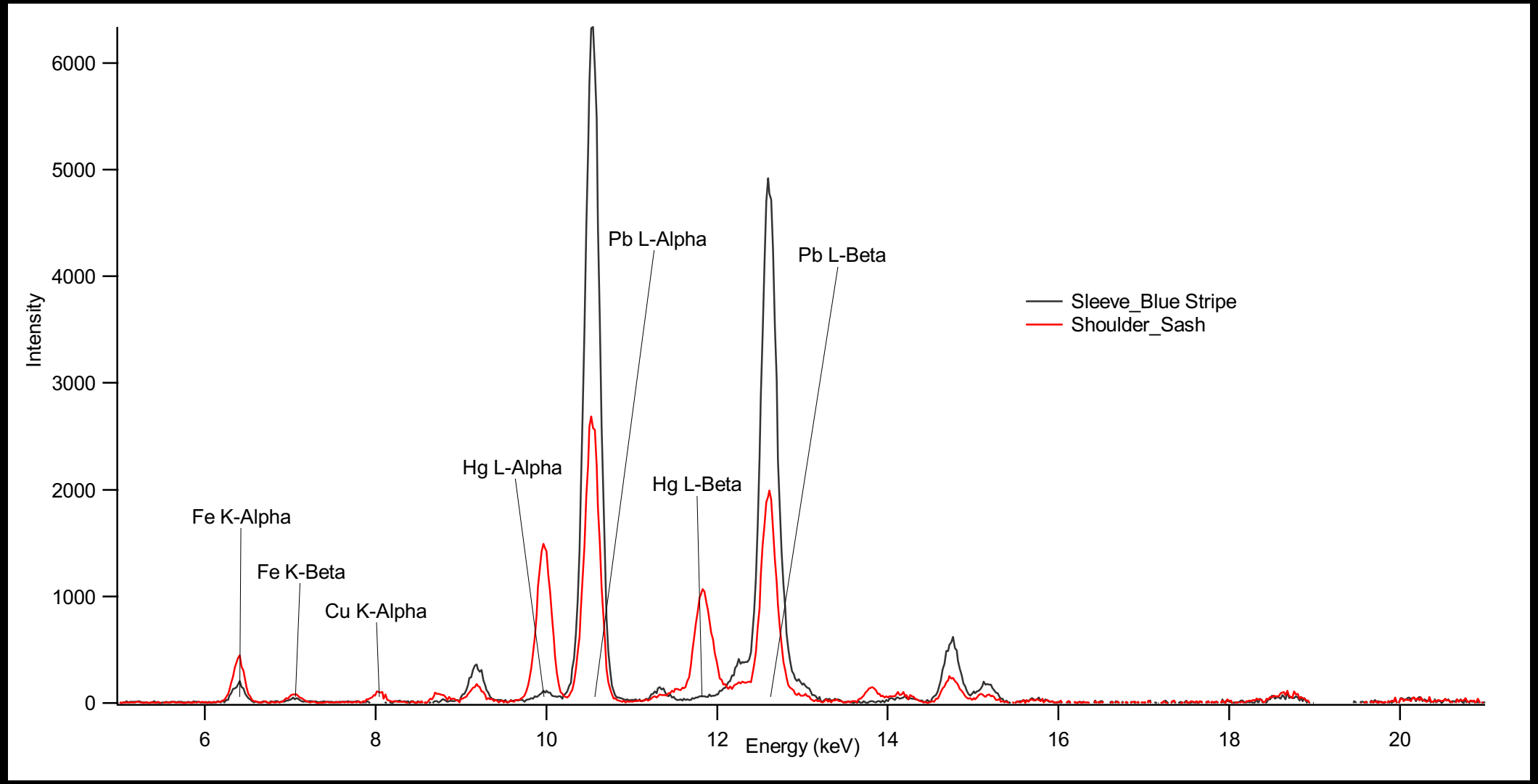
No Filter XRF Normalization and Background Subtractions



Blue Filter XRF with Normalization and Background Subtraction



Red Filter XRF with Normalization and Background Subtraction



RESULTS

Region	Conclusion	XRF	Raman
Drapes	Azurite & Lapis lazuli	[Ca], Fe, Cu, Pb	Azurite & Lapis lazuli
Armor trim	Lapis lazuli and lead	Fe, [Cu], Pb	Lapis Lazuli
Sash	Vermilion and lead	Fe, [Cu], Hg, Pb	Vermilion
Left iris	Lead and vermilion	Fe, Hg, Pb	Not analyzed
Ground	Unknown	[Ca], Fe, Pb	Gypsum
Sleeve stripe	Lapis lazuli (?) Vermilion (?)	[Ca], Fe, [Hg], Pb	Not analyzed
Pink plume	Vermilion and lead	Fe, Hg, Pb	Not analyzed
Shoe sole	Unknown	Fe, Cu, Pb	Not analyzed

Minor elements are presented in brackets [ ]

DISCUSSION

- There is lapis lazuli in the armor trim (the obtained Raman spectra matches Raman spectra in literature[8])
- IRFC indicates lapis lazuli in the drapes,[9] but the high abundance of copper indicates azurite in XRF. Raman analysis indicates a mix of the two blue pigments.
- The ground layer had gypsum in Raman analysis. The fluorescence of gypsum is likely drowning out signal from other molecules in the ground.
- The high presence of lead could be either lead white or red lead being mixed with various other pigments in the portrait.
- No graphite was found in the ground layer during Raman analysis, but it could still be present (the black spots in the sample). While it was not found, it is not conclusive that graphite is absent.

[8]González-Cabrera, M.; Arjonilla, P.; Domínguez-Vidal, A.; Ayora-Cañada, M.J. Natural or synthetic? Simultaneous Raman/luminescence hyperspectral microimaging for the fast distinction of ultramarine pigments. *Dyes Pigm.* **2020**, *178*, 108349.
[9]Boust, C.; Wohlgelmuth, A. HistoricalPigments_BLUE_170920: Pigments under UV and IR radiations, in *Scientific imaging for cultural heritage,* ISSN 2609-780X, 18/08/2017, https://copa.hypotheses.org/552.

CONCLUSIONS & FUTURE WORK

- Lapis lazuli was found in the armor trim through Raman analysis.
- Vermilion was found in the sash and plumes by Raman and XRF.
- No graphite was found in the ground layer but could still be present as black spots were found in a cross section of the ground layer.
- Further study into the brown-beige ground layer would provide historical context into art as current analysis cannot move past the gypsum signals found in the Raman analysis
- Analysis of other paintings from North Italy during the seventeenth century and other works by Ceresa would further understanding about the style of art at the time in Italy and how his artwork fits in Italian and art culture.

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