Mary Kate Donais, David George — Saint Anselm College
Sally Roberts, Jack Roberts — Symphotic TII Corporation
Eric Wu — Enwave Optronics

ANALYSES OF ANCIENT ROMAN PIGMENTS BY PORTABLE X-RAY FLUORESCENCE AND RAMAN SPECTROSCOPIES

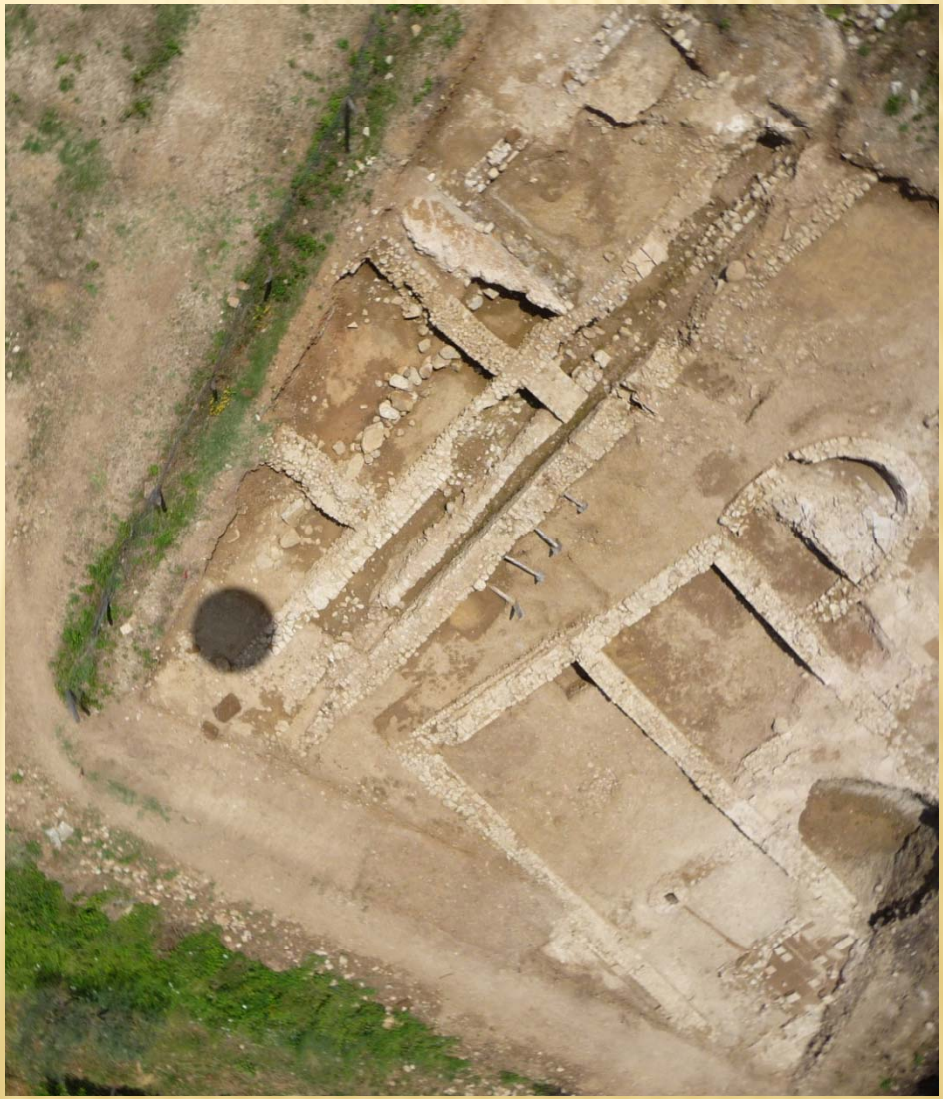
CASTEL VISCARDO EXCAVATION SITE

- 8 km northwest of Orvieto, Umbria
  - Rome to the south, Florence to the north
- Near Palgia River
- Important location
  - Links Tiber valley, Via Cassia, and Via Traiana Nova
- Discovered by agricultural activity in late 1980s
- First explored in 1990 and 1993
- Excavated by Saint Anselm College students and Faculty since 2006
  - Four seasons thus far
  - 5 weeks each summer

SITE MAP

- Six trenches dug thus far
  - Designated by letters
- Loci within trenches
  - Designated by numbers

CASTEL VISCARDO



CASTEL VISCARDO

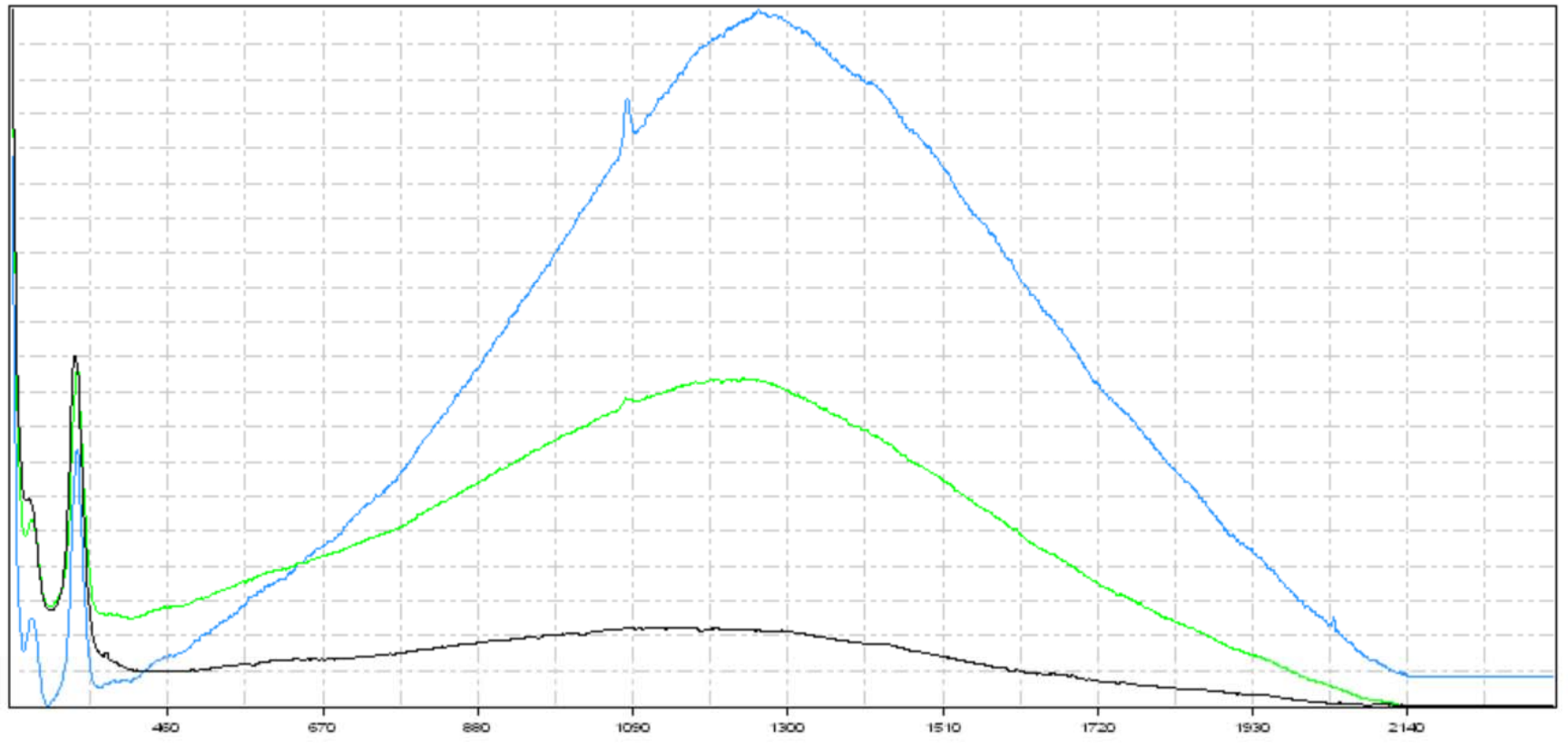
MATERIALS SCIENCE AT THE SITE

- Portable X-Ray Fluorescence (Alpha Series - Innov X)
  - 2008 and 2009
  - Mortars, terra cotta, pigments, metallic artifacts
- Portable Raman (InSITE Raman Analyzer—Symphotic TII Corporation)
  - 2009
  - Pigments
    - Natural Pigments, LLC
    - www.naturalpigments.com

PAINTED FRESCO FRAGMENT - 07C338? TRENCH C LOCUS 116, FIRST SAMPLE

SECOND PIECE

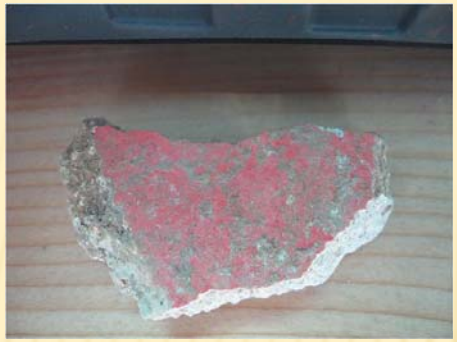
PAINTED FRESCO FRAGMENT TRENCH C LOCUS 116



Black: Commercial Vermillion pigment (HgS - Cinnabar)
Green: First Piece
Blue: Second Piece

XRF DATA

- 4.97% Hg
- 0.16% Pb
- 268 ppm As



- 4.34% Hg
- 0.15% Pb
- 170 ppm As

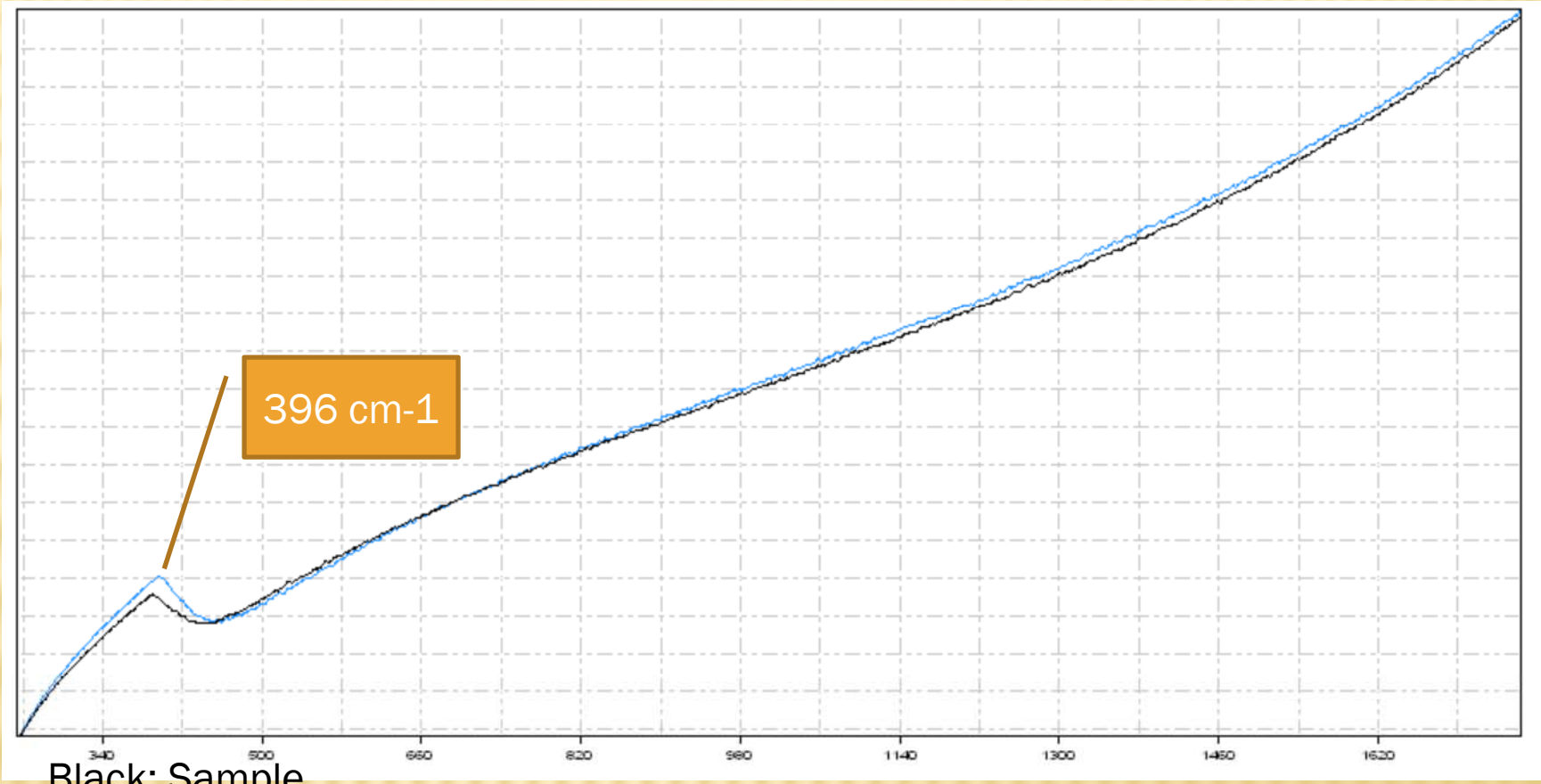
- 93.3% Hg

Pure Sample of Vermillion

FRESCO #06C499

Colors from left to right: Turquoise, White (thin stripe), Purple

FRESCO #06C499, GREEN PIGMENT



Black: Sample

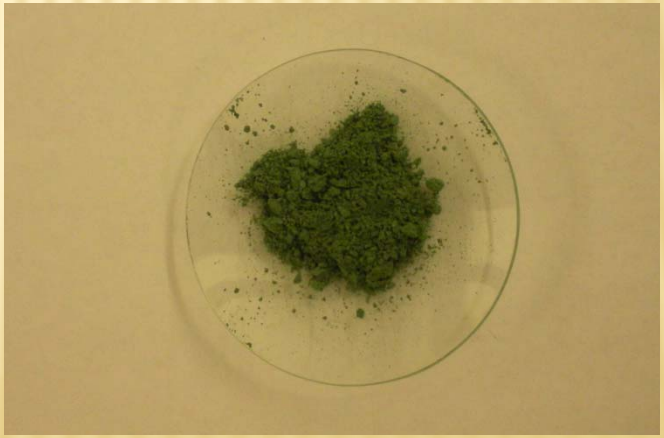
Blue: Commercial Celadonite green pigment ($K(Mg,Fe^{2+})(Fe^{3+},Al)Si_4O_{10}(OH)_2$)

Note that other pigments, not chemically related, will give this fluorescence peak, depending on the laser power.

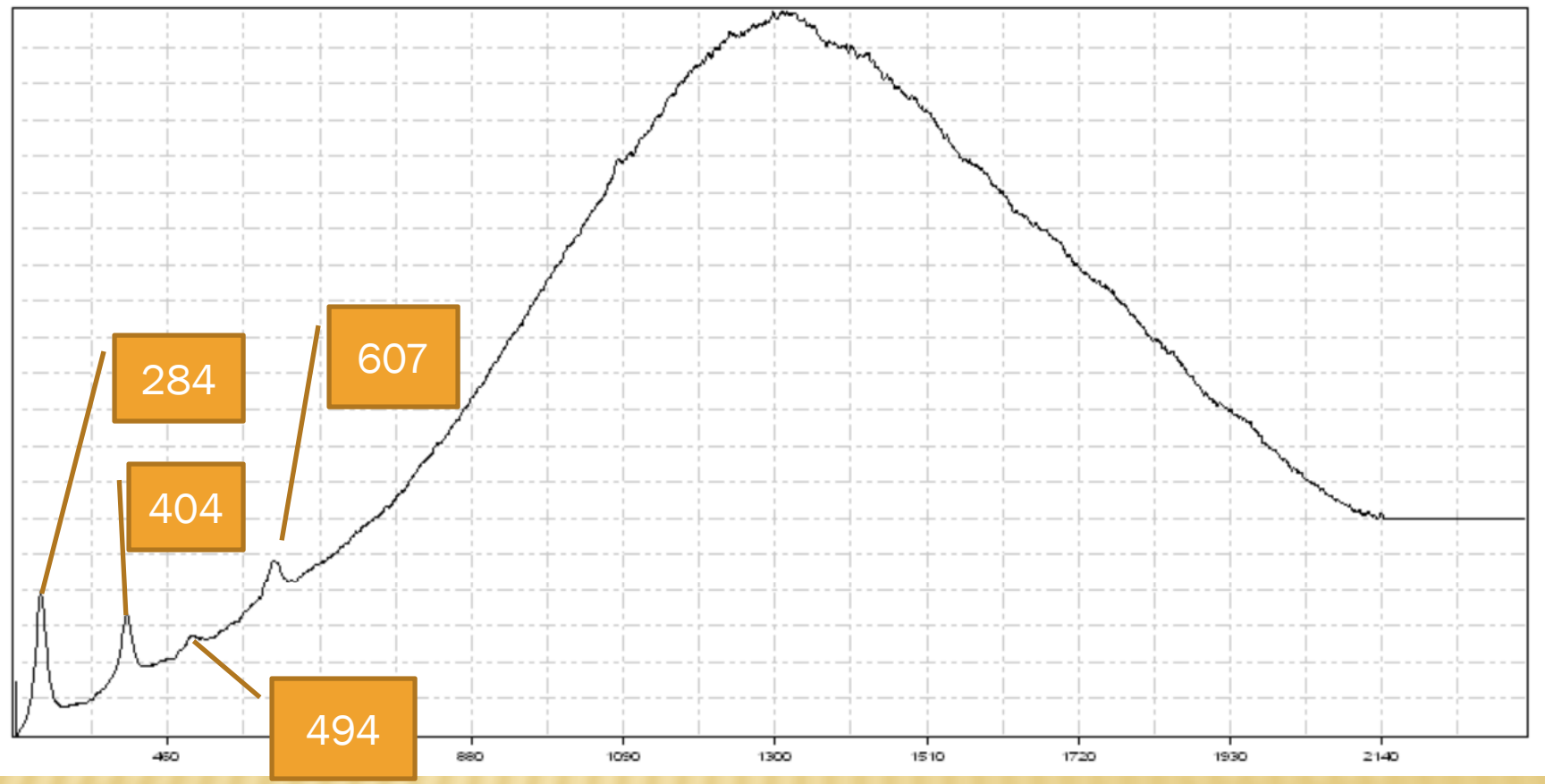
XRF DATA FOR GREEN PIGMENT

- 11.1% Fe
- 0.55% Cu

- 16.4% Fe



FRESCO #06C499 PURPLE PIGMENT

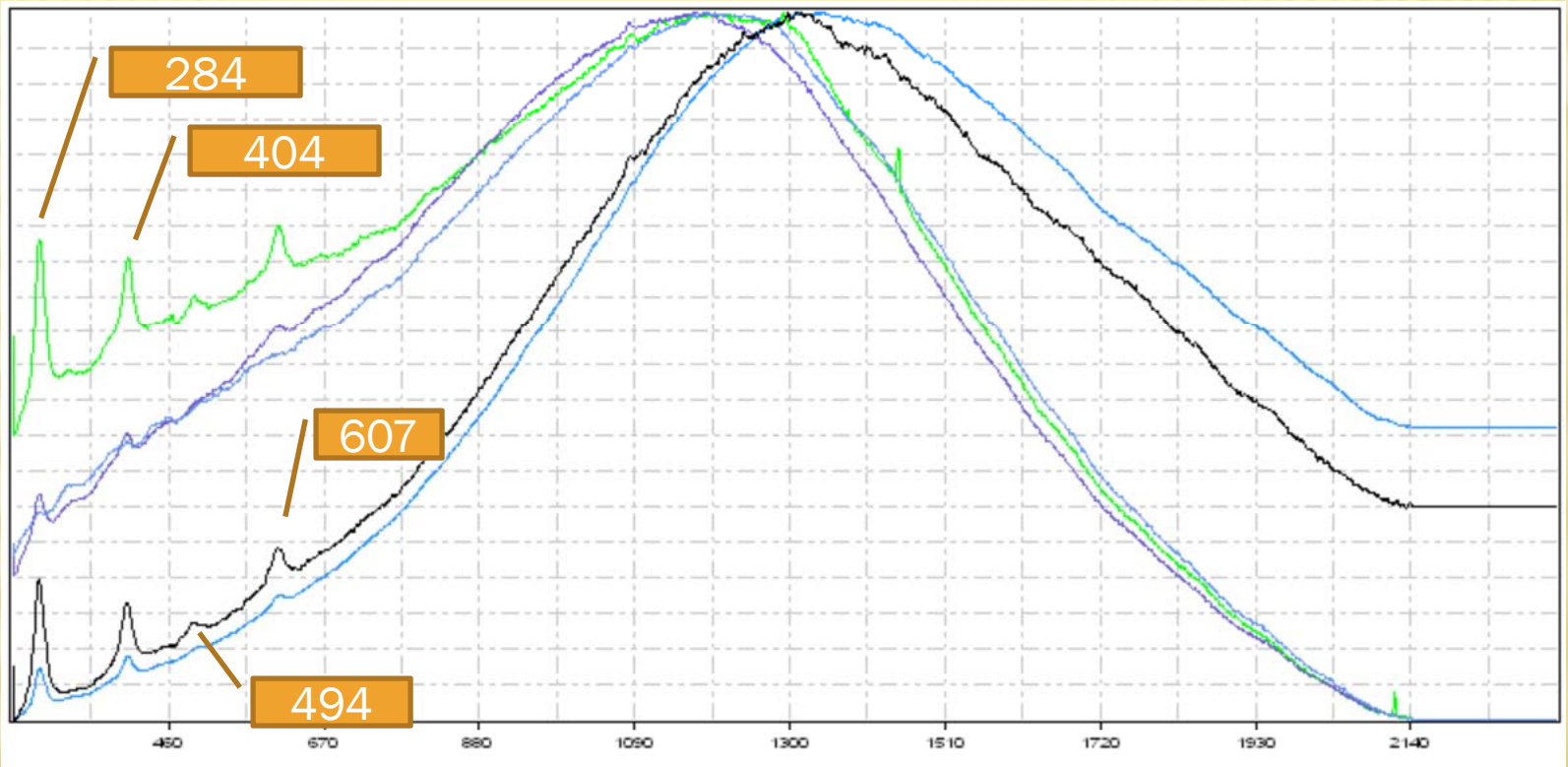


SAMPLE 116P PURPLE PIGMENT

SAMPLE 116B, PURPLE PIGMENT

SAMPLE 116F, PURPLE PIGMENT

PURPLE PIGMENT (HEMATITE)



Black: 116p

Blue: 116c p

Green:116c w

Violet: 116f p

Dark blue: 116b

Peaks characteristic of hematite (Fe_2O_3)

XRF DATA FOR PURPLE PIGMENTS

- 17.9% Fe
- 53.6 ppm Hg
- 102 ppm Zn
- 44 ppm As

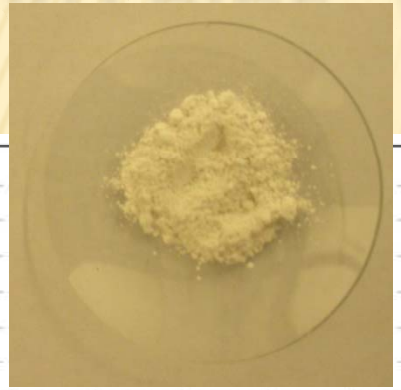
- 18.1% Fe
- 143.3 ppm Hg
- 161 ppm Zn
- 58 ppm As

- 11.8% Fe
- 63.8 ppm Hg
- 149.2 ppm Zn
- 51.6 ppm As

The more purple version of hematite is the alpha form of Fe_2O_3

- 35.0% Fe

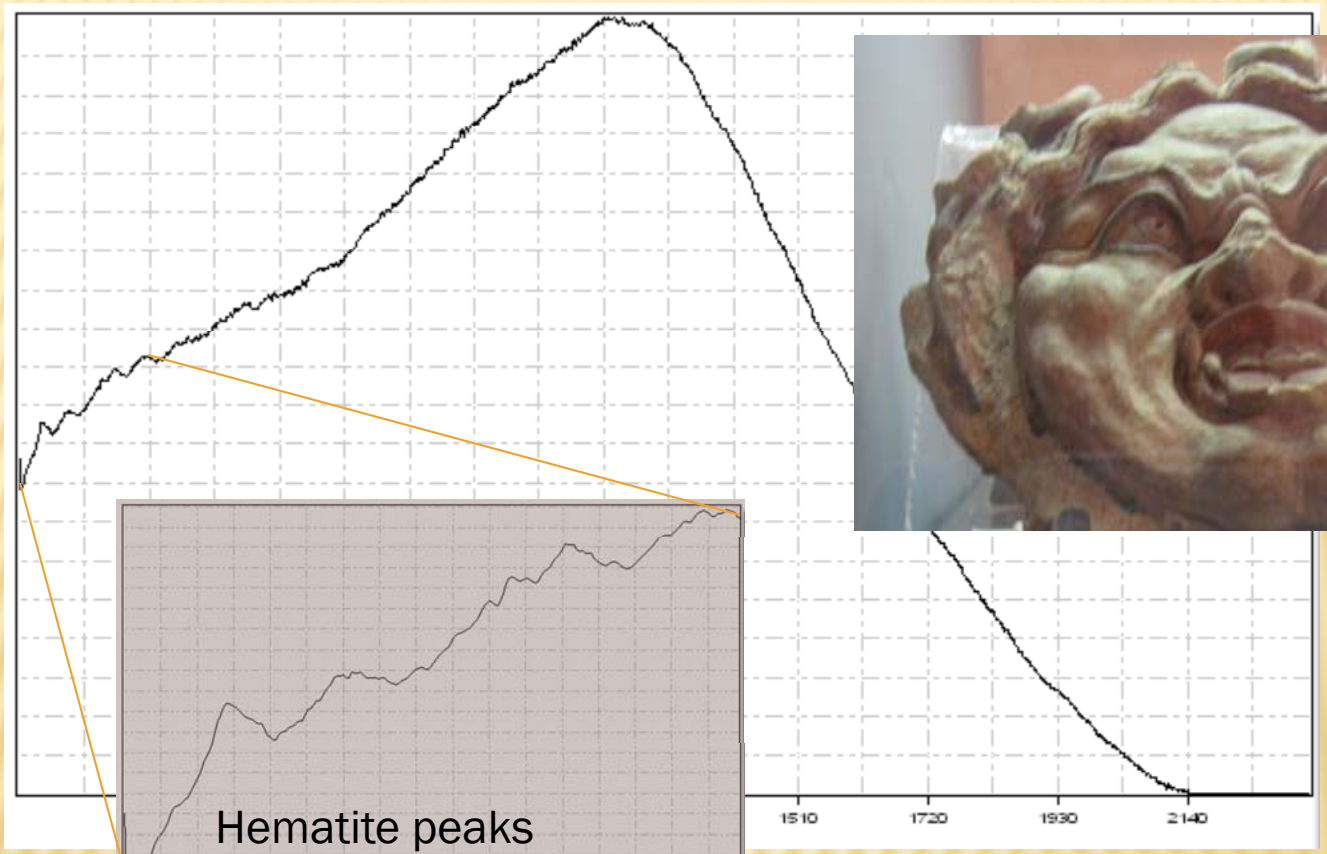
LEAD PIPE, TRENCH C LOCUS 131



Black: commercial lead white pigment $((PbCO_3)_2 \cdot Pb(OH)_2)$

Blue: Scraped lead pipe.

ETRUSCAN MUSEUM *IN-SITU* ANALYSIS



Reddish pigment on lower lip shows peaks characteristic of Hematite

CONCLUSIONS

- Portable instruments more available to archaeological sites
  - Quickly becoming essential tools
- Combination of XRF and Raman ideal for pigment identifications
- XRF simple enough for students to use

ACKNOWLEDGEMENTS

- Innov X Systems Inc.
  - Academic Grant Program for loan of XRF