

Advanced XRF Tools and Methodologies for the Revisualization of Vanished Ancient Polychrome

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Acknowledgments

We acknowledge support of this work by the project CALIBRA/EYIE (MIS 5002799), implemented under Action “Reinforcement of the Research and Innovation Infrastructures,” funded by the Operational Programme “Comparativeness, Entrepreneurship and Innovation” (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund), and the INSTAP project entitled: “The Technology of Early Cycladic Marble” which provided also partial funding support.

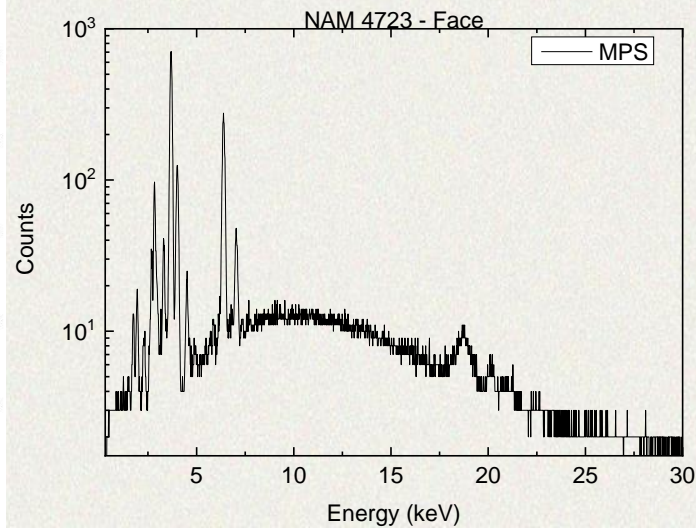
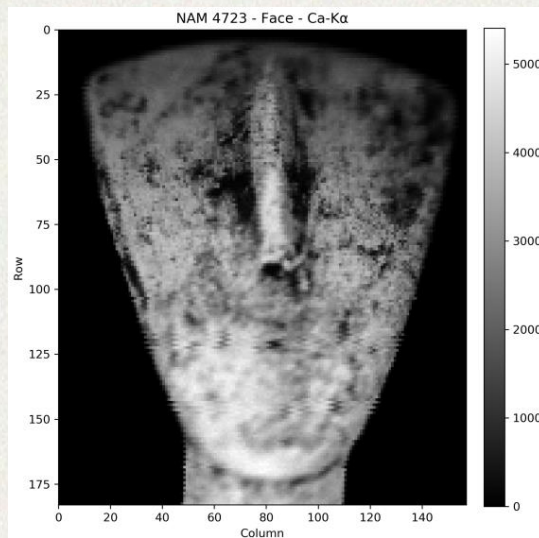
Introduction

Aim of the study

- ❑ investigation of the existence of patterned polychrome through the identification of traces of remaining pigments on Early Cycladic marble figurines and vessels belonging to the collection of the National Archeological Museum (NAM) and the Museum of Cycladic Art (MCA)
- ❑ characterization the pigments' chemical composition

Background: The MA-XRF (macro-XRF) Imaging Technique

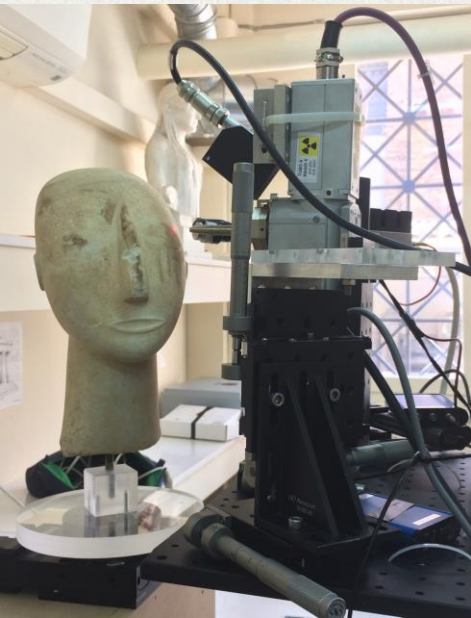
- ❑ non-invasive technique, providing detailed mapping of the elemental distribution in cultural heritage artifacts
- ❑ offers the capability of visualizing the distribution of chemical elements on the entire surface in images of easy understanding and interpretation



Methods

Macro-XRF Imaging of Cycladic Figurines

LANDIS-X Scanner



- ❑ 30W Rh-target X-ray tube coupled to a polycapillary lens
- ❑ 26 μ m spot diameter at Rh K α -line, 1cm focus distance
- ❑ two 50 mm² active area SDD detectors
- ❑ energy resolution 133eV at 5.9keV
- ❑ time-list event mode
- ❑ Two digital X-ray Processors
- ❑ DSP with 40ns time resolution
- ❑ 3-axis fast scanner

Scanning parameters: Unfiltered 40kV excitation at 400 μ A.

3909, NAM

15 artifacts
examined
in total

5 Figurines, 1 Vessel (National Archaeological
Museum)

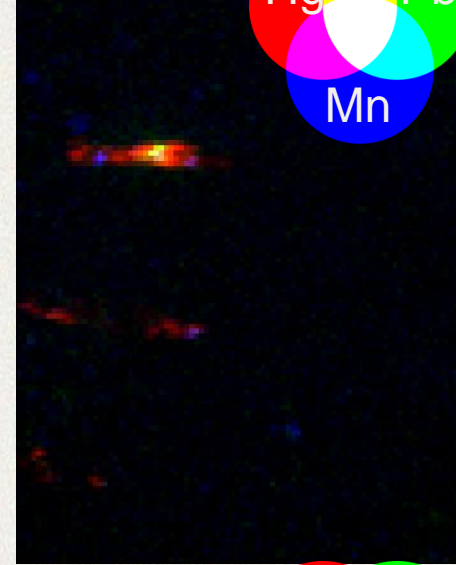
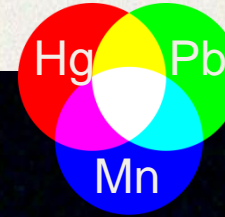
7 Figurines, 2 Vessels (Museum of Cycladic Art)

Looking for vanished traces of pigments:
cinnabar, lead white, iron-based ochres

Results

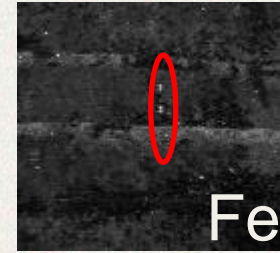
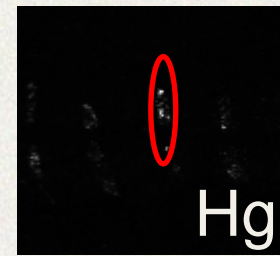
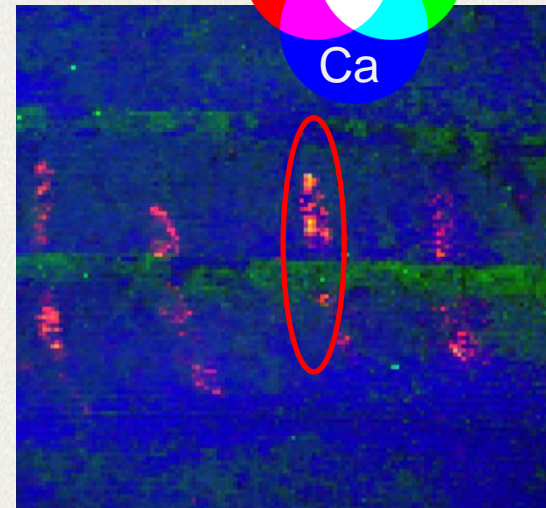
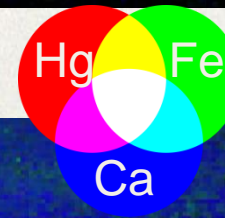
Evidence of mixing of pigments or forming a paint layer stratigraphy!

NG252, MCA



Mixing or overpainting of cinnabar (HgS), lead white ($\text{Pb}-2\text{PbCO}_3\cdot\text{Pb}(\text{OH})_2$) and umbra ($\text{Fe}_2\text{O}_3\cdot\text{MnO}_2$).

NG251, MCA

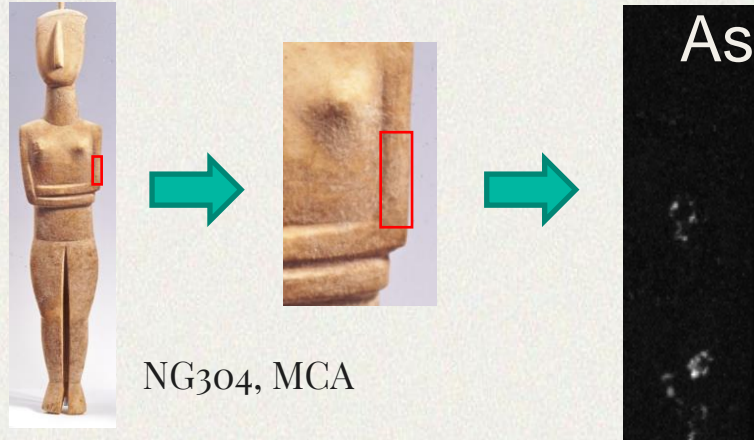


Mixing or overpainting of cinnabar (HgS) and an iron-based ochre

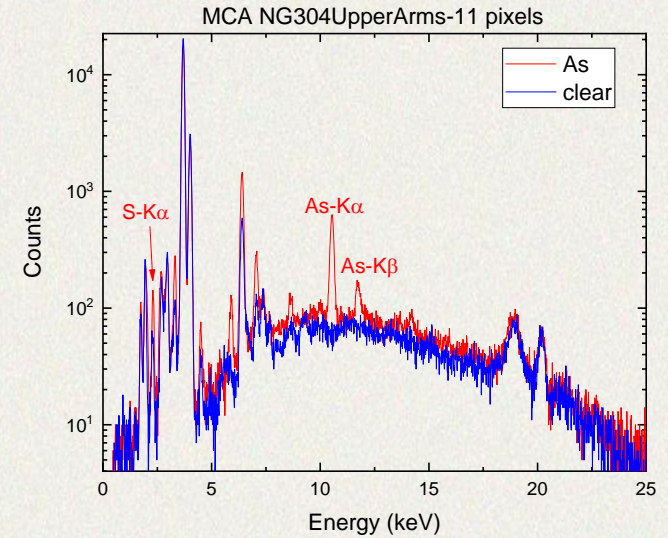
Results

- Detection of an arsenic-based pigment; orpiment (As_2S_3) or realgar (As_4S_4).

Earliest occurrence in Greek polychrome!

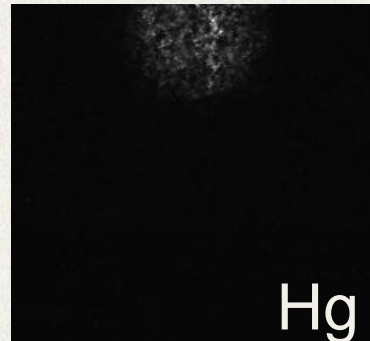
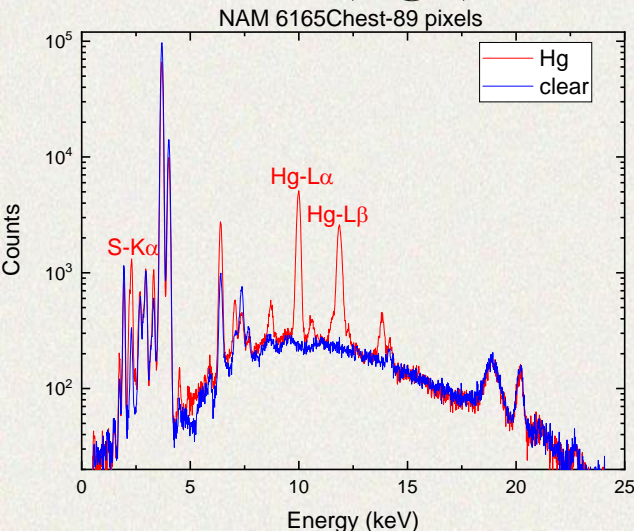


NG304, MCA



- Identification of degraded cinnabar (HgS).

Phase transition to metacinnabar (α' - HgS)
Conversion into corderoite ($\text{Hg}_3\text{S}_2\text{Cl}_2$)



6165, NAM



Conclusions

- ❑ Pigments identified by MA-XRF imaging of Cycladic Figurines and Vessels:
 - **Cinnabar** (HgS) (6/12 Figurines, 1/3 Vessels)
 - **Iron-based ochre** (Fe_xO_y) (3/12 Figurines, 3/3 Vessels)
 - **Umbra**(Fe₂O₃·MnO₂) (4/12 Figurines, 1/3 Vessels)
 - **Orpiment** (As₂S₃) or **Realgar** (As₄S₄) (1/12 Figurines)
 - **Lead white** (Pb-2PbCO₃·Pb (OH)₂) (3/12 Figurines, 1/3 Vessels)
- ❑ Possible identification of organic **Murex purple** (C₁₆H₈Br₂N₂O₂) (0/12 Figurines, 1/3 Vessels)
- ❑ Contaminants: **Lithopone** (BaSO₄·ZnS) (2/12 Figurines)
- ❑ Findings suggest that **various pigments** (cinnabar, lead white, umbra and iron-based ochre) were not only applied as single paint layers, but also by **following a more complex elaboration** (mixing or forming a paint layer stratigraphy).

Acknowledgements

- ❑ Dr. Katia Manteli, curator of the Collection of Prehistoric Antiquities of the National Archaeological Museum
- ❑ Dr. Nikolas Papadimitriou, curator of Cycladic and Ancient Greek Art Collections of the Museum of Cycladic Art
- ❑ Kiki Birtacha, archaeologist