



UNIVERSITY OF
IOANNINA



3rd International Conference TMM_CH

**Transdisciplinary Multispectral Modelling and Cooperation
for the Preservation of Cultural Heritage**

**Recapturing the World in Conflict through Culture
promoting mutual understanding and Peace**

20-23 March, 2023 Eugenides Foundation Athens, Greece



«Protection of our cultural Heritage: Examination of bending issues during preservation of wall-paintings»

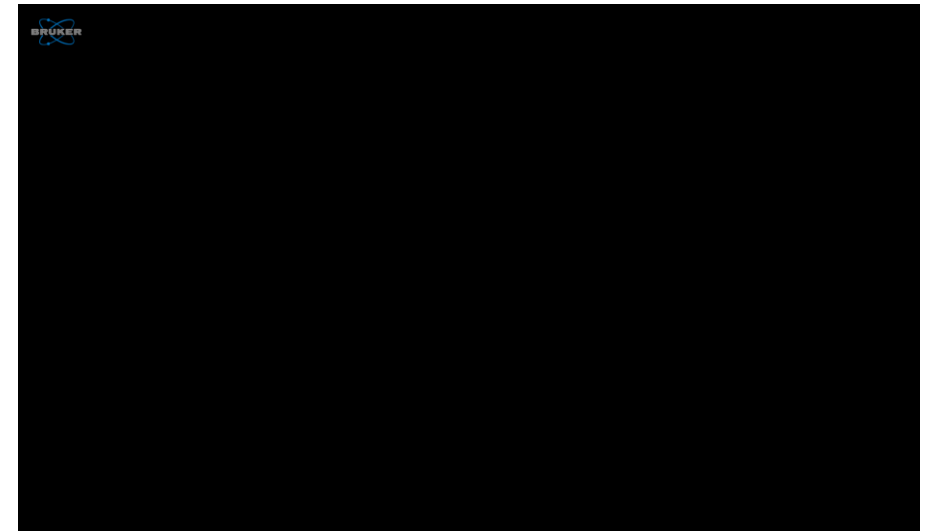
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COMPOSITE AND SMART MATERIALS LABORATORY
(csmlab.materials.uoi.gr)



Motivation

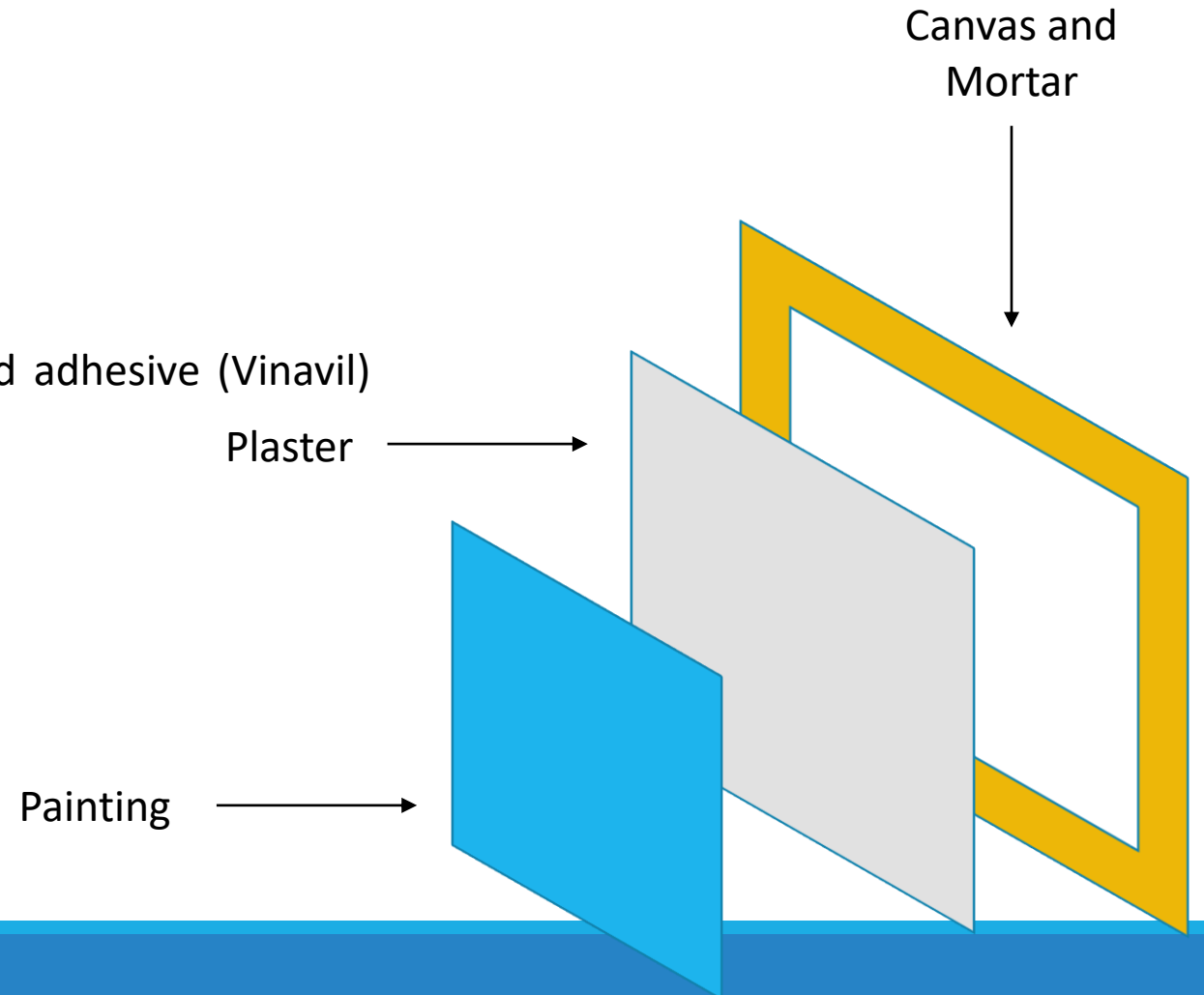
- Conservation techniques are being constantly improved for the optimal preservation of cultural heritage artefacts.
- The evaluation and identification of the materials of an artefact is fundamental for the design of a preservation or restoration strategy.





Preservation Process

- I. Removal from the wall
- II. Rinsing with water and ethanol
- III. Coating with Primal acrylic paint
- IV. Attachment on a framed canvas with a vinyl-based adhesive (Vinavil) and mortar mixture
- V. Drying in room temperature.











Introduction and Goals

- I. Two wall paintings from the 19th century that were extracted from two different neo-classical mansions at Ioannina, Greece, were examined.
- II. In the second wall painting, bending phenomena and crack failure was observed after the utilization of the framing protocol during the preservation process.



Introduction and Goals

- I. The specimens were studied with an integrated approach, combining stoichiometric, and spectroscopic techniques.
- II. Samples were extracted from the painting surface and the substrate plaster of the two wall-paintings

Painting 1 (P1)		 
Painting 2 (P2)		 



Examination Method

- The wall-paintings underwent both structural and stoichiometric examination:
- Stoichiometric:
 - X-Ray Diffraction (XRD)
 - Raman Spectroscopy
 - Fast Fourier Infrared Spectroscopy
- Structural:
 - Micro-Computed Tomography (μ CT)
 - Humidity chamber immersion



Results



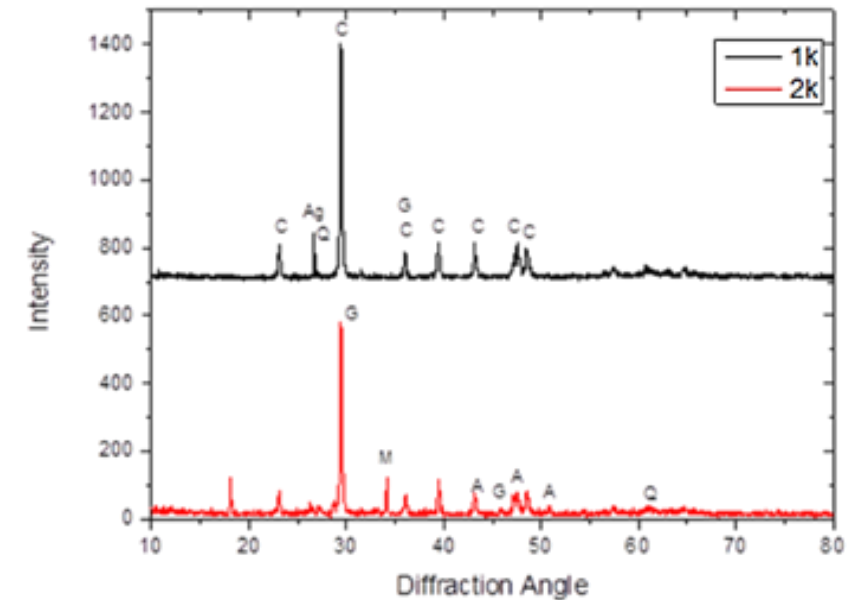
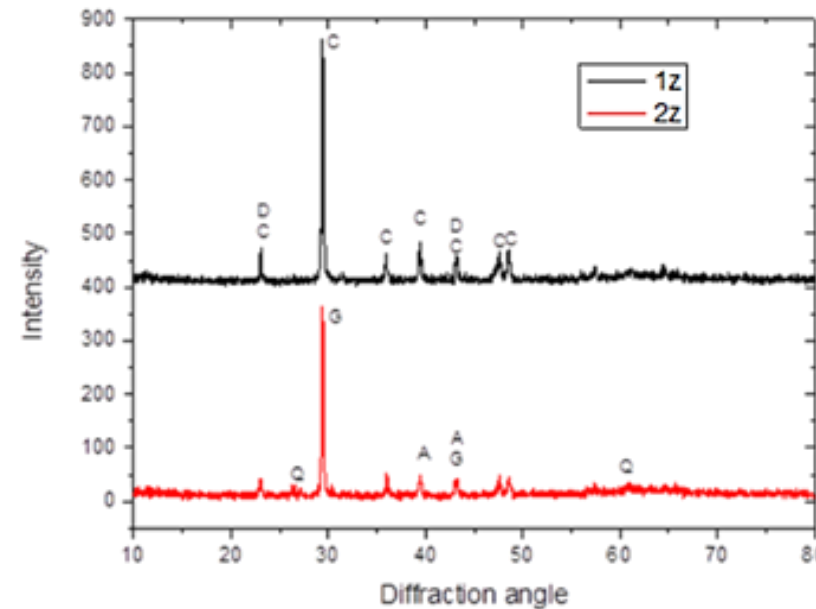
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X-ray Diffraction (XRD)

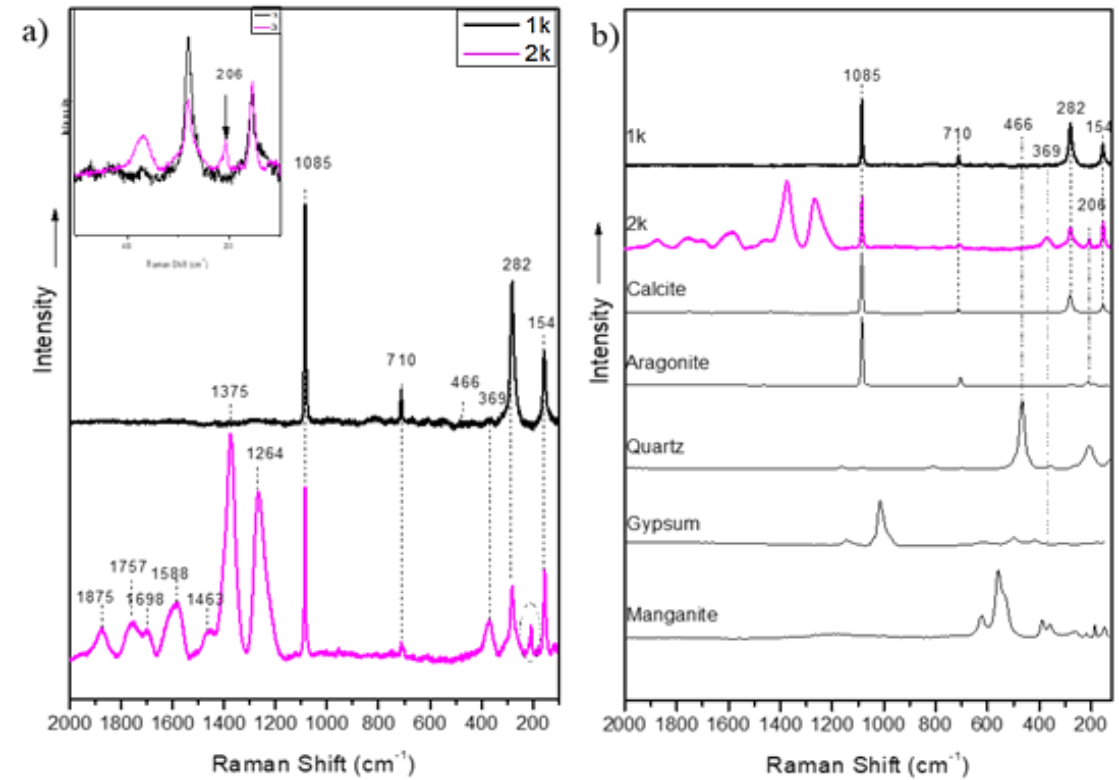
- XRD results of the painting surface for paintings 1 and 2.
- C=Calcite, D=Dolomite, Q= Quartz, G=Gypsum, M=Manganite, Ag= Ag₂O₃, A=Aragonite.





Raman Spectroscopy

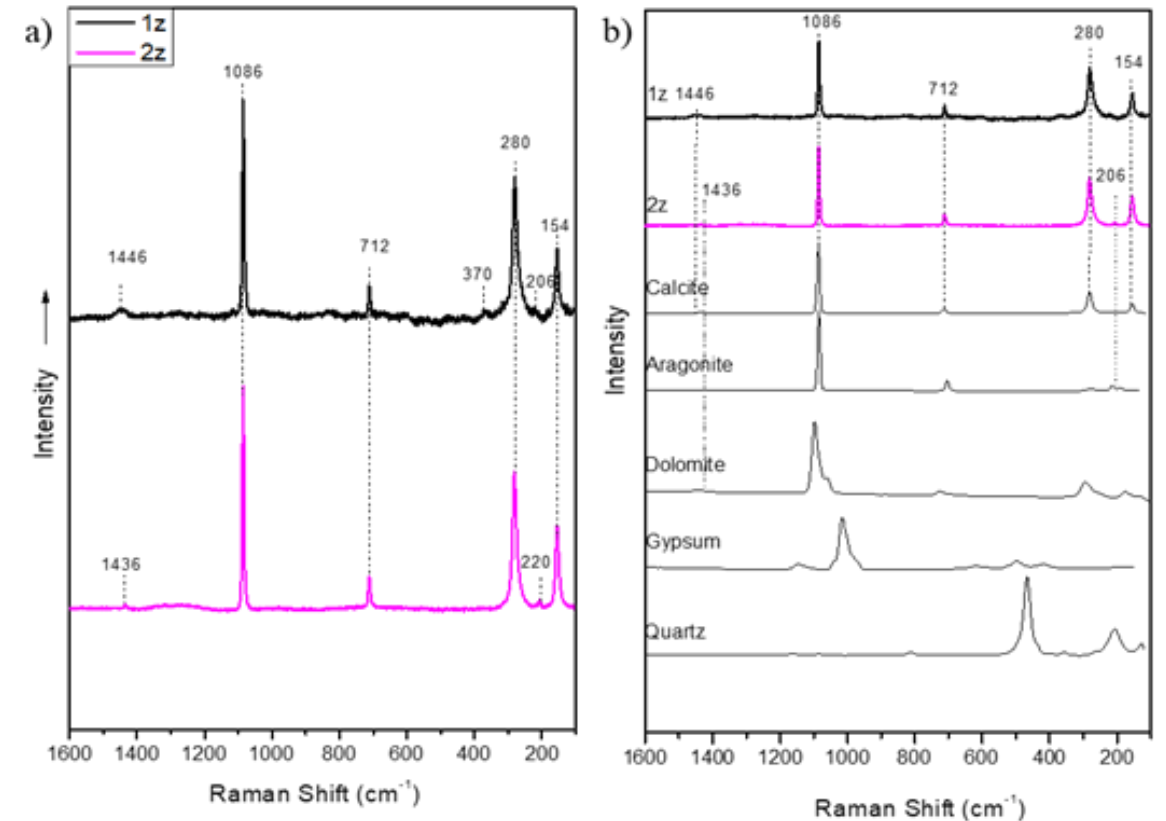
- Raman Spectra of plaster substrate for paintings 1 and 2.
- Comparison of the Raman spectra to XRD results





Raman Spectroscopy

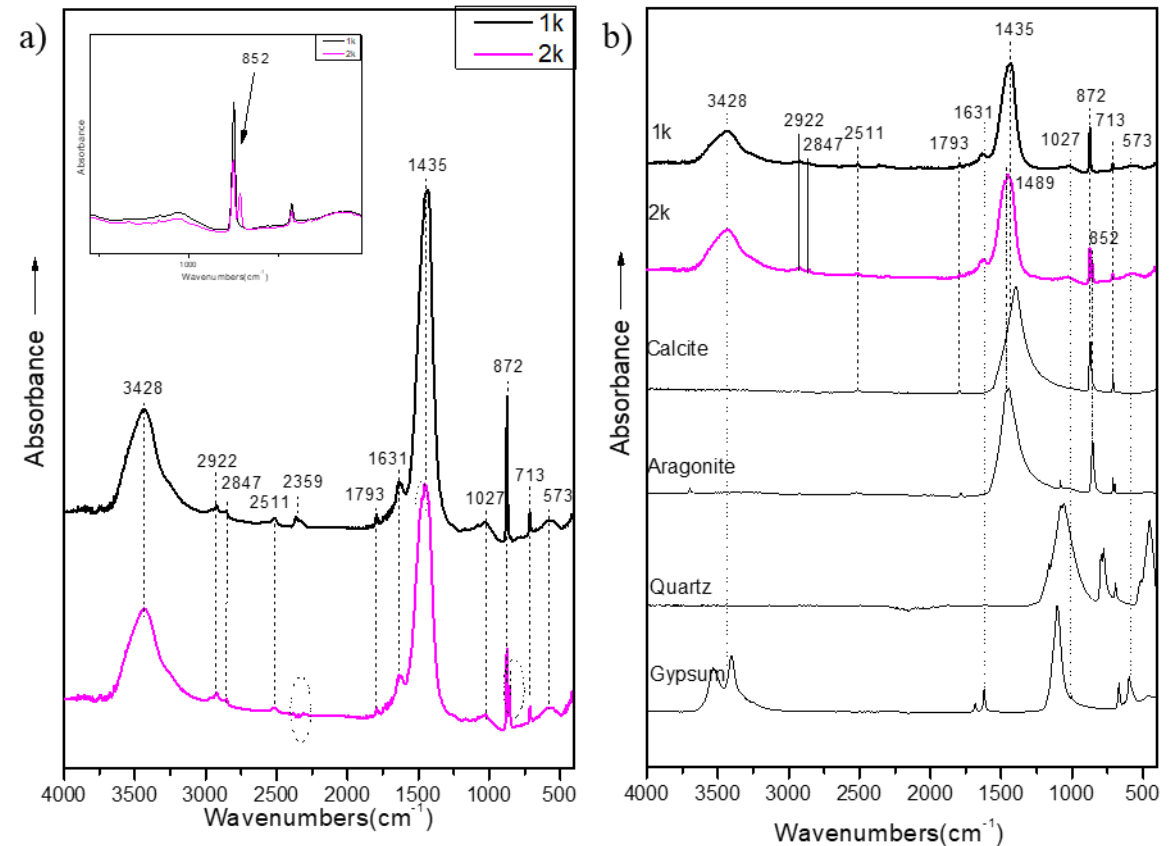
- Raman Spectra of painting surface for paintings 1 and 2.
- Comparison of the Raman spectra to XRD results





Fast Fourier Infrared Spectroscopy

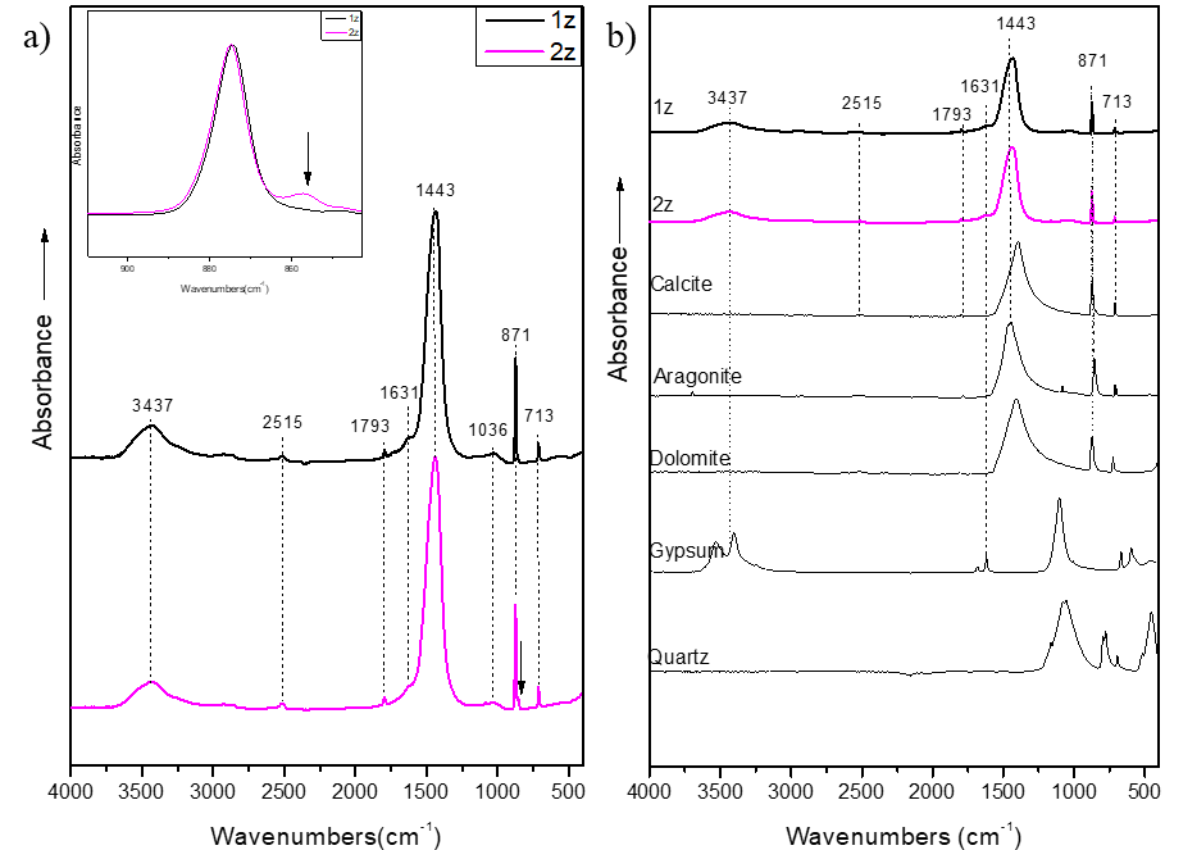
- FTIR spectra of the plaster substrate.
- In agreement with Raman and XRD results.
- Presence of Aragonite and gypsum





Fast Fourier Infrared Spectroscopy

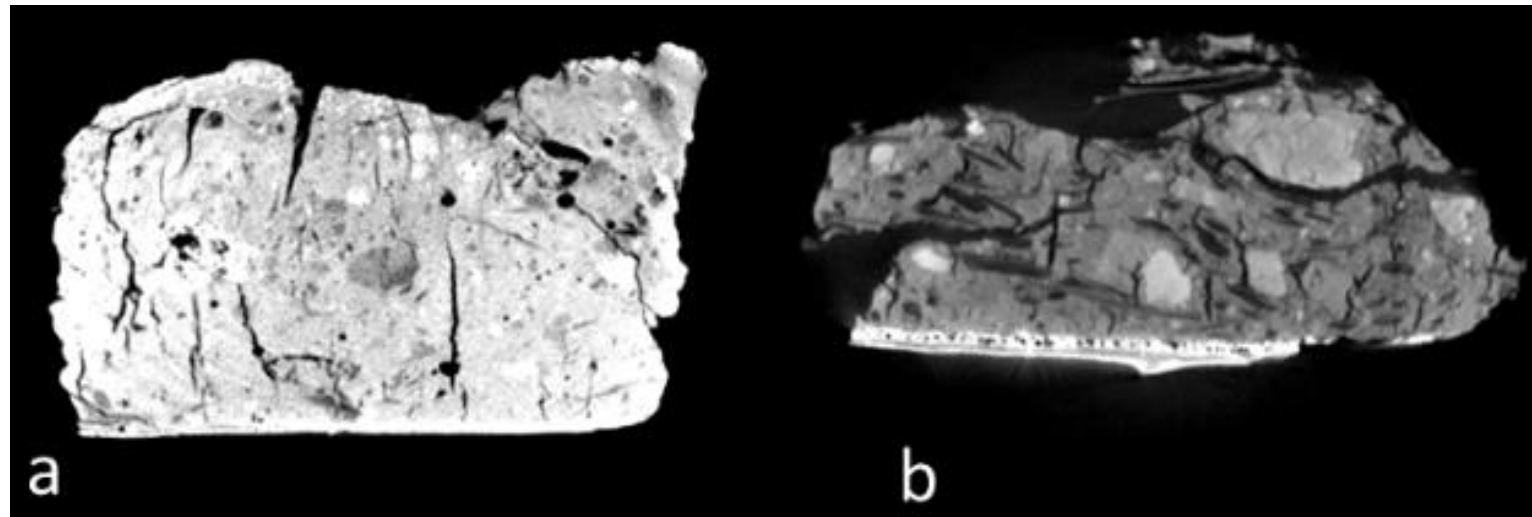
- Mid-IR spectra of the painting surface
- In agreement with Raman and XRD results.
- Presence of Aragonite and gypsum





Micro-Computed Tomography

- Two samples containing the whole volume of the artefact were examined with uCT.
- Sample (a) was extracted from the defective wallpainting while Sample (b) from the reference wallpainting.

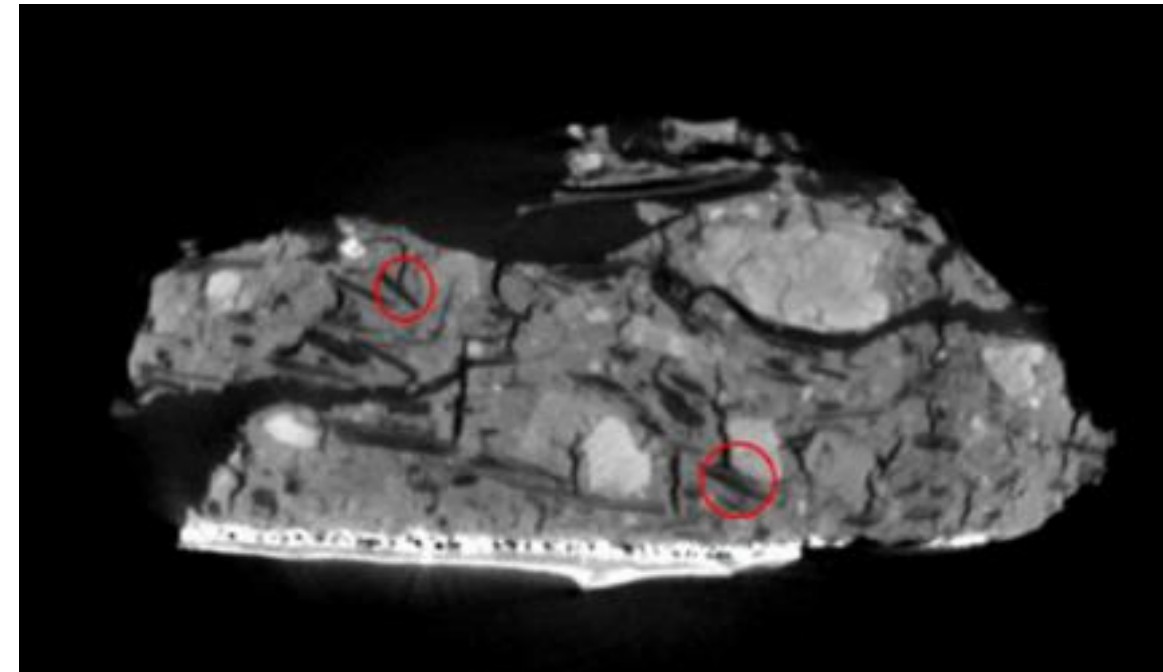




Micro-Computed Tomography

- P1 contains a reinforcing agent (straws).
- Higher porosity values exhibited as much as 22 %
- After immersion in an humidity chamber, no signs of water absorption were perceived.

P1 sample. Total Area of ROI = 23 mm²

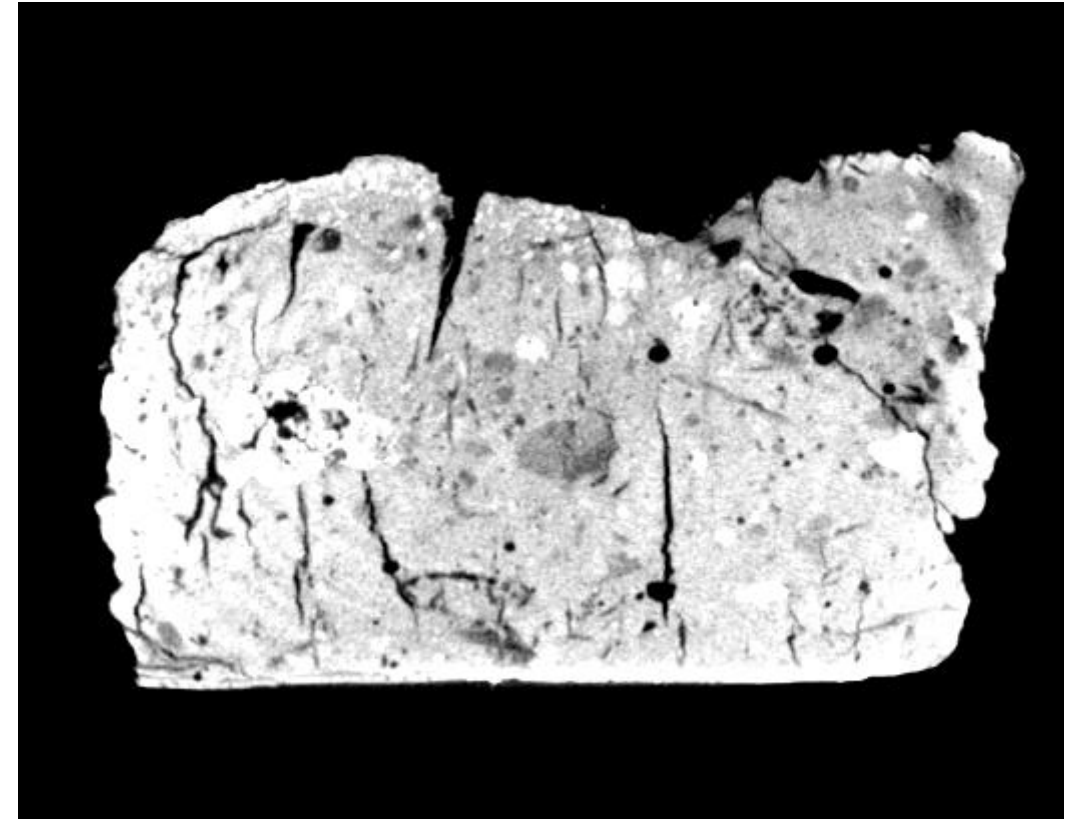




Micro-Computed Tomography

- P2 does not contain a reinforcing agent.
- Lower porosity values exhibited as much as 7 %
- After immersion in environmental chamber, no signs of water absorption were perceived.

P2 sample. Total Area of ROI = 24 mm²



Conclusions

- Vinavil and mortar were applied to consolidate and strengthen the initial substrate of the painting.
- The applied adhesion to P1 was successful due to the higher porosity.
- The addition of fibers in mortars contributes to volume stability.
- In contrast, P2 had low porosity due to its different microstructure. As observed by the preservation team the consolidant did not diffuse evenly into the substrate.
- Upon the hydration of the mortar/Vinavil mixture, the uneven distribution of the Primal caused differential strains at random sites and ultimately bending and microcracking.

Acknowledgements

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Thank you for your attention

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- **Mechanical / thermomechanical** characterization
- **Thermoelectric** composite materials & energy harvesting



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Engineering

