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Multi-scale and multi-technique approach of the colouring matter of Holocene schematic rock art: the Otello rock shelter (Bouches-du-Rhône, France)

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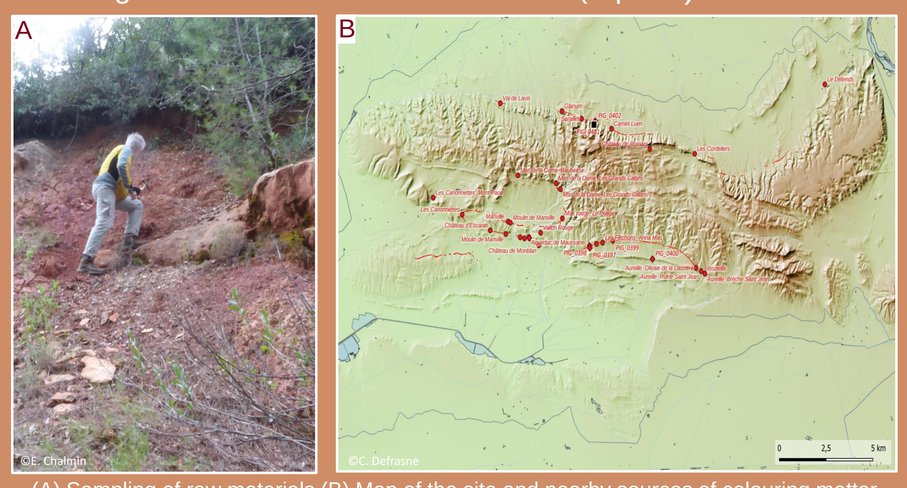
Introduction

Holocene schematic rock art is characterized by a **repertoire of recurring forms** reduced to their simplest expression, painted in open air rock shelters or, sometimes in caves, from Iberian Peninsula to Italy. The research in which this work takes place aims to examine the possibility of identifying graphic syntaxes that can inform us about the **cognitive nature** of this **non-figurative graphic expression**. In this perspective, the contribution of the study of colouring matters is indispensable. Physical and chemistry characterization could be very complementary to archaeology and well adapted for such a problematic. This poster presents our multi-scale and multi-technique methods and some first results.

The Otello rock shelter in Bouches-du-Rhône, France

Corpus

- A very large number of figures (>200)
- A great polychromy (5 colours)
- Many superimpositions
- Colouring matter in and around the shelter (Alpilles)



(A) Sampling of raw materials (B) Map of the site and nearby sources of colouring matter

Main goals

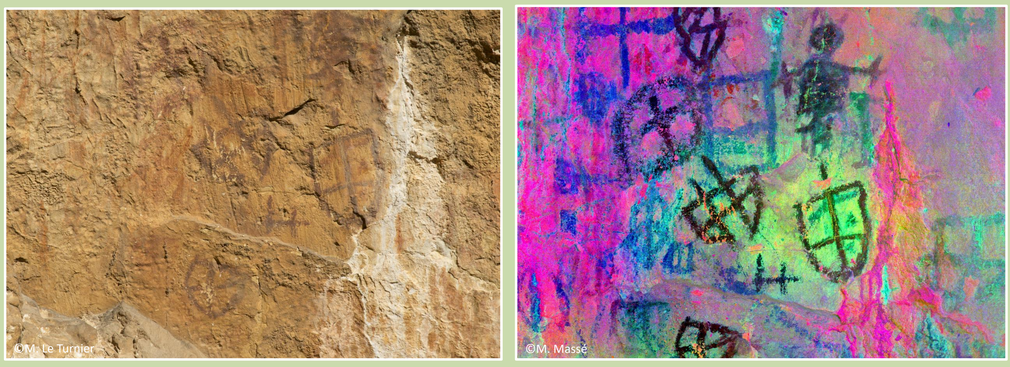
Characterize the diversity of the pictorial matter to:

- Identify the figures that can be grouped in order to question graphic syntaxes, or structure.
- Contribute to the identification of a relative chronology of the painted figures.
- Search for the origin of the colouring matter.
- Understand associated technical processes.
- Contribute to the understanding of the social practices and uses of territory.

Methods

Multi-technique approach is essential to study cultural heritage material which are rare, complex, and heterogenous. We use both :

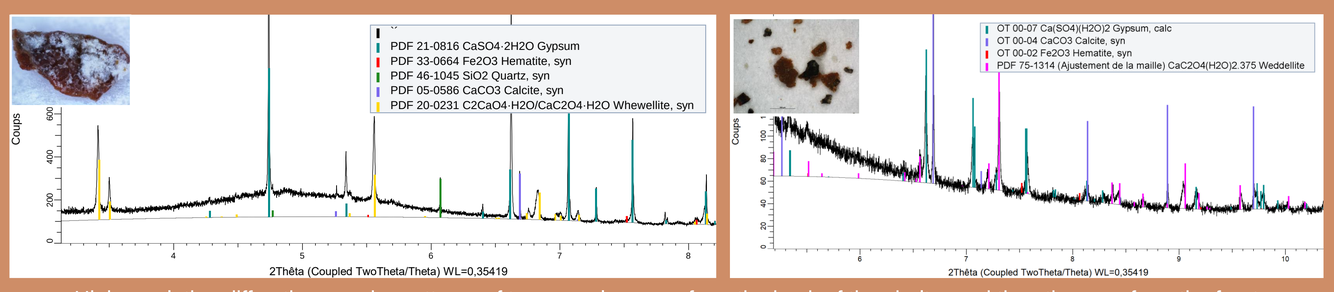
- ***In situ* non-invasive methods** directly on the surface**:**
  - **X-ray fluorescence**: point elemental
  - **Hyperspectral imaging**: reflectance imaging with a large spectral range (from infrared to UV-visible)
  - **Diffuse reflectance spectroscopy**: point acquisition of spectrum reflectance
- Analyses on **micro-samples:**
  - **Optical microscopy**
  - **SEM-EDS**: Scanning Electron Microscopy and elementary analyses
  - **Synchrotron techniques**:
    - High resolution powder diffraction (ID22, E = 35keV, 1mm)
    - High-spatial-resolution powder diffraction and fluorescence for structural imaging and elemental (ID13, E = 12,92keV,1µm)



Photography and hyperspectral Imaging: better visibility of the different figures

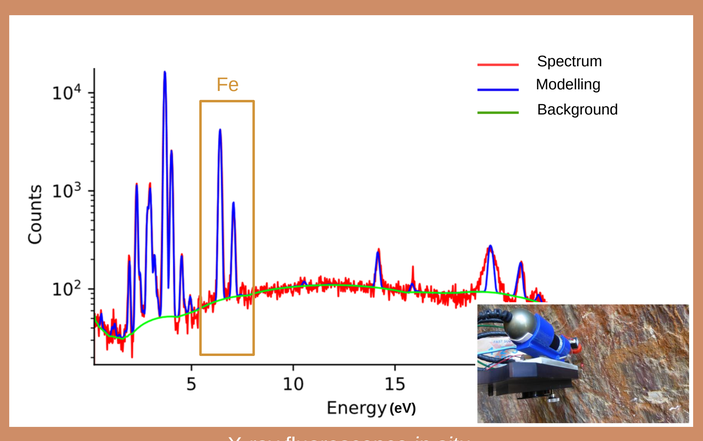
First results and hypothesis

- Omnipresence of the signal of wall alteration. Different forms of calcium oxalates: weddellite at the bottom of the shelter and whewellite at the front.

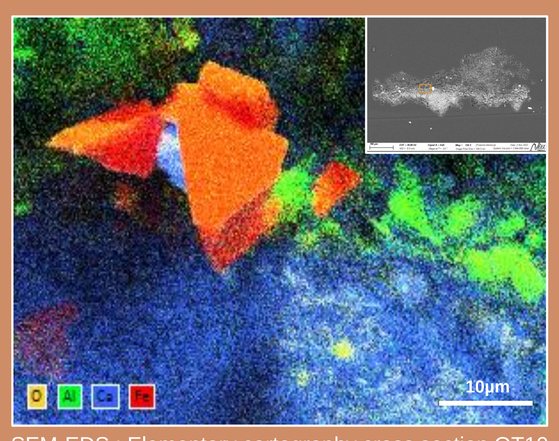


High resolution diffraction powder patterns of two samples : one from the back of the shelter and the other one from the front

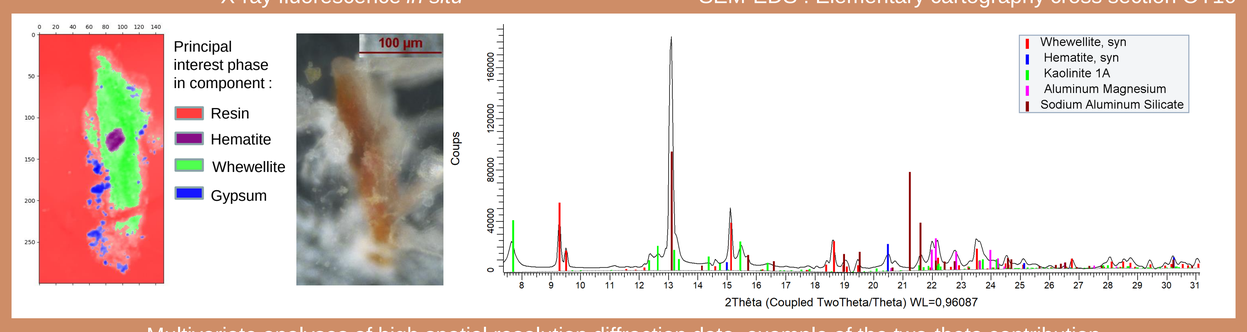
- **Ferruginous crystals (hematite)** are presented in the pictorial layers.



X-ray fluorescence *in situ*

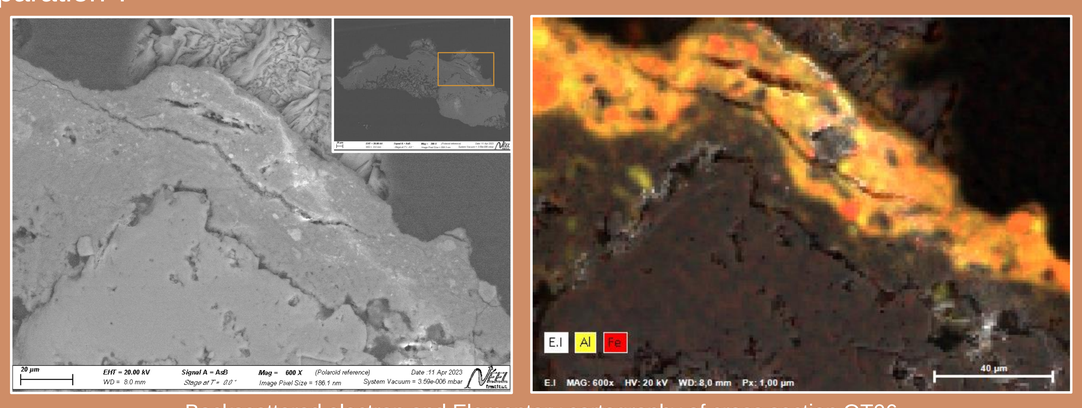


SEM-EDS : Elementary cartography cross section OT10



Multivariate analyses of high spatial resolution diffraction data, example of the two-theta contribution for the principal component which present the peaks of Hematite, microtome section OT08

- A different micro-morphology of the iron grains: different raw material source or different kind of preparation ?



Backscattered electron and Elementary cartography of cross section OT06

Conclusion

- First promising results: multi-scale and multi-technique approaches seem well adapted.
- Presence of different alteration phases.
- There are clues to search for the origin of the colouring matter: morphology of iron oxides.

Perspectives

- Understanding the origin of the repartition of calcium oxalates (humidity, temperature, presence of organic matter…).
- Better understanding of the conditions of wall alteration, taphonomy: link with the archaeo-geomorphological study of the shelter.
- Link the results together and compare them with other methods (hyper-spectral imaging) and geological references.
- Use this method on other sites and compare the results.

(A) Batch of coloured natural powder in sample holder for reflectance analysis, which were sampling next to Otello rock shelter in the context this Phd project and the pigment library 'pigmentothèque' (B) Eissartènes rock shelter Var, France (C) *in situ* microscopic observation with Dino-Lite

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