

**XVII SEMINÁRIO INTERNACIONAL DE ARTE RUPESTRE
DE MAÇÃO
XVII MAÇÃO'S INTERNATIONAL ROCK ART SEMINAR
APRIL 9th-10th 2014**



**Rupscience Project: Final Results
(PTDC/HIS-ARQ/101299/2008).**

Hugo Gomes & Pierluigi Rosina

Rupscience

Portugal, Spain, Colombia



Ruptejo – Portuguese Tagus Valley



*Abrigos com Arte Esquemática
Pintada do Centro de Portugal*

EBO -Angola



Collaborations with Ethiopia (ARCCH), Brazil (FUNDHAM)



Main Objectives

❧ *Chemical-mineralogical characterization of Pigments and Raw Materials.*



❧ *Absolut Dating*

❧ *Production & Preparation Techniques*

❧ *Conservation*



OCHRE

The term “Ochre” is commonly used for any rust rock containing iron oxides or hydroxides.



- ✧ The hematite (α - Fe_2O_3) is a red colour iron oxide
- ✧ The goethite (α - FeOOH) is a yellowish iron hydroxide.



Natural Iron Oxides Dry Pigments: Yellow Ochre, Raw Sienna, Burnt Sienna, Raw Umber, and Burnt Umber

The oldest (~ 75,000 years) and most unequivocal evidence of the use of ochre in human culture comes from the archaeological site of Blombos Cave (Africa), where two pieces of ochre engraved with abstract designs were found (Blake, 2008).

Analysed sites

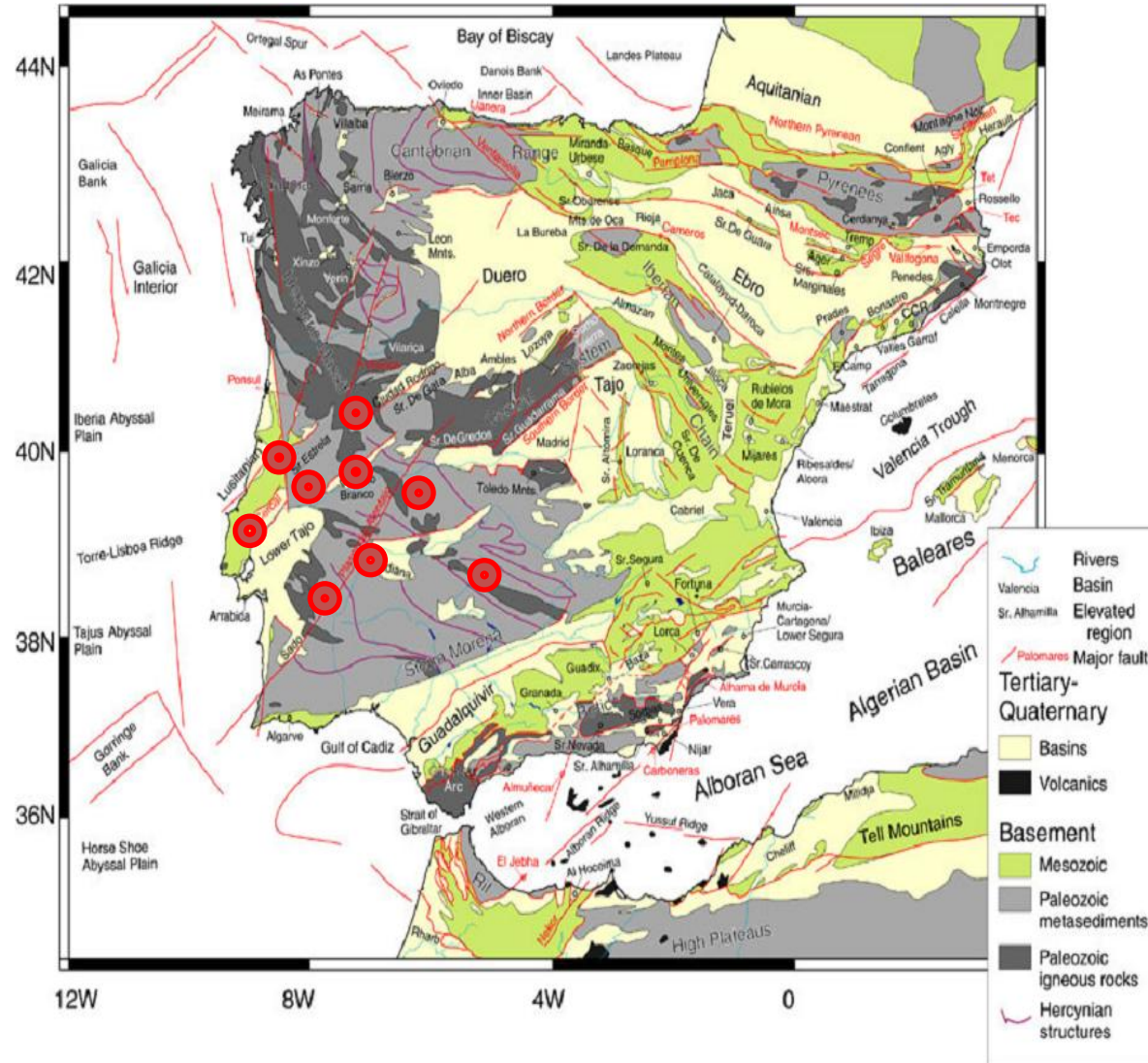
- ❧ *La Calderita - (Mérida, Spain)*
- ❧ *Friso del Terror - (Monfrague, Cáceres, Spain)*
- ❧ *Abrigo Puerto Roque (Valencia Alcântara, Spain)*
- ❧ *Pego da Rainha - (Mação, Portugal)*
- ❧ *Abrigo do Lapêdo 1 (Leiria, Portugal)*
- ❧ *Lapa dos Coelhos (Torres Novas, Portugal)*
- ❧ *Abrigo do Ribeiro das Casas (Almeida, Guarda, Portugal)*
- ❧ *Abrigo do Erges (Segura, Portugal)*
- ❧ *Perdigões (Montemor, Portugal)*

- ❧ *Gode Roriso – Etiópia*
- ❧ *N´Dalambiri – Ebo, Angola*
- ❧ *Toca do Paraguaio – Piauí, Brasil*
- ❧ *Boqueirão da Pedra Furada - Piauí, Brasil*



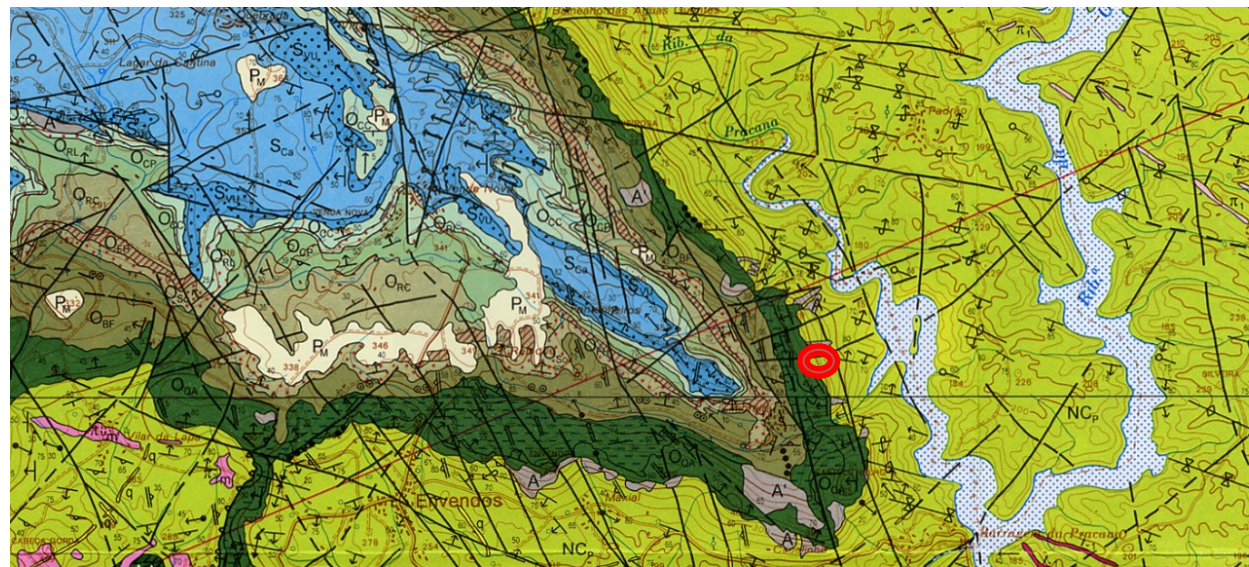
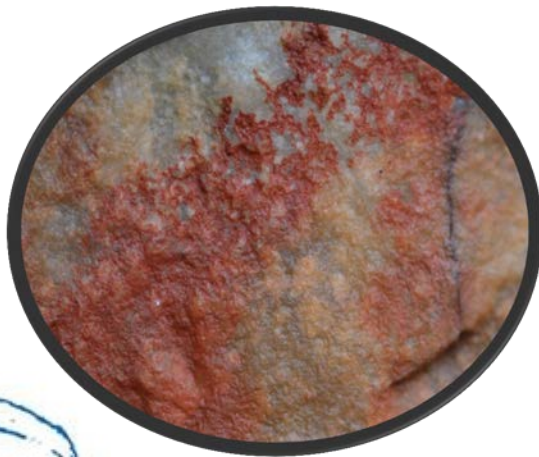
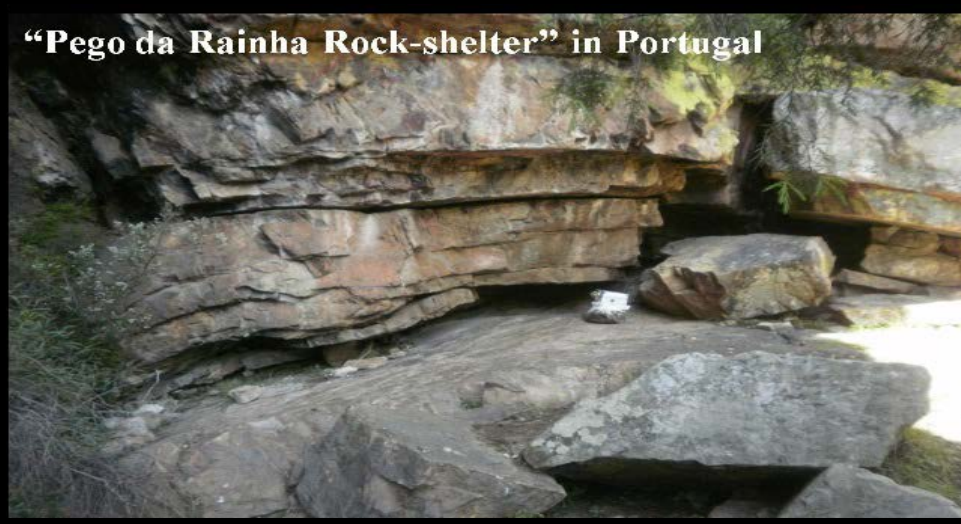
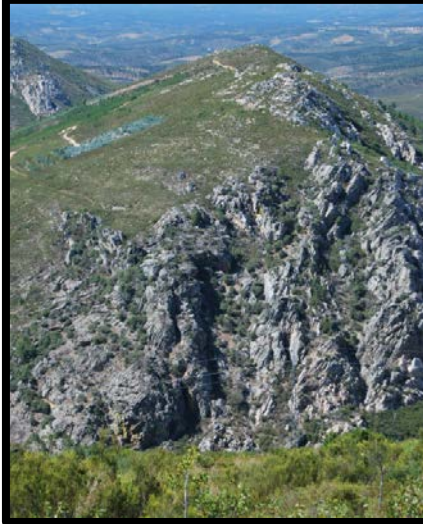
Western Iberian Schematic rock art

- Pego da Rainha
- Lapêdo 1
- Lapa dos Coelhos
- Friso del Terror
- La Calderita
- Puerto Roque
- Erges
- Almeida
- (Perdigões)



Pego da Rainha - Mação

The selected areas holding rock art paintings in Iberian Peninsula can be found in the top of quartzite crests and are culturally attributed to the Neolithic/Calcolithic periods.



La Calderita - Spain



"La Calderita rock-shelter" in Spain



Puerto Roque rock-shelter - Valencia de Alcântara



Important rock-shelters to the characterization of schematic rock art in the limestone masif in Portugal

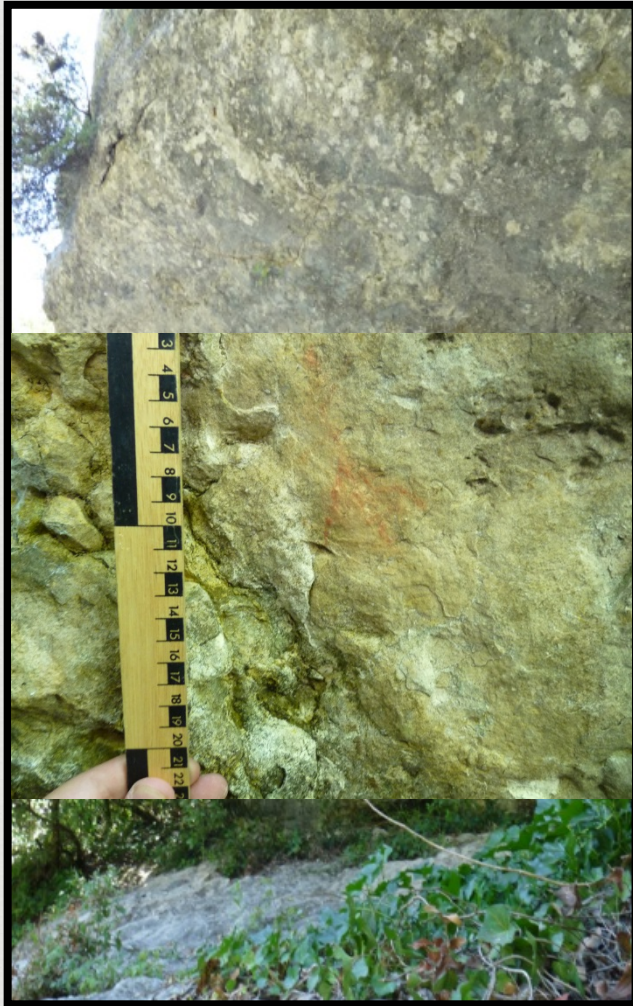


Lapêdo 1 rock-shelter



Lapa dos Coelhos

Important rock-shelters to the characterization of schematic rock art in the limestone masif in Portugal

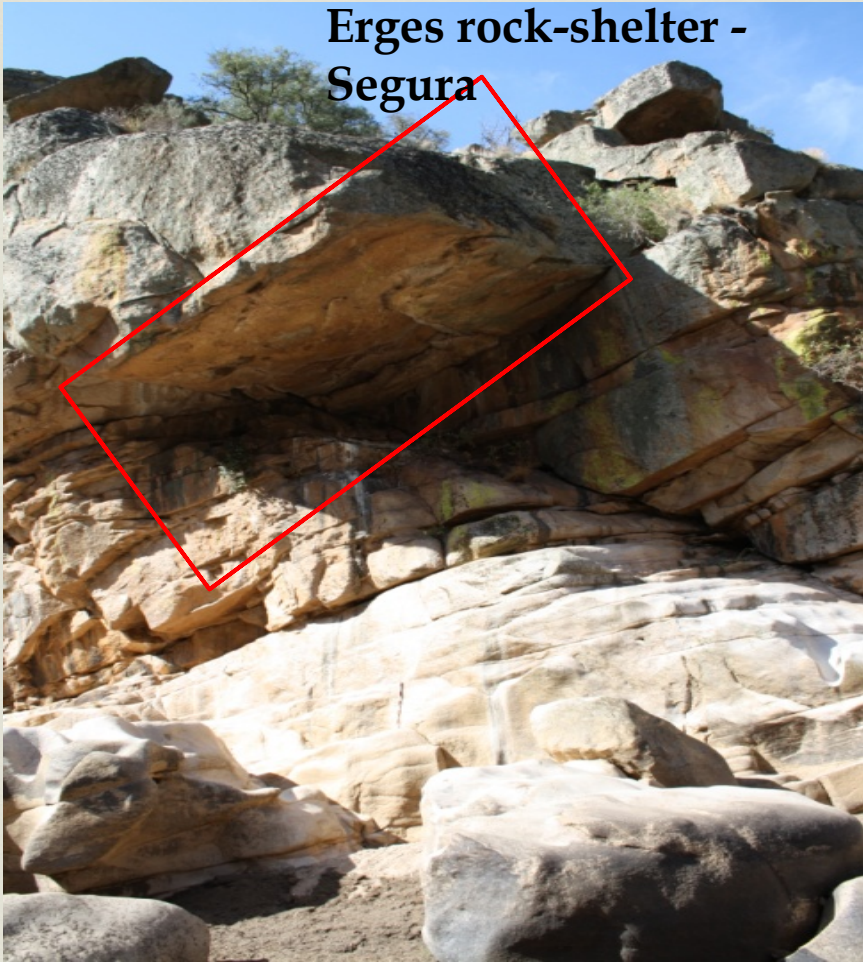


Lapêdo 1 rock-shelter



Lapa dos Coelhos

Erges rock-shelter -
Segura



Hesperian Massif -Granites





Panel 1 - Zoomorphic (vandalized) (2)



Panel 2 - Anthropomorphe (1)



Ribeiro das Casas rock-shelter

Panel 3 -
Anthropomorphic (3) (4);
oxides? (5) and granite
substrate (6).

Perdigões (Chalcolithic / Bronze age Tombs 1 and 2)



Gode Roriso - Etiópia





© Guia de Turismo

Data das imagens: 2/8/2011 10:56:53-93°S 14°40'49.227E elev. 1321 m altitude de visualização: 2,10 km

N'Dalambiri -Ebo (EBO Project)



50 cm

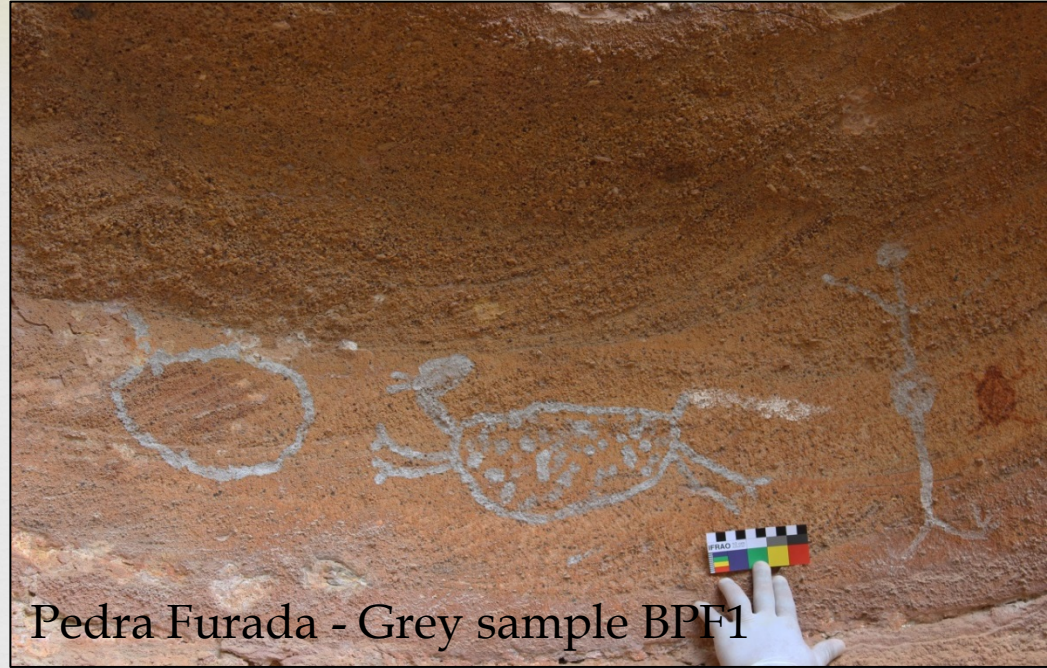
A1

A2

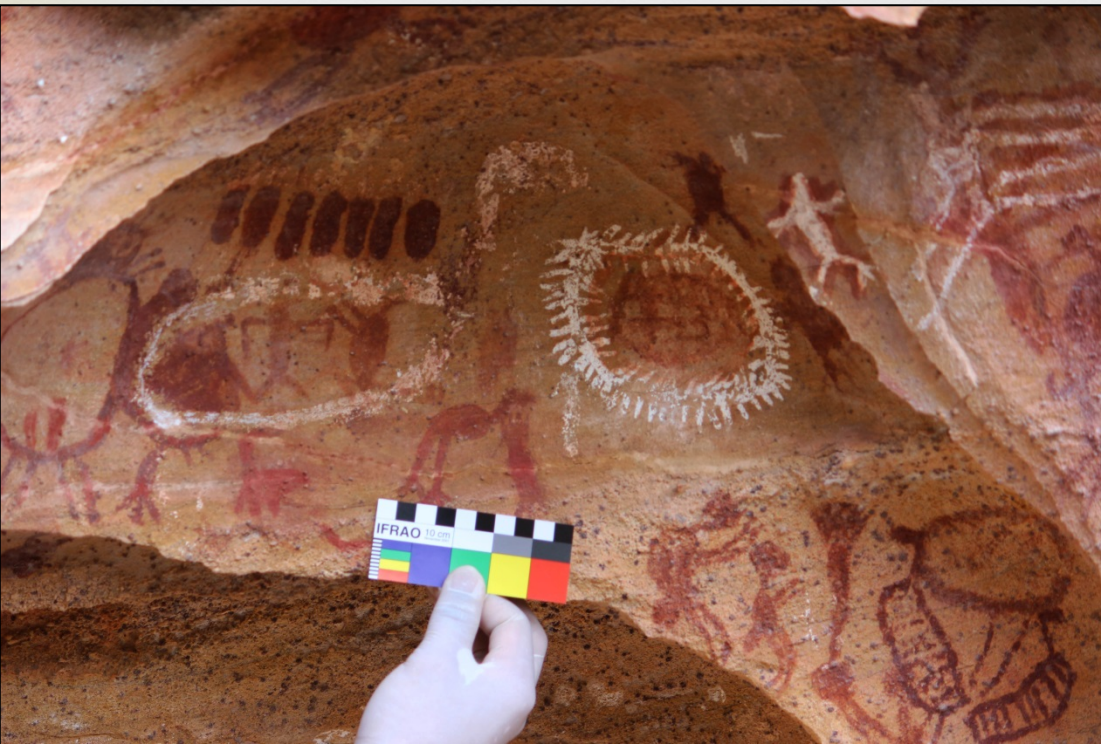
A3



Pedra Furada - White sample BPF2.



Pedra Furada - Grey sample BPF1

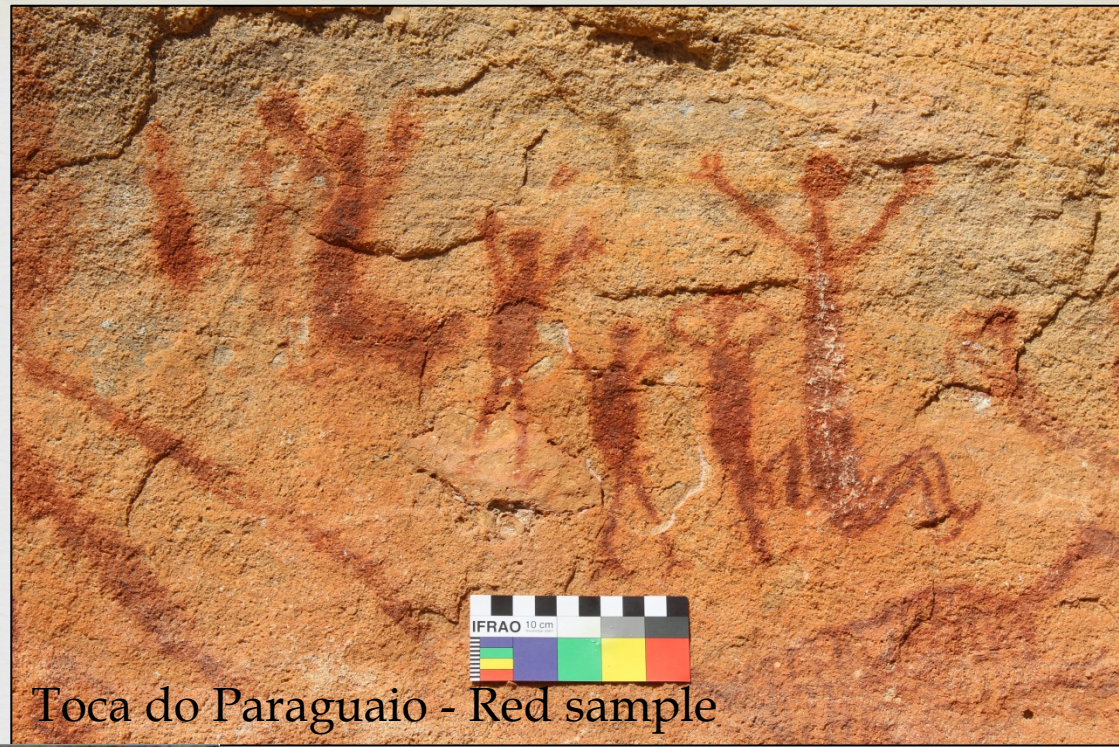


Pedra Furada - Red sample BPF3.





Toca do Paraguaio - Red sample



Toca do Paraguaio - Red sample



Materials and Methods – “Protocol”

Panel Characterization

- **Macro-flora e micro-flora (bio-colonization)**
- **Concretions**
- **Water flow**
- **Pigment deterioration (conservation/preservation)**
- **Superposition's and stylistic chronology)**

How to collect samples

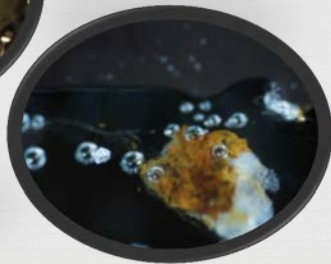
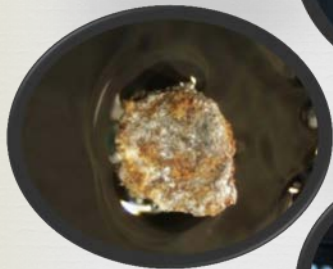
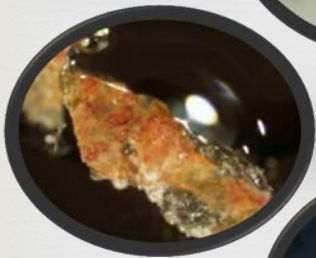
- Ethic code: *Code of Ethics and Guidelines for Practice*. American Institute for Conservation – www.Conservation-us.org. (Wainwhite *et al.*, 2000)
- Applied Methodology

Objectives

- **Pigments composition**
- **Raw-Materials**
- **Production /preparation and application techniques**
- **Chronology (Absolut dates)**



Pigments

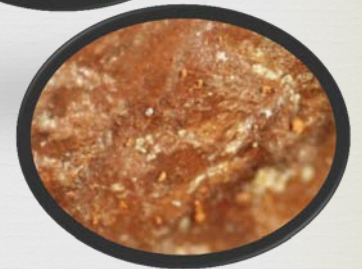
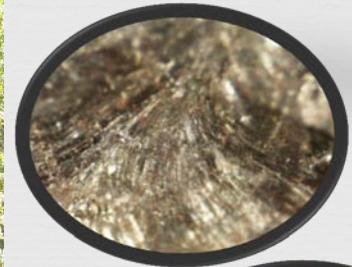
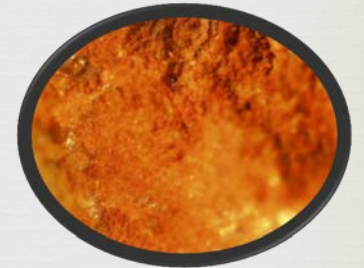


Sampling

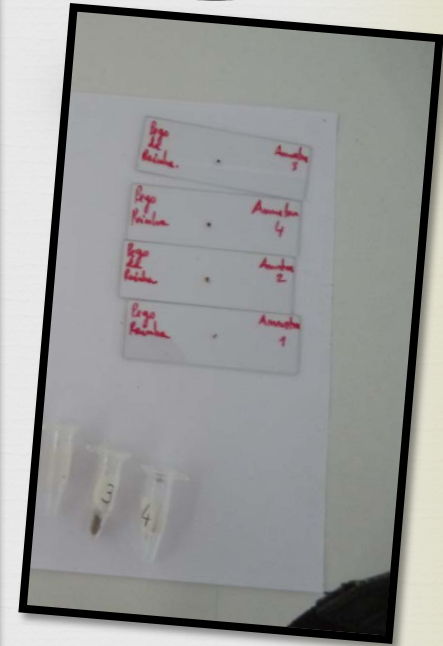
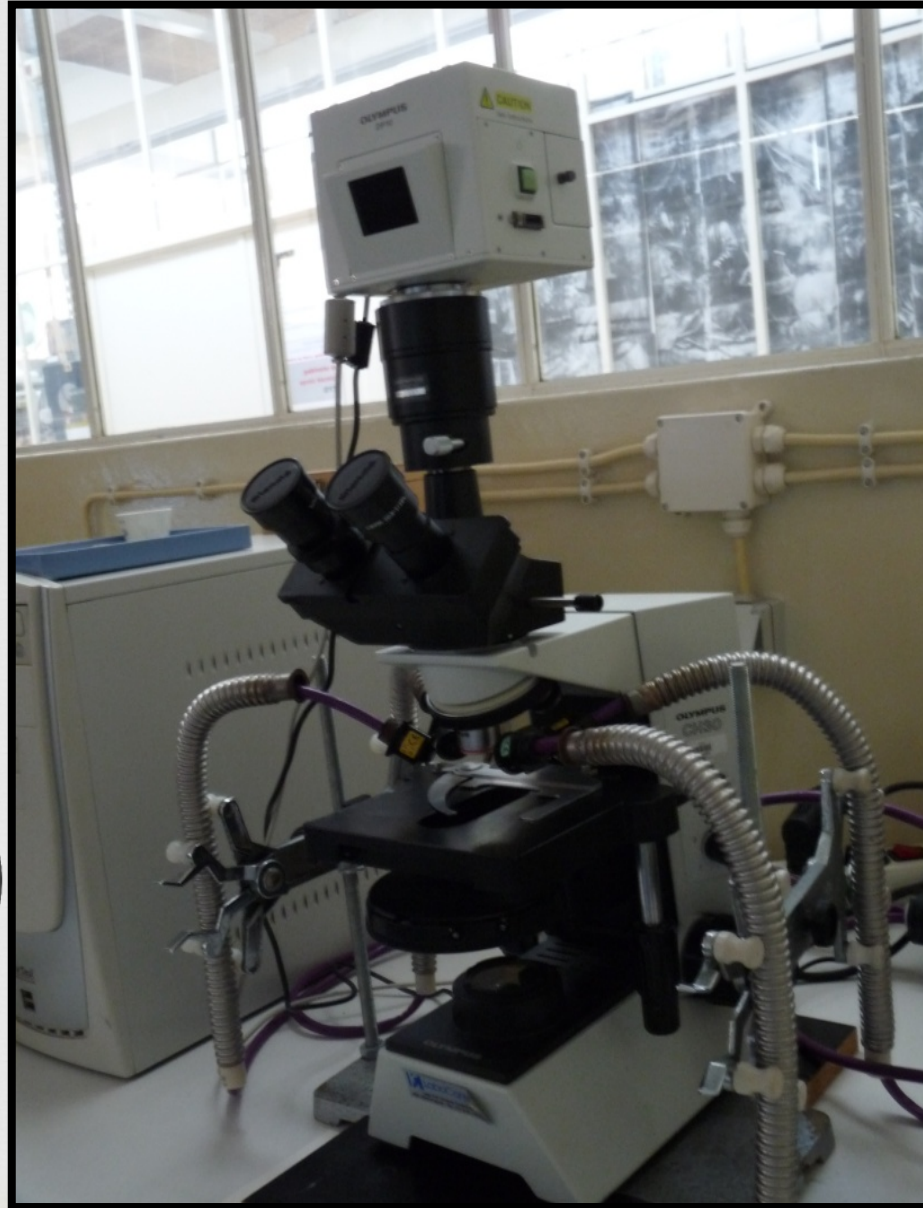
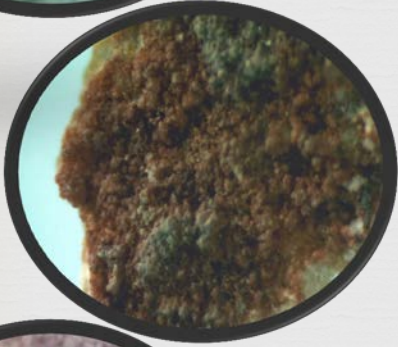
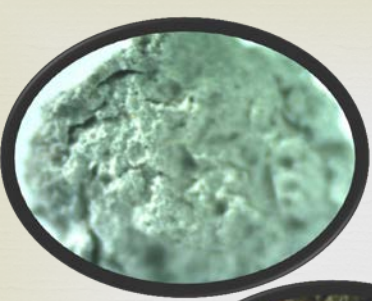


Around 100 samples

Ocre



Sample preparation...





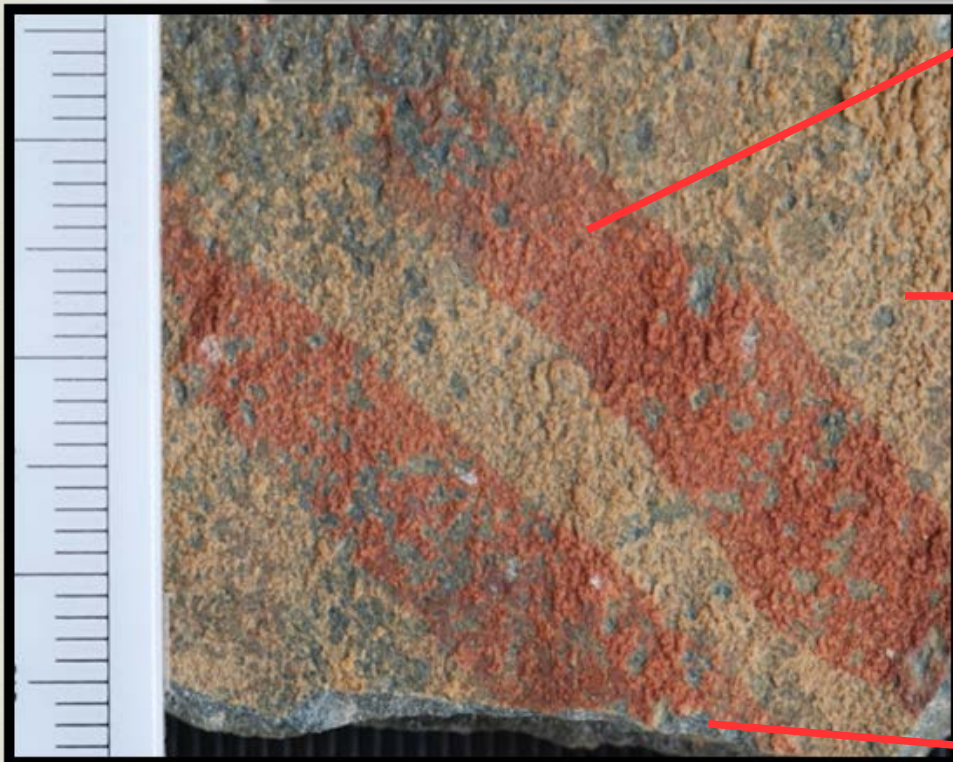
Pigment



Concretion




Substrate



Natural Detachment Fragment

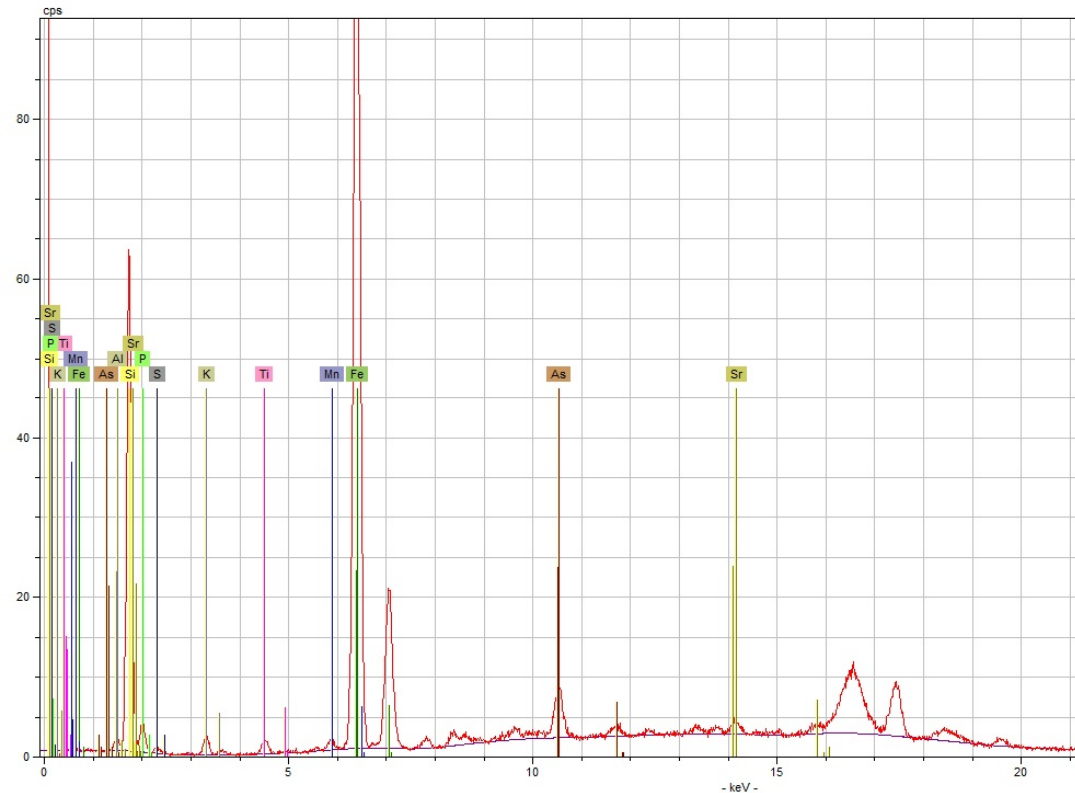
Archaeometric techniques

- Raman Spectroscopy
- X-microfluorescence 
- Micro-stratigraphy
- SEM - Scanning Electron Microscope



X-microfluorescence

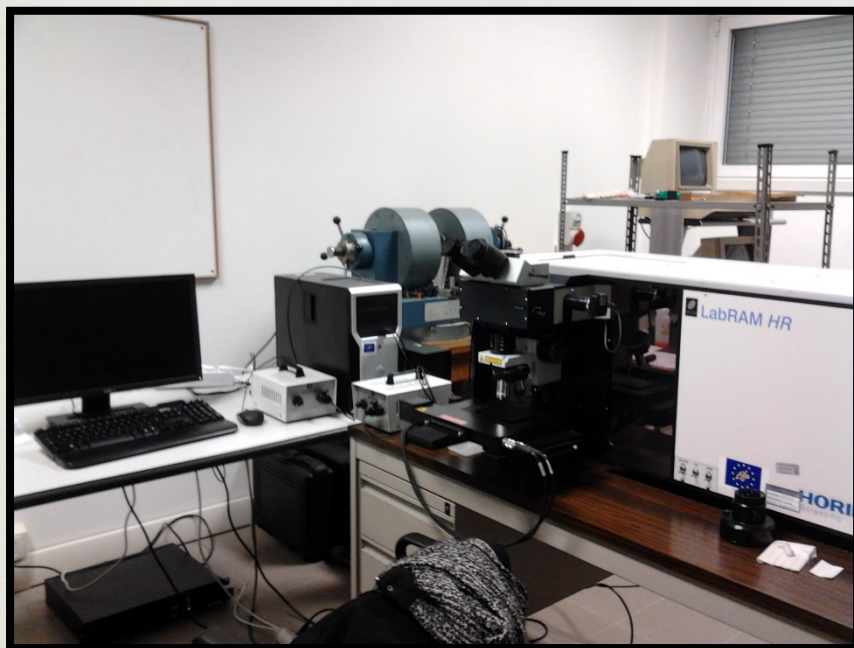
EDXRF spectrometer (intensity $40\mu\text{Å}$, 25 kV, aquisition time 50 sec, calibrated by Cu). Spetrum was read with Amptek Program.



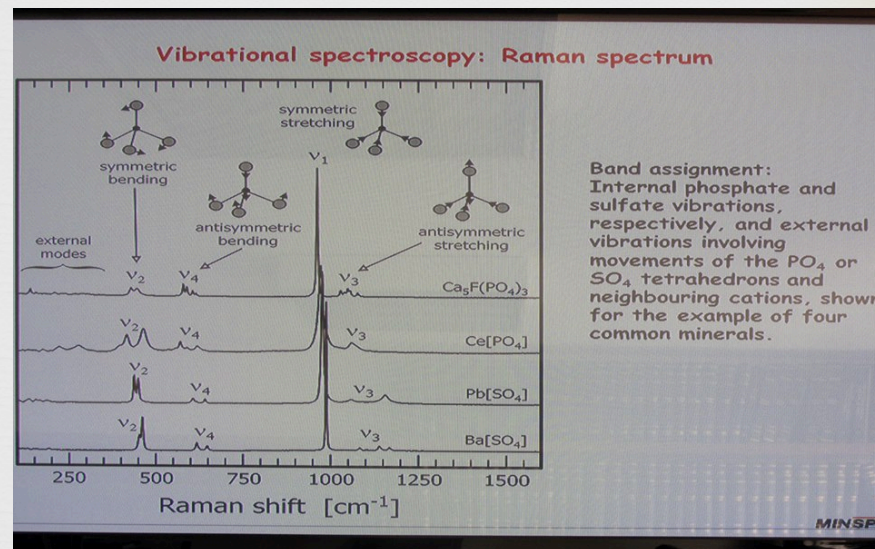
X-microfluorescence /SEM

<i>Element</i>	<i>Substance</i>
Fe	Hematite/ Goethite
Hg	Cinnabar
Ca, K, P	Concretions/Substrates
Others	Impurities and alterations

Raman Spectroscopy



Earth Sciences Department of University of Ferrara, Italy

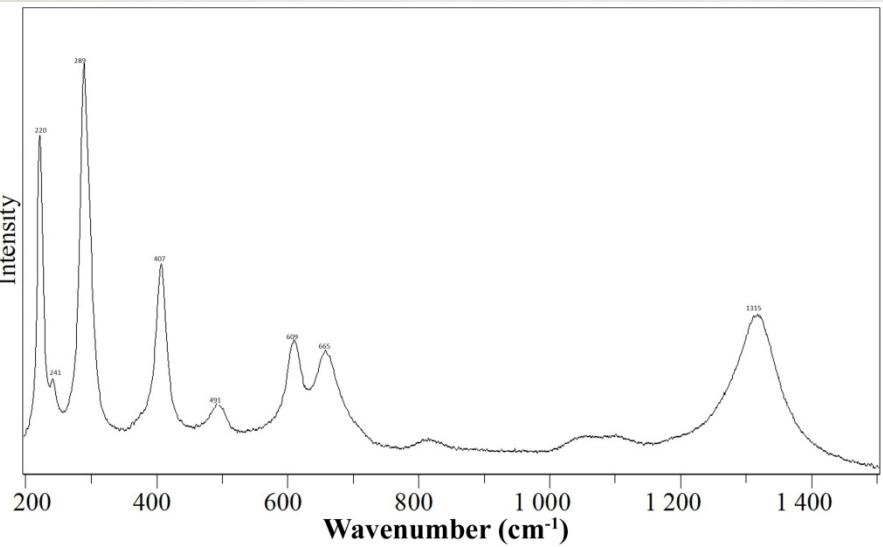


Raman spectra of the samples were obtained using an Olympus BXFM Microscope coupled with a LabRam HR800 spectrometer (Horiba Jobin Yvon, France) fitted with an air-cooled CCD detector (1024×256 pixels), set at -70°C.

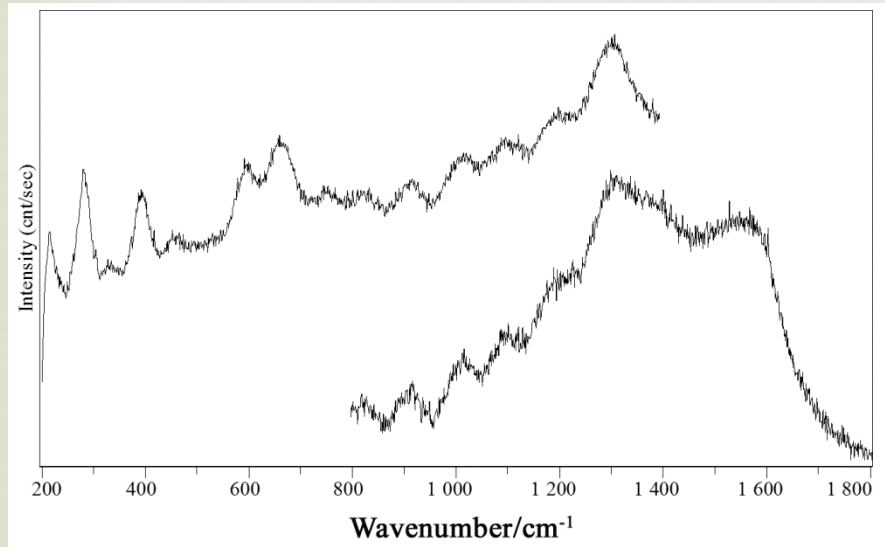
Raman spectra were recorded using a He-Ne laser as excitation source with a wavelength of 632.81 nm.

The removal of spikes of cosmic rays and baseline correction (for fluorescence background subtraction) were performed using LabSpec 5 software.

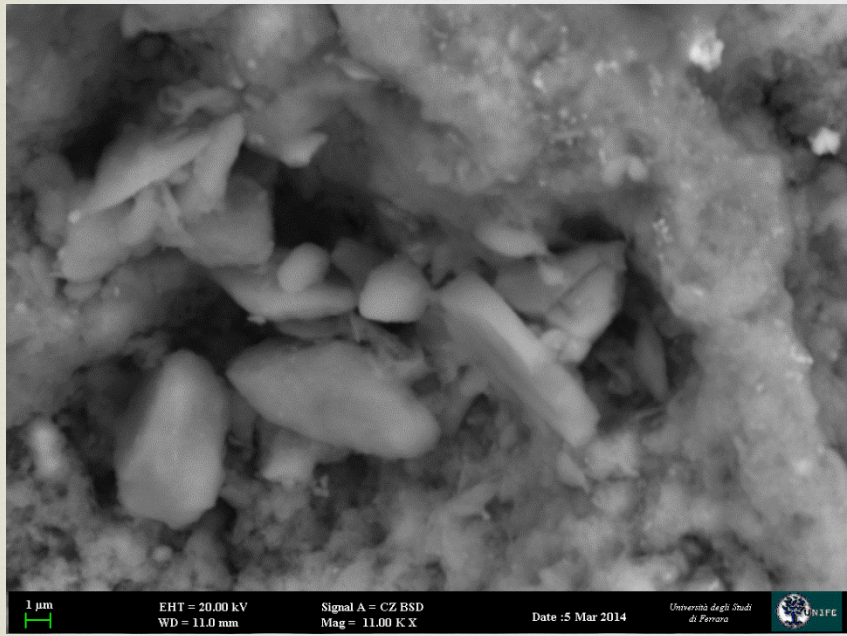
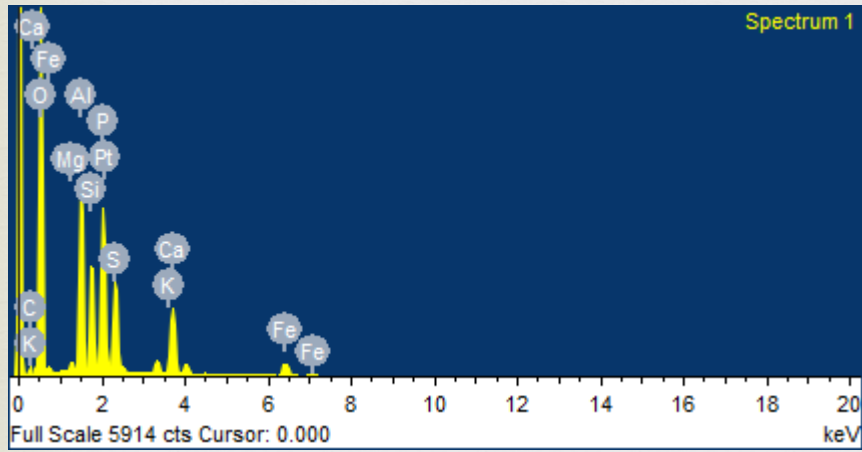
Raman Spectroscopy



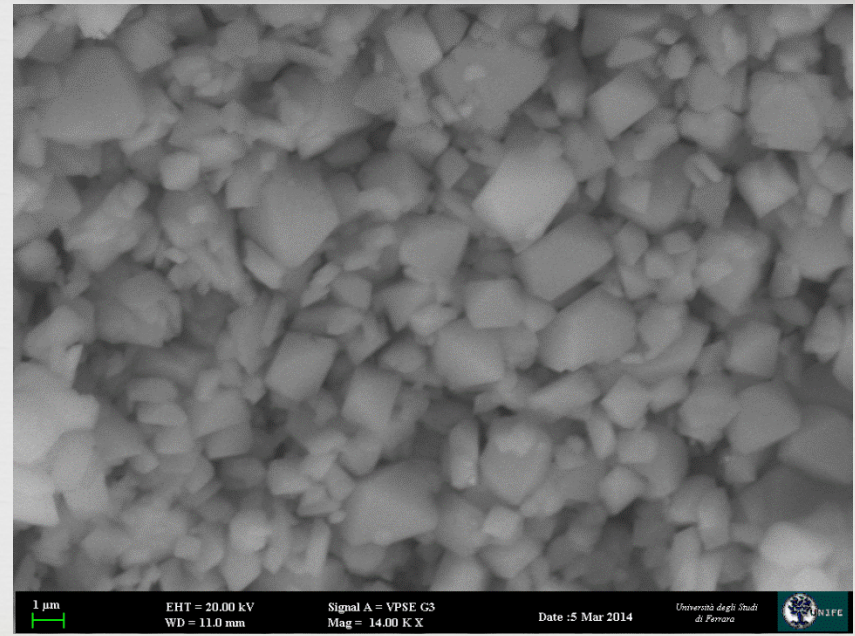
Raman Results		
<i>Substance</i>	<i>Colour</i>	<i>Sites</i>
Hematite	Red	All sites
Goethite	Yellow/Orange	La Calderita
Carbon	Black	Ethiopia, EBO
Calcite	White	EBO
Beeswax	White	Ethiopia
Cinnabar	Red, Pink	Perdigões
Organics	Not identified	



Scanning Electron Microscopy



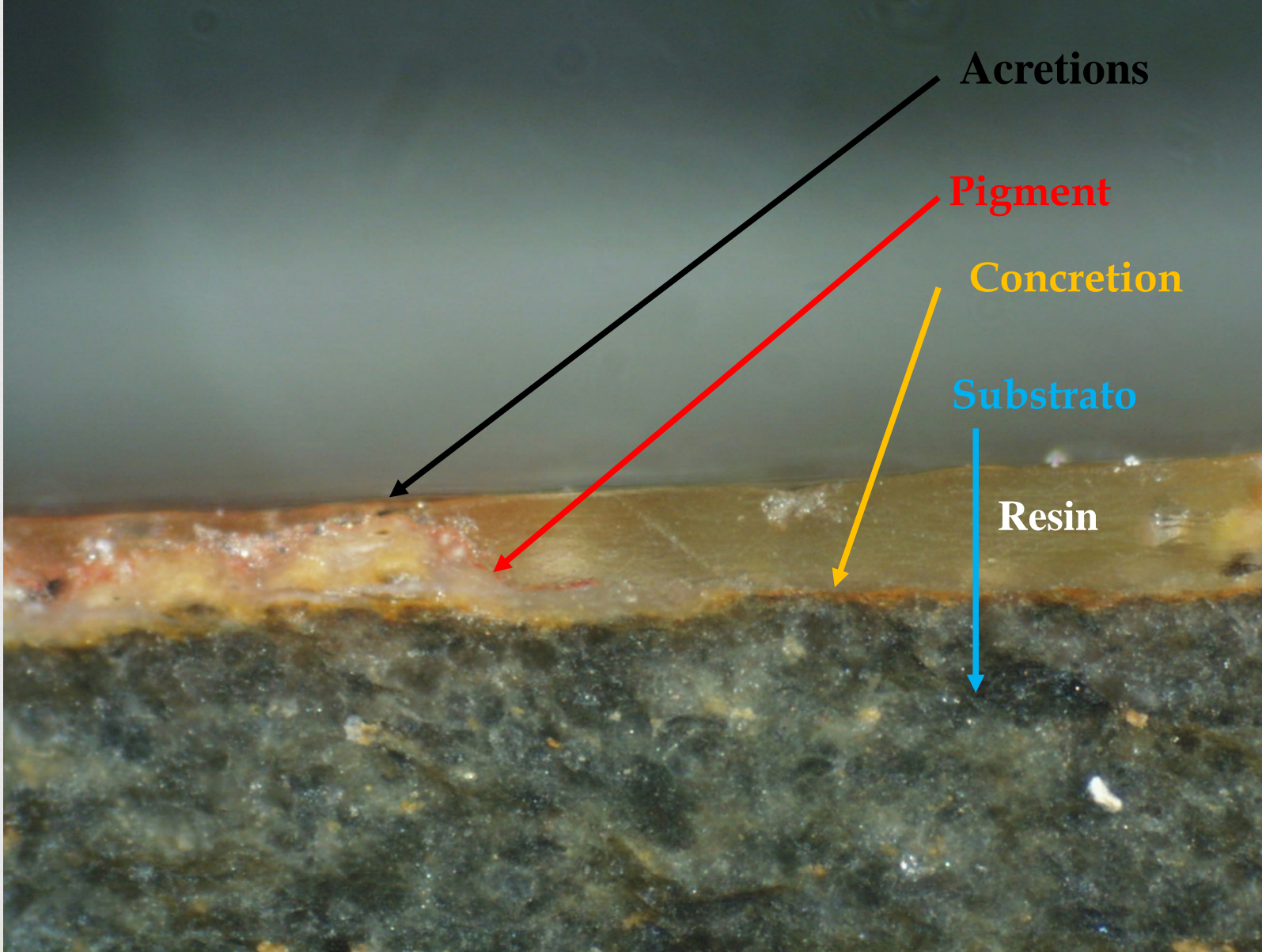
Hematite



Cinnabar

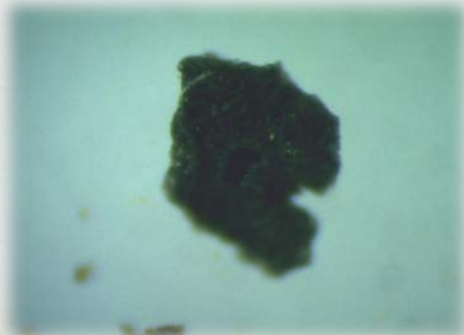
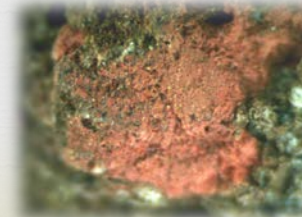
Micro-stratigraphic Analysis

Optical microscope PCE - MM 200 Digital Microscope 60x and 210x.



Pigment and Technique

Raw Material	Sites	Technique
Hematite	<i>All sites</i>	Natural or Burnt ochre
Goethite	<i>La Calderita</i>	Natural or Burnt ochre
Lepidocrocite	<i>Pego Rainha</i>	Natural ochre
Calcite	<i>Ebo</i>	Smashing?
Carbon	<i>Ebo, Ethiopia</i>	Charcoal
Beeswax	<i>Ethiopia</i>	Encaustic process
Cinnabar	<i>Perdigões</i>	Mixture & maceration



Absolut Chronology



Bovines– Stylistic Chronology

The red geometric figures seem to be the oldest representations of Gode Roriso in Ethiopia.



White pigments are taken from this motifs

Absolut Dating (Beta Analytic.Inc)

Sample	Lab code	Weight (mg)	Date (BP)	13C/12C Ratio ‰	Conventional radiocarbon age (BP)	Calibrated age (2 Sigma)
Gode Roriso 2	Beta-358358	51	1000±30	-27.3	960±30	Cal AD 1020 to 1160
Gode Roriso 3	Beta-358359	17,9	1040±40	-23.3	1080±30	Cal AD 890 to 1020

Journal of Archaeological Science
Volume 40, Issue 11, November 2013, Pages 4073–4082

Review
Identification of pigments used in rock art paintings in Gode Roriso-Ethiopia using Micro-Raman spectroscopy

Hugo Gomes^a, Pterugi Rosina^a, Parviz Holakoei^b, Tadele Solomon^c, Camela Vaccaro^d
^a Polytechnic Institute of Tamar, Quaternary and Prehistory Group of Geosciences Centre (IJD 73 – FCT), Portugal
^b Earth Sciences Department, University of Ferrara, Italy
^c Authority for Research and Conservation of Cultural Heritage (ARCCH), Ethiopia

Conservation



- Research on the interface between the lichens and substrates suggests that the weathering of minerals can be accelerated by the growth of some species of lichens.
- The identification and description of species of lichens in rock shelters with different lithologies associated to rock art in Portugal was carried out.
- The field work in rock-shelters with pre-historic paintings in Portugal and Spain, allowed the establishment of some correlations between the frequency, diversity, species distribution, climatic conditions, and forms of deterioration, slope and sun exposure of the rock art panels.



Candelariella Sp.



Lecanora muralis



Rizocarpon geographicum

- This study allowed to determine that the mostly representative lichens are crusty and pulverous species;
- The biggest representation of crusty species, with higher penetration into the substrate, resulting in a remarkable acceleration of the fragmentation of rock art panels and consequent destruction of paintings.
- This results help us to generate conservation policies and measures to apply in rock art sites.

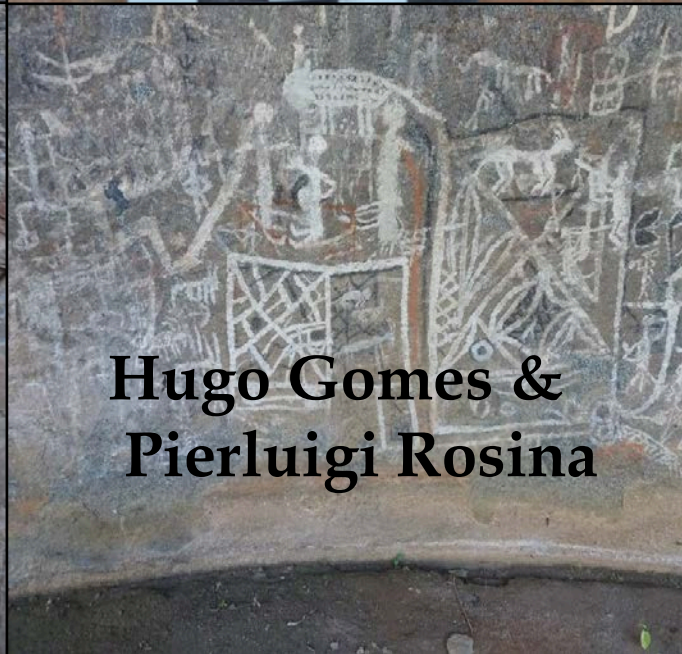


Final Remarks

The use of archeometry in rock art pigments fill an area of research where the results reach their purpose:

- ❑ **Characterization of the components of the pigments,**
- ❑ **Raw-Material identification**
- ❑ **Details of the production processes (such as heating, crushing or mixing of substances)**
- ❑ **Application techniques**
- ❑ **Chronology (Absolut dates)**
- ❑ **Conservation measures**

Obrigado
Thanks
CIAO



Hugo Gomes &
Pierluigi Rosina