

Characterizing Red Coloring Matter Samples from the Altamira Cave Using Semi-Quantitative Chemical Imaging and X-Ray Absorption at the PUMA Beamline, SOLEIL

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ABSTRACT

Paleolithic cave art stands as one of the earliest forms of art of modern humans, and as such it is important and necessary to analyze it and aim for a better comprehension of it. The coloring matters that can frequently be found are black, red or yellow. The study of black Paleolithic coloring matter has been well developed, and analytical procedures have been established [1],[2]. However, the study of reds is more complicated, as the coloring matter and the cave wall support present a similar chemical composition [3]. The aims pursued in our ongoing research are to improve the red Paleolithic pigments' characterization with respect to the *in situ* analyses that can be undertaken with a portable instrument in a cave, and to find differentiation criteria between the composition of the walls and that of the coloring matter, which would help to improve the performances of these *in situ* measurements [4].

In this study we present the results of the micro-X-ray fluorescence (μ XRF) and X-ray absorption (XANES) analyses at PUMA, SOLEIL, of red coloring matter samples coming from different figures from one of the most important and renowned examples of polychrome cave art, the Techo de los Polícromos from the cave of Altamira in Northern Spain. Applying such sensitive non-destructive techniques allowed us to study trace elements, chemical markers, and phases and identify the coloring matter in a way that is not possible *in situ* as of today (namely with portable XRF and X-ray diffraction). Here we present results of the characterization of these red samples, along with a comparative analysis of different representations between them. These may yield new insights on the creation steps of these prehistoric figures. Finally, we further improved the identification of elements to be searched for during *in situ* analyses with a μ XRF equipment such as Ti, Cr, Mn, Zn, Rb, Sr or Br in this cave or in others.



Figure 1. Techo de Los Polícromos, Altamira, with one of the analyzed locations marked with a white cross. © J. Tapia /CNRS-C2RMF

REFERENCES

- [1] Trosseau et al. JAAS 2021
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