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First use of portable system coupling X-ray diffraction and X-ray fluorescence for *in-situ* analysis of prehistoric rock art

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Abstract

Study of prehistoric art is playing a major role in the knowledge of human evolution. Many scientific methods are involved in this investigation including chemical analysis of pigments present on artefacts or applied to cave walls. In the past decades, the characterisation of coloured materials was carried on by taking small samples. This procedure had two main disadvantages: slight but existing damage of the paintings and limitation of the number of samples. Thanks to the advanced development of portable systems, *in-situ* analysis of pigment in cave can be now undertaken without fear for this fragile Cultural Heritage.

For the first time, a portable system combining XRD and XRF was used in an underground and archaeological environment for prehistoric rock art studies. *In-situ* non-destructive analysis of black prehistoric drawings and determination of their composition and crystalline structure were successfully carried out. Original results on pigments used 13000 years ago in the cave of Rouffignac (France) were obtained showing the use of two main manganese oxides: pyrolusite and romanechite.

The capabilities of the portable XRD-XRF system have been demonstrated for the characterisation of pigments as well as for the analysis of rock in a cave environment. This first *in-situ* experiment combining X-ray diffraction and X-ray fluorescence open up new horizons and can fundamentally change our approach of rock art studies.

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