



Full length article

Micro-Raman spectroscopy for the characterization of rock-art pigments from *Abrigo del Águila* (Badajoz – Spain)P. Rosina^{a,*}, H. Gomes^b, H. Collado^c, M. Nicoli^e, L. Volpe^d, C. Vaccaro^e^a Geosciences Center (UID_73) Polytechnic Institute of Tomar, Portugal^b Geosciences Center (UID_73), Portugal^c ACINEP, Geosciences Center (UID_73), Portugal^d TekneHub, Italy^e University of Ferrara, Italy

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ABSTRACT

Micro-Raman spectroscopic technique allowed the characterization of organic and inorganic pigments of different colours sampled from a rock-art shelter named *Abrigo del Águila*, located in the district of Badajoz, Cabeza del Buey (Extremadura – Spain). Micro-Raman analyses has been coupled with SEM observation and elemental analyses (EDS). The white and the black colours, used for non-representative figures, have been identified respectively as anatase and amorphous carbon, while two different type of red pigment has been found on figurative representations. The darker one, sampled, from a sun-figure, comprises an indeterminate organic compound beside of hematite. The second one, sampled from an anthropomorphic figure, is of a brilliant red and only hematite has been recognized in it.

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1. Introduction

As confirmed by several previous studies, μ -Raman spectroscopy is proving to be a valuable tool for the investigation of pigments used in prehistoric rock-art paintings as well as on a wide range of archaeological artefacts [1–5]. In this work Raman spectroscopy and SEM-EDS analysis have been carried out in order to characterize rock-art pigments from *Abrigo del Águila* (Cabeza del Buey, Badajoz, Spain).

1.1. Regional and geological settings

The archaeological site of *Abrigo del Águila* is placed in the East part of the quartzitic alignment of *Sierra de la Rinconada* (Fig. 1). The site is located 40 meters above soil level, within a great rock crack of about meters of length. Since prehistory this place have played an important role for its orographic characteristics as it's located in the region which separates *Sierra de la Rinconada* from *Sierra de la Osa*, becoming an inevitable passage for the routes towards the prairies of *Sierra de la Rinconada*.

1.2. Rock art pictographs at *Abrigo del Águila*

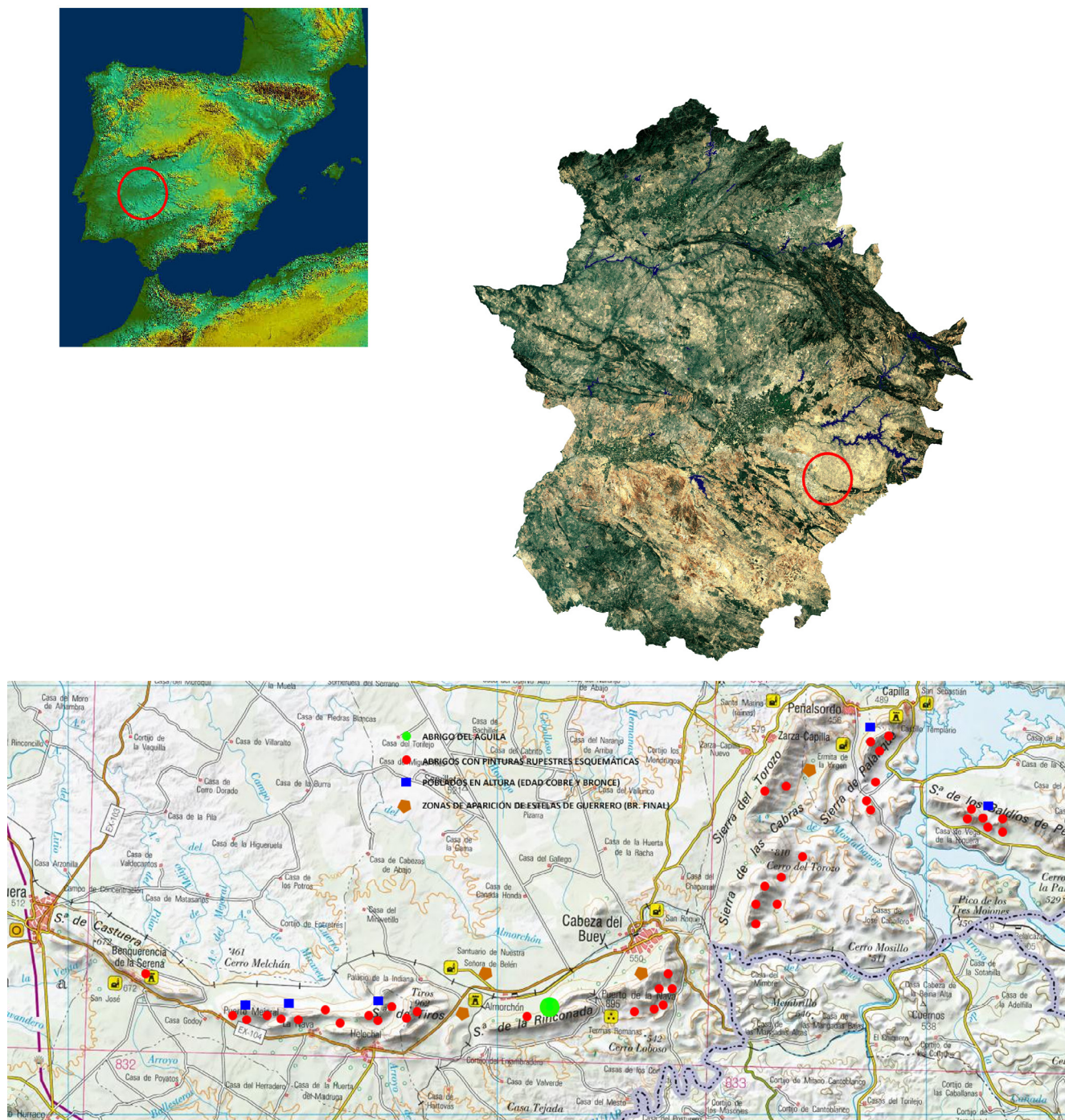
The present paper classifies and investigates rock-art pigments from the archaeological site of *Abrigo del Águila*. The pictorial rock-art group consists of thousands of figures that are arranged in 45 rock panels and are placed in the inner part of the rock-shelter. Preliminary studies revealed repeated pictorial motives that are irregularly spread on the surface of the archaeological site: some of the areas are characterized by few motives, while other show real palimpsests. Motifs are both abstract and figurative (see Tables 1 and 2).

Despite the high concentration of these figures, it is difficult to evaluate the figurative overlapping in order to determine the diachronic evolution of the graphical use of this site. Even if it is not possible to establish a detailed chronology, cultural references exist that allow to refer the site to the lap-time between the end of the Neolithic and the Copper Age [6].

In schematic rock-art of Iberian Peninsula figures are usually of a red colour, drawn with mineral pigments rich in iron oxides, such as hematite or goethite. Black and white pigments are, instead, uncommon [7]. At *Abrigo del Águila* rock-art shelter most of the figures are red, but white and black representation are also present. The red colour is of several shades, from orange tones to darker ones. The different colour shade could be due to several factors

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such as conservative state, environmental and biological degradation, interaction with rock surface, diverse adherence to the rock support, different thickness of pigments (Fig. 2).

2. Materials and methods

2.1. Sample collection

Nine samples were collected in strategic figurative representations, in order to encompass all the chrono-cultural spectrum of

the painting motives and variation of the colour of the figures (white, black and various shades of red) were also taken into account. Where possible, sample collection has been done using non-contact ethical extraction techniques (applying the code of ethics and guidelines for practice of American Institute for conservation). Each sample, weighing between 10 and 100 mg, was extracted in areas of the panel where pigment was easily observed. Each sample was obtained using a sterilized tungsten scalpel and insert in a 0.5 ml microcentrifuge tube [8].

The archaeometric research aims to create knowledge based with all the relevant parameters and can provide reliable data for

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