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THE PAVEMENTS OF THE ROMAN SITE OF COSTA DE LA SERRA (LA SECUITA, TARRAGONÈS). A MULTIDISCIPLINARY STUDY

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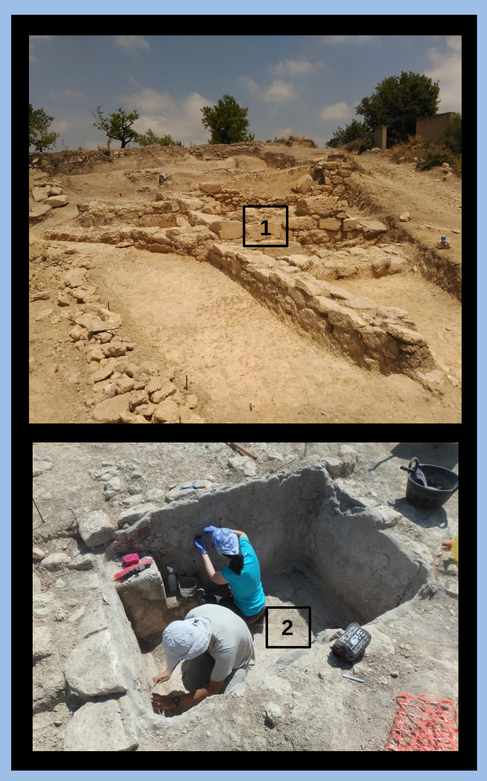
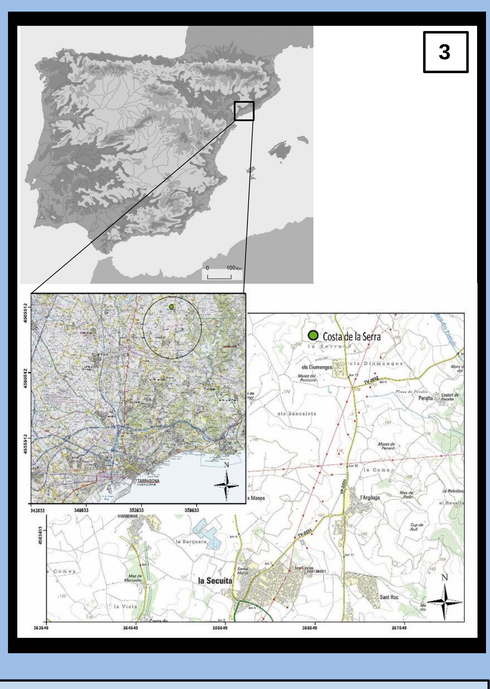


INTRODUCTION

The site of Costa de la Serra is located in the municipality of La Secuita, some 13 km north from the city of Tarragona. It is a late-republic small fort, dating back between the end of the 2nd century BC and the beginning of the 1st century BC. Placed on a low hill that visually dominates the inland of the Camp de Tarragona area, its surface is slightly over 2000 m^2. Since 2014, the ICAC has been conducting archaeological fieldwork, in the framework of the project "*Formes d'ocupació del territori i evolució del poblament a la Cessetània occidental durant la protohistòria (Ier mil·lenni aC)".* These works revealed the existence of a military settlement, which was intentionally devastated at the moment of its abandon. The fort would have been presumably in use for a short time, most likely during the Sertorius war (80-72 BC). Moreover, two towers located at the southern and eastern façades were documented. They have also identified several walls belonging to barracks, as well as three cisterns to collect rainwater, together with a channelling system partially covered by slabs, probably also linked to the water management.

The aim of this poster is to briefly present the first results of an interdisciplinary investigation developed by archaeologists, conservator/restorers and archaeometrists on a set of mortars recovered from the destruction levels of Costa de la Serra site. The samples have been analysed by means of scanning electron microscopy coupled with an energy dispersion X-ray spectroscopy analyzer (SEM-EDX), x-ray diffraction (XRD) and petrographic inspection through thin section analysis (PE). The goal was to determine the composition and method of preparation of these mortars to enable establishing their type and function, prior to undertake the conservation and restoration work. Besides, we intend to highlight the interest of this type of pavement, often underestimated, as well as to emphasize the importance of multidisciplinary teams contributing to the preservation of our heritage.

1. Detail of the tower located at the SW of the fortification and structures related.
2. Cistern located on the upper zone of the site. Consolidation work in progress.
3. Location of the site of Costa de la Serra (La Secuita, Tarragonès).



WHAT DO WE STUDY?

The sample studied represent a set of mortar pavements traditionally called *opus signinum.* However, there is still no agreement about which denomination should be used. In any case, this is an old technique consisting in a mixture of lime, sand, water and powder of tiles or *puzzolana*, giving a reddish aspect to the surface. These pavements are either non decorated or decorated with simple geometric motifs made with colored tiles or marble fragments. In some cases, a layer of red paint is applied to enhance the color of the surface. The main characteristics of such pavements are impermeability, solidity and an insulating nature (Vassal, 2006).
To present, the concept of *opus signinum*, highly controversial in the last years, is falling into disuse. It is now frequent the use of "*mortier de tuileau*" (Vassal, 2015) (tile mortar), which includes the wide variety of mortar types existing in Roman times with the previously explained characteristics.

Different fragments of mortars recovered at Costa de la Serra

SAMPLE

ARCHAEOLOGICAL CONTEXT: Most of the individuals were recovered from stratigraphic layers that backfill the area of the Southern façade tower (**1**) once the settlement is abandoned. Those materials are supposed to be the remains of the domestic area of the garrison officers. Similar remains, from other stratigraphic layers offering the same chronology, were also found backfilling other areas of the site. Those results enable us to infer that the whole settlement was abandoned in the same period.

DESCRIPTION

PAV001

Mortar: made up of ceramic fragments of small size in the upper preparation layer and big size in the lower one.
Surface: no incrustation layer disturbs the visibility of the ceramics included in the upper layer of mortar.

(4 – 5 cm thickness)

PAV002

Mortar: single layer mortar made up of ceramic fragments of different types varying from small to medium size.
Surface: It exhibits areas with incrustation layers. The visible surface is more regular and smooth than PAV001, showing a pinkish base with visible fragments of ceramics.

(4 – 5 cm thickness)

PAV003

Mortar: single layer mortar made up of ceramic fragments of different types and varying size.
Surface: it shows an incrustation layer that partially covers the surface. The visible surface is finer than PAV001 but coarser than PAV002. Similar appearance to PAV001 but showing more heterogeneous size of visible ceramics.

(3.5 – 3.8 cm thickness)

PAV004

Mortar: single layer mortar made up of ceramic fragments of different types varying from medium to big size.
Surface: it shows an incrustation layer that partially covers the surface. This is as fine as PAV002 but showing a greyish color. The visible surface is similar to PAV002 but showing a greyish base. The visible ceramics are clearly bigger than those observed in the previous individuals.

(5 cm thickness)

PAV005

Mortar probably from a cistern.
Mortar: made up of small ceramic fragments very homogeneous in size in the upper preparation layer over a layer having ashes, characteristic of structures for containing liquids.
Surface: it shows few rests of incrustations. The visible surface of this individual can be considered the finest and smoothest of all individuals. It exhibits a pale salmon color without visible ceramic fragments.

(1.5 cm thickness)

PAV006

Mortar: single layer mortar made up of ceramic fragments of different types varying from medium to big size.
Surface: it shows areas of incrustations covering a red, probably painted, layer. Overall, it is a regular, fine and smooth bright red surface with certain medium size ceramics.

(3.5 – 4.5 cm thickness)

PAV007

Mortar probably from a cistern
Mortar: made up of ceramic fragments of small size in the upper preparation layer and big size in the lower one.
Surface: very fine surface of powdery appearance, regular and smooth. The base is greyish with isolated visible ceramic from the upper layer of the mortar.

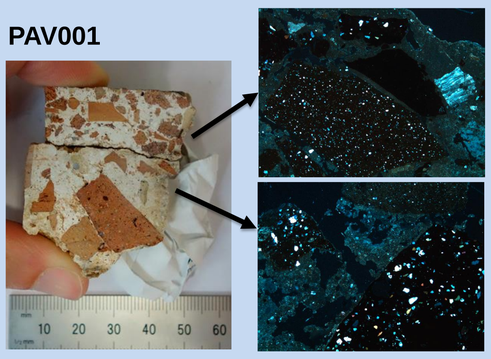
(2 – 2.5 cm thickness)

ANALYSIS

All individuals were prepared for their petrographic inspection through thin section analyses. A Leitz Laborlux 12 Pol (2.5x, 4x, 10x and 40x) microscope was used for the identification and description, on the one hand, of the preparation layers of the mortar pavements; and, on the other hand, for the identification and description of the inclusions present in those layers. Besides, mineralogical characterization was performed by means of XRD with a PANalytical X'Pert PRO MPD powder diffractometer (radius = 240 millimeters), in order to identify the main phases of the mortars (binder, inclusions and possible secondary phases). In situ surfaces of PAV004, 6 and 7 were also examined by XRD. Additionally, SEM-EDX observations were performed on fresh fractures, transverse to the surface, of the mortar matrix and on the actual surfaces of PAV004, 5, 6 and 7 using a Jeol JSM-6510 operating at 20 kV. This study allowed the observation of the microstructure, identification of secondary phases, surface layers and incrustation layers.

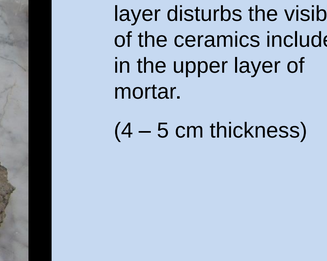
FIRST RESULTS

PAV001

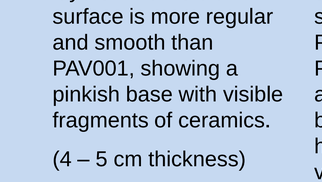


Fabrics	F1 (a, b, c)	F2 (a, b)	F3 (a, b)	F4 (a)
PAV001	a, b, c	a, b	a, b	
PAV002	a	b	b	
PAV003		a	a, b	a
PAV004		a	a	
PAV005		a	a, b	
PAV006	b	a, b	b	a
PAV007	b	a	a, b	

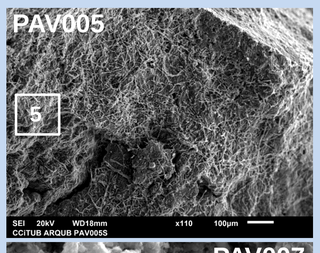
Mineralogical and petrographic analyses point out that all individuals are lime based mortars, showing differences in grain size, without mixing of gypsum or clays. The study also shows that most of the inclusions are fragments of angular ceramics, of assorted composition and varying size, together with other stone aggregates. The ceramics can be classified in four different fabrics (some of them with subfabrics). All mortars exhibit ceramics belonging to more than one fabric and these fabrics are shared by different individuals. Textural and compositional study allows to distinguish differences among the preparation of mortars. While most of them are single layer, PAV001, 5 and 7 exhibit two different layers. The lower one contains larger inclusions in PAV001 and 7, while in PAV005 the lower layer is composed of ashes. Finally, it must be highlighted that individuals PAV005, 6 and 7 exhibit a covering layer in the surface.



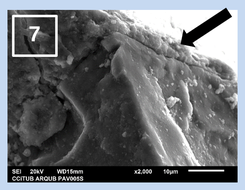
PAV004



Some individuals exhibit incrustation layers (**4**) in the surface. In all cases, the examination reveals that these layers are the result of calcium carbonate precipitation.

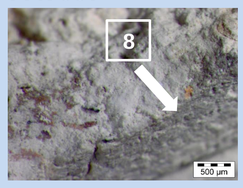


Individuals PAV005 and 7 exhibit trace fossils (**5**, **6**) of ichnotaxa probably produced by phototrophic microborers, possibly calcifying cyanobacteria. These communities easily develop in mortars, the most bioreceptive construction material, under conditions of low light intensities and high relative humidity or with presence of water. Their activity is one active agent of biodeterioration of mortars producing colored patches mainly of biofilms, but also favouring the rise of hard crusts and patinas. Moreover, they also contribute to the mechanical degradation (Ariño and Saiz-Jiménez, 1996; Heindel, Wisshak and Westphal, 2009).

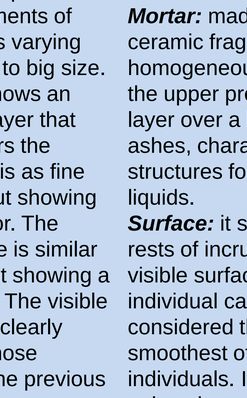


PAV005

PAV007

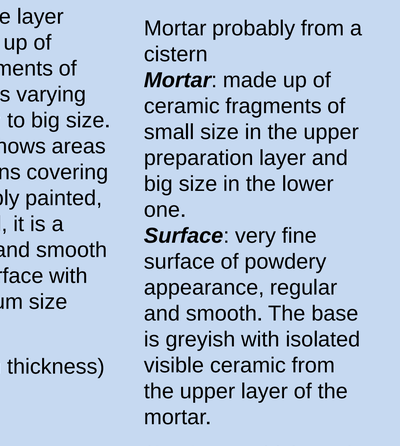


PAV006



The Surface layers of PAV005 (**7**) and 7 (**8**) are just fine layers of calcium carbonate without inclusions. In PAV006 (**9**), the surface layer is hematite (**10**), which provides the red color, mixed with calcium carbonate.

Cal: calcite; Hem: hematite; Qz: quartz; *: unidentified



CONCLUSIONS

Prior to conduct conservation and restoration works, it is compulsory to perform a study to assess the nature and condition of the movable or immovable property of interest. The preliminary results here exposed are part of such study.
Regarding the composition of these hydraulic mortars, we could identify single layer or double layer preparations of lime based mortars mixed with a diversity of ceramic fragments, of different size, together with other stone aggregates. This will shed light on the different techniques employed in their preparation, their similarities and differences. Moreover, regarding the conservation and restoration work, we have identified the composition of concretion layers (PAV002, 3, 4, 5 and 6), the trace fossils of ichnotaxa possibly produced by cyanobacteria (PAV005 and 7) and the identification of calcium carbonate (PAV005 and 7) or hematite (PAV006) superficial layers. All these identifications will help the design of the restoration work. It is also important to highlight that the colonisation of mortars by phototroph cyanobacteria is an event that should take place when the mortars where in situ, in use or already abandoned, most probably in contact with water. These colonies would imply the degradation of walls or floors of these possible cisterns.
The continuation of the present analytical work will help deepening these preliminary results. It will also enable to establish a data base of mortars (their technical traditions and problems) that will serve as a comparative basis in new studies. Finally, it should be pointed out that the success of such studies is only possible through the collaboration of different complementary specialists allowing to conduct an interdisciplinary research.

ACKNOWLEDGEMENTS

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BIBLIOGRAPHY

Arino, X., Saiz-Jimenez, C., 1996. Factors affecting the colonization and distribution of cyanobacteria, algae and lichens in ancient mortars. In: Riederer, J. (Ed.), Proceedings of the Eighth International Congress on Deterioration and Conservation of Stone, Vol. 2. Rathgen-Forschungslabor, Berlin, Germany, 725-731.
Heindel, K., Wisshak, M., Westphal, H., 2009, Microbioerosion in Tahitian reefs: a record of environmental change during the last deglacial sea-level rise (IODP 310), Lethaia, 42, 322-340.
Vassal, V., 2006. Les pavements d'opus signinum: Technique, décor, fonction architecturale. BAR International Series, book 1472, Oxford, England.
Vassal, V., 2015. Techniques et décors des bassins en mortier de tuileau. Atti XII Colloquio AIEMA, Venezia 2012.Scripta Ed.451-457