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Study of historical value mortars

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Abstract

The rehabilitation of buildings, or historic landmarks, has gained in importance over the years. It is increasingly important to safeguard the cultural identity and history of a country. In this research the mortars of the Roman city of Conimbriga were studied, being one of the oldest archaeological cities in Portugal. Conímbriga has its origin in a Celtic Castro of the tribe of the Conii, at the end of the Iron Age. It was occupied by the Romans from 139 BC. It was under the Emperor Augustus Empire, in the second century AD, that the city achieved its splendor, having then been built public baths and a Forum. With the decline of the Empire, in the late fourth century, a monumental defensive wall was erected, which did not prevent the assault of the city by the Suevi, in 468, and the consequent decline of the city. Large excavations carried out throughout the 20th century revealed a valuable and complex set of buildings, including thermal baths, an aqueduct that runs more than 3,400 meters from the source, and remains of a Christian basilica, probably from the 6th century. In this type of rehabilitation works the use of mortars was predominant, hence the importance of their study to know how they behave. In order for a rehabilitation intervention to be successful it is necessary to know the existing support in place to guarantee the compatibility of the materials. It was necessary to go "in situ" to collect the samples with the proper authorization of the Museum of Conimbriga. These mortar samples were analyzed and characterized by scanning electron microscopy (SEM) for further analysis. The composition of the samples will allow to adjust dosages and to choose a restoration mortar, as close as possible, to the one that was collected in order to preserve the maximum historical identity of the place.

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Keywords: Mortars, SEM characterization, history, Conimbriga.

1. Introduction

In Portugal, the Roman Empire brought the development and handling of lime in construction, and raised mortars and their potential to a higher level of understanding. The invasion of the Iberian Peninsula by the Arabs, brought new concepts and additives allowing applications in interiors and exteriors that are still used in current times.

In this work ancient mortars were collected "in situ" and records of the characteristics and possible pathologies of this type of mortar were created along with information about their physical, chemical and mineralogical constitution.

2. Case study

The studied samples were collected in the county and parish of Condeixa-a-Nova, place of Condeixa-a-Velha, Conímbriga, which is the largest and best preserved Roman archaeological station in Portugal.

It borders to the south by the Moorish river, to the north by a valley and the source by the extensive forest of Bufarda. Conimbriga is currently recognized as a national monument, defined by decree in 1910. See fig.1.

Table 1 shows the collected samples localization in Conimbriga city.

Fig.1 - Aerial view and redesign of Pedro Alarcão and Virgílio H. Correia, from Conimbriga.

Table 1- Localization of the collected Conimbriga samples

Amostra	Sample nº	Tipo de amostra	Localização		Cronologia
A1		Argamassa à superficie	Gruta superior do Morgado		7000 - 700 AC
A2	9	Painted surface mortar	Conimbriga	Room of the deer hunt in the house of the fountains	II c. AD or early to mid- IIIc.
A3	8	Surface mortar		Vestibule of the house of the fountains	II c. AD or early to mid- IIIc.
A4	11	Foundation mortar		Building in sector G17 (exc. 2016)	III – IV c. AD (?)
A5	5	Surface opus signinum		South Baths natatio	Flavio-trajanic period (c. 80-100 AD)
A6	12	Painted surface mortar		Building in sector G17 (exc. 2016)	III – IV c. AD (?)

3. Results and Discussion

3.1 Petrographic Analysis

The sample was collected at a Conimbriga swimming pool, South Baths, sample number 5. It consists of brick and quartz fragments, but also contains traces of muscovite, calcite, and potassium and chalcosodic feldspars.The binder consists of clay minerals and micritic calcite (particle size less than 5 µm).The brick fragments are essentially made up of quartz, muscovite, tourmaline and calcite. The petrographic analysis may be seen in Fig. 2.

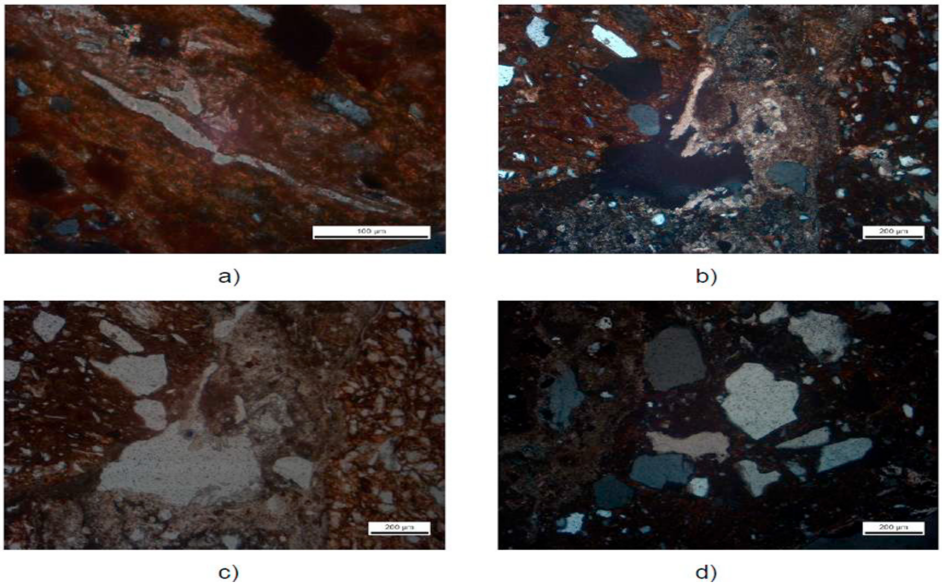

Fig.2 – Petrographic analysis of sample 5.

All fragments are angular in shape. The brick binder is made of clay minerals closely associated with micritic calcite and iron hydroxides.

3.2 SEM Analysis

Images were collected at 250x magnification. Looking at the shape, it appears that the sample is relatively heterogeneous, with smaller particles being rounded and larger particles being mostly trapezoidal and pointed, the size differences between larger and smaller particles are not considerable. .

Both photomicrographs show that the material is found to be slightly heterogeneous, with the smallest particles being around 20 µm and the largest being around 200 µm.

These results may be observed in Fig.3.

Amostra 5		
Características	Tipo	Heterogénea
	Forma	Arredondadas (particulas menores);
	Dimensão média	
	Dimensão mínima	20 µm
	Dimensão máxima	200 µm
	Ampliação	250 X

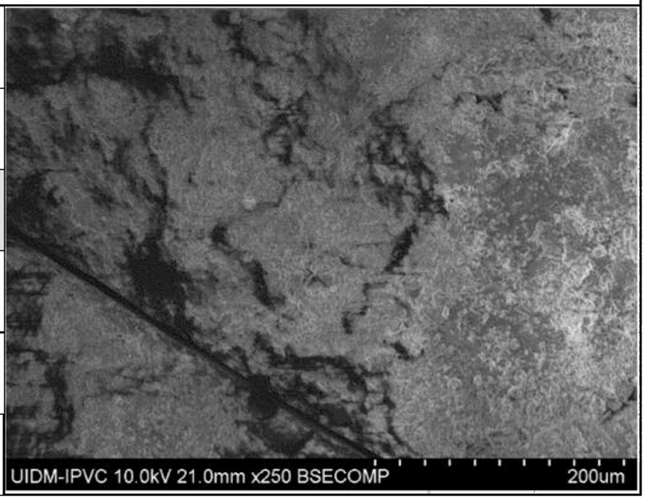

Fig. 3 – Conimbriga mortar (sample 5), SEM observation, 250xmagnification.

3.3 EDS and WDS Analysis

Table 2 shows sample 5 EDS and WDS analysis for sample 5. It may be seen that the mortar is mainly constituted by silicon, calcium, aluminum and magnesium (about 25,6%) with traces of sodium and phosphorous. Note that elements like sulfurous, carbon and oxygen are not detected.

Table 2 – Sample 5, EDS and WDS results.

Element (%)	Si	Ca	Al	Mg	Na	P
Sample 5.1	6,635	16,646	1,455	0,386	-	0.392
Sample 5.2	4,372	12,148	1,473	0,473	0,510	0,187

4. Conclusions

The records of elders provide valuable insights into the old fabrication of the materials which was an important support in the elaboration of the thesis. In the old mortars found in Portugal, vast diversity of compositions presented lime as main binding.

Traces of Sodium and Phosphorus were probably marked by the presence of salt pans in the place.

The composition of the fragments is basically constituted by quartz and "brick" (remains of quartz, moscovite, tourmaline and calcite, possibly correspondent to an older mortar, reused as an inert in the new one).

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