Materials Characterization 146 (2018) 189–203

Contents lists available at ScienceDirect

Materials Characterization

journal homepage: www.elsevier.com/locate/matchar

New compositional data on ancient mortars and plasters from Pompeii (Campania – Southern Italy): Archaeometric results and considerations about their time evolution

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ARTICLE INFO

Keywords:
Cocciopesto
Lavapesta
Lime
Constructive phases
Production technology

ABSTRACT

Twenty-six samples of mortar used for various construction applications (joint mortars, floor mortars, filling mortars and plasters) were collected from different areas of the archaeological site of Pompeii (Campania - Sothern Italy). The mortar samples belong to various historical periods covering approximately 2000 years, from the 2nd century BC to the post excavation period (18–19th century). The samples were characterized employing Optical Microscopy (OM), X-ray Powder Diffraction (XRPD), X-ray Fluorescence (XRF), Electron Probe Micro Analysis (EPMA) and Raman Spectroscopy. Moreover, image analysis was carried out using JMicroVision software in order to determine the percentages of binder, macropores and aggregate, in terms of crushed ceramic fragments (cocciopesto), rock fragments and monocrystals.

The application of these techniques allowed obtaining a complete chemical and minero-petrographic characterization of the samples, which may prove useful for preparing compatible repair mortars for future restoration works. The archaeometric study provided new data on the production technology of the mortars and the analogies and differences observed among the samples, enabled us to distinguish different constructive phases, thus confirming or rebutting the archaeological hypothesis on the dating of some samples. By combining compositional variables through the discriminant analysis, it was also possible to analyse the time evolution of the materials and to construct preliminary multivariate statistical models, helpful to identify the various typologies of mortars used in the different historical periods.

1. Introduction

Mortars are very complex artificial stone materials and, in the historical tradition, a lot of recipes that regard their manufacturing are present [1,2]. The production of mortars is linked to the technological know-how of the manufacturer who prepared them, while their composition largely depends on the raw materials located in the area in which the mortars are prepared, although in some cases, the raw materials may be brought from very far away [3].

The archaeometric study of mortars, which focuses on their chemical and minero-petrographic characterization, enables us to identify the raw materials used and their provenance, to recognize the manufacturing footprint of ancient builders and to discriminate the constructive phases of the buildings and/or the archaeological sites under study [4–23]. The data obtained may also useful for preparing compatible mortars for restoration works [24,25], which can be made with a mixing system based on optimization software [26,27].

This study is part of the agreement signed in 2015 between the University of Calabria and the Archaeological Park of Pompeii with the Applied Research Laboratory. The work concerns the characterization of 26 samples of mortars used for different building applications, which were sampled in different areas of the city and belong to various historical periods. The aim of this study is to identify compositional analogies and differences among the mortars sampled in the same area and

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https://doi.org/10.1016/j.matchar.2018.09.046
Received 18 July 2018; Received in revised form 26 September 2018; Accepted 28 September 2018
Available online 02 October 2018
1044-5803/

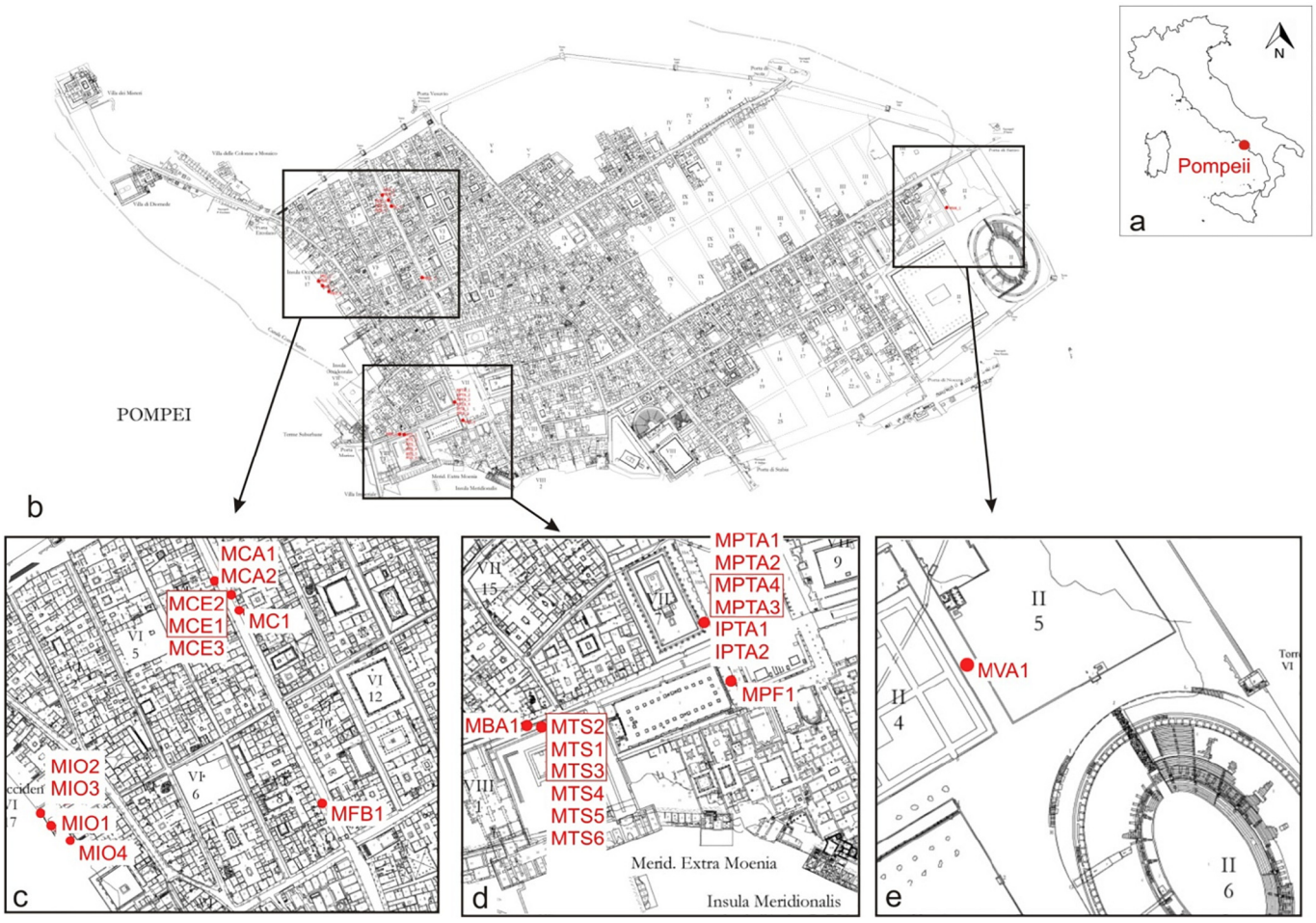

Fig. 1. a) Location of Pompeii in Southern Italy. b) Sketch map of Pompeii with the sampled areas. c) Insula Occidentalis (Regio VI) with sampling points. d) West Portico of the Forum, northern terrace and Via Marina, with sampling points. e) Amphitheatre alley with sampling point. Mortars in red rectangles were sampled in stratigraphic succession. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

belonging to the same constructive typology (joint mortars, floor mortars, filling mortars and plasters) and to verify, using a statistic approach, the existence of compositional differences related to time evolution, in order to examine the possibility of building a preliminary model, based on compositional variables, which may prove useful for distinguishing the mortars used in different historical periods.

The city of Pompeii, located in Southern Italy (Fig. 1a), was discovered in the mid-1700s as part of an excavation program started at the behest of the Bourbon dynasty. The city was situated on the southern slope of Mount Vesuvius, near the sea, in the River Sarno valley, on a plateau produced by a prehistoric lava flow [28,29]. The area, which had been inhabited since the Middle and Recent Neolithic Age [30,31], was under Etruscan rule from the late 7th to the early 6th century BCE. Following the battle of Cumae, in 474 BCE, the area came under Greek domination and later passed under the control of the Samnites. In the 4th century BCE Pompeii came under the domination of Rome, which led to a significant growth of the city until 62 CE when Vesuvius erupted destroying most of the city. Pompeii was then reconstructed, but in 79 CE an eruption completely destroyed the city burying it under tons of ash and lava [32–34]. Pompeii is one of the Roman cities to be preserved in such an exceptional way, as it was buried by the volcanic eruption in 79 CE, for this reason the site offers a complete picture of a Roman town in the first century CE in all its facets: urban, architectural and decorative mansories, wall paintings and mosaics.

2. Materials and Methods

The twenty-six samples of ancient mortars were taken from different areas of the archaeological site (Table 1 and Fig. 1b): the Regio VI in the Insula Occidentalis (Fig. 1c - samples MIO) and in the Mercury street (Fig. 1c- samples MFB1, MCA, MCE and MC1); the West Portico of the Forum, in front of the Basilica (Fig. 1d - sample MPF1) and in the Temple of Apollo (Fig. 1d - samples MPTA and IPTA); the northern terrace behind the Temple of Venus (Fig. 1d - samples MTS); Via Marina (Fig. 1d- sample MBA1) and Amphitheatre alley (Fig. 1e). The samples belong to different historical periods (Table 1) ranging from the 2nd century BCE to the Borbone's age (18th century), according to probable dating defined by the experts who supported the sampling.

The sampled mortars have different constructive functions and were therefore classified as: joint mortars (used for joining bricks or stones together); preparatory floor mortars (used to make the preparatory layer [rudus] of a floor); floor mortars (used as a finishing layer for floors/pavements); filling mortars (used to fill gaps or holes) and plasters (used to finish vertical surfaces). More specifically, the following mortars were sampled: 9 joint mortars, 3 preparatory floor mortars, 7 floor mortars, 1 filling mortar and 6 plasters (Table 1). Examples of sampling are in Fig. 2, where are shown the joint mortar MFB1 collected in a probable cesspool (Fig. 2a), the plaster MCA1 and the joint mortar MCA2 sampled, in stratigraphy, in correspondence of a drainpipe (Fig. 2b) and plasters IPTA1 and IPTA2 sampled from two wells (Fig. 2c, d).

The floor mortars are composed of two types of aggregate: