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Original article

Technological and microstructural characterization of mortars and plasters from the Roman site of Qasr Azraq, in Jordan

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ABSTRACT

This work presents the analytical results of the mortars and plasters characterization from Qasr Azraq, located in the city of Azraq (north-eastern Jordan). The castle has undergone several interventions and modifications during its service life; the archaeological surveys have shown that the actual building is a medieval reconstruction of a Roman fort, still reflecting the original structure. This research paper encompasses 64 samples from different historical periods and structures of the monument, aiming to reconstruct the timeline of different phases and to highlight technological choices. Conclusions are drawn on the basis of interpretation and integration of in situ observations, historical data and analytical data. The mortars were characterized following a multidisciplinary approach, combining macroscopic observation with petrographic examination, mineralogical analysis (XRD), microstructural and chemical analysis (SEM-EDS) and quasi-quantitative chemical analysis (pXRF) of mortar samples. Moreover, microstructural and mechanical properties of representative samples were studied. The results indicate the use of five different types of mortars, grouped based on composition and characteristics of binder and aggregates, ranging from pure lime mortars to hydraulic, gypsum-lime and earthen mortars. Overall, this paper contributes to the better understanding of building techniques and mortar production technology in the Near East during time.

1. Introduction

Qasr Azraq is a Roman castle found in the north-east of Jordan, in the major oasis of the region (Figs. 1 and 2). The main archaeological studies of the site are attributed to the extended archaeological survey conducted by Kennedy in 1982 onwards and the excavations carried out by the Department of Antiquities between 1977–2008, the best documented being the excavation directed by Ahmad Lash in 2008 [1–4]. From these previous studies, it is evident that the actual building was a Roman fort that has undergone important rebuilding and modifications.

The aim of this paper is to elucidate the technological properties of different types of mortars and plasters historically used at Qasr Azraq, to reconstruct the stratigraphy of the different phases and, when possible, to understand the dating of the different phases or interventions. Overall, the paper underlines the selective use of different raw materials for mortars production by different occupants of the castle and contributes to the wider repository of technological data on mortars and building technology of architectural monuments in the Arabic area. Moreover, this paper presents a methodological approach for grouping and studying the technological features of a large amount of mortar samples.

1.1. Historic introduction

Originally, the castle was part of the strong military presence on the defended border which characterized the eastern provinces during the Severian period and intensified under the Tetrarchy, during the 3rd century [5]. The earliest certain date for the Roman occupation of the oasis is related to Septimio Severus (193–211 AD); however, there is no evidence that directly relates the building to this period and the oldest certain date of the site is given by inscriptions found *in loco* dedicated to Diocletian and Maximilian (287–305 AD) [3]. Another inscription dedicated to Constantine provides evidence of building refurbishment during the beginning of the Byzantine period [1,6–8]. During the 5th century AD there is no evidence of occupation at Azraq, this can be the result of a period of relative peace with the Persian, as well as of a new

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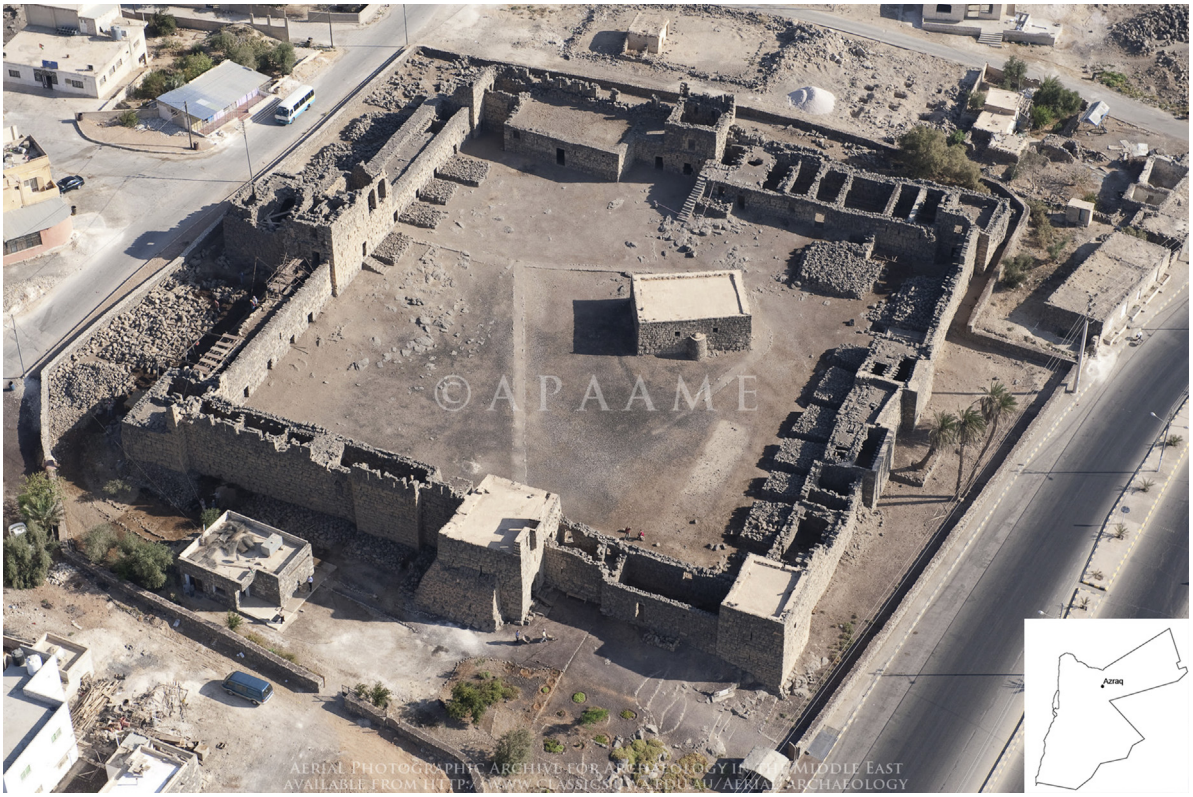

Fig. 1. Aerial photography of the castle of Azraq (After APAAME [62]).

Fig. 2. Photogrammetry of the external walls of Azraq castle: a: northern external elevation; b: western external elevation; c: southern external elevation; d: eastern external elevation. Parts that it was not possible to process in grey. Photogrammetry: Marta Tenconi.

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