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An infrared microspectroscopic study of plasters and pigments from the Neolithic site of Bestansur, Iraq

Jessica Godleman [a], Matthew J. Almond [a,*], Wendy Matthews [b]

[a] Department of Chemistry, University of Reading, Whiteknights, Reading RG6 6AD, United Kingdom
[b] Department of Archaeology, University of Reading, Whiteknights, Reading RG6 6AA, United Kingdom

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ABSTRACT

Infrared (IR) spectroscopy and microspectroscopy (μ-IR) supported by environmental scanning electron microscope–energy dispersive X-ray analysis (ESEM-EDX) has been utilised to investigate the technology and use of multi-coloured architectural plasters and pigments by Neolithic communities at the archaeological site of Bestansur, Iraq, c. 7600 BCE. Sub-samples of architectural materials and pigments were analysed using IR spectroscopy and fragile samples and thin sections were analysed using μ-IR and ESEM-EDX to determine the mineralogical and elemental composition of individual components and layers and the history of construction and use of three large rectilinear buildings.

In addition, experimental investigations were undertaken into the application of IR to study the firing of calcium carbonate and of clays to investigate if this technique was able to detect evidence of fired-lime materials and of reddening of building materials by fire. Whilst the IR analysis alone was not able to characterise the plasters and pigments, when combined with ESEM-EDX the minerals responsible for pigmentation in the samples were clearly identified. The green clay was determined to be local celadonite-bearing marine clays. The red pigment was found to contain iron, most likely in the form of hematite. The black pigment contained manganese and iron, likely to be present as manganese dioxide and magnetite. The investigations of firing indicate that a hard white exterior may come from fired-lime while a reddish silty clay wall surface had probably not been subject to high-temperature burning.

Analysis of a series of wall plasters and pigments from Building 8 (pre-7600 BCE) revealed experiment and development in technologies and materials throughout the occupation of the building, which in the final sequence resemble those from significantly later level at the site of Çatalhöyük, Turkey (c. 7000 BCE).

1. Introduction

Micro-analyses have been widely applied in studies of historic and Classical building materials and art (Damiani et al., 2003; Duran et al., 2010; Gliozzo et al., 2012; Miriello et al., 2011, 2015) and are increasingly being applied to the study of earlier archaeological building materials and pigments (Anderson et al., 2014a, 2014b; Regev et al., 2010a, 2010b) although there is scope for much wider application to these (Weiner, 2010). The great strengths of micro-analyses of intact samples are that they enable integrated high-resolution characterisation of the microstructure, composition and sequence of specific architectural components and materials as well as post-depositional alterations and features (Matthews et al., 2013). These data are vital to examination of the source materials and manufacture of architectural materials as well as for studies of their value and significance. This information can be determined according to where such materials were obtained from, the skill level required to produce them, and how spatially and temporally they were placed within a building to create particular settings for social, cultural and political interactions. The aim in this paper is to apply IR and ESEM-EDX analyses to examine the composition, technology and use of architectural materials in one of the heartlands of early built environments and agriculture, the Zagros region, at the site of Bestansur, Iraq, c. 7660 BCE.

Some of the earliest architecture in the world was constructed during the Natufian period from 12,500 to 9500 BCE. The earliest buildings were circular and constructed from a dry stone foundation with the superstructure composed of brushwood. The Natufian communities are thought to be ancestors of the first builders of the Neolithic age which showed a great advance in the architectural technologies during the transition from mobile hunting-gathering to more sedentary agriculture. From c. 8500–7500 BCE there was a major shift in building from circular to rectilinear architectural structures across this region, suggesting considerable knowledge transfer in architectural technology as well as early domesticated plants, animals and other material artefacts (Zeder, 2009).The Zagros mountain chain and foothills of Iran and Iraq were one of the regions inhabited by wild species that were later domesticated in the Early Holocene, notably wild goat and barley which

* Corresponding author.

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provided a sustainable basis for more year round settlement (Zeder, 2009). Although some of the earliest scientific investigations into the origins of agriculture and sedentary communities architecture were undertaken in the Zagros piedmont and highlands in Iran and Iraq in the 1960s–70s (Braidwood et al., 1983; Hole et al., 1969; Smith, 1990), it is only recently that the importance of this region in these major transformations to more sedentary agricultural lifeways has been re-emphasised due to renewed excavations and fieldwork (Matthews and Fazeli, 2013).

The aim of one of these projects; the Central Zagros Archaeological Project (CZAP) is to investigate early Neolithic resource management and sedentism at four sites in the Zagros to study local and regional variation in strategies and interaction between piedmont and highland zones (Matthews et al., in press). This major project is co-directed by the University of Reading, the Department of Antiquities and Heritage Sulaimaniyah - Iran's Cultural Heritage Handicraft and Tourist Organisation and Bu Ali Sina University. The four Neolithic sites investigated span c. 9800–6000 BCE, and comprise Bestansur and Shimshara in the piedmont zone in Iraq and Sheikh-e-Abad and Jani in highland Iran. The research in this paper focuses upon samples of architectural materials and pigments from Bestansur, c. 7660 cal BCE – a site which has yielded intact Neolithic objects across an area of at least 100 × 50 m (Richardson, 2014). Five seasons of excavation have been undertaken at this site and a map showing the location of trenches is given in Fig. 2. The samples whose analysis is described in this paper were all taken from two trenches (Trenches 1 and 10, Fig. 2). (See Fig. 1.)

Those samples from Trench 10 were selected from two large buildings with plastered walls showing pigments and paints – Building 5 and Building 8 (see Fig. 6). Building 8 has been dated to pre-7600 BCE while Building 5 was constructed on top of Building 8 and is dated to c. 7600 BCE. The older Building 8 was constructed from boat-shaped mudbricks in walls coated with multiple layers of green, grey, brown and white plasters and washes and red pigmented wall painting in decoration. The later stages of decoration in Building 8 are not dissimilar to those seen at the more recent, internationally-renowned World Heritage site of Çatalhöyük in Turkey. The later Building 5 was constructed from rammed earth (pisé) architecture with more minimal plastering and decoration although fragments of red pigment and wall-painting

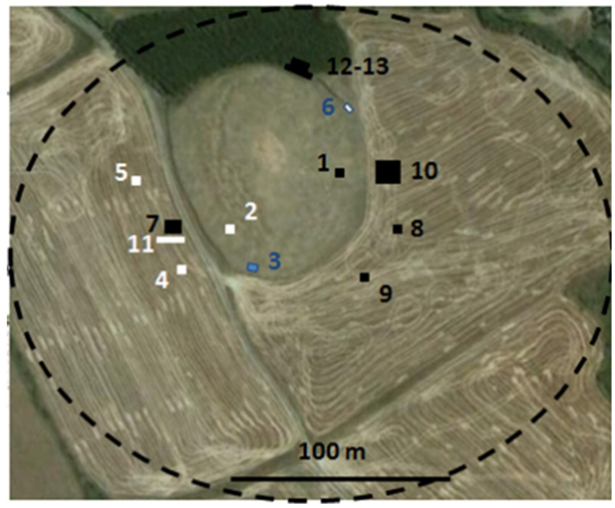

Fig. 2. Aerial photograph of the mound at Bestansur, Iraq showing the position of trenches. The samples whose analysis is described in this paper were selected from Trenches 1 and 10.

have been found. >28 humans were buried, largely below the floors in a large room of this building labelled as Space 50 (Fig. 6).

The aim of the research described in this paper was to answer some specific questions concerning composition and use of plasters and pigments from these three buildings using infrared microspectroscopy supported by environmental scanning electron microscopy energy dispersive X-ray analysis (ESEM-EDX) where appropriate. The specific questions to be addressed were as follows.

Trench 1. Building 2:

i. Can evidence be found that clays found in walls of buildings in this trench have been heated e.g. by burning?

Trench 10. Building 5:

i. Is there any evidence that the hard whitish plasters at the front entrance of the building were made from fired lime i.e. $CaCO_3$

Fig. 1. Location of sites being investigated within the Central Zagros Archaeological Project (CZAP).