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Sedimentary processes involved in mud brick degradation in temperate environments: a micromorphological approach in an ethnoarchaeological context in northern Greece

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ABSTRACT

Sun dried mud bricks are a common building material across the globe, found in many archaeological sites in the Old World since ca. 11,000 years ago. This material is known to disintegrate due to exposure to the elements, mostly affected by rain. Yet, the geomorphic and sedimentological characteristics of this disintegration process have never been studied in detail until recently. Here we report on mud brick degradation processes observed in an abandoned mud brick village in northern Greece. We demonstrate that mud bricks have unique micromorphological characteristics that differentiate them from natural soils. Upon degradation some of these characteristics are lost (e.g., planar voids after fibrous vegetal temper). Rain initiates brick degradation at the upper parts of walls where from brick material is washed down walls and deposited at their feet, forming a conical talus. The talus deposits show micromorphological features indicative of a variety of flows, including wet and dry grain flows, debris, hyperconcentrated and water flows. These flows seem to operate simultaneously across small distances. These talus deposits are different micromorphologically from natural soils thus their characteristics can be used to identify degraded mud brick material in archaeological sites. This, in turn, may help identify the location of long degraded mud brick walls (in the absence of stone foundations) and identify the relationship between house floors and degraded infill that accumulated on floors following wall degradation. A comparison between the current observations with a previous study we conducted in an abandoned mud brick house in arid southern Israel, illustrates the generality of these low energy slope processes in mud brick degradation, which emphasizes the worldwide applicability of the processes identified in this study.

1. Introduction

Building with mud, a worldwide construction technique, prevails from the early Neolithic until modern times. The current study is situated within the broad geographical area where building with mud in the past resulted in the formation of mound sites (also known as *tells*), found from the Balkans in the northwest to India in the southeast (Rosen, 1986). Within this wide geographical area, human use of (mud constructed) space has been extensively studied (e.g., Parker and Foster, 2012; Rainville, 2005). However, degradation of such mud structures, where ancient activities took place, is not well studied. We contend that understanding archaeological domestic mud constructed contexts must take into account both human use of space and how it is affected by mud wall degradation. The importance of studying mud wall degradation lies in it being a source of archaeological infill sediments. Identifying and distinguishing between various archaeological infill sediments which include earth building materials such as mud bricks, beaten earth floors and mud plastered roofs, is not an easy or straightforward task. During excavation, the identification of mud brick material is mostly based on brick shape, if preserved, and the presence of straw or elongated voids indicative of straw temper that was added during mud brick production (Goldberg, 1979; Rosen, 1986). In most archaeological contexts mud bricks do not preserve in their original shape (unless fired, see Homsher, 2012) and may lose their

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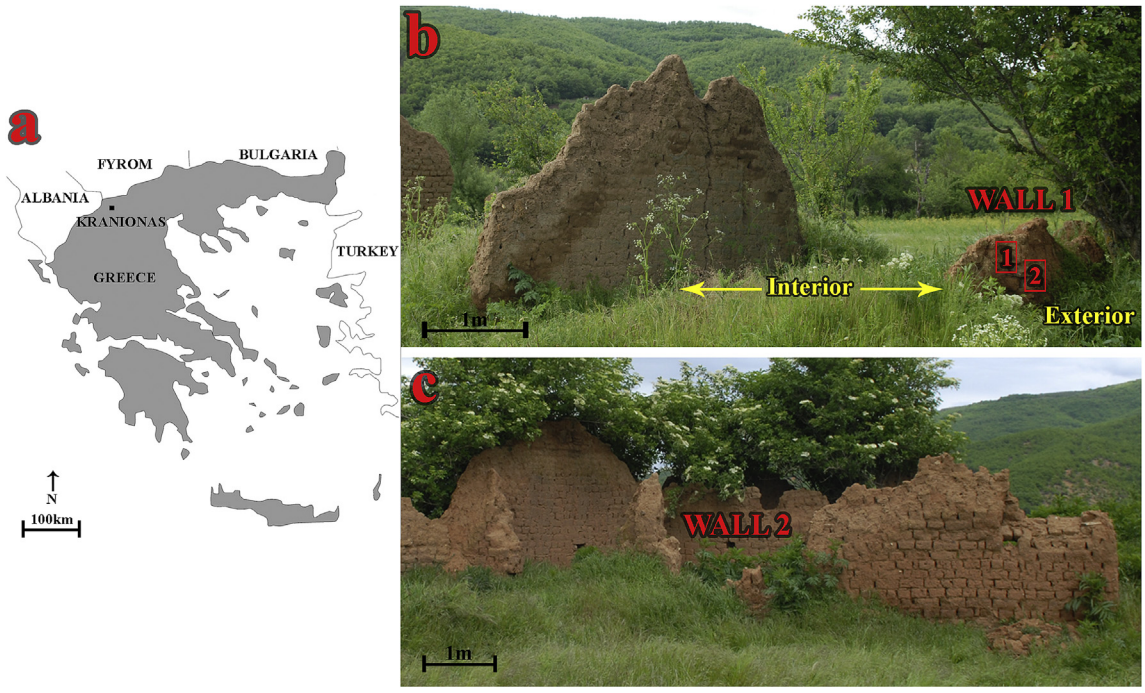

Fig. 1. The study area. (a) Map of Greece showing the location of Kranionas. (b) The abandoned barn where Wall 1 was trenched and sampled. The interior of the barn is marked, as well as the area outside it, to the west. Boxes 1 and 2 indicate the location where intact preserved mud bricks were sampled as reference material. (c) The burnt-down barn where a trench was excavated from its center to the face of Wall 2.

indicative elongated voids due to degradation processes (Friesem et al., 2011).

The few studies which addressed the issue of mud brick degradation focused on ethnoarchaeological abandoned contexts where a range of degradation stages, from full preservation to complete decay, can be more easily observed (Friesem et al., 2011; Goodman-Elgar, 2008; Koulidou, 1998; McIntosh, 1974, 1977). In his work in Ghana, McIntosh (1974, 1977) did not apply any microscopic analysis and based his insights on excavation and field observations within a modern village and an archaeological site. Koulidou (1998) investigated depositional patterns of mud wall degradation in two abandoned pre-modern mud structures in Northern Greece. She identified a reduction in grain sizes from the wall towards the center of the studied rooms. Goodman-Elgar (2008) studied degradation processes in abandoned earthen dwellings in Bolivia through micromorphological analysis. She highlighted the difficulty to identify degraded mud bricks due to post-depositional processes such as bioturbation (Goodman-Elgar, 2008). Overall, these pioneering studies did not supply unequivocal criteria for identification of archaeological infill sediments that originate from degraded mud bricks.

More recently, some of us studied the degradation processes of mud brick walls in a pre-modern abandoned mud brick house in an arid environment in southern Israel by employing several geoarchaeological methods (Fourier-transform infrared spectroscopy, X-ray fluorescence and micromorphology; Friesem et al., 2011). Due to the nature of the study area, which is surrounded by shifting sand dunes, we were able to identify three types of infill sediments that accumulated within the abandoned house: wind-blown sand, mud slurries from degrading mud brick walls, and mixtures between wind-blown sand and mud slurries. Micromorphology allowed us to pinpoint mud flow as the general mechanism that operates in degradation of mud bricks and infilling of abandoned mud brick houses. In addition, we noted that vegetal temper or its typical pseudomorphic voids (c.f., Goldberg, 1979) are absent in degraded mud brick material. The color, texture and mineralogical differences between the wind-blown sands and mud slurries were so clear (in the specific context studied; see for example Fig. 4 in Friesem et al., 2011) that identifying mud brick material in similar environments is relatively easy. This is clearly not the situation in most other areas of the world, where wind-blown sand or dust are not so voluminous, and it is still highly difficult to differentiate degraded mud brick material from local soils, as pointed out by Goodman-Elgar (2008). We therefore carried out another geo-ethnoarchaeological study in a region of temperate climate where the amount of wind-blown dust is negligible and amount of rain is higher than in southern Israel. This allowed us to test the generality of the processes identified in the arid environment, and to refine the understanding about the mechanism of formation of degraded mud brick (infill) sediments.

Here we present a study focusing on mud brick degradation processes in two pre-modern abandoned mud structures in northern Greece. The main objective of this study is to identify and describe the geomorphological and sedimentary processes involved in mud structure degradation in order to supply criteria for identification of degraded mud brick sediments. The ultimate goal of this study is to distinguish archaeological infill sediments resulting from mud wall decay, from earthen floors, and from regional soils.

2. The study area

The study took place in the village of Kranionas, located 12 km northwest of Kastoria, at 817 m above sea level (Fig. 1a). Average annual precipitation is around 700 mm spreading relatively evenly along the year, with ca. 50–80 mm per month during fall, winter and spring, and ca. 25–40 mm per month during the summer. The mean annual temperature is 12 °C but may be as low as −22 °C during the winter, with 30–100 days of snow and 80 days of frost per year.