Made from Mud: Functional Categorization and Analyses of Bronze Age Earthen Materials from Western Turkey

Jana Mokrišová – Christopher H. Roosevelt – Christina Luke – Caitilin R. O'Grady

ABSTRACT
This contribution presents the results of a pilot study of earthen materials excavated at the Middle to Late Bronze Age site of Kaymakçı, located in western Anatolia. It argues that systematic collection and analysis of fragmentary and difficult-to-identify earthen materials is challenging, yet crucial. These materials inform on activities of which traces are preserved in the archaeological record but which have been largely under-researched. Flourishing studies on earthen findings foreground architectural materials, such as mudbrick, and well-preserved features and objects. However, earthen objects and architectural features were utilized more widely than in building architecture and only a small portion of excavated sites has good preservation. We, therefore, present the different categories of earthen materials discovered at Kaymakçı, specifically architecture, installations, and portable items. Our work demonstrates that by incorporating new knowledge of archaeological remains at the site and re-studying the earthen assemblage it is possible to gain a better understanding of the morphological, functional, and social aspects of this dataset.

KEYWORDS
Late Bronze Age; western Anatolia; Kaymakçı; architecture; mudbrick; earthen materials.

INTRODUCTION

Studies of earthen architecture and earthen features of the built environment in the Bronze Age and later periods in the eastern Mediterranean have multiplied since the 1980s and accelerated in recent years (e.g., Jerome 1991; Shell 1997; Nodarou – Frederick – Hein 2008; Sauvage 2008; Mielke 2009; Homsher 2012; Costi de Castrillo – Philokyprou – Ioannou 2017; Devolder – Lorenzon 2019). A focus on extant features, such as mudbricks and wattle and daub construction from the Middle East, Egypt, Anatolia, and the Aegean allowed for development and improvement of existing analytical methods and insights into the technical, environmental, and cultural milieu of ancient communities (e.g., Guest-Papamanoli 1978; French 1984; Rosen 1986; Emery – Morgenstein 2007; Nodarou – Frederick – Hein 2008; Love 2012; 2013; Rosenstock 2009; Lorenzon – Iacovou 2019). Studies of the processes of formation and degradation of Mediterranean mudbrick architecture have also increased in the past few decades (e.g., Shaffer 1993; Stevanovic 1997; Friesem *et al.* 2011; Friesem – Karkanas – Tsartisidou 2014; Forget *et al.* 2015; Peinetti *et al.* 2017; Cammas 2018). Moreover, new work on fragmentary building materials and features have now supplemented the dataset (Avrami – Guillaud – Hardy eds. 2008; Claasz Coockson 2010; Jazwa forthcoming). Together, this research has shed unprecedented light on earthen architecture and placed it at the center of holistic research combining archaeological, architectural, and scientific approaches.

Despite such gains, at least two significant gaps in research remain. First, published contributions tend to discuss well-preserved examples and almost complete architectural features. Only a small portion of excavated sites can boast conditions ideal for the preservation of features and objects made from earth, and such a situation is uncommon to most archaeological sites. Second, publications focus predominantly on mudbrick from architectural contexts. This trend is understandable because excavations of mudbrick architecture have highlighted its important role in vernacular traditions of the eastern Mediterranean and the Levant since the Neolithic period (e.g., Aurenche 1981). Moreover, this is in part due to the long-acknowledged difficulty of identifying earthen materials in their secondary and tertiary contexts (Goldberg – Macphail 2006, 227, 279, 283; Cammas 2018). Yet, features and objects made from a mixture of sand, clay, silt, and organic and inorganic aggregates were utilized more widely than in building architecture. Hearths, ovens, linings, containers, trays, and other items were also made in similar materials. Such features and objects propose challenges for archaeologists, because their remains are often preserved in only limited traces, and their identification is ever more difficult owing to a lack of published comparative examples, in contrast to the growing body of literature on mudbrick architecture.

This article tackles this combined problem and addresses the most common preservation scenarios – that of very fragmented archaeological remains with only a few well-preserved diagnostics – by presenting a range of earthen features and objects. These include, but are not limited to, mudbrick from the Middle to Late Bronze Age site of Kaymakçı in western Turkey. We argue that systematic collection and analysis of fragmentary and difficult-to-identify earthen materials is challenging yet very rewarding because it informs on activities of which traces are preserved in the archaeological record but which have been largely understudied, if not wholly ignored. In short, we stress the importance of thorough study of all types of excavated materials collected in a systematic manner.

Excavations at Kaymakçı started in 2014. Since then, our team has documented a varied range of earthen features. In excavations between 2014 and 2018, 364 samples of earthen materials were recovered, demonstrating that the mixture of sand, silt, clay, and organic and inorganic temper created malleable utilitarian materials abundant across the site. Such mixtures were used not only in the construction of buildings, but also in the manufacture of a range of features of both utilitarian and aesthetic value. Indeed, while extant mudbrick architecture at Kaymakçı is limited, the abundance of earthen features such as fragmentary hearths, ovens, and trays attest to the application of the material in broader contexts. In what follows, we present an overview of the different categories of structural and utilitarian earthen features and objects found at the site.

KAYMAKÇI: THE ARCHAEOLOGICAL CONTEXT

The archaeological site of Kaymakçı is located in the middle Gediz River valley in western Anatolia, modern Turkey, on a ridge above the western edge of Lake Marmara (the ancient Gygaean Lake or Lake Coloe) (**Fig. 1**). The site was discovered during a regional survey in 2001 and studied intensively in subsequent surveys between 2006 and 2013; excavations began in 2014 (Roosevelt *et al.* 2018; see also Roosevelt – Luke 2008; 2009; 2010; 2011; 2012; 2013; Luke – Roosevelt 2009; Roosevelt *et al.* 2014; Roosevelt – Luke – Sekedat 2016).[1] Earthen architectural remains from ancient and modern times have been investigated within the scope

1 The Kaymakçı Archaeological Project (KAP) is a part of Gygaia Projects, a research collaboration directed by Christina Luke and Christopher H. Roosevelt that promotes archaeological research, sustainable management of cultural and natural heritage resources, and the engagement of interested communities in the Marmara Lake basin.

of the project over the past ten years through pedestrian survey, excavations, and ethnographic work (Luke – Cobb 2013; Luke – Roosevelt – Scott 2017; O'Grady *et al.* 2018). This contribution focuses exclusively on archaeological evidence for the use of earthen materials through excavated remains from the ancient citadel of Kaymakçı, and thus complements previously and concurrently conducted ethnographic, heritage, and conservation studies.

Kaymakçı is positioned on the lower promontory of the Gür Dağ ridge, in an area rich in natural resources such as wood, earth, and water. Fortifications enclose an area of 8.6 ha,

Fig. 1: Map of the middle Gediz River valley in western Turkey, showing the location of Kaymakçı (© Gygaia Projects).

making it one of the largest 2nd millennium BCE citadels in western Anatolia. The settlement is an ideal candidate for one of the major centers of the so-called Arzawa Lands, specifically the Seha River Land (Roosevelt – Luke 2017). Material culture at Kaymakçı is mostly local inland western Anatolian, with only few imports identified to date (Roosevelt *et al.* 2018, 664–665). The site was occupied as early as the Middle Bronze Age (2000–1700/1650 BCE), but the main

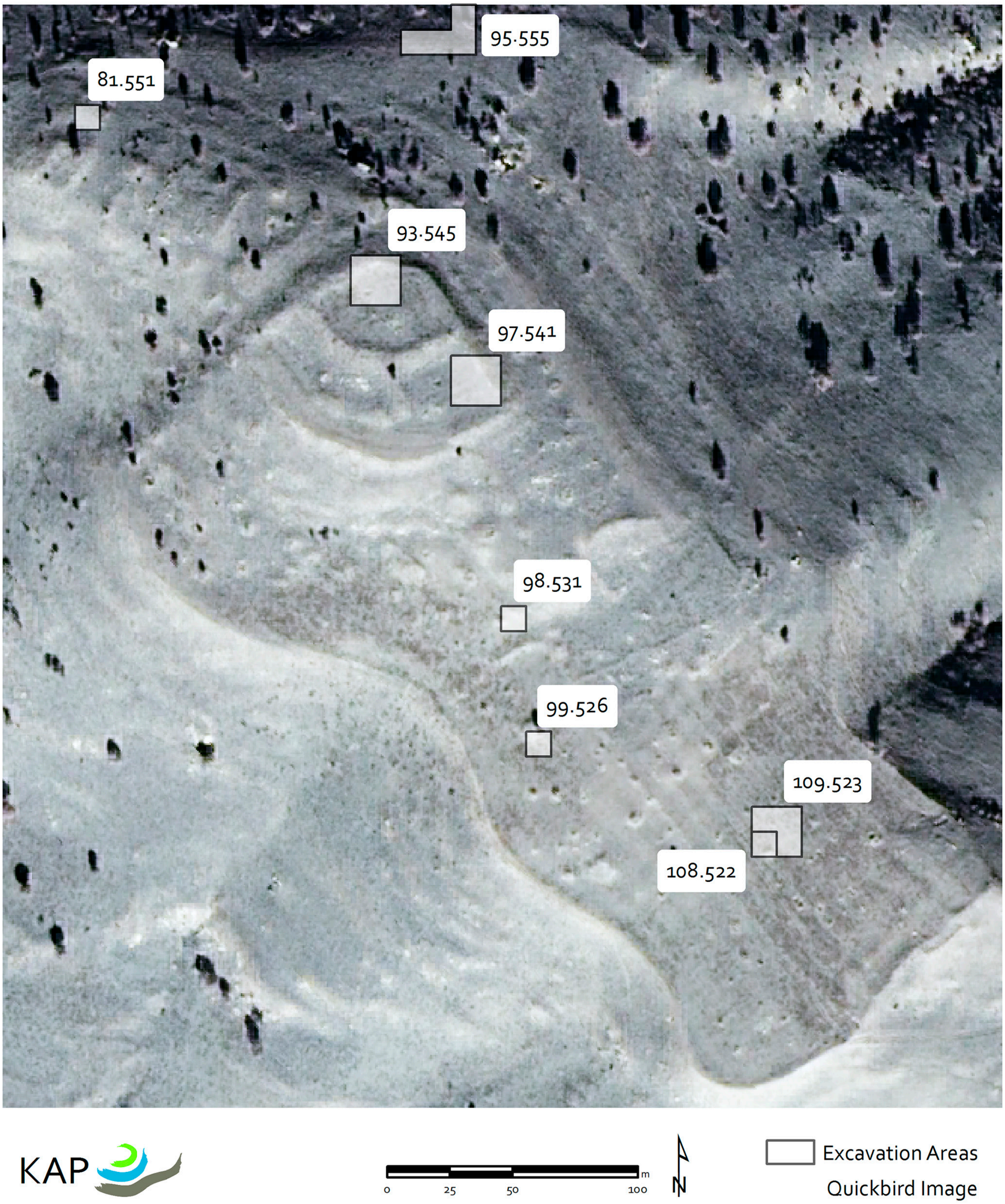

Fig. 2: Plan of excavation areas at Kaymakçı (© Gygaia Projects).

phase of activity belongs to the Late Bronze Age (1700/1650–1200 BCE), when the fortifications and all architectural remains so far discovered were built. The Late Bronze Age occupation can be further divided into two phases: the LB 1 phase (17th–15th century BCE) and the LB 2 phase (14th–13th century BCE). The site was abandoned in the final Late Bronze Age or perhaps as late as the beginning of the Early Iron Age (1200–1000 BCE). The fortified area of the citadel is topographically and architecturally divided into several sectors, in which excavations have explored northern sections of the fortification system itself, a central inner citadel and its surrounding slopes, and a broad southern terrace (**Fig. 2**), with varied activities taking place in each.

The inner citadel on top of a natural hill represents the heart of the site and is secured within three arcs of fortification walls. It has been excavated in areas 93.545, 97.541, and 98.531. This sector was dedicated to storage, at least during the end of LB 1 and throughout the LB 2 period, as well as other regular residential and small-scale productive activities, such as food preparation, textile production, and other crafting activities. An extensive southern terrace is divided by a wide street into two segments to the northeast and southwest. It has been explored through excavations in area 99.526 to the west and 108.522/109.523 near its center. Residential, household, and workshop activities took place here, including food processing, small-scale crafting, and storage. Fortifications are an especially dominant feature of the site's topography, and their contours can be readily traced with the aid of satellite imagery. The area west of the inner citadel was most heavily and extensively fortified, and key sections of the fortifications were excavated in areas 81.551 and 95.555.

EARTHEN MATERIALS AT KAYMAKÇI

The primary objective of the pilot field study was to identify and document the wide range of structural and utilitarian earthen features and objects at Kaymakçı, to identify their structure and composition as well as function and distribution across time and space. Therefore, despite the near total absence of built features at the site above foundation levels, the excavation team collected fragmentary earthen materials from the onset of the fieldwork, as it was hoped that new methods and wider scholarship on earthen materials would allow for identification of new datasets that inform on architecture, the use of space, household and production activities, as well as technological choices. As we will demonstrate later, this effort was extremely productive and resulted in identification of a broad range of materials and activities. This section describes the building blocks of our field activities – the sample collection procedures – and introduces the categories of extant structural and utilitarian earthen features and objects, their basic morphologies, fabrics, and functions.

Mud- and clay-based features and objects are typically made in relatively flexible manners; mixing recipes vary and are usually location specific (evidenced by both ethnographic and archaeological studies: Morgenstein – Redmount 1998; van Beek – van Beek 2008; Nodarou – Frederick – Hein 2008; Claasz Coockson 2010; Homsher 2012; O'Grady *et al.* 2018; Devolder – Lorenzon 2019). They contain sediment, aggregates, and binding agents, and the remaining portion is usually complemented by vegetable temper and stone aggregate. Similarly, structural and utilitarian earthen features and objects are simply a modelled mixture of sand, clay, silt, and organic (straw, chaff) and inorganic (stone, calcium carbonate, shells, pottery) temper or aggregate. The differential representation of these components influences physical properties, such as tensile strength, shrinkage, and plasticity (Rosen 1986; Houben – Guillaud 1994, 23–27; Kemp 2000, 79–83; Guillaud 2008, 21–26). Specialized knowledge is needed in order to produce a material that performs well given a specific environment or context of use. Most items, such as mudbricks and hearth fragments, are made of locally available materials to fit specific conditions (Homsher 2012, 2–5; Cammas 2018, 161). This high degree of locality in terms of resource procurement and manufacture also means that earthen features and objects can vary significantly between sites. Studying these features yields not only technological, but also valuable cultural information (Love 2013).

In general, archaeological remains made of earthen materials are challenging to detect and excavate if they are not baked by intentional or accidental firing, as they tend to disintegrate quickly without constant maintenance. According to excavations to date, Kaymakçı appears to have never suffered wide-spread burning and the end of its occupation is marked by a thorough abandonment. Additionally, Kaymakçı has a relatively shallow stratigraphy, and buried ancient remains have experienced post-depositional degradation resulting from environmental conditions as well as modern agropastoral activities, such as sheep and goat herding and plowing. A combination of these factors results in generally poor preservation of earthen architecture and other features at the site. In this and similar cases, it is easier to identify the remains of features commonly identified in the wider region, such as mudbrick superstructures, than features that are fairly understudied, such as *ad hoc* working platforms made of mud, poorly preserved hearths, and the like.

Despite these challenges, collection protocols established at the onset of the excavations at Kaymakçı prescribed collecting fragments of incompletely preserved as well as well-preserved earthen materials, thus creating an extensive and consistent dataset. Earthen features and objects were used widely throughout the site, and the collection strategy aimed to capture their variability. Precise stratigraphic and contextual information was documented for each collected sample in the field, and full sample descriptions including basic characteristics were produced in the excavation laboratory.

Increasingly, archaeologists have successfully applied quantitative methods to study mineral and chemical compositions using portable X-Ray fluorescence (pXRF) (Emery – Morgenstein 2007; Love 2012; Costi de Castrillo – Philokyprou – Ioannou 2017; Lorenzon – Iacovou 2019), X-Ray diffraction (XRD) (Tung 2005; Devolder – Lorenzon 2019), neutron activation analysis (NAA) (Nodarou – Frederick – Hein 2008), granulometry (Goldberg 1979; Jerome 1991; Homsher 2012; Love 2017), and micromorphology and petrography (Cammas 2018; Lorenzon – Iacovou 2019; Devolder – Lorenzon 2019).[2] While scientific practices are becoming increasingly streamlined, implemented analyses vary based on research goals. These types of analysis have demonstrated their usefulness, especially when there is good preservation and comparative datasets; most of them are, however, costly and often require transfers of samples to laboratories that must follow country-specific guidelines, producing increasing logistical and administrative challenges. Yet, simpler field-based methods – such as macroscopic qualitative observations of a sample's morphology, fabric, and aggregate combined with particle-size analysis – are able to provide useful insights into the differential use of resources and manufacturing techniques, because the vast majority of earthen material manufacture is local, resources are pooled from small catchment areas, or the materials are reused and recycled. This suggests that limited variation in quantitative signatures can be expected. These field-based methods, moreover, can be much more viable for researchers in cases where greater administrative challenges and/or smaller research budgets prevail. This rationale is also the primary reason why these techniques were piloted at Kaymakçı.

2 Preliminary unpublished studies were conducted as part of the Central Lydia Archaeological Survey including micromorphology of a small number of hardened mudbrick fragments found during pedestrian survey in the Marmara Lake basin. See Wolff 2008 and Curtis 2009.

SAMPLE COLLECTION AND ANALYSIS

Samples for this study derive from over four seasons of excavations (2014–2016, 2018). Samples were collected from all excavated areas and comprised both substantially preserved as well as fragmentary items, including those showing evidence of manufacturing or functional characteristics such as fingerprints and reed impressions, while at the same time ensuring collection of representative ranges of temper, shapes, and color. This strategy was chosen in order to facilitate future analyses and maximize the potential of the dataset for comparative purposes. Most earthen features and artifacts came from secondary or tertiary deposits and were thus very fragmented; only a few features were retrieved from primary contexts. Such intact features were carefully excavated and documented in place, with smaller samples extracted from clean fresh surfaces to avoid contamination. At the end of the fieldwork day, they were taken to the excavation laboratory for further analysis. The samples were brushed off and left to dry in the shade in open plastic sample bags to allow gradual evaporation of moisture. Macroscopic analysis recorded the color, dimension, fabric description, shape, and state of preservation of individual samples. The color was determined by a standard Munsell color chart, using Pantone Capsure units to ensure standardization across the dataset. Any evidence of manufacturing technique, if present, was carefully noted and documented (e.g., mold and finger impressions, intentional baking). All samples were photographed and weighed.

Visual inspection of earthen materials is highly informative (especially concerning aggregate), but particle-size analysis provides a quantitative differentiation of composition. Granulometric analysis was conducted on selected non-hardened baked samples from interesting archaeological contexts or with visually striking characteristics. While particle-size analysis using the hydrometer method has been the established practice, it requires export of archaeological samples to an institutional laboratory. A field-based procedure, however, was implemented in Kaymakçı's excavation laboratory following the field protocol of S. Love (2017), which allows for a quantitative identification of properties of earthen materials with good precision directly in the field laboratory. This protocol, summarized below, was chosen as the most efficient avenue for analysis of the composition of structural and utilitarian earthen features and objects.

Granulometric analysis through wet sieving with the aid of nested sieves (using a Science-ware® mini-sieve micro sieve set) was conducted in the excavation laboratory. An approximately 25 g sample was lightly crushed with a ceramic mortar. Although P. Goldberg and R. Macphail suggest treatment of samples with a solution of hydrogen peroxide before wet sieving (Goldberg – Macphail 2006, 336–339), the authors followed Love (2017, 356) in considering that such pre-treatment was unnecessary because most organic matter in the earthen material had already decayed. Moreover, dry samples were not pre-sieved through a large mesh so that the original matrix of the samples was preserved, even at the cost of more heterogeneous sand fractions; the heterogeneity of coarseness was in itself reflective of sourcing and manufacturing choices. The crushed samples of 25.0 g were dissolved in 100 ml of deflocculant made of 20.0 g of laundry soap dissolved in 500 ml of deionized water. The samples were left in the solution for at least seven hours in order to loosen individual particles. The solution was then poured over a series of nested sieves with mesh sizes of 500 μm, 250 μm, 125 μm, and 63 μm to distinguish between coarse, medium, fine, and very fine sand. Particles smaller than 63 μm comprised a mixture of silt and clay, which were not processed any further by the hydrometer method, because this would have required exporting the samples to an institutional laboratory. Sieved samples were left to dry slowly in a shaded area over the course of a few days. Each fraction was weighed to a 0.01 g precision, and visual observations and photographs then documented dry samples using a Leica stereoscopic binocular microscope under 12.5 magnification.

RESULTS

In total, 364 fragments were recovered and saved for study, of which 40 samples were processed with granulometric analysis. Analyzed samples and fragments varied remarkably in terms of shape, context, and morphology, and although they were initially all classified as 'mudbrick', a close examination showed they in fact represented an array of different morphological and functional categories. These fragments comprised well-known as well as previously unidentified classes of unfired to low-fired structural and utilitarian earthen features and objects. As they were made of earthen mixtures, they shared some common visual characteristics. Samples were usually reddish in color, ranging from red (2.5YR 5/6) and reddish brown (2.5YR 5/4), to weak red (10R 4/2) and brown (7.5YR 6/4). While some samples were preserved in their original forms and were either unfired or low-fired, some bore traces of both oxidation and reduction, a remnant of uneven firing, perhaps through accidental as opposed to intentional contact with higher temperatures. In such cases, gray reduced fabrics ranged from dark reddish gray (5YR 4/2) to gray (2.5YR 5/1). Macroscopic analysis combined with particle-size analysis revealed that sample fabrics were usually coarse, with varying additions of organic and inorganic tempering agents that improved the physical properties of the raw earthen materials. Chaff and straw were common additives in architectural materials. Other organic materials, such as bone and shell, were used only very occasionally. Stone inclusions were very common, too. Micas (biotite, muscovite, and mica-schist), limestone, and calcium carbonate were recognized in virtually all samples, while quartz was less common.

CLASSIFICATION OF FUNCTIONAL CATEGORIES

The collected samples were identified as belonging to one of the three categories: *architecture*, *installation*, and *portable item*. These were further subdivided into more specific categories common across these broader functional categories. Commonly, the original function of recovered samples could not be identified with certainty due to poor state of preservation and the disturbed nature of some of the excavated deposits. These samples were assigned an 'unclear' identifier, which could be allocated to any of the major functional categories. A significant portion of the original dataset – 116 out of 364 samples, thus 31.9 % of the entire assemblage – was identified only as 'earthen' in material, but 'unclear' in functional category.

The following section introduces all the major categories of earthen features and objects found at Kaymakçı and provides an overview of their characteristics and function.

ARCHITECTURE

The buildings at Kaymakçı consisted of stone socles with mudbrick superstructures, which were preserved only rarely and in rather fragmentary states. However, detailed documentation of standing features and collapse deposits around walls allowed an understanding of much of the architectural composition at the site (**Tab. 1**).[3] Architectural fragments from more deeply buried levels of the site tend to be sun-dried and fairly well preserved – a clear distinction from those buried more shallowly. Mudbricks and other earthen objects found in upper levels closer to topsoil and in pits tend to be accreted and exposed to fire. This distinc-

3 Munsell colors provided in the tables reflect interior measurements, whenever possible, as those colors were more indictive than exterior readings, which often combined the color of the object/feature and accretion.

	Excavation Area	Context	Sample	Colour
Architecture – mudbrick	81.551	9	4	7.5YR 5/2
	81.551	9	5	10YR 4/2
	81.551	9	7	5YR 5/2
	81.551	9	18	7.5YR 5/2
	81.551	16	8	5YR 5/4
	81.551	38	19	10YR 5/1
	93.545	7	4	5YR 5/4
	93.545	7	134	5YR 5/4
	93.545	19	1	7.5YR 6/4
	93.545	27	1	7.5YR 6/4
	93.545	54	5	10YR 7/4
	93.545	114	5	5YR 5/6
	93.545	135	6	7.5YR 6/4
	93.545	149	6	5YR 6/6
	93.545	158	1	7.5YR 6/4
	93.545	191	6	2.5YR 5/6
	93.545	196	392	10YR 6/4
	93.545	197	1	7.5YR 5/4
	93.545	199	9	5YR 6/6
	93.545	204	194	7.5YR 5/4
	93.545	211	5	7.5YR 7/4
	93.545	216	6	10YR 6/4
	93.545	220	6	7.5YR 6/4
	93.545	223	5	10YR 6/2
	93.545	234	1	10YR 6/4
	93.545	280	7	10YR 7/4
	93.545	289	1	10YR 5/1
	93.545	291	7	10YR 4/2
	93.545	294	1	2.5YR 6/2
	93.545	330	7	5YR 6/4
	93.545	331	1	10YR 6/2
	93.545	340	6	5YR 6/4
	95.555	46	7	10YR 6/4
	95.555	60	10	7.5YR 6/4
	95.555	60	338	5YR 5/4
	95.555	63	11	7.5YR 4/4
	95.555	80	1	5YR 6/4
	95.555	103	1	7.5YR 5/2
	95.555	130	11	10YR 4/1
	97.541	15	1	7.5YR 6/2
	97.541	148	1	7.5YR 6/4
	97.541	289	56	7.5YR 5/2

	Excavation Area	Context	Sample	Colour
Architecture – mudbrick	97.541	305	1	5YR 6/4
	97.541	374	1	10YR 4/2
	97.541	384	1	10YR 4/1
	97.541	16	6	7.5YR 6/2
	97.541	97	1	10YR 4/2
	97.541	104	1	5YR 5/4
	97.541	128	1	5YR 6/4
	97.541	146	1	n/a
	97.541	237	66	5YR 5/4
	97.541	265	1	7.5YR 5/4
	97.541	330	9	5YR 5/4
	98.531	8	8	5YR 6/4
	98.531	8	95	5YR 6/4
	98.531	8	106	5YR 6/4
	98.531	34	3	2.5YR 5/2
	99.526	4	5	7.5YR 7/4
	99.526	4	26	10YR 6/2
	99.526	7	8	7.5YR 6/4
	99.526	11	10	10YR 5/1
	99.526	71	6	5YR 6/4
	99.526	113	1	10YR 6/2
	99.526	122	89	n/a
	99.526	149	6	n/a
	99.526	194	2	10YR 6/4
	99.526	238	1	10YR 5/1
	99.526	300	1	10YR 6/2
	99.526	338	1	5YR 6/4
	99.526	350	4	5YR 5/4
	99.526	445	7	7.5YR 6/2
	99.526	515	5	7.5YR 5/2
	99.526	573	10	5YR 5/4
	99.526	630	1	7.5YR 5/4
	99.526	660	5	10YR 6/2
	99.526	671	2	7.5YR 6/4
	108.522	7	2	7.5YR 6/4
	108.522	14	4	5YR 5/4
	108.522	30	6	5YR 6/4
	108.522	52	5	7.5YR 5/2
	109.523	115	1	7.5YR 5/2
	109.523	162	1	10YR 5/4
	109.523	195	1	7.5YR 5/2
	109.523	281	1	10YR 5/4

	Excavation Area	Context	Sample	Colour
Architecture – mudbrick	109.523	290	40	7.5YR 5/4
	109.523	304	6	7.5YR 6/4
	109.523	309	7	7.5YR 6/2
	109.523	322	1	7.5YR 5/4
	109.523	327	1	7.5YR 6/4
	109.523	328	1	10YR 6/2
Architecture – impressed	93.545	149	10	7.5YR 6/4
	93.545	154	38	7.5YR 7/2
	93.545	177	5	5YR 5/4
	93.545	184	1	5YR 6/4
	93.545	184	2	5YR 6/4
	93.545	184	4	5YR 6/4
	93.545	184	5	7.5YR 6/4
	93.545	191	109	5YR 6/6
	93.545	196	391	7.5YR 5/4
	93.545	196	393	10YR 6/2
	93.545	204	5	10YR 6/4
	93.545	204	206	2.5 YR 5/6
	93.545	204	212	10YR 5/4
	93.545	204	216	7.5YR 6/4

	Excavation Area	Context	Sample	Colour
Architecture – impressed	93.545	232	7	7.5YR 6/2
	93.545	232	8	5YR 4/4
	93.545	240	5	5YR 6/4
	93.545	240	7	7.5YR 6/4
	93.545	273	6	7.5YR 6/2
	93.545	277	13	5YR 7/4
	93.545	286	43	2.5YR 6/6
	93.545	287	6	10YR 4/2
	95.555	41	7	n/a
	97.541	68	13	7.5YR 6/6
	108.522	9	142	7.5YR 6/4
	108.522	85	30	n/a
	109.523	118	11	n/a
	109.523	258	37	10YR 5/1
Architecture – unclear	99.526	121	6	7.5YR 5/4
	99.526	121	13	7.5YR 5/2
	99.526	142	1	7.5YR 5/2
	99.526	169	1	7.5YR 5/2
	99.526	169	7	7.5YR 5/2

Tab. 1: List of all earthen architectural fragments identified at Kaymakçı. In some cases, color could not be identified due to severe accretion on the surface.

tion is primarily reflective of relatively rapid re-burying and reuse of spaces and materials as opposed to a perhaps prolonged abandonment in the latest levels, resulting in deterioration of contemporary materials.

Architecture – mudbrick

Mudbricks are a fundamental part of Bronze Age architecture in western and central Anatolia, especially well attested by structures from Early Bronze Age contexts at Troy and Middle to Late Bronze Age contexts at the Hittite capital Hattuša (Naumann 1971, 43–51, 348–381; Seeher 2007; Mielke 2009). The inhabitants of Kaymakçı built using mudbrick, and the medium continued to be an integral part of a local vernacular architectural tradition in the region well beyond the Bronze Age. After the abandonment of Kaymakçı, mudbrick was used extensively by Iron Age Lydians for the construction of buildings and fortifications at their capital city of Sardis (Ramage 1978), and mudbrick was the predominant building medium throughout the region until recently (Luke – Cobb 2013).

During excavations at Kaymakçı, the 'architecture – mudbrick' category was applied to earthen brick-shaped objects found associated with wall construction. The excavated architectural remains are characterized by the use of stone socles with mudbrick superstructures, so far revealed *in situ* in only a few rare cases. The best-preserved evidence for mudbrick superstructure consists of two courses set seemingly atop stone foundations in area 97.541, sheltered from weather and degradation by the collapse of a larger wall located immediately north of it (**Fig. 3**).

Fig. 3: In situ stone socle with lower courses of mudbrick superstructure in area 97.541 (© Gygaia Projects).

Overall, 90 samples of mudbrick in various states of preservation were identified and studied. Mudbricks range in color from red (2.5YR 5/6) or reddish brown (2.5YR 5/4), to weak red (10R 4/2) or brown (7.5YR 6/4). Some bricks bear traces of both oxidation and reduction, a remnant of uneven firing, probably a result of accidental contact with fire and perhaps even during abandonment or post-abandonment events. Colors of burnt mudbricks range from dark reddish gray (5YR 4/2) to gray (2.5YR 5/1). Inclusions tend to be poorly sorted organic and inorganic aggregate, mostly of local origin. Chaff and straw are abundant, while other organic materials such as bone and shell are used only occasionally. Micas (primarily biotite), limestone, and calcium carbonate are also very frequent, and quartz occurs occasionally.

Many mudbrick samples retain evidence of original surface morphology, in part because of the likely accidental contacts with fire mentioned above. Common attributes include a roughly flat top surface with finger impressions and raised edges resulting from the maker's fingers pushing the wet clay toward the edges of the mold. Side surfaces tend to be flat. In many preserved samples, the basal surface is uneven and retains relatively deep impressions of grass, remnants of the surfaces on which bricks were formed. These preserved features indicate the use of molds for the shaping of bricks. The term 'mold', although standard, is somewhat of a misnomer as mudbricks were often formed using a reusable four-sided frame lacking a bottom (indicated by the grass impressions left on bottom surfaces). Frames were presumably constructed of wood, a material readily available in the area.

Only three nearly complete examples of mudbricks have been excavated to date. Examples did not always preserve full lengths along both top edges, but measurements seem to be fairly consistent across the dataset. Excavated examples suggest use of a roughly square frame with lateral dimensions of 32.0–34.5 cm and a height of 7.8–8.6 cm (**Fig. 4**).[4]

Slight variations in size may be attributed to shrinkage while drying. Some bricks, however, were intentionally made thinner – 6.2 cm thick on average. No evidence of mud plaster used as a protective coating of bricks survives, and mud mortar used in vertical interstices

4 Note that dimensions given here are revised from those provided in O'Grady *et al.* 2018.

Fig. 4: Example of a nearly complete mudbrick (97.541.148.1) (N. Gail; © Gygaia Projects).

Fig. 5: Mudbrick bearing traces of mud mortar (93.545.294.1). The coarse aggregate of the mortar, rich in micaceous and calcium carbonate aggregate, is visible on the vertical interstice of the brick (N. Gail; © Gygaia Projects).

between horizontal courses of bricks has not been documented so far. A very coarse mortar on a vertical interstice, however, has been observed on a single mudbrick (93.545.294.1). The mortar was rich in micaceous and calcium carbonate aggregate (**Fig. 5**).

Architecture – impressed

This category was originally classified as 'architectural fragments', that is, earthen fragments that bear reed and wood impressions resulting from being part of wattle and daub construction. As new evidence surfaced in the course of excavations, however, this category was extended to include not only remnants of wattle and daub architecture, but also uneven fragments with smooth surfaces that seem to have been wedged between wooden planks and/or rocks. Many of the recovered fragments were heavily accreted on all sides, suggesting they were broken up already in antiquity and exposed to heat unevenly.

Overall, 28 fragments of impressed earthen material have been identified. They are hardened, and their fabrics and inclusions are visually similar to those of mudbricks (calcium carbonate, micas, and limestone), although they rarely contain chaff and straw. Inclusions are well sorted, and fabric is usually medium to coarse. They tend to be preserved by contact with intense heat in reducing conditions, as fabrics range from dark grayish brown (10YR 4/2) to light brownish gray (10YR 6/2) or pinkish gray (7.5YR 6/2). In fragments with reed impressions, reed diameters vary significantly, from 0.9 to 3.3 cm (**Fig. 6**).

Fig. 6: Example of an impressed architectural fragment (93.545.204.5) (N. Gail; © Gygaia Projects).

Some fragments seem to have been pressed into the corners of perishable structures and are irregular in shape as a result. They bear linear impressions on one of their surfaces, while the opposite surface tends to be irregular, either rough or smoothed. Other fragments seem to have been pressed between wooden planks or straight-edged items, such as flat rocks (**Fig. 7**).

All were retrieved in very fragmentary state, most commonly from the fills of semi-subterranean, rock-cut and built features located in area 93.545 of the inner citadel, in fills dating to both LB 1 and LB 2 phases. They thus may provide rare evidence of perishable superstructures of buildings in the area constructed using twigs/reeds and mud in wattle and daub construction, and/or the linings of negative features. Their association with the

Fig. 7: Example of an impressed architectural fragment with straight edges. The fragment would have been impressed into flat wooden planks, as indicated by parallel impressions visible in the lower part of the fragment (93.545.286.43) (N. Gail; © Gygaia Projects).

semi-subterranean circular features of the inner citadel, whose most likely interpretation is storage pits, at first led to a suggestion that the pits had once been lined with plaster or mud mortar. Only one small fragment was found attached to the interior face of one such pit, however (93.545.227.1), which relegates the interpretation to an unproven hypothesis at present. Alternatively, it is possible that ephemeral shelters or fences were erected around the circular features as a means of spatial differentiation.

Architecture – unclear

This category comprises compact modelled earthen masses – parts of rammed earth or mud-bricks – likely used as parts of walls or architectural props. These fragments have been classified as 'unclear' because their formation processes cannot be identified with certainty, while their structural function in architecture is clear. This is a very rare category, with only five examples excavated to date, all of which come from the southern terrace (areas 99.526 and 108.522/109.523). In area 99.526, for example, mudbricks were used to form a platform for the wider addition to an earlier wall 99.526.51. The color of the feature was brown (7.5YR 5/2 to 5/4). The mass has been preserved without accretion, but its exterior edges are rounded rather than sharp. It seems to have been composed of at least four blocks of bricks that were pushed against the wall to provide support for the erection of the new wider wall. The mass is poorly sorted, without much straw and chaff, but with a lot of stone aggregate, such as micas. The matrix of the fragment is relatively homogeneous in terms of inclusions, opening up the possibility that it was made by accumulating larger volumes of mud and coarse sand, which were then roughly shaped in place.

INSTALLATION

The term 'installation' was chosen for its neutrality in describing a diverse category of im-movable earthen features such as hearths, ovens, and working platforms (**Tab. 2**). These hard--packed features were common on the southern terrace in area 99.526, and particularly in the

	Excavation Area	Context	Sample	Colour
Installation – surface	93.545	37	61	n/a
	93.545	54	53	7.5YR 5/2
	93.545	65	29	10YR 5/2
	93.545	65	30	5YR 5/4
	93.545	65	31	5YR 4/4
	93.545	65	32	5YR 4/4
	93.545	65	33	5YR 4/2
	93.545	131	108	10R 5/4
	93.545	131	109	10R 4/4
	93.545	177	74	5YR 5/4
	93.545	184	5	7.5YR 6/4
	93.545	190	5	5YR 4/2
	93.545	203	6	10YR 3/1
	93.545	204	7	5YR 6/4
	93.545	218	1	2.5YR 4/4
	99.526	10	81	10YR 5/4
	99.526	21	10	2.5YR 5/4
	99.526	70	5	n/a
	99.526	264	1	10YR 6/2
	99.526	276	1	5YR 5/4
	99.526	289	1	5YR 6/4
	99.526	310	1	5YR 5/4
	99.526	393	1	5YR 6/4
	99.526	397	3	2.5YR 4/4
	99.526	498	1	5YR 5/4
	99.526	651	4	5YR 6/2
Installation – substructure	99.526	292	2	10YR 5/2
	99.526	308	3	5YR 6/4
	99.526	356	2	7.5YR 5/2
	99.526	397	7	5YR 4/4
Installation – mudbrick	93.545	196	6	5YR 5/4
	99.526	271	1	10YR 7/2
	99.526	299	1	7.5YR 7/2
	99.526	305	1	5YR 5/4
	99.526	305	2	5YR 6/4
	99.526	325	1	5YR 6/4
	99.526	326	1	7.5YR 5/4
	99.526	327	1	5YR 6/4
	99.526	393	2	7.5YR 5/2
	99.526	396	6	5YR 6/4
Installation – mudbrick	99.526	417	2	10YR 6/2
	99.526	426	1	7.5YR 6/2
	99.526	428	1	10YR 6/2
	99.526	509	1	7.5YR 5/2
	99.526	613	1	7.5YR 5/2
	99.526	631	2	10YR 6/4
	99.526	693	3	7.5YR 5/2
	109.523	306	4	5YR 5/4
Installation – tray	93.545	184	3	7.5YR 6/4
	93.545	204	8	5YR 6/4
	93.545	204	200	7.5YR 6/4
	97.541	68	17	5YR 5/4
	99.526	350	5	7.5YR 6/4
Installation – impressed	99.526	604	6	5YR 4/4
	99.526	640	2	5YR 4/4
	99.526	645	1	5YR 5/4
	99.526	697	1	7.5YR 6/4
Installation – unclear	93.545	37	60	5YR 4/2
	93.545	78	47	7.5YR 6/2
	93.545	139	6	2.5YR 5/6
	93.545	238	2	n/a
	95.555	96	5	10YR 2/1
	97.541	111	203	5YR 6/4
	97.541	260	1	7.5YR 5/2
	98.531	6	79	10YR 4/4
	98.531	34	4	2.5YR 4/4
	98.531	117	1	n/a
	99.526	6	97	10R 5/4
	99.526	17	8	n/a
	99.526	72	4	n/a
	99.526	297	9	5YR 6/4
	99.526	297	98	5YR 6/4
	99.526	351	5	2.5YR 4/4
	99.526	513	1	5YR 5/4
	99.526	601	4	5YR 5/4
	99.526	674	2	7.5YR 6/4
	109.523	91	1	5YR 4/1

Tab. 2: List of all earthen installation features and fragments identified at Kaymakçı. In some cases, color could not be identified due to severe accretion on the surface.

stratigraphic layers corresponding to the LB 1 phase. This phase of activity was not associated with more formal architectural features, which appeared at the transition of Kaymakçı's LB 1 to LB 2 phase (the late 15th century BCE). In LB 2, the investigated strata suggest that the area was dedicated to household production and food preparation activities. Despite this function, collected fragments of earthen features were often sun dried or soft-baked at low temperatures, and were thus suitable for granulometric analysis, the results of which are discussed further below. In addition to area 99.526 on the southern terrace, earthen installations have been found also in the inner citadel in area 93.545.

Installation – surface and substructure

This category contains a range of features that vary in visual characteristics but are united by function. They often take a circular form and are characterized by a flat hardened surface supported by a relatively fragile mudbrick substructure. They are rich in coarse stone aggregate and were exposed to low heat. This exposure is most likely a result of their function as hearths, ovens, and working platforms. Although the surfaces of such features and their underlying substructures can be easily distinguished visually and were classified accordingly into distinct subcategories, they were often discovered in very fragile and crumbly condition, meaning that they could not easily be excavated separately. They are presented together here for this reason, reflecting their conditions upon excavation. In total, 26 surface and four substructure fragments of such features have been studied.

Fig. 8: Well-preserved oven (93.545.171) built near a wall of the inner citadel during excavation. Sectioning reveals its pebble and cobble base layer (© Gygaia Projects).

Fragments of surfaces come from the topmost layer of a built earthen feature. Surface fragments comprise a hardened cap ranging in color from grayish brown (10YR 5/2) and brown (7.5YR 6/4) to light reddish brown (5YR 6/4), and occasionally even weak red (10R 5/4). Fragments of substructure, the layer below the surface of a built earthen feature, are strikingly different in terms of color and aggregate. They can be reddish brown (2.5YR 4/4 or 5YR 4/4) or dark reddish brown (5YR 4/2), and all recovered samples are rich in stone aggregate, especially micas and occasionally also limestone. Some samples, however, visually resemble the hard cap surface with their yellowish brown (10YR 5/4) color. Both surfaces and substructures lack chaff and straw inclusions, in contrast to mudbrick, and are compact, dense, and heavy.

One better preserved oven was discovered in a late LB 2 level of the inner citadel in area 93.545 (93.545.171; Roosevelt *et al.* 2018, 183–184). The surface of the circular installation was preserved *in situ* (**Fig. 8**). Upon excavation, it was possible to determine that the structure was likely originally covered, as two vertically set upright slabs in the enclosing stone circle seemed to define the east-facing mouth of the oven.

The surface of the structure was well preserved. This uppermost layer consisted of two parts: a thin and relatively hard earthen cap (0.5–0.9 cm) and, immediately beneath it, a softer layer 2.0–5.0 cm thick. Although the cap is baked hard, the soft subsurface immediately beneath it is prone to disintegration, hence the two could not easily be separated during excavation, suggesting that both the surface and the layer immediately beneath were originally constructed together. Both are rich in sand and micaceous aggregate. The surface hardened as a result of activities that took place on top of it, with fairly low temperatures perhaps reaching around 200° C and penetrating only shallowly. Beneath these upper layers – the surface and immediate subsurface together – the continuing substructure of the oven consisted of progressively coarser layers of earthen material approximately 6.0–8.5 cm thick. These layers were pressed into a dense layer of schist and limestone pebbles and cobbles at the base of the feature. Fragmented materials of similar composition were found in significant numbers in the fill of a circular feature (93.545.63) in the same area, suggesting that a large portion of the surface and substructure of a similar installation was discarded there.

Feature 99.526.79 in area 99.526 on the southern terrace presents an example of a working platform, or perhaps a different type of hearth or oven, supported by a layer of cobbles and enclosed by a mudbrick rim (**Fig. 9**; Roosevelt *et al.* 2018, 191). It consists of a series of alternating hard packed, clay-rich surfaces with earthen substructure: the earlier surface 276 (light reddish brown, 5YR 5/4) was supported by two fills, 286 and 295 (reddish brown, 5YR 5/4), superimposed by a later surface 264 (light brownish grey, 10 YR 6/2), and fill 267 (reddish brown, 2.5YR 4/4). Its surfaces are relatively heterogeneous as they were built at different times. The topmost hardened surface had a very hard, ca. 0.8 cm thick lens, with a slightly softer and wider ca. 1.4 cm thick lens immediately below it, similar to the uppermost layers of the installation in 93.545.

The feature is surrounded by three vertically positioned mudbricks creating a rim that delineates the feature on its south side. These concentrically arranged rim mudbricks differ in color, and their temper consists mostly of stone aggregate – micas and limestone – as well as calcium carbonate, with little visible chaff/straw, thus distinguishing them from structural mudbricks used for architectural purposes. These types of rim mudbricks are described fully in the following section.

Fig. 9: Large platform/oven (99.526.79) during excavation. Sectioning reveals its cobble base layer as well as a mudbrick rim that delineates its southwestern edge (bottom right corner of image) (© Gygaia Projects).

Installation – mudbrick

Architecture comprises only one possible use of mudbrick at Kaymakçı. The edges of earthen surfaces, platforms, and hearths/ovens were sometimes defined by mudbrick rims. Eighteen mudbricks from such features have been identified, all of which were placed on end to create an elevated rim defining the edge of an installation. Mudbricks used in such contexts had recognizably rectangular forms and fabrics lacking straw or chaff that differ from those of architectural mudbricks. They served as a means of delineation rather than as components of wall superstructures. Differences from architectural mudbrick in form, composition, and function thus suggest special purpose manufacture. Moreover, it seems that bricks of different dimensions were used to frame installations, but their complete dimensions cannot be identified without difficulty, because most were found very abraded around their edges or only partially preserved.

Mudbricks used in installations were found almost exclusively in area 99.526 on the southern terrace. Features 99.526.385 and 99.526.386, identified as hearths, ovens, or some other type of cooking platforms, showcase the use of these types of mudbricks (99.526.393.2, 426.1, 428.1) (**Fig. 10**). Both features were of oval shape and delineated on all sides by mudbricks that, together, created an elevated rim surrounding the functional surface. Each rim was constructed of three individual rectangular mudbricks, each stood on their short ends. Each mudbrick bore different visual characteristics and varied compositionally in terms of sand, clay, and silt ratios. Here, individual bricks ranged from brown (7.5YR 5/2) to light brownish gray (10YR 6/2).

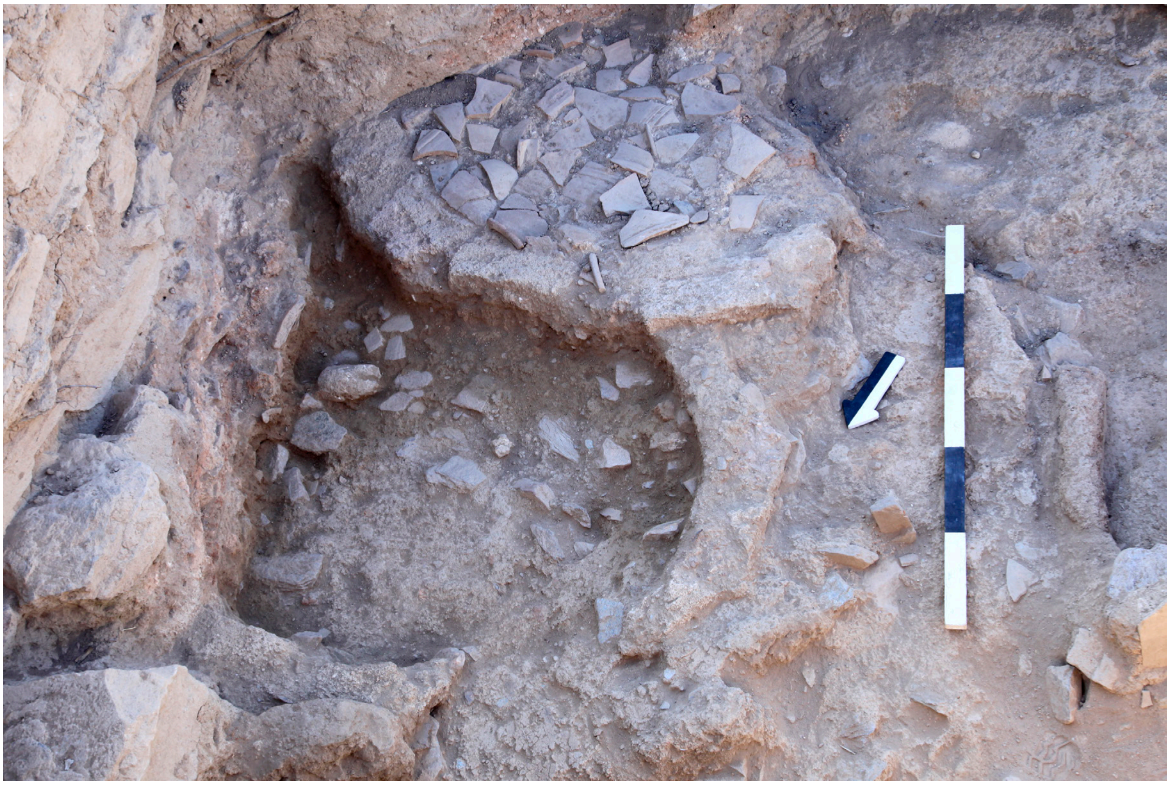

Fig. 10: Sherd hearth (99.526.385) and hearth (99.526.386) during excavation. A mudbrick rim lines the northern edge of the feature (© Gygaia Projects).

Likewise, the relatively large and incompletely preserved platform/oven discussed above concerning its surface and substructure characteristics (99.526.79), included three successively built rims of mudbrick (99.526.271, 299, and 305) (**Fig. 9**). Each of the rims had a distinct color and coarseness, as revealed by particle size analysis (discussed in the next section). The outermost ring (271) had a light gray exterior (10YR 7/2) and brown interior (7.5YR 5/4); the middle ring (299) a pinkish gray exterior (7.5YR 7/2) and light reddish brown interior (5YR 6/4); and the inner ring included two varieties of mudbrick excavated separately: 305.1 had a light reddish brown exterior (5YR 5/4) and light brown interior (7.5YR 6/4), and 305.2 had a light reddish brown exterior (5YR 6/4) and light brownish gray interior (10YR 6/2). Together, they provide a highly visible and functional separation between the installation and the room in which it was used.

Installation – tray

This category comprises tray-shaped features that constituted the permanent equipment of certain buildings. Most of the identifiable examples exhibit a flat base with raised angular edges with rounded rims, presumably designed to serve as large but shallow receptacles or mud-made containers. Their size and weight distinguish them from portable trays (see below); they are heavy, quite thick and large, and have uneven bottom surfaces that bear the impressions of the surfaces on which they sat. Only five fragments have been identified, four of which were found broken and discarded in fills in area 93.545 in the inner citadel.

The size and shape of non-portable trays cannot be determined with certainty owing to their fragmentary state of preservation, but it is possible that they had rectangular or semi-

-rounded plans. Their raised exterior edge walls are generally low and are rounded on top. Their colors range from light brown (7.5 YR 6/4) to light reddish brown (5YR 6/4). Micas and limestone are common stone inclusions; chaff and straw are present in small quantity. Even color and hardness throughout suggest controlled firing at low temperatures. The bottom bears impressions of the surface on which the installation would have been set, including impressions of straw and chaff, suggesting they were fired in situ (cf. 'utilitarian ceramic trays' from Mitrou, dating to the Middle Helladic II–Protogeometric period; Jazwa forthcoming).

An illustrative example of a tray with a raised rim is fragment 99.526.350.5 (**Figs. 11**). The tray is only 3.1 cm thick and its straight rim with rounded top rises to a height of 9.65 cm. Its interior and exterior surfaces are smoothed. Its bottom surface is rough, slightly irregular, and seems to have taken the shape of the surface it was placed on when wet. Although the fragment is accreted on its interior and exterior surfaces (including the bottom), it is clear that all surfaces were smoothed and evenly treated with a slip, unlike other recovered examples.

Fig. 11: Example of an installation – tray with straight raised edges and slip (99.526.350.5). Photograph and section (N. Gail and P. Demján; © Gygaia Projects).

Fig. 12: Example of a roughly smoothed installation – tray (97.541. 68. 17) (N. Gail; © Gygaia Projects).

Most other trays have similarly flat bottoms and straight raised edges but are only roughly smoothed and bear no other treatment. An example of this more typical type is fragment 97.541.68.17 (**Fig. 12**), the maximum preserved bottom thickness of which is 3.2 cm, while the raised edge rises to a height of 6.4 cm. The fabric of this tray includes micaceous and quartz particles, calcium carbonate, and only a small amount of chaff and straw.

Installation – impressed

This category is rather narrowly defined and includes mud- or clay-rich linings of negative features in area 99.526. So far, only four samples have been recovered. One sample was excavated *in situ* (**Fig. 13**), while the other three were collected from fills of pits or other negative features.

Fig. 13: Clay-rich lining of a pit (99.526.604), classified as belonging to the installation – impressed category during excavation. The lining is only partially preserved and visible near the right edge of the photo (© Gygaia Projects).

Each is composed of a thick layer of evenly fired and finely processed clay up to 6.8 cm thick and is usually dark red in color (5YR 4/4) with a hard, light brown lens along its uneven exterior surface (7.5YR 6/4). The irregularity of the surface likely results from the mud- or clay-rich mixture being pressed into place by hand, or perhaps by a small flat implement, prior to firing. The composition of these linings is rich in very well-sorted clay and bears very little stone aggregate and almost no calcium carbonate particles. Small pieces of charcoal, however, can be seen throughout the matrix. It is not immediately clear whether they were fired intentionally, but they are very hard, suggesting they were exposed to prolonged heat in the course of their use.

Installation – unclear

A large proportion of this category, including 20 samples in total, could not be identified beyond their association with installations. While highly recognizable as belonging to such features based on their shape, texture, and color, their size and state of preservation or their position within individual features leaves their function or original form unclear.

PORTABLE ITEM

Portable items were found in very fragmentary state, but they are identifiable by their shape, worked top surfaces, coarse fabrics, and well-sorted dense matrices, often resembling very coarse pithoi (**Tab. 3**). Yet, they are clearly flat and are not processed or fired with the same care allotted to coarse ceramics, such as pithoi.

	Excavation Area	Context	Sample	Colour
Portable item – tray	93.545	98	158	5YR 5/4
	93.545	185	6	7.5YR 5/2
	93.545	196	394	5YR 6/4
	93.545	240	8	7.5YR 6/2
	93.545	265	12	7.5YR 6/2
	93.545	278	6	5YR 5/1
	93.545	300	7	5YR 5/4
	93.545	334	60	10R 5/4
	97.541	68	15	5YR 5/4
	97.541	199	5	7.5YR 5/2
	99.526	169	9	2.5YR 5/4

	Excavation Area	Context	Sample	Colour
Portable item – unclear	93.545	149	11	n/a
	95.555	109	7	5YR 4/4
	97.541	25	641	2.5YR 6/4
	97.541	111	139	7.5YR 6/4
	98.531	6	80	2.5YR 4/4
	108.522	63	5	10YR 4/1

Tab. 3: List of all fragments of earthen portable items identified at Kaymakçı. In some cases, color could not be identified due to severe accretion on the surface.

Portable item – tray

Flat and relatively thin fragments of hardened portable earthen materials were found primarily in the inner citadel excavations. In total, 11 fragments are characterized primarily by their flatness and thinness: their top surface is smooth, their bottom either smooth or rough, and curved raised edges terminate in rounded rims. Their form and sturdy lightness suggest their function as utilitarian and portable trays. They were likely fashioned and fired at low temperature in the same place, even though most have smooth bottoms, suggesting they were handled during shaping. Representative samples are noticeably lighter than non-portable 'installation – tray' fragments. Their coarse fabric has well sorted inclusions, the most common of which are micas and calcium carbonate. Their color ranges from reddish brown (2.5YR 5/4) to pinkish grey (7.5YR 6/2). Their thickness ranges from 1.9–4.9 cm, with an average around 3.2–3.6 cm. Their overall size and shape cannot be determined with certainty owing to their fragmentary state of preservation, but they were likely either rectangular or semi-rounded in plan: most examples have curved rather than straight edges in plan with straight raised edges. (**Fig. 14**).

Examples of a similar class of objects have been documented recently at the Late Bronze Age site of Mitrou in eastern Lokris, Greece. The abundance of 'utilitarian trays' at Mitrou does not

Fig. 14: Example of a portable tray (93.545.265.12) (N. Gail; © Gygaia Projects).

appear to be an exception; rather, according to K. Jazwa, similar artifacts have been recovered from other Late Bronze Age sites in Greece but remain unpublished or have been misidentified as roofing tiles or crucibles (e.g., at Kynos, Nemea, Alimos, Kalapodi, and Tsoungiza; see Jazwa forthcoming, with bibliography). Unlike examples from Kaymakçı, however, Mitrou's trays tend to be of a rectangular shape, and are rich in organic aggregate and prone to cracking. Much later examples of similar trays – so-called bread trays – are well-known from Lydian Sardis, yet no relation to Kaymakçı's Bronze Age varieties can be established (c.f. Ramage 1978, 8, fig. 18; these were of rectangular shape with flat central part and straight raised edges).

Portable item – unclear

A smaller subset of portable items, six fragments altogether, could not be identified with precision, although they are flat and have fabrics similar to those of trays. As their raised edges are not preserved, however, and thus their shape cannot be ascertained, they remain categorized as portable, yet unclear in form.

UNCLEAR

As the name indicates, samples that could be classified as neither architecture, installation, nor portable item have been grouped in a separate 'unclear' category (**Tab. 4**). The vast majority of fragments were too poorly preserved for any functional identification – in total, 116 fragments or 31.9 % of the entire dataset. The sheer number of fragments in this category demonstrates that much of our ability to identify form and function depends on preservation as well as context. However, an additional 31 samples could be assigned to a functional subcategory –

mudbrick or impressed. Of these, 29 samples could be identified as some type of mudbrick. They were poorly preserved or lacked contextual clues, which made more specific association with architecture or installations impossible. Their morphology, color, and inclusions match both those of mudbricks associated with architecture and installations, but because of their extreme fragmentation, it was decided not to sort them further based solely on the presence – common in bricks associated with architecture – or absence – usually absent in bricks associated with installations – of chaff and straw. Similarly, two 'impressed' fragments bearing impressions of reeds, planks, and rocks were too fragmentary for their function to be determined; they might have been part of either architectural features or installations.

GRANULOMETRIC ANALYSIS

In the previous section major functional classes of earthen materials were outlined, explaining macroscopic differences in terms of color, fabric, and aggregate composition. In this section (cf. also **Tab. 5**; **Pl. 1/1**), qualitative macroscopic characterization is supplemented with the results of quantitative granulometric (or particle-size) analysis. As described earlier, particle-size analysis evaluates the ratio of silt, sand, and clay in sun-dried, non-hardened earthen materials. This, in turn, offers insights into resource needs and manufacturing processes and reflects manufacturer choices and user preferences. In total, 40 samples were selected based on two primary factors: context – samples were selected from a representative range of well-preserved features or stratigraphically significant fills; and preservation – samples were selected from fragments that were only sun-dried (and not exposed to elevated temperatures) so that they could be dissolved in a deflocculant solution. Most common inclusions seem to be of local origins: micas (biotite, mica-schist, and occasionally muscovite), limestone, and occasionally also grog and shells. In a few samples, quartz was detected as well. While chaff and straw inclusions are common in mudbricks, they preserve as voids or impressions in mudbrick fabrics only and thus are undetectable by this analysis.

Architecture

Impressed earthen architectural fragments were often too fragmentary and/or hardened to allow particle-size analysis, resulting in a selection of architectural fragment samples deriving only from mudbricks and unclear fragments. Mudbricks present the most informative dataset because of abundant comparative research. The ideal ratio of sand to clay and silt in mudbricks is posited to be less than 50 % sand and 25–45 % clay. This ratio yields the best combination of tensile strength (assured by coarse sand and aggregate), binding strength between particles (assured by silt and clay), and minimal shrinkage during drying (assured by the addition of temper) (Rosen 1986; Emery 2009, 2). Mudbrick compositions at Kaymakçı varied greatly, as five of the nine processed samples contained more than 50 % silt/clay, while the remaining four samples range between 16.6 % to 35.2 % silt/clay content. Unclear architectural fragments were less coarse in general, with higher percentages of silt/clay (41.2–70.9 %) than sand.

Installations

Installations comprise a special category of evidence at Kaymakçı, as many were recorded in better preserved lower stratigraphic levels, thus providing rare glimpses of the site's primary contexts. Moreover, much of these features – including hearth, ovens, and/or working platforms, with their mudbrick rims – did not harden, which, on the one hand, made excavating them more challenging, but, at the same time, allowed for a better characterization of their morphology and composition.

	Excavation Area	Context	Sample	Colour
Unclear– unclear	81.551	3	46	7.5YR 6/4
	81.551	3	96	7.5YR 5/2
	81.551	4	5	n/a
	81.551	20	92	5YR 6/4
	81.551	31	10	n/a
	93.545	2	3	n/a
	93.545	2	6	n/a
	93.545	7	8	n/a
	93.545	7	30	n/a
	93.545	18	5	n/a
	93.545	36	9	7.5YR 6/4
	93.545	43	64	5YR 6/4
	93.545	53	7	n/a
	93.545	68	8	5YR 4/4
	93.545	124	6	n/a
	93.545	124	21	5YR 5/6
	93.545	138	6	n/a
	93.545	189	8	n/a
	93.545	245	5	n/a
	93.545	249	9	5YR 5/4
	93.545	263	6	n/a
	93.545	270	6	n/a
	93.545	275	6	n/a
	93.545	277	3	n/a
	93.545	280	9	10YR 6/4
	93.545	286	6	n/a
	93.545	292	1	n/a
	93.545	296	6	n/a
	93.545	297	6	n/a
	93.545	298	8	n/a
	93.545	299	6	n/a
	93.545	300	25	7.5YR 6/4
	93.545	302	6	n/a
	93.545	303	4	n/a
	93.545	304	6	n/a
	93.545	307	6	n/a
	93.545	308	7	n/a
	93.545	315	6	n/a
	93.545	333	8	n/a
	93.545	335	7	n/a
	95.555	2	8	n/a
	95.555	2	164	n/a

	Excavation Area	Context	Sample	Colour
Unclear– unclear	95.555	41	46	n/a
	95.555	91	6	10YR 2/1
	95.555	115	6	n/a
	95.555	120	5	n/a
	95.555	130	7	n/a
	95.555	141	11	n/a
	97.541	2	8	n/a
	97.541	6	86	n/a
	97.541	6	87	n/a
	97.541	10	3	n/a
	97.541	16	614	n/a
	97.541	17	4	n/a
	97.541	22	2	n/a
	97.541	22	9	n/a
	97.541	33	3	n/a
	97.541	38	6	n/a
	97.541	43	3	n/a
	97.541	46	6	n/a
	97.541	49	5	n/a
	97.541	51	6	n/a
	97.541	51	7	n/a
	97.541	98	8	n/a
	97.541	100	5	n/a
	97.541	159	3	n/a
	97.541	218	7	n/a
	97.541	261	1	10YR 3/2
	97.541	268	6	n/a
	97.541	278	72	n/a
	97.541	384	2	n/a
	97.541	486	5	n/a
	98.531	1	63	2.5YR 5/6
	98.531	3	67	7.5YR 6/4
	98.531	6	10	n/a
	98.531	15	3	n/a
	98.531	26	3	n/a
	98.531	34	7	2.5YR 4/4
	98.531	101	9	n/a
	99.526	1	35	10R 4/4
	99.526	5	54	2.5YR 6/6
	99.526	6	4	n/a
	99.526	7	3	2.5YR 5/6
	99.526	10	4	n/a

	Excavation Area	Context	Sample	Colour
Unclear– unclear	99.526	11	65	10YR 6/2
	99.526	11	69	n/a
	99.526	29	8	n/a
	99.526	102	4	n/a
	99.526	103	3	n/a
	99.526	107	120	5YR 5/4
	99.526	126	2	n/a
	99.526	128	231	n/a
	99.526	162	7	n/a
	99.526	169	4	n/a
	99.526	568	76	7.5YR 5/4
	99.526	632	2	5YR 5/4
	99.526	658	1	7.5YR 5/4
	99.526	665	5	n/a
	108.522	2	23	7.5YR 5/2
	108.522	5	38	7.5YR 6/4
	108.522	7	58	n/a
	108.522	10	173	n/a
	108.522	18	13	2.5YR 6/4
	108.522	24	1	7.5YR 6/4
	108.522	30	81	n/a
	108.522	41	82	n/a
	108.522	78	150	n/a
	108.522	11	165	5YR 5/6
	108.522	12	21	7.5YR 6/2
	108.522	13	114	10YR 6/2
	109.523	4	108	n/a
	109.523	4	316	n/a
	109.523	4	419	n/a
	109.523	53	5	n/a
	109.523	85	7	n/a
	109.523	282	31	5YR 5/4

	Excavation Area	Context	Sample	Colour
Unclear – mudbrick	81.551	3	9	7.5YR 5/2
	93.545	85	1	n/a
	93.545	132	3	n/a
	93.545	133	4	n/a
	93.545	199	160	5YR 6/6
	93.545	227	1	7.5YR 4/2
	93.545	228	1	n/a
	93.545	271	6	10YR 6/2
	93.545	299	8	n/a
	93.545	344	6	10R 5/4
	95.555	2	9	n/a
	95.555	27	8	n/a
	95.555	31	8	n/a
	95.555	46	14	n/a
	97.541	289	7	5YR 6/4
	97.541	313	6	7.5YR 6/6
	99.526	5	4	n/a
	108.522	11	162	5YR 6/4
	108.522	48	8	10YR 6/2
	109.523	59	1	n/a
	109.523	105	1	n/a
	109.523	258	4	n/a
	109.523	262	6	5YR 6/4
	109.523	262	8	7.5YR 7/2
	109.523	301	6	7.5YR 4/4
	109.523	302	1	n/a
	109.523	309	266	5YR 4/2
	109.523	314	8	2.5YR 6/6
	109.523	314	37	5YR 5/4
Unclear – impres-sed	97.541	49	6	n/a
	97.541	118	116	5YR 5/4

Tab. 4: List of all earthen fragments of unclear form and function recovered at Kaymakçı. In some cases, color could not be identified due to severe accretion on the surface and/or extreme fragmentation.

In general, ratios between different sand fractions and silt/clay varied significantly. This is particularly true of the 'installation – mudbrick' category, wherein three samples had very high silt/clay content (>70 %), but most of other samples had lower levels of 44–58 %. With a very low silt/clay content of 8 %, a significant outlier is presented by installation – mudbrick 99.526.305.1, which encircled working platform/oven 99.526.79 (**Fig. 9**). The sample contained a very high content of coarse sand, making it very crumbly and unstable, which had been

Category	Sample	% Coarse Sand	% Medium Sand	% Fine Sand	% Very Fine Sand	% Silt/Clay
Architecture – mudbrick	93.545.196.392	74.6	4.5	3.6	0.7	16.6
Architecture – mudbrick	93.545.197.1	12.0	5.2	5.7	2.6	74.5
Architecture – mudbrick	97.541.237.66	23.8	6.6	4.3	9.0	56.3
Architecture – mudbrick	97.541.265.1	20.5	3.6	5.0	4.8	66.1
Architecture – mudbrick	99.526.300.1	11.6	4.6	8.8	3.8	71.2
Architecture – mudbrick	99.526.350.4	17.3	4.1	15.2	2.2	61.3
Architecture – mudbrick	99.526.445.7	37.3	12.2	10.3	5.1	35.2
Architecture – mudbrick	99.526.515.5	58.0	2.4	9.0	6.9	23.7
Architecture – mudbrick	99.526.573.10	11.6	4.5	7.2	4.4	72.3
Architecture – unclear	99.526.121.13	15.5	4.1	5.6	4.0	70.9
Architecture – unclear	99.526.142.1	39.5	3.5	7.1	8.7	41.2
Architecture – unclear	99.526.169.1	16.7	4.7	9.8	9.0	59.8
Architecture – unclear	99.526.169.7	23.6	8.0	10.8	5.1	52.7
Installation – mudbrick	99.526.271.1	16.6	7.3	10.2	8.4	57.4
Installation – mudbrick	99.526.299.1	7.2	2.7	5.6	6.1	78.4
Installation – mudbrick	99.526.305.1	71.6	9.6	8.8	2.0	8.0
Installation – mudbrick	99.526.305.2	18.3	4.4	2.6	3.9	70.8
Installation – mudbrick	99.526.325.1	26.3	6.1	18.6	4.2	44.9
Installation – mudbrick	99.526.326.1	20.9	6.4	7.1	9.6	56.0
Installation – mudbrick	99.526.327.1	20.7	7.2	15.9	6.2	50.0
Installation – mudbrick	99.526.393.2	22.0	7.2	10.4	13.8	46.6
Installation – mudbrick	99.526.417.2	13.1	4.7	5.7	7.6	69.0
Installation – mudbrick	99.526.426.1	16.7	5.5	6.0	15.4	56.4
Installation – mudbrick	99.526.428.1	11.0	2.2	3.8	2.5	80.4
Installation – mudbrick	99.526.509.1	18.8	4.0	8.1	6.6	62.5
Installation – substructure	99.526.292.2	58.7	0.1	2.6	5.8	32.8
Installation – substructure	99.526.308.3	9.5	4.6	9.8	8.4	67.8
Installation – substructure	99.526.356.2	19.8	9.3	13.0	7.0	50.9
Installation – substructure	99.526.397.7	16.4	5.8	4.9	5.5	67.4
Installation – surface	93.545.190.5	31.9	6.2	8.8	3.8	49.4
Installation – surface	93.545.218.1	34.0	4.7	4.4	10.3	46.6
Installation – surface	99.526.264.1	41.4	10.8	0.3	22.4	25.1
Installation – surface	99.526.276.1	22.2	5.6	14.4	4.5	53.6
Installation – surface	99.526.289.1	34.6	6.4	7.8	10.3	40.6
Installation – surface	99.526.310.1	18.2	9.0	11.8	8.9	52.1
Installation – surface	99.526.393.1	18.9	6.2	7.3	12.5	55.1
Installation – unclear	99.526.297.9	24.0	8.1	7.4	10.5	50.0
Installation – unclear	99.526.297.98	59.7	4.7	3.9	15.1	16.6
Installation – unclear	99.526.351.5	41.6	4.1	6.4	6.7	41.3
Installation – unclear	99.526.513.1	24.8	7.9	8.2	7.0	52.1

Tab. 5: Results of granulometric analysis as percentage representation of sand and silt/clay particles in earthen features from Kaymakçı.

noted already during excavation. Installation mudbricks that delineated features contained primarily clay and silt with dense stone aggregate and without significant straw and chaff. Moreover, individual bricks in a mudbrick installation tended to be visually different. An example of such a situation is represented by a series of mudbricks associated with circular hearth 99.526.315. Here, a series of installation mudbricks (99.526.325, 99.526.326, and 99.526.327) encircled the hearth (**Fig. 15**). All these mudbricks were rather coarse, rich in schist inclusions, and of brown to light reddish brown color (5YR 6/4, 7.5YR 5/4, and 5YR 6/4 respectively), but their morphologies differed, as will be discussed in the following section.

Fig. 15: Poorly preserved circular hearth (99.526.315) with a series of mudbricks around it creating a rim (© Gygaia Projects).

Installation surfaces proved to be a relatively less heterogeneous category, whereby silt/clay content in seven samples fluctuated between 25.1–55.1 %. Here, granulometric analysis confirmed observations from excavation, namely that these surfaces are quite coarse, containing a higher proportion of coarse sand fraction. In comparison, installation substructures tend to have a higher amount of silt/clay (50.9–67.8 %), with the exception of a sample from a deposit with a slightly unusual lower content of silt/clay (32.8 %), adjacent to another mudbrick-rich feature by wall 99.526. 15. Four 'installation – unclear' samples were analyzed in the hope that results might inform on function. Their silt/clay content of 41.3–52.1 %, however, fits comfortably within all categories. An outlier, a sample of a mud-rich feature (99.526.297.98) with significant coarse sand (59.7 %) and low silt/clay (16.6 %) quantities was excavated in a soft fill below hearth 99.526.292. Yet another sample (99.526.297.9) from the same feature had an equivalent amount of sand to silt/clay. This difference suggests an uneven mixing of sediment in preparation for this mud-rich feature.

Most crucially, granulometric analysis beneficially informed on the morphology of entire features. For example, the various components of working platform/oven 99.526.79 (**Fig. 9**; **Pl. 1/2**) can be effectively distinguished, even if individual strata and components appeared visually similar. The topmost surface 99.526.264 was rich in clay, while the lower surface 99.526.276 contained more sand. The rim-forming installation – mudbricks 99.526.305.1 and 305.2 were visually very similar (5YR 5/4 and 5YR 6/2 respectively), but rather heterogeneous in terms of composition; all but mudbrick 99.526.305.1 contained a high percentage of silt/clay.

One of the more substantially preserved earthen features so-far excavated at Kaymakçı, circular oven 93.545.171 (**Fig. 8**), enabled easier identification of components of ovens and hearths throughout the site. As already described, it consisted of a hard, grayish mud cap and substructure of increasing coarseness. The cap preserved a very noticeable 0.56 cm hard lens, with a substructure that could not be easily separated from it. However, as the entire context was non-hardened, we were able to subject the looser matrix located immediately below the cap to particle size analysis (sample 93.545.190.5 from the southern section, 93.545.218.1 from the northern section). As the feature was sectioned during analysis, the results here demonstrate the natural variation within sediments. While a sample taken from a southern section was made of nearly equivalent amounts of sand (50.6 %) and silt/clay (49.4 %), a sample taken from the northern section consisted of slightly less sand (46.6 %) and more clay (53.4 %).

Portable item

All tray-like fragments – portable items and installation – trays – were recovered in a hardened form and were therefore not viable for granulometric analysis.

DISCUSSION

This study highlights that traditionally unclassified earthen materials, features, and objects are important and that constructively approaching the typically fragmentary preservation of such remains is a productive exercise. At the beginning of the excavations at Kaymakçı, our team was more successful in identifying built architectural features, but was challenged by earthen working platforms, linings, and portable objects, or fragments discarded in secondary and tertiary fills, often very disturbed as a result of post-use and taphonomic factors. This tendency is understandable and in part reflects the general attitudes of scholarship towards publishing earthen architecture and better-preserved subsets of excavated datasets. In the case of fragmentary remains, the function of which is not immediately clear, however, it is important to understand how or how much a lack of comparable studies compromises interpretation. We therefore isolate a number of key takeaways in what follows.

Earthen features and objects were made locally and by hand, perhaps close to their places of use. This allowed for the development of diversification and personalization to fit specific purposes, often of multiple functions, which brings out the malleability of earthen materials as the basic building blocks of diverse activities conducted at Kaymakçı. Overall, however, based on studies of formation processes and the degradation of earthen materials, it can be suggested that many of the earthen features and objects so far excavated were left exposed for some time before their burial.

A further obstacle to identifying the function of much earthen material is the fact that most fragments come from secondary or even tertiary fills rather than primary deposits. An exception to the rule is the group of installations, well-preserved examples of which were excavated across the site. This allowed our team to reconstruct the original function and form of a number of categories of earthen materials, including surfaces and supporting substructures as well as delineating features. In area 99.526, which provides the most secure contextual information for a wide range of earthen material functions, earthen features and objects were often found in association with domestic and storage as well as small-scale craft production activities. In terms of mudbrick and earthen features, this area produced more diverse features than elsewhere nearby and in the inner citadel, where varied activities such as storage, food processing, and cooking took place.

In general, we can now distinguish better functions across earthen features and building media, thus not limiting our observations to earthen installations. For example, impressed architectural fragments bearing reed and wood impressions were originally classified on their own; as a result of better understanding gained in the course of our work, however, their primary function has been redefined as that of lining in architecture. This allows for a better recognition of similar function across broad categories, namely with respect to lining of negative features, now classified as 'installation – impressed'. Likewise, with increasing knowledge of material variation at Kaymakçı, many items earlier misclassified as coarse or low-fired ceramics could be identified as portable items of earthen manufacture. The earlier misclassification of such materials is understandable; they have relatively coarse fabrics and well-sorted dense matrices, but they are neither processed nor fired with the same care allotted to low-fired ceramics.[5] It is thus not inconceivable that utilitarian earthen objects have been misclassified as mudbrick, coarse or low-fired ceramic items, or even tiles, as suggested for Late Bronze Age Greece (Jazwa forthcoming). Western Anatolian trays might have been misclassified as large pithos fragments, because their thickness – slightly lesser than those of 'installation – tray' fragments – is similar to that of large storage vessels, although the curvature of the shape is negligible. It is less likely that trays have been misclassified as tiles, however. Roof tiles have yet to be identified at Late Bronze Age Kaymakçı or nearby contemporary sites, and current evidence suggests the use of flat, rather than pitched, roofs made of reeds and earthen materials.

Specifically concerning mudbrick manufacture, our new knowledge of LB mudbrick making practices informs on the cultural and functional preferences in Anatolia and the wider Mediterranean. In this respect, the square dimensions of mudbricks from Kaymakçı are of interest for at least two reasons. The use of square bricks requires frequent alterations if bricks are laid in superimposed courses of a wall; offsetting each course is required to avoid destabilization resulting from vertical interstices that cross multiple horizontal courses. Such offsetting can be achieved by cutting a brick in half and inserting half bricks into every other course; laying the wall with stretchers and headers; and using other molds for fashioning differently sized bricks (Naumann 1971, 89–91; Wright 2006, 96–108). It is entirely possible that inhabitants of Kaymakçı used mudbricks of varying sizes for such purposes. At this point, however, questions concerning methods of construction and manners of bonding at Kaymakçı cannot be addressed owing to the limited nature of available evidence.

A further observation of interest concerning Kaymakçı's square bricks (with lateral dimensions of 32.0–34.5 cm and a height of 7.8–8.6 cm) concerns possible connections with other regions in terms of building technology. Documented examples from the eastern Mediterranean, the Aegean, and Anatolia suggest a preference for rectangular bricks in the Aegean and on Cyprus, with sides 40.0–60.0 cm long (Nodarou – Frederick – Hein 2008; Shaw 2009; Costi

5 The range of related portable items made of low-fired mixtures of sand, clay, and silt, with little aggregate, include coarse utilitarian pottery, weights, and architectural moldings, none of which will be discussed in this article given their study as part of ongoing ceramic and small finds research.

de Castrillo – Philokyprou – Ioannou 2017; the dimensions of rectangular mudbricks at Neopalatial Malia, however, range more widely 27.0–62.0; see Devolder – Lorenzon 2019). Hittite traditions, on the other hand, employed square bricks (with lateral dimensions of either 40.0 or 50.0 cm and 10.0–12.0 cm thick) as well as half-bricks (Seeher 2007, 73–78). The size of the bricks is related to not only the established building strategies, but also the measurement systems in place (Mielke 2009, 99–100). Moreover, Hittite construction incorporated wooden elements which would have increased the elasticity of buildings (Mielke 2009). No wooden elements have been discerned at Kaymakçı – through either direct or indirect evidence in the form of negative impressions. Returning to bricks, it is worth noting that the larger bricks employed in Hittite architecture seem to have been common in antiquity. Lydian mudbricks from Iron Age Sardis tended to be large, yet they were rectangular, measuring either 40.0 by 25.0 cm and 8.0–10.0 cm thick, as used in buildings in sector HoB, or 50.0 by 30.0 cm and 10.0–12.0 cm thick, as used in the fortification wall of sector MMS (Ramage 1978, 5–6). The long dimensions of later 1st millennium BCE rectangular mudbricks from Greece were often similarly large (41.0–52.0 cm) (Schwandner 1999, 529; Seeher 2007, 31). Moreover, many mudbrick makers used different mudbrick recipes (Love 2017, 353), and Hittite mudbrick makers used different raw materials, as visible through color variations from red to yellow (Seeher 2007, 31). A similar trend of differentiation has been observed at Kaymakçı as well as at Sardis. Further study of mudbrick dimensions and compositions has the potential to shed additional light on the reconstruction of patterns of contact and influence between western and central Anatolia and the Aegean.

The combination of macroscopic with granulometric particle-size analyses of earthen features and objects in this study reveals individual choices and the preferences of past manufacturers and users. Granulometry sheds light on manufacture and aids in distinguishing between different recipes. There is an inherent bias in this dataset, however. Particle size analysis relies on loosening of individual earthen particles with the aid of a deflocculant solution, and it cannot be applied to hardened features, whether hardened in their original state or as a result of depositional and post-depositional processes. Most of the processed samples, therefore, come from area 99.526 on the southern terrace and belong to the following categories: architecture – mudbrick; architecture – unclear; installation – surface; installation – substructure; installation – mudbrick. The results are highly informative, nonetheless. The analysis shows that earthen materials at Kaymakçı vary substantially in terms of sand to clay/silt ratios. Yet, visual and compositional differences within single features tend to be common across sites (Love 2017, 354) and this trend is, therefore, by no means unique to Kaymakçı. Overall, it can be suggested that the heterogeneity of composition in this class of materials can be explained either by reuse of previously manufactured earthen materials or by differential manufacture and resource acquisition. In any case, there seems to be a certain level of disinterest for visual homogeneity and tensile properties within single features, such as hearths/ovens. If visual homogeneity was indeed important, perhaps these features were originally covered with a coating, such as plaster, to unite their appearance.

Last but not least, this study also provides information on the differential functionality of areas enclosed by Kaymakçı's fortification wall (**Tab. 6**; **Pl. 1/3**; Roosevelt *et al.* 2018, 648–662). The excavated sections of the fortifications in areas 81.551 and 95.555 were clear of much debris, with only humble earthen materials retrieved. Areas 97.541 and 98.531 on top of the citadel were dedicated to storage, residential, and workshop activities, at least during the end of LB 1 and throughout the LB 2 period. These areas yielded mostly architectural mudbricks and very fragmented remains of installations and portable items. Area 93.545, located at the center of the innermost ring of fortifications, was very likely dedicated primarily to storage

	81.551	93.545	95.555	97.541	98.531	99.526	108.522/109.523	Total
Architecture – mudbrick	6	26	7	14	4	19	14	**90**
Architecture – unclear	0	0	0	0	0	5	0	**5**
Architecture – impressed	0	22	1	1	0	0	4	**28**
Installation – surface	0	15	0	0	0	11	0	**26**
Installation – substructure	0	0	0	0	0	4	0	**4**
Installation – mudbrick	0	1	0	0	0	16	1	**18**
Installation – tray	0	3	0	1	0	1	0	**5**
Installation – impressed	0	0	0	0	0	4	0	**4**
Installation – unclear	0	4	1	2	3	9	1	**20**
Portable item – tray	0	8	0	2	0	1	0	**11**
Portable item – unclear	0	1	1	2	1	0	1	**6**
Unclear – unclear	5	35	8	24	7	19	18	**116**
Unclear – mudbrick	1	9	4	2	0	1	12	**29**
Unclear – impressed	0	0	0	2	0	0	0	**2**
Total	**12**	**124**	**22**	**50**	**15**	**90**	**51**	**364**

Tab. 6: Overall counts of the different types of earthen features and objects per excavated area.

activities, and earthen materials and objects here were broadly represented by the fills of the pits. In fact, much of the material was highly fragmented. Remains of architectural fragments, parts of installations, and portable items were discarded as part of secondary and tertiary fills, perhaps as a result of periodic clearing of the area. On the southern terrace, residential, household, and workshop activities, such as food processing, small-scale crafting, and storage, took place in areas 99.526 and 108.522/109.523. Area 99.526, in particular, was important for the present study, as it was the only area in which earthen installations, such as hearths and ovens, were preserved in situ (as part of late LB 1 and early LB 2 strata). Despite the relatively good preservation of features that were buried in the deeper stratigraphic levels, much of the material remains of unclear form and function.

CONCLUSIONS

This study presented an overview of different categories of earthen materials discovered at the site of Kaymakçı. It aimed to demonstrate the importance of studying datasets in their entirety and in a reflective manner, grappling even with remains of unknown form and function. Even if one in three collected fragments from the excavated areas at Kaymakçı could not be identified beyond being purposely manufactured from a mixture of sediment and aggregate, careful documentation of both the context of discovery and the characteristics of excavated features and objects allowed for new information and interpretation. While this number may seem large at first, the proportion of unidentifiable fragments was much higher in the first year of the study. By tackling these traditionally unclassified materials, incorporating increasing knowledge of Kaymakçı's archaeological remains, and re-studying the earthen assemblage, we gained a better understanding of the entire dataset and were able to interpret its function in more specific terms. This result was possible only because of collaboration across the various specialisms of the excavation team, bringing into conversation excavators, ceramics and small finds specialists, as well as analytical scientific and conservation crews.

While the multiyear analysis of earthen materials and features produced a general classification for Kaymakçı, the morphology and function of earthen features and objects at sites both near and far away might differ significantly because of the 'hyper-local' nature of this class of archaeological material. We therefore stress the need of increased site-specific research and publication that would allow data comparisons. It is not only the diversity of local forms and their poor preservation, however, that makes inter-site comparisons difficult. Issues of recognition and misidentification, too, are pervasive, because this is a challenging class of material to excavate, identify, analyze, and curate. Yet, it is precisely this very challenging nature of the material that makes its increased study and publication imperative in order to reveal the diversity of ways it was used every day by Late Bronze Age communities in the eastern Mediterranean.

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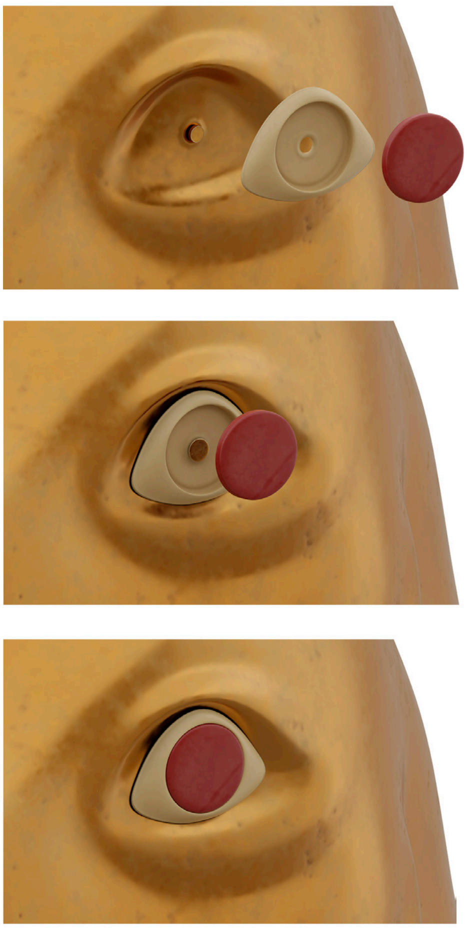
Jana Mokrišová
Research Associate
Faculty of Classics, University of Cambridge
Sidgwick Avenue, Cambridge, CB3 9DA
jm2421@cam.ac.uk

Christina Luke
Department of Archaeology and History of Art
Koç University
Rumelifeneri, Sarıyer
İstanbul, TR-34450
christinaluke@ku.edu.tr

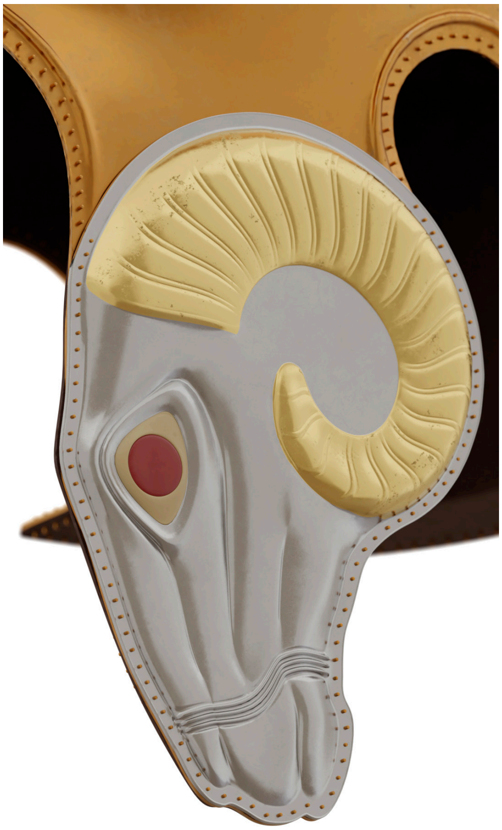
Christopher H. Roosevelt
Department of Archaeology and History of Art
Research Center for Anatolian Civilizations
Koç University
Rumelifeneri, Sarıyer
İstanbul, TR-34450
chroosevelt@ku.edu.tr

Caitlin R. O'Grady
Institute of Archaeology
University College London
31-34 Gordon Square
London, WC1H 0PY, UK
caitlin.r.ogrady@ucl.ac.uk

Pl. 2/1: Detail of the ivory and painted eyes that decorate the protome, restored by J. Ternbach (photos by G. Zuferri, with permission of the SLAM).



Pl. 2/2: 3D reconstruction of the assembly sequence of the eyes that decorated the protome. This sequence is also applicable to the Cheekpiece appliqués with the only difference being the position of the central nails: present in the structure of the protome and applied from the outside for the Cheekpieces (3D drawing M. Sánchez).



Pl. 2/3: 3D reconstruction of the original cheekpiece with a combination of silver, gilded silver appliqué, with an ivory and glass paste eye, on the bronze helmet (3D drawing M. Sánchez).

Pl. 2/4: 3D reconstruction of the protome with a realistic system of horns and ears. Nothing of the original system is preserved. Only the two fragments commented on in Fig. 17 could be related, without certainty (3D drawing M. Sánchez).

Pl. 2/5: 3D exploded drawing of the parts that shaped the original helmet, in order of assembly (3D drawing M. Sánchez).

Pl. 2/6: 3D reconstruction of the original appearance of the helmet (3D drawings M. Sánchez).

Pl. 2/7: 3D reconstruction of the bell cuirass (3D drawings J. Quesada).

Pl. 2/8: 3D reconstruction of the decorated greave fragment following the morphology of the so--called Club Variant (3D drawings J. Quesada).