"From the Ground Up. Earth in Minoan Construction Techniques. The Case of Building 5 at Palaikastro"

Devolder, Maud

ABSTRACT

The violent destruction by fire of Building 5 at Palaikastro, Crete, provided a interesting and varied collection of well-preserved fired-earth elements. Those include fragments of mudbricks, mud coatings, roofs/ceilings, doorjambs, and other samples which bear impressions of wooden elements, probably from installations made of a combination of earth and wood. The publication of a selection of the samples has two purposes. The first is to offer a typological description of the earthen features in order to elucidate their various functions and their importance in Minoan architecture. Thus considered, the fragments described illustrate particular construction techniques and help reconstructing the original appearance of the building. The second purpose of this study is to consider the knowledge Minoan builders had of materials and techniques involved in earthen architecture. This study may allow some insights into the status of the practitioners of architecture and the degree of involv...

CITE THIS VERSION

From the Ground Up: Earth in Minoan Construction. The Case of Building 5 at Palaikastro

MAUD DEVOLDER

The violent destruction by fire of Building 5 at Palaikastro, Crete, provided an interesting and varied collection of well-preserved fired-earth elements. Those include fragments of mudbricks, mud coatings, roofs/ceilings, doorjams, and other samples which bear impressions of wooden elements, probably from installations made of a combination of earth and wood. The publication of a selection of the samples has two purposes. The first is to offer a typological description of the earthen features in order to elucidate their various functions and their importance in Minoan architecture. Thus considered, the fragments described illustrate particular construction techniques and help reconstructing the original appearance of the building. The second purpose of this study is to consider the knowledge Minoan builders had of materials and techniques involved in earthen architecture. This study may allow some insights into the status of the practitioners of architecture and the degree of involvement of inhabitants or of specialists in construction.

Because it was destroyed by a violent fire at the end of Late Minoan (LM) IB, Building 5 at Roussolakkos in Palaikastro, Crete, offers an interesting and varied collection of fired-earth elements illustrating the role of this material in Minoan Neopalatial architecture (Fig. 1). One of the two aims of this paper is to offer a typological description of these remains, illustrating particular construction techniques and helping to reconstruct the original appearance of the building.2 While this latter aspect will be considered in full detail in the final publication,3 the role and composition of a selection of the most significant samples is studied here. Combined with observations on published samples from other contemporary buildings, the present report aims to elucidate the various functions of earthen elements and their importance in Minoan architecture. It will be suggested that the specialised use and character of earthen architectural features point to a common use of a material that is often barely preserved and only rarely given sufficient attention in excavation reports.4

1 Thanks are due to the directors of the Palaikastro excavations, Hugh Sackett, Sandy MacGillivray and Jan Driessen, for permission to study and reproduce the material presented here. Particular thanks go to Jan Driessen for his advice and comments, as well as members of the Topography of Power project at the UCLouvain. I am extremely grateful to Pamela Jerome, Joseph Shaw, Martin Schmid, Jules Bou-harmont and Anaya Sarpaki for their help and comments on specific subjects, as well as to Carl Knappett for comments on early drafts.


Building 5 at Palaikastro was discovered in the course of the British School excavations at Palaikastro, between 1986 and 2003. Built in LM IA, it was considerably modified in the course of its history before it was destroyed by fire in LM IB. After minor damage following a presumed fire in the course of the LM IB period, some of its rooms were given ashlar façades, a few floors needed relaying, some walls were rebuilt and the north-western part was cut off from the remaining building. It is here that fragments of a large chryselephantine statuette were found. After the LM IB destruction, the north-western part of the building was partly cleaned out and reused during LM III. In the south-eastern part, however, the mass of burnt collapsed destruction debris remained and it is from this level that the material presented here derives. Indeed, the undisturbed state of the destruction layer comprised an exceptional concentration of earthen elements, allowing a contextual study. The samples described illustrate the knowledge Minoan builders had of materials and techniques involved in earthen architecture. Some aspects such as the composition of various earthen features lead to a better understanding of the possible ways in which their production was organised. In fact, the material described here allows us to explore a key question in Minoan architecture: what was the status of its practitioners, and how involved were ordinary people and/or construction specialists.

The destruction layer of Building 5 comprised, in addition to a large quantity of shapeless mudbrick fragments, a series of samples illustrating the various uses to which earth was put in construction techniques, ranging from bricks and revetments to ceilings, floors and other structural elements. Five categories of materials could be distinguished: fragments of mudbricks, mud coatings, roofs/ceilings, doorjambs, and samples which cannot be fully identified beyond the fact that they bear impressions of wooden elements. The latter probably formed part of installations that combined earth and wood such as niches, window-sills, shelves, boxes, bins, compartments etc. Although the basic component of all the samples is earth, their specific composition, especially where binding elements are concerned, differs consistently, allowing straightforward macroscopic typological distinctions. The samples presented here were selected because they illustrate specific features in terms of function or composition. The present investigation is only part of an initial analysis of the building, but points to the need, if not to reassess, then to define more accurately the role of earth, and the particular shapes formed by this material in Minoan Neopalatial architecture. Moreover, further studies on the role of wood may provide interesting insights into earth construction, perhaps clarifying the existence of various earthen-wall categories.

### Mudbrick walls

Most of the mudbrick walls in Building 5 have disappeared, owing to post-depositional vicissitudes. Often, only their stone socle survives, but some standing architectural remains in the building act to preserve the bricks. Many others, in various degrees of preservation, were found during excavation. In order to be suitable for construction, bricks should present a heterogeneous granulometry: gravel, silt, sand and clay, with the latter material ensuring the cohesion between the various particles. Their heterogeneity ensures the right balance between a sufficient plasticity of the matrix on the one hand, and cohesion of the elements on the other hand, so as to avoid disintegration during the drying process. It is this particular combination which justifies the use of the term ‘earth’ rather than clay since the latter represents only one of the different components of the matrix and it is better to...
avoid the term since one risks confusion with both a geological deposit and a specific grain size. Several studies have stressed the importance of *terra rossa* in Aegean earth construction, implying an earth type formed by the slow weathering of dense, hard limestone, with enrichment of Fe$_2$O$_3$. In the case of Palaikastro, it has been suggested that the toponym of the site ‘Roussolakkos’ – if not related to the Greek verb *reo* ‘to flow’ – may mean ‘red pit’ and be a result of the presence of a clay pit area against the lower slopes of the Petsofas hill, just next to the excavations, where the Minoans exploited their building earth. It is perhaps good to remember that the recommended clay proportion for making earth suitable for architecture is between 5 and 30%, with a minimum of 40% sand particles. Samples from Building 5 tested by P. Jerome indicate proportions fitting these ranges. As far as the temper and binding elements within the matrix are concerned, gravel, pebbles, sherd, straw and cereal by-products, sea grasses, leaves and some shells have all been identified, both in standing architecture.

---

Fig. 1. Plan of Neopalatial Building 5, Palaikastro (Jan Driessen)

---

8 GUEST-PAPAMANOLI (n. 4), 5. P.S. JEROME (n. 4, 1991), 40–63 conducted several analyses on the earth material of Building 5 of Palaikastro, especially in view of conservation (XRD, petrography, CaCO$_3$ and rare earths analysis).

9 J.L. BINTLIFF, Natural Environment and Human Settlement in Prehistoric Greece (BAR Suppl. 28, Oxford 1977), 92; A. FOU-CAULT and J.-F. RAOUULT, Dictionnaire de Géologie (Paris 2001), 349. Note that the definition given here is *sensu stricto*, but it is sometimes used to mean a clayey earth.


12 Jerome (n. 4, 1993), tabl. 4.
and in collected samples (Fig. 2–3). This confirms observations made elsewhere.13

While sherds have evidently been deliberately added to the matrix of the bricks, autopsy shows that gravel is naturally present in the terra rossa of the clay pit area to the south-east of the site. Pebbles are likely to have been collected on the nearby beach. Some white inclusions visible in some pieces may be the result of the high temperature to which the building was submitted during the LM IB fire destruction since the calcareous gravel (CaCO₃) present in the matrix lost CO₂ by firing and became lime (CaO) through contact with atmosphere moisture. It is also possible, however, that calcite chunks were deliberately added as a temper.14 All these mineral components, whether or not deliberately added to the matrix, reduced its plasticity, at the same time reducing the risk of deformation and shrinkage.15 Perhaps the addition of sherds also helped this last factor by distributing stress throughout the feature, as is the case for vegetal inclusions.16

Microscopic observations of mudbrick samples have also shown the incorporation of grog, i.e. burnt clay, in the matrix: “Grog was typically added to mudbricks for tempering, and the finer the grog mixed in with the clay, the stronger the resulting material.”17

The impressions of vegetal inclusions that can still be identified belong to sea grasses, straw and leaves. Because of their shape, these are considered important components against shrinkage, since sea grasses and especially straw help to conduct water out of the feature and distribute stress over the whole material. Straw, mainly awns and chaff, and sometimes even culms of barley (Hordeum but species not identifiable) have been identified, but other cereals cannot be excluded. Gramineae weeds are also present and there is possibly even the impression of a grape pip.18 While most of these vegetal inclusions are only preserved as imprints, some appear mineralised. The presence of straw allows us to distinguish between pieces which belong to mudbricks and those which belong to mud-coating fragments. Although it is present in both, it can be found in far bigger proportions in the coating. This may be because the thinness of the mud coat resulted in a faster drying and hence a more drastic shrinkage with a danger of cracking and crumbling, a risk which

14 DANDRAU (n. 4), 93f; It seems a temperature of more than 800° C. was reached in room 2, MACGILLIVRAY et alii (n. 6), 58; CUNNINGHAM (n. 5), 36f.
15 DANDRAU (n. 4), 94.
16 SHAW (n. 4, 1973), 187 suggests sherds and stones added strength to the material.
17 JEROME (n. 4, 1993), 384.
18 Identifications by Anaya Sarpaki.
was countered by a more intense use of temper. The imprints that are still visible on most of the mudbrick (and doorjamb) samples match nicely those left by sea grasses that still cover the shore at Palaikastro and which one of the early excavators had already found in collapsed roof layers in block Epsilon.\textsuperscript{19} Their shape is very characteristic with long leaves, 1 cm-wide, with slight striations and a curved end. It can be identified as \textit{Zostera marina}, a common marine weed of shallow waters in the Mediterranean.\textsuperscript{20} The particular shape of the impression left on some mudbricks and doorjamb fragments and, in particular, their total absence from the mud-coating fragments, suggests that this sea grass was intentionally used as a binder. It was, however, avoided in the application of mud coatings undoubtedly because of a risk of foliation that would be created by the shape of sea grass in a thin feature. In the case of mudbricks, the large size of the piece meant that the risk of foliation was negligible, and the sea grass in fact ensured cohesion of the matrix by twirling into it.\textsuperscript{21} In any case, the purpose of the various major vegetal inclusions (sea grass, straw and associated cereal by-products) would have been twofold: as temper and a cohesion agent. The presence of these components in various types of samples, easily justified by their specific purposes, therefore allows an easy typological distinction between earthen-feature elements, the fragmentary state of which sometimes poses a problem in terms of identification.

Building 5 is a good example of the brick moulding which is often commented on in Minoan architecture.\textsuperscript{22} No straightforward module can be identified but some recurrent dimensions do appear.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|p{8cm}|}
\hline
Length (m) & Width (m) & Height (m) & Provenance \\
\hline
0.42 & - & 0.09 & \textit{In situ}, northern part of wall between rooms 5 and 6 \\
0.49 & - & 0.09 & \textit{In situ}, northern part of wall between rooms 5 and 6 \\
0.24 & - & 0.11 & \textit{In situ}, in the north wall of room 4 \\
0.14 & - & 0.07 & \textit{In situ}, in the north wall of room 4 \\
0.20 & 0.10 & - & \textit{In situ}, in the north wall of room 4 \\
0.20 & 0.10 & - & \textit{In situ}, in the north wall of room 4 \\
0.25 & 0.17 & - & Sample from room 4 \\
\hline
\end{tabular}
\caption{Dimensions and provenance of \textit{in situ} and sampled bricks.}
\end{table}

\textsuperscript{19} M.R. DAWKINS, Excavations at Palaikastro. III, BSA 10 (1903–04), 205.
\textsuperscript{20} I thank Prof. J. Bouharmont, of the Université catholique de Louvain, for his identification of the sea grass. Note that \textit{Posidonia oceanica}, of a family close to that of the \textit{Zostera marina}, was identified in the bricks of Gournia, Malia and Nirou Chani by A. GUEST-PAPAMANOLI (n. 4), n. 21.
\textsuperscript{21} It may be surprising to encounter marine inclusions in the bricks since the salt may have migrated and provoked the disintegration of the mudbrick. Perhaps the grasses were washed with river water before being integrated in the matrix. Note that during the restoration of the nearby Toplou Monastery, sea grass was spread on the reeds of the roof to support a layer of \textit{lepidochoma}. The salt favoured the conservation of the sea grass, hence ensuring its supporting function over a long term (J.A. MacGillivray, pers. com).
\textsuperscript{22} C. PALYVOU, Akrotiri Thera. An Architecture of Affluence 3,500 Years Old (Philadelphia 2005), 114 mentions hand-shaped mudbricks that were used exclusively for partitions at Akrotiri [e.g. room 4-4a in the West House, rooms 3, 7 in Xeste 3, room B1a-B1b in Beta-South, rooms D9.1 and D9a in Delta West, room 2 in Alpha East and room D2 in Delta East]. In the palace of Gournia, moulded bricks were found (J. SOLES, The Gournia Palace, AJA 95 (1991), 34, n. 19) and A. DANDRAU (n. 4), 315 mentions a hand-shaped sample from Kavousi-Vronda.
These, together with the regular sides of the bricks, suggest they were moulded, and that the same mould was used for the mudbricks of a single wall, but it must be added that not enough measurements could be taken to be absolutely certain. Two partitions preserved in situ in the area between rooms 4 and 7 (Fig. 1) nevertheless show that while moulding was the most frequent technique, hand-shaping was also used.

A long, curved mudbrick of 58 by 11 cm can still be seen in the wall between room 2 and corridor 20 (Fig. 4). The curvature seems to result from the fact that the mudbrick was inserted in the wall and placed partly on top of a stone while not sufficiently dry, and then submitted to the pressure of the upper part of the wall, rather than suggesting that this was hand-moulded. This piece may shed light on another aspect of the brick-manufacturing process. In fact, it seems likely that this brick was moulded on the construction site itself, explaining why it was still wet when the wall was constructed, a feature which would not have occurred if the brick had been transported from a more distant production area. This may contradict the hypothesis of a large-scale production centre at the ‘clay pit’ of Roussolakos, where bricks could have been mixed, moulded, dried and transported to the construction spot when ready, once required. This therefore suggests that mudbrick production was a non-industrial activity, organised and carried out by a small number of people gathering the necessary raw materials and producing the bricks on the construction site itself, responding to the sporadic and immediate needs of the construction. This is also suggested by the dimensions of the bricks. While similar dimensions are repetitive enough to suggest moulding, no standardization occurs to illustrate a larger-scale industrial production. The matrix of some bricks corroborates this hypothesis of a small-scale, on-the-spot production. Inclusions which may be considered as accidental or fortuitous have been found, such as bone fragments which are not common enough in the matrix to support a claim that they were necessary components; rather they seem to come from on-site rubbish dumps. Some bricks even contain remains of wall plaster suggesting that wall-collapse was also integrated in the bricks. These plaster bits are flat and very regular and were clearly part of ancient wall revetments. Unfortunately, the existence of a small-scale production, as corroborated by various pieces of evidence, tells us nothing about the status of the workers or working teams involved. Also, if some conclusions about the character of brick manufacture can be drawn, they cannot necessarily be extended to all the mud features in the building. The material provided by Building 5 excavations does not even make it possible to assess the scale of production of other mud features: wall, ceiling and floor revetment, features combining wood and earth, doorjambs, described below, even less to assess the status of their producers. That those people were well acquainted with earthen building techniques seems obvious, but we cannot infer whether or not they were specialists, whether full- or part-time. Again, and we could take the example of carpenters here, it is hard to state whether building activities were part of a common knowledge, or required specialisation.

No manufacturing place has hitherto been discovered but a stack of mudbricks discovered in the Little Palace at Knossos may have been used for Neopalatial repairs (A. EVANS, The Palace of Minos: a Comparative Account of the Successive Stages of the Early Cretan Civilization as Illustrated by the Discoveries at Knossos. II.2. Town-Houses in Knossos of the New Era and Restored West Palace Section, With its State Approach (London 1928), 519); according to E. Hatzaki, however, those bricks rather suggested a LM IIIA mudbrick wall of which only the rubble base remained in situ, E. HATZAKI, Knossos. The Little Palace (London 2005), 71.
Mud coatings

During the excavation of Building 5, a large number of pieces were collected which we have termed ‘mud coatings’, in order to avoid the terms ‘clay’ (for reasons explained above), and ‘plaster’ (which is altogether better reserved for a different type of revetment). Some wall surfaces in Building 5 preserve substantial coatings in situ. With thicknesses varying between 0.5 and 3 cm, the most common thickness being 1–1.5 cm, these mud coatings were intended to provide an even surface, both for rubble and earthen walls. In most cases, these coatings were supposed to receive another, finer revetment. The section of many samples shows the presence of superimposed layers of coatings, from a coarser and thicker levelling layer to very thin and fine superimposed coatings. While the superposition of several thin layers may have been intended to isolate the wall better, it is not impossible that the successive re-coatings of the surface suggest maintenance works and occasional refurbishment over time. The composition of these mud coatings is quite characteristic. The first wall coating is generally rather thick and coarse, containing gravel and a large amount of straw and cereal by-products. As discussed above, no sea grass was found in the coatings, an absence we explained by the risk of foliation. The purpose of vegetal inclusions, however, is particularly important to enhance the plasticity of mud coating, making it possible to apply a smooth and regular coating of the matrix on the wall, and hence reduce the risk of shrinkage. The role of straw as a temper and a cohesion factor is thus imperative (Fig. 5). In some cases, the impressions even appear on the surface of the pieces, which may imply that the original final coating has disappeared, so that what is now left is actually the core of the mud coating.24

The superimposed final coating layers preserve colours that range from pinkish-yellow to red. Some pieces with whitish layers seem to be composed of some kind of earth naturally rich in calcite, which could be spread to form an attractive protective coating,25 obviating the need for a transformation by burning the raw material. Perhaps this is the material that can be seen in the eastern wall of room 4 as well as in several samples. Although the final coatings are visible in the section of the samples, the initial appearance of the coated surface is, unfortunately, usually hidden by a layer of post-depositional incrustation. But in the examples where this incrustation was removed, a surface was revealed with a colour varying from white to yellowish-pink or red.26 No analysis has as yet been done on the components, but the recurring presence of orange, red or dark brown hues on the fragments can be noted. Various types of ochre are the usual materials identified in Minoan Crete for such colouring.27 In most cases, however, it is unlikely that the post-depositional layer on the mud coat is hiding anything, since it appears that a calcareous plaster may have been preferred for such a decorative purpose, notably because of the continuous re-coating maintenance necessitated by mud coatings.

Wood and earthen architecture

It has been repeatedly suggested in literature that walls consisting solely of mudbricks – and one could extend this to all earthen walls – are too weak to

---

24 For a Protopalatial parallel from Quartier Mu at Malia, see DANDRAU (n. 4), 344–345, fig. 5.II.22 and SHAW (n. 4, 1973), 215, fig. 244–245.
25 DANDRAU (n. 4), 376.
26 The use of a scalpel was avoided when the painted surface was adhering to the post-depositional layer.
support the load of an upper floor level. In order to
counter this weakness, however, timber was extensively
used in Minoan construction, a practice from which
Building 5 does not seem to depart. This technique
allowed thin earthen partitions to be load-bearing. However, except for doorjamb posts, the imprints of
such wooden features are rarely conserved, owing to
the actual limited preserved height of earthen walls.
The walls between rooms 5 and 6, between rooms 2
and 3 and between rooms 2 and 12 are fortunate ex-
ceptions, however (Fig. 6). Apart from wall-bearing
purposes, wood was also used in combination with
earth for other structural functions.

‘Triangular-section’ fragments
from the ceiling/roof

This term is used to designate a category of frag-
ments which showed up in considerable numbers in
rooms 2, 6 and 13 (Pl. I, IIA, b, and d, IIIa, b, and d 30).
All these samples show a similar composition with tiny
mineral inclusions and straw binding but no sea grass,
as visible in the section (Fig. 7). All pieces present three
faces forming a roughly triangular section, of which
the two opposite concave surfaces that are usually dark-
ened seem shaped by rounded beams. The third side
differs from piece to piece but some samples show
a flat side or a – sometimes slightly – squared impres-
sion perpendicular to the two concave ones.

In most cases, the very flat, regular, and sometimes
washed aspect of the third face suggests this was vis-
ible, probably as a ceiling element. Parallels exist at
Kommos, Chania and Phaistos and these allow the
original wooden structure of the ceiling to be recon-
structed.31 That these fragments could have been parts

---

28 SHAW (n. 4, 1973), 156, 188–189; PALYVOU (n. 22), 121–
123, fig. 171; more recently, E. Tsakanika-Theochari at the Creto-
logical Conference held in Chania in October 2006 and at the Mi-
noan Seminar in Athens on the 15th of December 2006.

29 Great building heights are sometimes reached for mudbricks
buildings making extensive use of wood, P.S. JEROME, G. CHIARI
and C. BORELLI, The Architecture of Mud: Construction and Re-
pair Technology in the Hadhramaut Region of Yemen, Journal of Pres-

30 The 101 numbers refer to the Palaikastro database.

31 Shaw and Shaw (n. 4), 128, 139, 146, 155, 158, 164, 175,
251 n. 45, pl. 2.23, 2.24, 2.25, 2.26, 2.27, 2.28 and 2.31; P. MILI-
TELLO, Gli Affreschi Minoici di Festos (Studi di Archeologia Cre-
tese II, Catania–Athens 2001), 123, tav. XIII, 3, fig. 34; HALLA-
GER (n. 4), 285, fig. 4. Also, SHAW (n. 4, 1977), 229.
Plate II: – a. ‘Triangular-section’ fragment from the ceiling/roof [101.117A]; – b. ‘Triangular-section’ fragment from the ceiling/roof [101.117E];
– c. Fragment bearing the impression of a wooden feature [101.267]; – d. ‘Triangular-section’ fragment from the ceiling/roof. Note the wooden fibres impression [101.156A]; – e. Fragment bearing the impression of a wooden feature [101.266A]; – f. Doorjamb fragment with an impression of a post [101.166]
of a floor on a higher storey seems unlikely since their flat surface is too fine for such a purpose, and no traces of an overlying coating appear. The impressions indicate the presence of medium-diameter cross-beams (c. 10 cm) and not reeds of a much smaller diameter. So rather than a ceiling of beams covered by reeds, rooms 2, 6, and 13 were covered with a system of beams crossed by smaller ones (Fig. 8). It is indeed surprising how few pieces from Building 5 show the impression of reeds.

In fact, in some cases, a third impression, darkened by fire and perpendicular to the two adjoining beam impressions, points to the presence of a third wooden element, very likely a structural beam. It is important

---


---

32 See for example P. WARREN, Myrtos: An Early Bronze Age Site in Crete (BSA Suppl. 7, London 1972), fig. 122; SHAW (n. 4, 1977), ill. 1; PALYVOU (n. 22), fig. 181 & 183.

to note that while adjoining round-beam impressions appear, there are no fragments that show adjoining square impressions, which seems to imply that the samples listed just above came from the intersection between rounded beams and another wooden structural element which may have been the main supporting feature, larger than the ones it supported, and very likely squared. In fact, the perpendicular impression is rarely rounded, and in some cases a thin impression of the wooden fibres is still visible (Fig. 9; Pl. If and IId for the wooden fibres).34

Since two types of triangular pieces were found, it seems that the ceiling was made of large squared beams, supporting smaller round ones, and not reeds. Given that these pieces only come from rooms 2, 6 and 13, we do not know what type of roofing was used over the other rooms. Archaeological data suggest that an upper storey existed above at least some of the ground floor rooms, and the absence of samples elsewhere may simply be due to conservation conditions and the fact that some rooms were reoccupied at a higher level or that different techniques were used in the building.

Doorjambs

Several standing doors in Building 5 are still framed in situ by impressions of one or two doorjambs. All present two opposing post impressions, with a mixture of earth, similar to that found in mudbricks, packed in between. Figure 10 shows the disposition of this feature, of which parallels were recovered at several other Minoan sites.35

The construction process of these doorjambs is illustrated by fragments found in room 5 (sample 101.219) of which the section indicates a radically different composition between the core of the doorjamb and the thick coating in which the two angular posts were impressed. While the core shows a composition typical of mudbricks – straw, sea grass, gravel, pebbles – the matrix covering it uses much finer inclusions. It seems that the core was put in place first, coated, and then only the posts – squared in the case of this sample – inserted into it. Figures 11–13 show the impressions visible on the larger of the two fragments composing the feature, as well as the clear distinction between the coarser core and the finer coat, with the core clearly visible in figures 12 and 13. One of the two flat sides shows the remains of red hues probably suggestive of the red paint that once covered the fine coat. The other side has a flat, quite regular coating. It is possible that this last side was pressed against the projecting partition between rooms 5 and 7 (Fig. 1), based on one of the slabs visible in the building, and offering the north-eastern doorjamb of one door, the western side of which may be the one remaining against the wall between rooms 5 and 6. The other two sides show post impressions, one of several indications of squared wood. A fragment of a doorjamb showing part of a similar squared impression and a matrix full of sea grasses may have initially belonged to the same feature. There is, however, a slight difference in width between the two pieces.

34 Note the large amount of tool types suited to the manufacture of wood described in SHAW (n. 4, 1973), 46–48, 55–58.

Fig. 11. Lateral view of doorjamb fragment [101.219] (Maud Devolder)

Fig. 12. Lateral view of doorjamb fragment [101.219] (photo Hugh Sackett)

Fig. 13. Section of doorjamb fragment [101.219] (photo Hugh Sackett)
Figure 14. View of doorjamb fragment [101.167] (photo Hugh Sackett)

Fig. 15. Section of doorjamb fragment [101.167] (Maud Devolder)

Fig. 16. Sample with lateral round impression [101.166] (photo Hugh Sackett)

Fig. 17. Hypothetical reconstruction of the original function of sample 101.23 as mud coating (Maud Devolder)

Fig. 18. Hypothetical reconstruction of the original function of sample 101.23 as internal fragment (Maud Devolder)
A long fragment of a doorjamb was found next to the wall to the south of room 12 (34×15×14.5 cm), in the area between room 6 and corridor 20. It shows two impressions of posts (c. 19 and 28 cm diam.) on one side – one of which is quite angular – and one large impression on the back, as if it was initially pressed against a large post (Fig. 14–15). The two posts were not impressed to the same depth in the fragment, which shows flat sides of 6 and 8 cm thick, but the most deeply impressed post seems to have had a larger diameter so the two posts were at the same level. Since this sample comes from the area between rooms 6 and 14–20, it may have been used as a doorjamb in the opening between these two rooms, a function confirmed on site by the badly preserved remains of a doorjamb. A third fragment of a doorjamb looks like a mudbrick but shows an impression of a post that is usual for doorjambs (Fig. 16, Pl. III). The impression is curved but with a change in angle. One surface seems to have been initially visible because one can still see the superimposed grey undercoat layers – probably because of the fire destruction. Some tiny patches of red paint are still visible, but these may also come from post-depositional coating. The back surface is flattish but still quite irregular. So, this piece may have been standing on its small side with a painted surface visible. Unfortunately, nothing can be said of the matrix because it is smoothened and partly hidden under the post-depositional coating. It was recovered near the doorjamb that is still standing between rooms 2 and 13, and may have belonged to the same feature.

**Samples showing indistinct wood and other vegetal impressions**

A last category of samples, of uncertain function, illustrates the importance and abundance of pieces attesting to the use of wooden elements in the construction. Several fragments bear the impression(s) of wooden elements, but it is not always possible to reconstruct their original appearance. One sample, for example, from room 6, presents one curved impression and one straight side. The surface between these impressions is flattish, but it is impossible to say whether or not this is due to a post-depositional process or whether this was initially really a surface. The answer to this question would make only one of the two following reconstructions possible (Fig. 17–18). Other samples preserve impressions of wooden features but also of other elements, sometimes circular, that are flat but of which it is not certain whether they are also the result of wooden features rather than original flat surfaces (Fig. 19–20, Pl. IIC and e, and Pl. IIIe). One of these samples, from room 6, is quite instructive because, in addition to a rounded surface, it also shows a flat back and a side impression of a beam. This may imply that these pieces are the remains of the original coating of some shelf or niche, enclosed between reeds forming the structure of the shelf. One sample seems to corroborate this identification because it preserves an impression on its back as if it had been pressed against a large stick or a small rounded beam or post. In this last case, a thick earth chunk initially sealing a container is also a possibility. Reed impressions on earth are variably ascribed to shelves, ceilings and possibly roof construction. There are only a few of such pieces, and it is impossible to be certain which function they originally fulfilled. The resemblance between

---

36 SHAW (n. 4, 1977), 229.
the impressions on one sample and a fragment – in this case on lime plaster – from Xeste 3 at Akrotiri may be noted where it was identified as a reed impression from a ceiling.\textsuperscript{37} Two further samples show the impressions of what look like vine leaves, a material sometimes used to cover the reeds of a roof and which were covered by layers of earth to render it waterproof.\textsuperscript{38}

Two last pieces should be mentioned because of the brushwood impressions they bear (Fig. 21, Pl. IIIc). Both present two central brushwood impressions in between parallel flat sloping plans, the last very likely representing a squared wooden beam. No immediate function can be identified but a very similar fragment was found at Phaistos (F 27°. 12 R)\textsuperscript{39}, for the function of which Levi hesitated between a model of a building or the impression of a wood and reeds structure.\textsuperscript{40} In this case, the second interpretation seems the most likely.

\section*{Conclusions}

While the identification of many samples still remains problematic, several recurring features, especially in terms of composition, allow a better understanding of the knowledge Minoan builders had of the properties of clay, inclusions and their suitability for particular architectural features. Moreover, the composition of the samples and their macroscopic distinction made it possible to identify other pieces which were too badly preserved to permit even a broad typological classification. Mudbrick fragments could easily be distinguished from mud-coating samples, giving a more precise idea of the aspect of the walls, especially when those bore the remains of the paint which initially covered them. While mudbricks are generally considered as forming upper-storey walls, the stratigraphy did not allow us here to distinguish them from ground-floor collapsed debris. But the fragments of ceiling/floor features bearing the impressions of wood confirm the existence of an upper storey, at least in rooms 2, 6, and 13. The preservation bias may be responsible for the absence of such data in other rooms, some of which revealed material which had fallen from the upper floor. This analysis is thus a modest contribution to macroscopic studies of poor architectural earthen remains.

As well as providing a material and stylistic approach to earth remains, this study also facilitates an indirect assessment of the organisation of earthen features production and the level of specialisation of people involved in architectural projects. The manufacture of mudbricks seems to point towards a low degree of specialisation, at best. There is no evidence at all for a centralised production and it is hence doubtful that this particular task represented an independent, specialised industry on Minoan Crete. But it would in any case seem exaggerated to use the term \textit{specialists} since it is obvious that, on a year-round basis, the manufacture of bricks and the construction of earth architecture did not represent a full-time activity. For one thing, weather conditions limit brick manufacture and earth architecture to only a few months a year. The knowledge of brick production was probably transmitted from one generation to another, not necessitating a special competence and simply being performed by the local community.

\begin{itemize}
\item \textsuperscript{37} Palyvou (n. 22), fig. 182. See also the impressions of parallel sticks left by a wooden shelf in Delta 2 at Akrotiri, Palyvou (n. 22), fig. 231.
\item \textsuperscript{38} Dandrou (n. 4), 360, fig. 5.II.12.
\item \textsuperscript{39} Militello (n. 31), 56, tav. III, 3-5.
\item \textsuperscript{40} D. Levi, Festos et la civilisation minoique (Incunabula Graeca 60, Rome 1976), 202, fig. 308.
\end{itemize}