STUDIES IN ARCHITECTURE AND RECONSTRUCTION OF UDABNO III-HOUSE D

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY
ÖZGECAN YARMA

IN PARTIAL FULFILLMENT OF THE REQIUREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN THE DEPARTMENT OF
SETTLEMENT ARCHAEOLOGY

December 2009

Approval Page

Approval of the Graduate School of Social Science

Prof. Dr. Sencer Ayata
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr.Numan TUNA
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Assist. Prof. Dr. Lale ÖZGENEL
Co-Supervisor

Assist. Prof. Dr. JAN. K.BERTRAM
Supervisor

Examining Committee Members

Prof. Dr. Numan TUNA	METU-SA	
Assist. Prof. Dr. JAN. K. BERTRAM	METU-SA	
Assist. Prof. Dr. Burcu ERCİYAS	METU-SA	
Assist. Prof. Dr. Lale ÖZGENEL	METU-AH	
Dr. E. Ioannidou-PİŞKİN	METU-SA	

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Özgecan YARMA
Signarure:

ABSTRACT

STUDIES IN ARCHITECTURE AND RECONSTRUCTION
AT UDABNO III-HOUSE D

Yarma, Özgecan

M.S., Department of Settlement Archaeology
Advisor: Assist. Prof. Dr. Jan-K. BERTRAM
Co-advisor: Assist. Prof. Dr. Lale ÖZGENEL
December 2009, 88 pages

The Udabno Project is an archaeological fieldwork in Eastern Georgia which includes three settlements from ca. 11^{th} \$10^{th}$ century BC (Udabno I, II and III). The project aims to provide information about the settlement of this period of time. Extensive surveys including geomagnetic prospection took place before the excavations and these are all reveal proto-urban settlement structures. In this project, one of the most important investigations is the pit dwellings, which are located in the middle of the settlement. The primary goal of this thesis is to reveal the construction process of those pit dwelling, House D, at Iron Age Udabno III by studying the excavation reports in order to be able to understand Udabno within its chronological and geographical context as well as shed light on the societal structure.

Keywords: Iron Age, Udabno, pit dwellings

ÖZ

UDABNO III-YAPI D ÜZERİNE
MİMARİ VE REKONSTRÜKSİYON ÇALIŞMASI
Yarma, Özgecan

Yüksek Lisans, Yerleşim Arkeolojisi
Tez Yöneticisi: Yrd. Doç. Dr. Jan-K. BERTRAM
Yardımcı Tez Yöneticisi: Yrd. Doç.Dr. Lale ÖZGENEL
Aralık 2009, 88 sayfa

Doğu Gürcistan'da yer alan Udabno Projesi üç adet M.Ö 10. ve 11.yüzyıllara ait yerleşimleri kapsamaktadır (Udabno I, II ve III). Yüzey araştırmaları ve kazı çalışmaları ile bu döneme ait ilk yerleşimler tespit edilmiştir. Projede ortaya çıkarılan en önemli yapısal kalıntılar yerleşimlerin orta kısımlarında yer alan çukur evlerdir. Bu tezin temel amacı kazı raporlarından faydalanarak, bu çukur evlerin yapım aşamalarını ve tekniklerini incelemektir. Yapım sürecinde yer aldığı düşünülen aşamalarla ilgili varolan verilerin sayısal değerlere dönüştürülmesiyle bu süreç ayrıntılı olarak ele alınmıştır.

Anahtar Kelimeler: Demir Çağı, Udabno, çukur evler.

TABLE OF CONTENTS

PLAGIARISM……..iii
ABSTRACT…… iv
ÖZ…….v
TABLE OF CONTENTS……..…vi
CHAPTERS
1. INTRODUCTION ……..… 1
2. HISTORICAL BACKGROUND ……..…. 5
2.1 Geography and Chronology of the Thesis Area ……..... 5
3. ARCHAEOLOGICAL MATERIAL……..…..8
3.1 Survey Results and Excavation Reports……..…..8
3.1.1 The Architecture……..……8
3.1.2 The Material Culture……..……12
4. METHODS OF THE STUDY…….. 13
4.1 Selected Buildings (Udabno III-House D)……. 13
4.2 Methodology…….. 18
4.3 Comparison with the Other Examples…….. 22
4.4 The Construction Process…….. 26
4.4.1. Prospection and Selection……... 26
1. Site Selection……..…….. 26
2. Organizing Settlement Structure……..…… 28
4.4.2. Actual Construction ……... 30
1. Collecting materials- Digging basement…..…. 31
2. Leveling floor……...…. 36
3. Building walls……..…. 36
4. Roof-posts construction……... 38
4.4.3. Inside Construction…….....43
1. Separating Rooms……..... 43
2. Covering Floor…….....44
3. Building Furniture……..……44
5. DISCUSSION: The Reconstruction of House D……..….45
6. CONCLUSION..... 47
REFERANCES..... 52
APPENDICES
A. FIGURES..... 55
B.TABLES……...……84

1. INTRODUCTION

In Georgia, many surveys and excavations took place especially during the Soviet period. However there is no centralized institution for any reference on dates, architecture, ceramic or material culture on these works. At this point, this fact makes Udabno excavations, reports and studies more considerable. The primary goal of this thesis is to reveal the construction method of the 'pit dwellings' of the Early Iron Age in Udabno (ca. 1000-900 BCE) by studying the excavation documentation in order to understand Udabno within its chronological and geographical context as well as to shed light on the societal structure. The excavations focusing on Eastern Georgia (Kakhetian province) were started by the Institute of Pre- and Protohistory and Medieval Archaeology at the University of Tübingen in the 1990's. Limited publications of few systematical research projects are available, in order to understand ceramics, architecture, economical activities and subsistence of this period of time (Bertram 2007: 230). All three Udabno settlements- I, II and III represent complete settlement plans with complex social structures, which is the first of its kind in this region. At this point, the aim of the Udabno Project was to present an independent place for reference for the chronology of the late second to early first millennium BCE by using typological considerations and radiocarbon dates (Bertram 2007: 239).

The Udabno Project is an archaeological fieldwork project in Eastern Georgia, which includes three settlements, Udabno I, II and III of the more or less contemporary periods of time, ca. 11^{th} \$10^{th}$ century BCE, which is not confuted by the radiocarbon dates and relative chronology of the pottery from the sites. The project aims to provide information about these settlements of this period. Extensive surveys including geomagnetic prospection took place before the excavations started and all this research revealed proto-urban settlement structures at the site. In this project, one of the most important inquiries are the "pit dwellings" with the walls lined by big size rectangular

stone slabs at Udabno I settlement and the same type of “pit dwellings” in Udabno II and III with combination of medium and small size of irregular local stones on the walls. Unlike the term “dugout dwellings” in literature the pits used as bases of the houses in Udabno are not regular. The term “pit dwelling” here refers to the semi-pit dug into the hillside with a shallow front for the entrance and deeper back side at the end. However the term pit house or dugout is used to mention the Udabno houses to comply with the terminology of the research.

In the Udabno I settlement, some pit houses (dwellings) where walls have been strengthened by orthostate-like big rectangular stones are found on the east of the citadel area. Furthermore Udabno II and III settlements have dwellings with walls formed by rows of irregular large stones (Bertram 2007: 230). There are more than 100 pit dwellings, which were found by geomagnetic prospection in Udabno I, II and III, and in total 28 of them have been completely excavated by the team. For this study only one of those dwellings have been chosen to examine the construction process which is why it is not possible to consider all Udabno dwellings this detailed. The House D from Udabno III has been chosen because this dwelling has been completely excavated and it is probably the best preserved example for this period. The details about the site and location selection, construction process like construction methods, resources, material choice, time-spent, and any possibilities of roof construction of the House D will be explored to reconstruct the dwelling in conformity with these details. The House D from Udabno III is selected as a key subject in order to explain the details of Udabno pit dwellings’ construction process. In general, the pit dwellings and their construction methods are rarely examined subjects in literature. Studying one of the best preserved pit houses in Udabno III might be a key study detailing the whole construction process including procurement of materials, estimated labor force for the construction and a visual reconstruction of the complete building at the end.

Archaeology not only deals with the way in which a site is modeled but also studies the processes involved with its other aspects. When we are identifying the construction process by using the available archaeological material, architectural information about building construction, catchment area, management and the labor force, the details of the reconstruction might prove a systematical construction process which might give us an idea about the societal structure of the settlement as well. By typological comparisons of architectural elements with the similar type of buildings, we can be able to interpret these structures' functions, and fulfill the missing data in order to propose a scientific reconstruction. All archaeological researches finally aim to comprehend the ancient people, their behavior, activities and the way they were living in their territory. Reconstructing the domestic architecture with its activity areas and the construction process indicates the facts about aforementioned aspects.

The available survey results and excavation reports of the Udabno Project are the main limitations for this study. Furthermore, there is a problem of the lack of archaeological studies and so few publications about architecture in South Caucasians. Because of this, examining the Udabno site by referring any neighboring similar settlements is not possible.

Additionally the thesis will include only the chosen building as representative of all. Only House D of Udabno III will be examined and reconstructed, and the results would be used as a key study to identify all Udabno houses which mostly have similar features. The chosen house Udabno III-D will be other limitation for the thesis. Some other houses from these settlements are considered when it is necessary to be more precise. The thesis subject will not cover the chronological problems of the area and that's why only the radiocarbon dates of Udabno will be given for chronology by not examining the chronological problems.

All kinds of architectural structures known from archaeological

researches from Udabno are mentioned with the details about the architectural elements of the chosen buildings further analyzed. Most of the pit houses of the site show more or less the same features like materials, architectural plans and functions however the other examples of pit dwellings in Udabno are only mentioned to indicate the regular use of some architectural elements. In order to understand the architectural evidence from Udabno, information about the comparative examples are also referred to point the fact how Udabno houses are different from those in terms of form, construction technique and other architectural details. Because the main aim here is to reconstruct the pit dwellings in Udabno, when enough information about the architectural details of those buildings is collected, this information is used to understand and reconstruct the construction process as a whole.

By the help of studies on reconstruction of the architectural remains, the evidence coming from Udabno can be evaluated to comprehend the chosen building's construction process. The intention of this thesis is to find out the materials resources, the catchment areas, organization of the labor force and finally the actual construction process as a whole. A number of questions are asked especially about the physicality of the Udabno houses based on the chosen example that focus on the reasons for choosing this type of structure as a dwelling and also on the construction method of these buildings including each step of construction process. Searching for the answers leads to make suggestions on the visual appearance of the dwellings and finally to present the differences from the other examples of such dwellings in other sites which make the Udabno examples unique in their own kind.

2. HISTORICAL BACKGROUND

2. 1. Geography and Chronology of the Thesis Area

The most possible date for the start of the Iron Age in Georgia is between 1100-900 BCE. During this period, very few but important cultural changes, which could be understood from the funerary practices, burials and the development in pottery production, occurred. The significance of these changes in general is still unclear, and it seems like there is a cultural continuation during this transition period in southern Georgia (Bertram and İlgezdi 2006: p. 169). In order to understand this transition level between Early Iron Age and Late Bronze Age (from ca. the middle to second half of the 2nd millennium BCE to early 1st millennium BCE), the vessels with angular-protruding rims from the excavations at Didi Gora and Tqisbolo-gora, and metal artifacts like Transcaucasian axes or Kakhetian daggers could be presented as interpretive markers. When the proto-urban settlement structure of Udabno is compared with the neighboring southern regions of the Caucasus, it appears that there are no remarkable changes in southern Caucasus as different from what we have in the Near East, Anatolia and East Mediterranean in terms of economical and political change (Bertram 2007: 238).

In total, 17 radiocarbon dates are available for Udabno I, II and III settlements. Udabno I has one calibrated date group for the citadel area and the other for the east of the citadel (Bertram 2009: 235-236). The citadel area is dated to the end of the 2nd millennium BCE. While the outside of the citadel on the east is dated as later to the 1st millennium BCE., Udabno II is well matched with those from Udabno I. On the other hand Udabno III dates are slightly later than those from I (east of the citadel area) and II. In general, the dates for the area east of the Udabno I citadel, Udabno II and Udabno III stand out for general uniformity. To sum up, settlements in Udabno can be dated to

early 1st millennium BCE. In order to have these dates, only wood charcoal has been sampled because of the insufficiency of grain or short-lived plant remains for dating (Bertram 2007: 236).

Many systematic settlement analyses have been undertaken in the Caucasus region especially during the Soviet period and later on resulted with very few publications about these field projects and surveys. This is the reason for having very few concrete comparisons for a settlement schema, and for supplying few fragmentary data for this period of time. The only records about the region are mostly about the kurgans, which are not enough to give any detailed information about the region's social structure or chronology. As a result of excavation and survey projects, Udabno shows the features of a planned settlement from early 1st millennium BCE. There are very few settlements in the southern region that can be considered as representatives.

In terms of integrating the relative chronology of the pottery from the settlements, it is obvious that the pottery and the radiocarbon dates do not contradict. From all three Udabno settlements, typical polished decorations, incised lines, and vessels with angularly protruding or outward-swinging rims are found for this period (Bertram 2009: 236).

The sites Metskheta, and Treli are established in a phase from ca. 1300 BCE to 1100 BCE. In terms of pottery, these sites have parallels to the ceramics from Udabno like cups, bowls, bulbous-shaped jugs, and large vessels. However, the Metskheta and Tblisi grave sites have been dated typologically to an earlier period as compared with Udabno with lack of any scientific dates of assemblages. Again without any chronological dates, Tbilisi pottery appears in more archaic form (Bertram 2009: 237). The Iori-Alazani region shows a chronology for the late second and early half of the first millennia BCE which is based on the integration of radiocarbon dates. Ciskaraant-Gora and Noname-Gora settlements' calibrated radiocarbon dates suggest later dates as compared with Udabno when similarities with Didi Gora and Tqisbolo-gora settlements' pottery apparent which points to a continuous

tradition. Despite the differentiation of regional characteristics, which will be defined by further radiocarbon dating and pottery analysis, the archaeologists suppose a continuous development between the late second to early first millennium BCE.

There are two explanations for the start of Iron Age in Georgia. One is the use of iron and its expansion to whole east Georgia in 11th -12th centuries BCE. The term early Iron Age is used to define the last century of the second millennium BCE in terminology (Bertram 2009: 237). In terms of funeral practices and development of pottery, some changes and cultural development are apparent during this time. From that point of view, the observations about the burnt layer of Udabno settlements must be analyzed to see if there is any connection to war-like conflict and emigration from Anatolia into the Caucasus region. In order to create a general picture of this kind of cultural dynamics; the number of reliable dated complexes is very low.

It is still not possible to see how significant the changes were during the Transition Period from the Late Bronze Age to the Early Iron Age. With lack of any dating fixed to the initial appearance of those periods, one of the interpretive markers of this Transition Period is the vessels with angular protruding rims. K. Pitskhelauri provided an overview of the Late Bronze Age in eastern Georgia as a part of Kakhetian Archaeological Project results but there is no such systematic summary for the Early Iron Age. In order to understand the beginning of the Early Iron Age, it has to be connected to a clearly defined material culture (Bertram 2009: 238).

Finally, the gathered information about the changes in the transition period to the Early Iron Age in Udabno is limited compared to what we have in Anatolia and Near East during that period. Consequently Udabno's proto-urban settlement structure should be examined in the neighboring southern regions where economic and political changes occurred. All kinds of dating or chronological questions about Udabno, leads us to the problem of how further systematic research is needed.

3. ARCHAEOLOGICAL MATERIAL

3.1. Survey Results and Excavation Reports

Several projects on settlement archaeology in Caucasus region and eastern Georgia were started by the Institute of Pre- and Protohistory and Medieval Archaeology at the University of Tübingen in 1990s. Before that, there were very limited systematical researches available in literature, which is the reason of the new excavation project on the settlement Tqisbolo-gora and Didi-Gora in eastern Georgia (Bertram 2009: 229). During the Soviet period, by the help of the intensive field and survey work, many sites were discovered and recorded as a part of the Kakhetian Archaeological Expedition activities, under the direction of Prof. K. Pitskhelauri in 1990s. In 2000, excavations started here in this area including Udabno settlements, which are located on the David Garedzhi Steppe, between the Kura River to the south and Iori River to the north (approximately 50 km southeast of Tblisi) became the focus of the project. The field project has ended by 2008 and now the publication and study seasons proceed (Fig. 1).

3.1.1. The Architecture

The Udabno pit dwellings have more or less the same kind of planning in terms of spacial use, and building techniques. The houses were cut into the slopes using these back and side cuts as natural walls, which were strengthened by stones. All the dwellings face south where the entrances are located and the higher northern walls loose their heights towards south. All chosen buildings are pit dwellings which are rectangular in layout, with sunken floors. The plans of these houses show functional divisions like a kitchen area, working area on the north and storage on the south west corner of the building. This makes Udabno houses differ from the ordinary pit

dwellings known from other sites; they show different activity areas in terms of spatial complexity rather than having a single space for several household activities. In total, there are 25 houses, 18 from Udabno I, 2 from Udabno II and 5 from Udabno III exposed during the excavations.

The dwellings with walls formed by regular stone slabs are seen only in Udabno I, which is on a higher natural mound than Udabno II and III and that makes Udabno I more suitable for pit dwellings because it would require less effort for the digging process. Since the dwellings have a certain height, it is easier to achieve this height on a steep mound. There are some clusters of stones on the outer part of the walls that can be interpreted as supporting elements for the roof construction which would be further examined. Some of the pit dwellings in Udabno I have details like offsets, cracks on walls and some fallen stones of walls as indications of an earthquake. In addition to this, some of the houses with no kitchen or a working area might have been used for animals. There is no evidence of any particular human activity in these houses except for the pavement of stones with flat surfaces, which might haven chosen as a practical application for cleaning these quarters.

The Udabno I settlement has an irregular layout with the so called citadel area and the tail-like long and narrow extension towards south east of the settlement. The “citadel area” is clearly seen in the results of the geomagnetic prospection which took place before the excavations. The circular layout of the area is defined by a coarse fortification wall surrounded by 2 rows of parallel running ditches. During the excavations, part of the fortification wall is determined with the typical Udabno houses located inside and outside. Because of the destruction of the farming activities and the medieval installations at the highest parts of the mound, especially the central part of the citadel area is not well preserved. However a physical feature of the fortification wall and of the buildings leaning against the inner face of this fortification is detected. The fortification wall is built with larger stones on the outside while the inside is filled with smaller stones. This wall is divided into

separate compartments with thinner walls standing at right angle to the fortification. Installations like an oven in the corner, paved area running through one of the side walls and a clay platforms are detected inside these compartments, which are not well preserved and cannot be defined as dwellings conclusively (UI C-D and E). The south east extension is made of a single row of houses located side by side. In addition to this row there are other houses located outside the city walls slightly recognizable as having a similar layout to the typical Udabno houses, however these buildings are not preserved well to recognize their functions. While one of these outside houses has traces of an oven and a clay working platform on the north end, the other two (UI A and B) have a paved areas on the east running through the eastern outer walls as seen in the House D from Udabno III. The general layout and the use of space in the Udabno I houses (UI J-K-L-M-N and O) are similar with the key subject, however the installations and the details are only roughly visible, which makes it difficult to point out any of those as a comparative to House D. The only general feature of Udabno I houses is the strengthened walls done by orthostate-like stone slabs (Bertram 2009: 230).

Udabno II dwellings are relatively deeper than those in Udabno I. The houses here in Udabno II are also dug into the hill slope. The plans here are same with the houses in Udabno I and III with their kitchen and working areas on the north and entrances on the south. The walls of the pit dwellings here are supported with smaller sized stones; the geological conditions, that is the lime rock lying on the surface of Udabno I settlement is not the same in Udabno II and III.

Udabno II is also a settlement surrounded by a fortification wall in a rectangular-like layout and there are 2 houses exposed in this settlement. The UII A is a typical Udabno pit dwelling with an oven on the northwest corner, a paved area, working room and the storage. This house has a neighboring building without any household installations but with a completely paved floor. This paved building is assumed as a structure used for keeping animals.

In the other example UII B has no finds on the floor and no traces of any household installations, which makes the function of this building unclear.

The Udabno III houses are cut into the hill slope, with the entrance facing south. The dwellings here are much deeper than those in I and II. Same as the Udabno II houses, the back and side cuts are used as natural walls, which are strengthened by smaller stones than those in Udabno I houses. The plan of the house is similar to the houses in Udabno I and II with the entrances on south, kitchen and working areas on the north, except for a small depot section near the entrance. The high preservation quality of the finds and the furniture help us to define the function of the room. However, the destruction of the farming activities affected the preservation quality of the Udabno III houses located at the highest parts of the mound. The UIII E on the north part of the settlement is mostly destructed due to farming and there are almost no finds and architectural remains left from the building. UIII A which is close to the southeastern edge of the settlement is a complete empty building, which might have had some other function or it was left unfinished**.** UIII B and C are the closest houses to House D in terms of plan and they show more resemblances to the key subject except the size of the general layout (Fig 8). With the destruction on the entrance of the buildings the installations and the use of space are quite similar.

Except the Citadel Area, all exposed buildings of the settlements have intensive traces of burning on the floors. This indicates a possible fire, which is a possible reason for finding almost complete inventory of small finds and ceramics. The burned level had sealed the floor with well preserved ceramics and small finds, some of which provide detailed information about the divisions in the household that defines different activity areas. Thanks to this preservation quality of the fittings, furnitures and details working, living, cooking and storage areas, especially in Udabno III settlement, are clearly recognizable (Fig. 2).

The settlements must have been occupied for a relatively short period

of time like two or three generations, which might be proven by the absence of information about any large-scale reconstruction process. The clarity of the geomagnetic images of the sites confirms the nonexistence of any previous settlement (Bertram 2009: 231). Aforementioned burnt level is the evidence that suggests these buildings were not reused or reconstructed after the fire occurred (Fig. 4). The houses are simply built side by side in the general layout of the settlement. However the existence of any common utilization units is not proved during the field works or by the results of geomagnetic prospection. Consequently, it is impossible to make assumptions about the general settlement plan.

3.1.2. The Material Culture

Many stone implements like stone hooks, stone sickle insets, grinding stones, weaving combs, threshing boards and vessels for butter production show that farming activities were associated with the settlements of Udabno. The Udabno II and III houses seem to indicate a combination of both animal and human quarters that is explained by H-P.Uerpmann and M. Uerpmann in the study of animal bones, which shows the domination of cattle bones, followed by horse equids in this area (Bertram 2009: 231).

The ceramics from the settlements are examined in as many aspects as possible like function, technique and typology (Bertram 2009: 231). There are wide range of vessel forms like bulbous shaped pots as the most common group of finds, roughly finished hand-worked vessels and two-handled pots.

Wheel-made bulbous-shaped pots are found abundantly and generally in situ on the floors. The vessels have similar profile with those bulbous shaped pots except for the opening on the body next to the horizontal handle (Bertram 2009: 233). There are also small cups, cup-like vessels, bottle-like vessels as other finds in different forms (Bertram 2009: 234).

In terms of decoration, intented decorative motifs, fingernail

impressions, stamped motifs, incised lines on vessels are present with the domination of grooved incised lines (Bertram 2009: 234). The ceramics are re-baked and their surfaces are scorched by fire that makes it difficult to demonstrate any general suggestion about the technical features of the ceramics, however the identifiable portion of those indicates that most of the pottery from the settlements is wheel-made while five to ten percent of those are estimated as handmade productions (Bertram 2009: 234).

High number of inventories found in situ and the quality of the preservation eases the determination of the function of the pottery. Most of the finds are concentrated in the northern part of the houses around hearth locations, grinding stones and storage vessels. The placement of the fire place and the cooking area is normally the focus of the households as it is the main vital necessity of humans. The fire place is the one and only quarter of the house where the light, warmth and prepared food comes from. The grinding stones are in relation to the pestle implements. Pots are found as embedded in the floor with burned storage remains in them. Especially in Udabno II and III houses, we have remains of clay platforms with holes in their surfaces. The clay platforms have shallow pits in their surface in order to stabilize vessels on the working table (Bertram 2009: 235).

4. METHOD OF THE STUDY

4.1. Selected Building

The inner space of the building is formed by 5 activity areas used for different purposes and the complete dimensions of the House D are given in Table 1. The small separated activity area from the rest of the house used as the entrance (approx. 3.14 m. x 3.79 m. x 3.52 m.) is in between the storage's east wall, 3.79 m. part of west wall's southern end and the inner division wall on east-west direction running between the pavement area and the storage

room for 3.52 m. (Fig. 5). Most of the pit house examples from South America have their entrance placed in the top of the roof construction. The Udabno pit houses are different from those with its entrance on the south end, which is probably to take advantage of being away from cold winds from north, and for solar heating during winter. This portion of the dwelling is recognized as the entrance since its location as the closest to the entrance wall and the lack of evidence that any other household activities take place in this part of the house. This section of the house might be left after separating the other rooms. There is no particular way of using this "room" of the dwelling with the lack of any particular furniture. The entrance is most probably the remaining area after the construction of the other activity areas in the dwelling. The frontal wall of the house is left open for approximately 1.5 m. from the east for the entrance. The part of the closure wall, which creates the doorway is in two parallel courses visible on the ground and is made of the combination of large and small size stones.

A small activity area is formed by the southern 4.37 m. of the west wall of the house and the inner wall in north-south direction running from the south wall, which turns to a connection with the west outer wall on the 4.37 m. length used for storage (approx. 4.35 m.-1.30 m.). This area is defined as the storage room with the existence of in situ storage jars. Its limited measurements, makes this room unsuitable for any other activities. (Beh. 136-137). This is a not a very typical storage room with its placement on the edge of the structure, near the entrance, away from the kitchen and cooking area. Generally the storage rooms are located right next to the areas that cooking activity takes place. The reason to have the storage area like this is not clear yet. However, with the lack of any clear evidence, the area next to the cooking place might be another storage area for daily needs for cooking with the main storage next to the entrance. The evidence of circular shallow pot holes on the ground indicates keeping the storage vessels stabilized in the ground. The

signs of the large storage vessels shows that the storage room is very limited in dimensions and is able to keep limited number of large vessels, which are probably enough for the family members during winter and spring. The other possibility is using the small room to store animal food that is not needed as close to the kitchen area. However, the lack of any other storage next to the cooking place weakens this idea. There is an additional smaller room on the north side of the main storage room, which has no evidence to its purpose neither with its architectural form nor the finds in it. As long as we do not have any clear evidence of what we have in the storage vessels, it is difficult to propose about the function of the storage. However, it might be another storage area for food or instruments. The thin interval walls of the storage room are formed by small sized stones with only a few courses, which are found dispersed around roughly recognizable edges of the storage room. The dispersed stones of the storage room walls are 20-30 cm high from the ground level while the height difference from the frontal parts of the house's side walls is around 20-40 cm.

A stone pavement (width varying from 1.6 m. to 1.8 m.) is placed parallel to the east wall with almost the same space with the very north and south ends left (Fig. 6). The stones have flat surfaces but they vary in size. A line of small stones lies along the pavement to separate the living-working room from the paved area. The length of this pavement area is 7.65 m. in north-south direction. There are some stone domestic pavement examples used as bathrooms that were proved with the additional evidence to support this idea as in Ziyaret Tepe. The other stone pavement examples in dwellings from Central Texas indicates that the circular form of the pavement placed in the middle of the living area with a hearth support the idea of use of those as sort of working benches. The circular paved area has a hearth in the middle, which makes working on the paved area suitable by being close to the fire for warmth and light. In Udabno examples there is no such evidence to define the

function of this area as bathroom or working benches.

In order to explain the function of the paved area in House D, the other Udabno houses must be considered. Most of the Udabno buildings have a complete pavement covering the whole floor or a partially paved area like the one in House D. The completely paved buildings without evidence of any activity areas in Udabno are thought as animal quarters, which are easily cleaned from animal filthiness by the help of the stone pavement. The partially paved houses also have no clear evidence of any human activity taking place on the paved quarters and the pavement is always placed running with the eastern wall, next to the living-working room and is seen from the entrance. While the lack of any cooking, working or living activity on the paved quarters in the dwellings support the idea of using these areas as animal quarters, the form of this section weakens this idea. The paved area is divided from the living-working room only by a course of stone as simple division wall in stead of a wall with a complete height. This makes the pavement quarter in the house unsuitable to keep the animals inside with a completely open passing to the living room. As long as we only have the remains of stone construction without any evidence of wooden materials used, we cannot claim any wooden construction as an enclosure built on the single course of division wall, which is also only a possibility.

The room placed between the pavement construction and the west outer wall of the house is characterized by the help of a clay-stone construction on its northwest corner. This might be a working place with the evidence of finds and ceramics scattered around. Another line of small stones lies in the E-W direction at the north end of the pavement area from east wall to the west wall. Thus it separates this room from the northern kitchen area. By the help of the clay and stone construction on the northwest corner of the room, the function of the room is defined as the working room. Large grinding stone with the bench-like item that is made of a rectangular shaped clay

structure filled with stones are the evidence for the main function of the room. With the lack of any living room in the house, this room with the working area might be used as a living room at the same time. The dimensions of the room (7.50 m. x 3.45 m.) seem enough to use it as multifunctional. The working area of the house is 3.45 m. to 2.70 m., which leaves 4.80 m. to 3.45 m. of the room for other purposes (Fig. 7).

The kitchen area (Fig. 7) is delimited by the north outer wall of the house, part of east outer wall, part of west wall and the stone line on the south as division from the empty room and the pavement construction (approx. 5.90 m. x 2.60 m.). This part of the house has higher floor level than the rest of the house, which might be to give way to the accumulated water in such cases away from the kitchen area (Fig. 18 and 19). Here in this room there is an oven on the left corner (approx. 0.82x0.85 m.) with the clay construction running parallel to the north wall with almost the same depth with the oven. This construction is 0.40 m. high with pottery, object and bone finds on it. This clay construction with the oven on its one side, and all the finds strengthened the idea on its function as a working table. The sides of the platform except the one leaning against the north wall of the house are raised again with clay as frame. These structural details of the platform with the semicircular ash pit-like shallow concave and the pot bases on the surface, suggests the function of the platform is another fire place. This kind of fire place example is found in one of the Ilıpınar pit houses with the only difference being the form of the platform. However, the other Udabno pit houses show differences in terms of this clay construction that makes its function questionable. The clay construction from the other Udabno house has the same type of ash-pit like shallow concave in front of it and it contains a complete pot in the middle. Additionally, the pot stands in the other examples of clay construction in the kitchen area have pit-like forms dug into the construction, which is quite different from what we have in House D. The variety in the forms of these elements on the clay construction, make its

function open to discussion. Before defining the exact function of it, the function of the elements on it has to be analyzed, and this is difficult because of this various forms.

As the basic difference from the other Udabno settlements, the Udabno III house, House D has irregular vertical gaps at opposite walls at the same alignment, going bottom to top, possibly made on purpose. These gaps might be left for the posts, which are used to support the roof construction however there is no certain reason found in the detailed study of the construction.

4.2. Methodology

The term pit house in archaeology is commonly used for the dwellings, dug into the ground or into a hillside and which are found in numerous cultures of different periods in the world. A pit house can be defined with the remains of a dug out space in the ground and possible postholes which are used to support the roof construction. The function of this kind of houses can show differences. There are some example pit structures where evidence shows that these were used to store food or to keep animals. These houses also might be different in layout like rectangular or sometimes square. Examining the pit houses at the first step introduces the need of understanding the reasons for building such dwellings instead of regular house types.

The pit dwellings are mostly known from southwest America, Arizona (Hohokam) or New Mexico (Gallina phase houses) in literature. The article about the Gallina phase pit houses could be useful by adopting reconstruction methods of the pit dwellings with possible roof constructions (Green 1956: 188-193). The Hohokam pit houses, which are round in shape but built by similar techniques, are studied in terms of their construction methods that may assist to understand same kind of structures at Udabno (Rice 2003: 3). A study by P. Gilman deals with the pit houses at southwest America in terms of factors promoting pit structures, relations between settlement patterns, climate,

population densities, subsistence strategies and political organizations with pit house structures (Gilman 1987: 538-564).

In the Ethnographic Atlas, P. Gilman indicates the cross-cultural middle range model of pit house architecture defined as in use in 82 out of 862 societies in the research area. These societies are from the high mountain regions in east Africa, Paraguay and eastern Brazil (Gilman 1987: 540). There is no clear evidence to show any resemblance between the thesis subject, Udabno III-D house and these other examples from unrelated regions of the world however, examining these examples might be helpful to understand the function of pit dwellings and the reasons to build such houses.

The first inference of the research, depending on the evidence of stored food remains associated with the pit features and the presence of interior hearths in the pit structures, is the occupation through multiple seasons. P. Gilman also defines the pit structure as usually having biseasonal pattern by using the stored food during the cold seasons (Gilman 1987: 548). The ethnographic sample is based on the case studies about the northern societies and because of this reason, the occupation period of the pit houses here in these societies are generally during cold seasons. This fact might be the reason defined as the thermal efficiency of the pit houses by using soil's insulating properties and taking advantage of the low profile which protects the structure from wind and heating loss (Gilman 1987: 542). All these features obtain less effort to maintain stable heat in the structure (Gilman 1987: 544). The research of P. Gilman in the Ethnographic Atlas also reaches some other statistical results about the population estimates and political-economical system of the sample societies to indicate relation between those statistics and the presence of pit house structure, if there is any (Gilman 1987: 544- 547).

This is a known attempt by archaeologists who believe that past material culture, and the processes that created it might be interpreted in order to understand the human past. By the introduction of processualism, these approaches became more scientific and paid more attention to the

archaeological contexts of the finds and this made it possible to interpret all possible functions, procedures and comparisons. As known approaches of this kind, cognitive archaeology, post-processual archaeology and processual archaeology are not going to be discussed here as subjects, however, the main idea of these approaches will be taken as the main method for this study that accepts the combination of material culture and the actions as products of ideas. The interpretations based on these approaches might be developed by applying experimental evidence and logical inferences. In this study, the most possible way to reconstruct the building will be a guide to understand the construction process which might lead us to understanding the organization scheme here to build this house.

The processual archaeology believes that appropriate interpretations of long term patterns of culture change; past material culture is finally used to reconstruct systems and thoughts of past humans. As one branch of cognitive-processual archaeology attempted to focus on, the main subject is the processes of human decision-making, which provides clear reference for appropriate explanations for long-term cultural change.

The reconstruction of the actual construction process needs to account for the materials used in the process. The quantification of the materials allows describing different building types with a numeric cost, which puts all architectural works into a common terminology (Abrams 1998: 125). Abrams (1994) describes the architectural energetic as in the form of labor-time expenditure, which puts the quantification of construction cost into a common unit of comparison. In order to have the quantification of any architectural form, combination of rates of work per task and the volume of used raw material is needed (Abrams 1994: 39). The collection of materials and the labor force in the actual construction process have to be calculated with fact of environmental conditions during the construction time. The weather conditions might affect the time spent for collecting materials and the construction process however the activity might take place during the dry

seasons in order to have better working conditions with good weather and agricultural off period. This estimation is accepted for the calculations for the construction process of the Udabno houses.

Due to the lack of information about some specific details about the actual construction process and the nature of the materials used, there has to be some assumptions made in order to complete the missing parts of the process. The amount of the working hours and the number of people working for the construction are impossible to be known by the archaeologists who studied the structure; however in this study the calculations are made by accepting the working schedule as 8 hours a day. The amount of the labor force in the actual construction cannot be suggested by referring to any certain data so specific tasks of the process are accepted as undertaken by one person, sometimes with another one or two assisting. Again the missing information about any vehicles or instruments used during the transportation of the materials limits the variety of suggestions on calculating the man/days in this process. The weights of the materials transported to the site are estimated and then the quantity is divided into the portion that an ordinary workman can carry the most at a time. In addition to the distance the worker has to travel to transport the materials to the construction site, the distance that has to be walked during organizing the materials when using them in the construction is also suggested as 10 m. with an approximate calculation. During digging the pit as the base of the house, the loam is accepted as collected on the southern side of the building, which has no changes in elevation with the floor level of the house and that is a practical way of use of space during the construction. Probably the collected stones and the transported wooden materials were also collected in this spot; otherwise the worker would have to carry the stones or the timber from higher level to lower level to use these materials.

The final goal of this study is simulating a feasible construction process according to the suggested reconstruction of the building. In order to reach the results the architectural elements are quantified by using the amount

of the materials used. At first, the total volume of the materials used in the construction are computed and then the weight of those are calculated to propose the amount of labor force and time-spent for using these materials during the construction process. By this way, a reasonable scenario for the construction process and a possible reconstruction of the building is suggested.

4.3 Comparison with the other Examples

There is no such study in literature reconstructing the construction processes of pit houses from any ancient sites. However, there are some projects like Pontus, Ilıpınar, Kaman Kale-Höyük, Salat Tepe, and Gordion in Anatolia working on the same kind of pit house structures. Similar architectural features have been seen during the Early Iron Age in Gordion which could be useful for the comparison with those at Udabno (Voigt and Henrickson 2000:37-54). We have pit dwelling examples of the same kind also from Kaman Kale-Höyük (Kaman Kale-Höyük Publication Series 1995-2006).

In literature, pit dwellings are mostly known from southwest America, Arizona (Hohokam) or New Mexico (Gallina phase houses). The article about the Gallina phase pit houses could be useful by adopting reconstruction methods of the pit dwellings with possible roof constructions (Green 1956: 188-193). The Hohokam pit houses, which are round in shape but built by similar techniques, are studied in terms of their construction methods that may assist to understand same kind of structures at Udabno (Rice 2003: 1-52). A study by P. Gilman deals with the pit houses at southwest America in terms of factors promoting pit structures, relations between settlement patterns, climate, population densities, subsistence strategies and political organizations with pit house structures (Gilman 1987: 538-564).

Earliest colonial Pontus has some dugout and semi-dugout structures which are generally used to define the ethnic identity of the people who

constructed them. These examples are almost totally different from the one from Udabno in terms of dates, construction techniques and form.

The semi-dugouts are constructions dug slightly more than 0.3 m into the ground and the roof cornice is above the ground level but still not high enough for the construction of a normal ground doorway. The dugout constructions are dug into the ground as deep as its supporting walls which are faced with wattle and doub or stone (Tuplin 2004: 226-228). This kind of structures is distinctive for the period starting from the end of the 7th century to the last quarter of the 6th century (Tuplin 2004: 226).

The other dugout dwelling examples in the region are from Berezan Islands where Greeks were first settled when they sailed into northern Black Sea. The site is studied to understand the key for the story of Greek colonization in the late 19th century. The studies resulted that the Berezan settlement has dug out constructions from the first three quarters of the 6th century BCE. The simplicity of the construction and the interior layout are the basic characteristics of these dwellings which occupy an area from 5 to 16 m² (Solovyov 2004: 17). The 200 dwellings found, which are generally in quadrangular, oval and circular forms (Solovyov 2004: 18).

One of the pit dwelling examples is from the older sub-phase occupation level of the early farming period called period VB in Ilıpınar. The site near Bursa in Anatolia has a semi-subterranean house structure with some specific features. The dugout houses in Ilıpınar are circular or irregular quadrangular in form with the ovens, household finds and ceramics. The house has a hard mud floor which is sloped up towards the back side with some storage pots. Against the north wall there is a grinding installation and a shallow basin shead covered with mud plaster which had served to collect milled products. The plastered benches are along the south and the opposite side of the house. This house serves elementary level of comfort and subsistence to its inhabitants. In addition to the benches and mud plasters used in the house, the evidence for the roof structure is just a pair of buttresses

rather than any posts or postholes. Roodenberg himself, claims that living here during cold and damp period of the year is difficult and the example in Ilıpınar is accepted as seasonal shelter rather than a permanent dwelling structure (J.J. Roodenberg and L.C. Thissen 2008: 231-235).

Kaman Kale-Höyük also has some similar architecture in its Iron Age strata II-a and II-c. The buildings here are defined as half-basement structures which have floors at a level approximately 40-50 cm lower than the outer floor.

The half-basement structure numbered as R371 was found with large numbers of pumice stones and tamped hard walls in 2005. This Stratum II a building in Sector XXXI has a hearth near the northern wall with pottery sherds next to it in kitchen ware type, and two jars set into the floor next to the southern wall (Omura 2005: 7). The evidences show that the room was used as a kitchen rather than as a workshop (Omura 2005: 7).

The other examples from Kaman Kale-Höyük are found in again Stratum II a in Sectors XV and XVI. The rooms R361-363-366-and 373 found in 2004 were dug below their floors in 2005 and two other rooms have been found (R 372-378). These were same as the earlier 361 and 363 rooms in shape and size and some walls of those were made of single row of medium-sized stones. More importantly, the floor of the rooms were identified as hard-tamped earth at a level approximately 40 cm lower than the outer floor (Omura 2006: 7), which can be interpreted as either half-basement or semi-recessed ground style that has been seen on the site in many structures. As different from the dwelling in Udabno III, the semi-recessed building in Kaman Kale-Höyük was rebuilt several times, which is cleared by the evidence of artifacts and architectural remains found in these sectors (Omura 2006: 8). The one other well preserved half-basement example was found in the Sector XVIII and XX (Omura 2006: 15).

The half-basement style is typical for the Stratum II c from the beginning of the excavations. These small rooms were approximately 4mx5 m

in size and the walls of those were defined with large stones with medium size stones packed inside. The R222 in Sector XXX has a different mud-plaster on the inner sides of the walls (Omura 2007: 9). The other example in Sector XXXII, R 290 has bench-like features, which are made of sun-dried mud bricks attached to the walls inside (Omura 2007: 15).

The excavations in 2005 brought another example of semi-subterranean house to light in Gordion. The Late Hellenistic stratum of the site includes several phases of a semi-subterranean structure in the northern half of a trench. The evidences from the structure like a horse-shoe shaped oven with mud brick arms, cooking pots and baking tray suggest that this place is used as a cooking place rather than as workshop of smelting place (Sams, Burke, and Goldman 2007: 368). One of the objectives in the 2005 season as a part of Operation 53 was to complete the clearance of this pit house (Sams, Burke, and Goldman 2007: 375). The finely laid white plaster of the house has numerous tripod stand impressions, a small stone platform, 4 post holes (three of those are stone-lined, one is with a round stone pedestal), several pits and small rounded hearth. There is a circular hearth in the southwest corner of the house with the remains of rectangular stone bin made from reused ashlars in the northwest corner of the house. The building itself is dated to the first millennium A.D.

In Salat Tepe (Diyarbakır-Bismil), there are many examples of ash pits in 3-5m diameter in size. M 13 and L12 trenches have hearths on floors, which remind us the existence of early Iron Age pit houses, however there is no evidence of supporting wall stones or plaster inside that make impossible to define these pits as subterranean house structures (Ökse, Görmüş and İnal 2007: 57). Nevertheless, these pits are cut into hard mud brick debris, which may eliminate the need of wall stones and plasters to support the side walls of the pits. Again the evidence of straw floors of these features with the hearths on the floors may support the idea of having straw roofed, temporary semi-subterranean houses here. The existence of roughly made pottery sherds and

the features of the pits make it possible to consider a semi-nomad population using these pits as semi-subterranean houses. These suggestions can not be proved with further excavations because of the destruction of these pits by many grain silos (Ökse, Görmüş and İnal 2007: 313).

4.4. Construction Process

4.4.1. *Prospection and Selection*

The construction process of a building consists of different stages, including the site selection first of all, and outside and inside construction activities itself, and continues with the repairs and the modifications.

The process itself can be divided in four basic stages which are more or less standard for every type of building. In order to understand the whole process, the site selection and reasons to settle on that location should be examined first. The environmental situations around the site effects the selection of house type and material used in the building, which are the basic terms used to explain the building and the construction process. Site selection and organizing the settlement structure, which means house type, place and direction selection of the building depends on the environmental situations of the location that the building is constructed. Almost all kinds of environmental circumstances like topography of the region, natural sources on and around the area, climate and soil type affects the selection of the site. According to these environmental reasons the house type, direction of the structure and its placement in the area is also decided. This whole prospection and selection stage is the first phase of the construction process schema prior to the real construction activity.

4.4.1. 1. *Site Selection*

It is difficult to presume the environmental conditions of the Udabno settlements area, which affects the selection of the site. In order to understand the climate of the area in the past, pollen samples are collected from the site but the acid-like content of the lakes around the site makes the results of any pollen analysis unclear. However, by using the today's information about the natural conditions of the site, the environmental conditions around the settlements of the time when the site was settled are more or less predictable.

Udabno settlements are located on the David Garedzhi Steppe at approximately 900-1000 m altitude, which is a grass area that allows small scale agriculture and is suitable for animal breeding too. The function of the site seems to be agricultural with evidence coming from Udabno I and III. However, in addition to the suitability of the landscape for agriculture, the Udabno people most probably used the vegetation on steppes and half-steppes of the area for animal breeding too. With the evidence of sheep/goat and horse bones from the site, this assumption can be accepted as closer to reality. The landscape with its suitability for both agriculture and animal breeding might be the main reason for choosing this location to settle. Because the area was intensively used for agriculture during the Soviet times and the soil type of the area differs around the settlements, the analysis on the soil type and its suitability for agriculture is not completed yet. However we have clear evidence from the site to prove the existence of agricultural activity during the period of Udabno settlements. The high altitude of the site is generally not preferable because of the hard winter conditions with snow, however taking advantage of being situated on natural hills in terms of good protection and having wide view over the landscape to control the area, makes settling on high altitudes logical.

The condition of water sources around the site is another important

factor to decide the settlement area. There is no clear evidence of ancient water sources at the site however today the closest spring source to the settlement is at 1-2 km northwest of Udabno I. The situation today does not reflect the past's relationship between water sources and the settlement. If water sources were not as close as today, having number of storage vessels at the site might be commented as storing and keeping water from the water sources around the settlement by using these vessels. Another water source might be one of the lakes around the site.

The Udabno settlements are settled in the middle of a lake group, which is the subject of a PhD- thesis by Rene Kunze from Tübingen University. The water from these lakes has been analyzed and the result of the analysis confirms the suitability of the lake water for eatable salt production, which is very important for human and animals living in the settlement. There is no certain evidence of salt production in the chosen House D; however being close to the lakes and the salt lakes is certainly one of the most important reasons to settle in this region.

With the absence of any useful material sources like obsidian or copper around the settlements, the selection of the area for the Udabno settlements can be explained by the suitability of the landscape for animal breeding, agricultural activities, and protection of the site in addition to the close location of the site to the salt lakes.

4.4.1. 2. Organizing *Settlement Structure*

Almost every ancient civilization had their own architectural style, which generally resulted from environmental conditions and needs like having well ventilated structures in warm climate when cold regions need constructions with good heating facilities (Woods 2000: 10). The environmental conditions here play the most important role in terms of site

and position selection, building type, and construction material. For the Udabno examples, the major determinant factor is environment too.

The "pit house" is the term to define the house type, which is dug into the ground or into a hill side and defined with the remains of that space in the ground. The Udabno pit houses are not completely dug into the ground. This is the most suitable house type in terms of the regions' topography, climate, soil type and the material sources around the area. First of all, the advantage of pit dwellings over an ordinary house is the natural insulation of being into the ground. This kind of architecture into the ground with supporting stones lining as walls inside, takes advantage of the sheltering earth for insulation, cools the house down in summer and keeps it warm in winter with the advantage of its direction. The primary aspect of building pit houses in Udabno must be minimizing internal variations in temperature. This feature of the pit houses is also supported by having stone material for the walls that better regulates the temperature inside. Stone materials release heat at a slower rate, which continue providing heat for inside of the house (Abrams 1994: 33). Pit dwellings also minimize the need of wood for wall construction and are preferred in the areas where trees are scarce. These advantages of building a pit house makes it easier to chose this type of a structure here in this area.

At the deepest northern part of the house, the depth of the pit reaches more than a meter while the southern entrance part is almost 40-60 cm high. The pit dwellings at Udabno III are basically dug into the hill side on purpose. First of all, the hill side is preferred because of its direction.

All the Udabno houses including the dwellings in Udabno I and II with Udabno III as the focus here, are facing south with their entrances. This north-south direction of the houses takes advantages of heating. The southern entrance provides an access for the heat to enter the house, while the northern back side of the house takes the benefit of being into the ground, which prevents the cold weather from coming inside. Secondly, the reason of choosing hill sides in order to build a pit house is to use changing elevation of

the ground surface. The hill side, which has a lower elevation on the south that rises towards the north, provides less effort during digging the pit as the base of the house. By using the slope of the hill side, when the floor has the same elevation on any parts of the house, the natural walls of the pit get lower towards south.

In short, the pit dwellings in Udabno are preferred because they are energy efficient and protect people from harsh weather conditions with its natural insulation with their correct way of placement and direction and the construction requirements as addition to the natural insulation of the building type itself.

4.4.2. *Actual Construction*

After deciding the house type, the basic stages of the construction take place in the process. Because of the simple structure of the pit dwelling structures, the stages of the construction process consists of some basic and major parts, which are collecting materials and digging out the basic shape of the house as the first stages in the construction process; then leveling the floor to get ready for wall construction and lastly constructing the posts and the roof structure. The first two stages, collecting materials and digging out the basic shape might be simultaneous, depending on the labor force used during the actual construction. There might be enough people for these two different activities in order to reduce time spent on preparation for the construction. However, as long as we don't have any clear evidence about the active labor force for these activities, these must be accepted as two separate linear stages. Apart from the simple layout of the Udabno domestic buildings in terms of the tasks in the construction, a general suggestion for the organization during the construction process might be done. The general settlement plan, except rows of houses settled in defined fortification and in an exact layout, is sort of

irregular. The domestic buildings have more or less the same kind of use of space and do not need any architectural experts to be constructed, might be built with a simple organization which exists in today's rural settlements. The construction process might be handled by all habitants in the leadership of some more experienced individuals. People who are more experienced in building the walls, the roof and the insulation techniques, might lead the group of people for each task. In fact, all the tasks of the construction process are only simple and uncomplicated works needing labor force for carrying and gathering wood and stone materials needed and placing those in the way the experienced leaders described. The need of having a guide in such architectural processes provides efficient use of material and labor force by maintaining the concordance between the skills and the tasks in order to subserve its aim in a short time as a result.

4.4.2. 1. *Collecting Materials and Digging Basement*

Together with the other preparatory requirements, the first step before the actual construction is the preparation of materials (Wright 1985: 466). Four basic stages related with the materials used in the construction process are defined by E. Abrams. The material procurement is the first stage, which is followed by the transportation of the materials. In some cases these materials are manufactured before the actual construction (Abrams 1998: 125). The first issues related with the procurement of the materials are getting and setting them in place and putting them into the required form. In Udabno I, there are these kinds of worked stone examples, which are used to build so called "orthostate walls" by nicely shaped square blocks of lime stones. Because the lack of manufacturing stage of material process in the construction activity; the procurement of materials, transportation to the construction site and actual construction might be counted here in the construction of House D in Udabno III. These stages considered with quantification of the materials makes

observation of the flow of materials in greater detail, which creates basis for reconstructing labor organization (Abrams 1998:126).

The materials used in the construction have to be kept light and portable so that they can be carried simply by man power. By this way, the materials can be carried and put up by one or two skillful men and with a few assistants without any standing lifting equipment (Wright 1985: 467). In this case, two building materials, which are naturally ready to hand, are chosen to be used in the construction, local stone for the walls and trees to be used in the roof construction.

The closest wood source is assumed as the valley of the Iori River on approximately 10-15 km north of the Udabno settlements. The forest here is large enough to supply enough wooden material for such a settlement complex. If it is not, the mountain slopes of Sagaredjo town can be another wood source. Probably the steppe around the settlement could not be sufficient for wood supplies. The type of tree for wood sources is not known yet, however continuing process on charcoal analysis might clear this question up soon. The wooden materials are used to build up the roof construction covering the building and to support the roof with the posts.

In order to compute the amount of wooden materials that have to be carried to the construction site, which is 10-15 km away from the wood source, first the exact species of the wooden material has to be known. However, the charcoal analyses are not finished yet that makes impossible to use exact data like specific gravity and features of the timbers used. The species of the woods are assumed as pine tree, which exists in different climates, has variable specific gravity and medium toughness. The lightest type of woods has 0.43 gr/cm³ approximately when the heavy ones have 0.99 gr/cm³ maximum. The average of those, 0.71 gr/cm³ is accepted as the specific gravity of the wooden material used in House D (see Table 3). Wood is used for the standing posts, lintel carrying the roof structure, and smaller size of timbers to form the roof coverings. The sizes of those are given in the Table 4

that is used to calculate the weight of wooden pieces one by one. The heaviest material is the wooden timbers in 6 m. length. Each lintel is approximately 200 kg in weight however the real problem of transporting these materials to the construction site is the size of those. It is obvious that timbers with such length and weight have to be transported by help of some vehicles from such distance. It is impossible to carry all those by man power. By the help of the Uerpmanns' study about the animal bones from the Udabno sites, the existence of horses in the settlement is confirmed. Horses might be the vehicles for wooden materials' transportation. This assumption also suggests a solution to the weight and length of the materials. An average size of horse can carry approximately 300-350 kg on its back but assuming the timbers in such sizes are loaded on a horse back is not realistic. There might be another system set up to render the transportation possible by trailing the timbers by the horses instead of carrying. In such an organization, the worker is supposed to be going to the region that materials coming from on horseback (60-70 km/hour) in half an hour and placing approximately 350 kg timbers to the setup for trailing to the construction site. This return with such a heavy load might be in speed of worker's walking that takes approximately 3 hours. Transportation of woods in total takes 26 times of such 3.5 hours roundtrip, which makes 11.3 man/days (see Table 8). The materials might be collected on the southern end of the dwelling to keep them on the same level with the working area. The estimated man/days for the process of wood transportation does not include the labor force or time spent to cut out the timbers to collect or manufacture those to get ready for the construction.

The stone used in the architecture is considered as local because of its nature. In Udabno I buildings, lime stone is the main material, which is visible at the surface of the site. According to the Jan Bertram's personal observation, because of the geological situation, the lime rock at Udabno I is coming from the surface, which makes easy to attain bigger size of lime blocks and use them as big rectangular slabs in the construction of the buildings while in

Udabno II and III only small size of broken stones are reachable. So called "orthostate walls" of the Udabno I dwellings are made of firstly broken then nicely worked lime stones into squares. The Udabno II and III stone is also local. Pebbles and the broken stones used in the buildings are local and coming from the sedimentary fill on the north side of the settlements. In the walls of the House D there are only few large stones that differ from wall to wall between 0.50 m. x 0.17 m. x 0.46 m. to 0.75 m. x 0.42 m. x 0.46 m. In the wall construction most of the stones are of medium size (approx. 0.60 m. x 0.35 m. x 0.46 m.) and in the gaps between large and medium size stone, little pebble like stones are used to support the wall construction. Except for the pebble like small sized stones, there are approximately 1200 stones used in the wall constructions in the sizes listed above. When the heights of the walls are reconstructed to 2 m., the number of stones increases up to approx. 2150 (see Table 5). Because the stone supply is local and the materials are not large in size, the procurement and transportation of the stone materials is uncomplicated. It is not necessary to use heavy transportation vehicles or complicated lifting systems to bring the large construction stones to the construction site. The average weight of the large stones is approximately 250 kg (with approx. 2.5-2.7 gr/cm³ specific gravity of limestone: see Table 3) in however there are only 5-7 of such big stones in the whole building's construction. This small number of big stones might be carried by 4-5 people while the others might be easily carried and placed by one person. The 1200 wall stones take up approximately 17.45 m³ space by lining the pit's walls (see Table 2). However this is the total volume of the stone remains of the walls, which have to be elongated to have a precise height for the roof. The actual heights of the walls are accepted as 2 m. in this study, which makes the volume of the house walls approximately 31.28 m3 (see Table 2). The nature of the ground shows that it is possible to collect some of those stones during the digging process of the construction. In the possible reconstruction of House D, half of the stones are assumed to be collected during the digging

while the other half is gathered from the natural neighborhood. If this neighborhood is limited to a circle with 10 m. radius, half of the stones needed for the walls can be collected in 7.7 hours with approximately 1 man/day for the task. The working hours to collect the rest of the stones are calculated as part of the digging process mentioned above (see Table 9).

The tasks taking place during the construction process appear as linear stages but in fact most of them are conducted simultaneously (Abrams 1998: 125). However, it is now impossible to categorize the stages of construction process as linear or simultaneous with such limited information about the process itself. There might have been sharing the work out here in this step for digging the pit and procurement of the materials needed for the construction if there was enough labor force for both activities. As well as the need of transportation "tools" in the collecting material process, people need tools to expedite the digging the basement part of the process (Fig. 20). There are hundreds of finds of the tool type called "tochi", which is thought to be the digging tool during the construction of Udabno houses. These are "8" shaped tools, 6cm x 9 cm in size and made of a heavy kind of sedimentary lime stone, which is strong enough to be used for this activity (Fig. 20). With addition of a stick on one short side of the tool, it was used as a small kind of shovel like ones we are using today for this kind of activities. With a simple estimated calculation, 100-150 ml of soil can be removed at one time; this means digging out the whole basement of 90 m3 (see Table 2) makes approximately 1.115.400-743.600 times using this tool to complete the dug out for a building. However, with the lack of any clear evidence, using special type of bones as tools for digging seems more logical. Especially shoulder blades (scapula) of some cattle species like cow and horses might be used for this kind of activity with their shovel-like forms.

In order to have an almost complete suggestion for the digging process a certain scenario is assumed. According to this scenario the tools like tochi or scapula bones are used to soften the loamy soil, which is collected by hands

and put in baskets to be carried away to the southern end of the house for the same reasons with the collected stones here. When the distance the worker has to pass through during the collection of the materials on one end of the house is added to the digging activity, the task takes 8.6 man/days in total calculation (Fig. 22, 22a and 22b) (see Table 3, Table 6 and Table 7).

4.4.2. 2. *Leveling floor*

Right after digging the basement out and collecting the materials which will be used in the construction, the next step before the wall construction is leveling the floor. The preparation of the floor has to be done before the stone construction to smooth the ground in order to have the walls resting on the same surface. The basic advantage of having a straight surface on the base is retaining the wall base as leveled as possible, which increases the endurance of the wall, preventing it from collapsing. The irregular surface in the interior of the house is quarried away to provide a leveled floor and clear cut for wall footing. The clay-lime nature of the underground makes leveling process in the Udabno houses easier with its soft composition. However, observing the difference between the natural clay floor and additionally clay covered floor is almost impossible. In some places the ground is leveled with small pebbles, which are additionally covered with white lime material. These pebbles might be used to level a depression in the ground or to have a floor surface with harder nature. There is no regular use of pebbles as floor material, which makes it difficult to indicate any certain reason for using different floor materials.

4.4.2. 3. *Building walls*

Limestone is readily available and relatively easy to shape than any other stone types which make it one of the most common materials used in

architecture even today. It shows differences according to the chemical structure, chemical composition, geological formation and many other factors (Dinç 2004: 1). These differences affect the endurance to weather and water. Some types of limestone can be very weak or strong enough to endure these external factors while some of them are of good quality enough to be shaped appropriately. The exact type of the Udabno limestone is not known yet, however the use of nicely formed limestone blocks in Udabno I with the stones used in Udabno II and III in their original shapes gives an idea about the type of the limestone, which might be in medium hardness to be shaped and have medium endurance to the external circumstances.

The stone walls of the Udabno houses are built in dry stack method that does not need any additional material to hold the construction together, and they are leaning on the dugout's side walls (Fig. 12-16). The method of dry stacking is not appropriate for the high wall construction; however the Udabno house walls are approx. 2 m. in height and are resting on the natural inner sides of the pits, which makes the method suitable for the construction. Basically in order to have an appropriate stone wall with this method, the first thing that has to be considered is the selection of stones with the appropriate shape and weight. The heavier stones are more stable than the lighter ones, and needs harder work during their transportation to the site and during the construction process. Normally it is better to have two flat surfaces on the stones especially on the top and bottom of the courses of the wall. However the Udabno building construction does not contain such a method to make the wall construction durable probably because they had the advantage of leaning on the inner side of the pits. There might be no need to be selective about the shape and weight of the stones, which makes people spend more time and effort during the procurement of the stone materials. In the Udabno houses, it looks like dry stacking method was used for the wall construction but the stones are not laid in courses, lacking the shape and weight precept of the method. It is more likely supporting the soft inner walls of the pits by covering

them with irregular stones in order to prevent them from sliding. The stones are laid randomly by fitting the pieces that are not uniform enough together. Some pebbles and small size of stones are used to fill wherever they are needed to compensate the difference in height and weight (Fig. 23 and 23a).

The simple technique of the walls running through the inner side of the pit expedites the construction of those. The collected stone materials can be carried and located on their places in the walls generally by one worker with the help of an assistant for carrying 5-6 bigger size heavier stones. By calculating the distance that the worker has to pass through during carrying the stones from the southern end to inside the pit, the activity of building the walls takes 15.4 man/hours. This time can be round up to 2 man/days. The construction of the division walls in the house is not added to this calculation.

4.4.2. 4. *Roof and Posts Construction*

Generally the constructions of the pit houses from the other sites are completed with the construction of posts and the roof structure carried by posts. These posts have to be carefully chosen or trimmed to create a straight branch, which has to stand up right to support the roof. The endurance of the posts might be supported by constricting the posts in between the stones of the long east and the west walls. In between the stone courses of these walls, the vertical gaps take attention at this point however these are not regular and large enough to stand the posts in them. The other way to provide stability to the wooden posts is using the postholes and post pits, which are dug in features, which must be deep enough in the ground to hold the timber straight. They are generally recognizable on the surface as circular patches that help archaeologists to plot the layout of the structure and to have an idea about the type of roof construction (Fig. 24 and 25). Unfortunately, any evidence of post holes and pits is not determined in House D during the excavations. Instead, there are base stones, which are slightly carved round and deep in the middle

that might be used as post sockles. There are three stone sockles on the front bottom of the east wall, two in front of the west wall and none in the north wall while the south wall is not completely excavated. The lack of enough post base evidences in the structure makes it impossible to establish the exact placement of the posts carrying the roof. In order to have an idea about the roof construction, architectural possibilities with these evidences are considered only (Fig. 26 and 26a).

Generally the roof constructions of the pit houses are domed or sloping downward from the sides with the top entrance, which is also used as ventilation hole. The dome is also a better way for good ventilation. The beams around the entrance do not meet in the centre and they are supported by posts on the corners of the square form that rafters crated. The roof construction of House D is thought as completely different from the other examples. The roof covering the House D might be sort of flat with a slight downward slope towards the front side of the building. The first reason to have a slightly sloped roof is the size of the building. The examples with domed or sloping sides are generally square or circular buildings that the roof is divided into 4 or more equal parts in length and width with a square entrance on the top. This type of roof construction is impossible to be applied in the construction of House D with its rectangular form. As long as there is no need of a top entrance opening, the possibility of using the same roof construction with the other examples is weakened. Additionally, in House D there is no evidence of posts to support the rafters of the opening at the top. The divisions sloping downwards towards their sides are also not suitable for Udabno houses, which are built side by side with a shallow distance between them. The sloping sides of the roof construction give way to the water downwards to the space between two houses, which has not enough width to tolerate this much water and dampness. The water coming downwards might weaken and soften the natural walls of the pit and eventually the stability of the stone walls covering them. For this type of buildings with 6 m. of short 2

ends with much longer 14.5 m 2 sides, the best roof construction is an almost flat covering by using simple post lintel construction method. The roof of House D is suggested as coming slightly downwards from the north end to the southern end with the entrance to drain the water on the roof. The biggest disadvantages to a post and lintel construction are the limited weight that can be held up and the small distances required between the posts. In order to cover the whole length of 14.5 m, the roof has to be divided into smaller parts to strengthen the roof structure. The top plan of the House D indicates the existence of 3 pairs of post bases, which divides the 14.5 m length into 4 approximately equal parts by being placed close to the east and west walls (Fig. 26 and 26a). The average distance between the posts is 3.55 m, which is long enough to reduce the number of timber used for the roof construction and short enough to have a stabilized timber cover over the building simply by man power. Having a northern back wall of the house with the elongated southern wall on two side of the entrance, these 3 pairs of posts must be enough to support the roof construction at 10 points placed as 5 pairs opposite to each other. Even though the division of the 14.5 m into 5 parts is obtained, using these posts to support 6m length of timbers is still not practical. These 5 pairs of posts must carry 5 wide logs of 6 m. or there must be more posts supporting these long logs in the middle. Unfortunately there is no evidence of any post holes or pits on the floor to promote the idea of middle posts. However, these additional posts might be placed on the stone division walls, which are mostly running in between the post pairs on the inner sides of the house walls. Lastly, the suggested roof structure can easily have a ventilation hole for the oven on the northwest corner of the building by placing timbers without any supporting posts for the rafters of the opening. With the lack of enough evidence to confirm the certainty of such a roof structure, and with the help of the data found in the structure, the most possible roof construction is thought as suggested below, which can accommodate with the general plan of the building in practical.

In this kind of roof construction, there must be 8 posts on the sides with the addition of some possible middle posts in 2 m. height. These posts have to be light enough to be carried from the valley of the Iori River on approximately 10-15 km north of the Udabno settlements and have to be large enough in diameter to be able to support the lintel structure placed on top. Since we do not know the exact species of the wooden material used in the structure, it is presumed as the type with the average strength and special gravity. The type of the wooden material might be assumed as a kind of pine tree because of its existence in many different climates, its variable specific gravity from the lightest one to the middle range heavy type, and its medium toughness. The average specific gravity of wood is 0.71 gr/cm³ (see Table 3) and that is accepted for the wooden materials used in the construction of House D. In the suggested roof construction, the number of posts, lintels and wood used for the whole covering are approximately given which might be used to calculate the possible weight of the wooden materials carried to the site. The approximate diameters of the posts and lintels used in the construction are given in the Table 4. According to these presumptions, the main bearers are 10 main posts with 8 certain posts on the sides and 2 possible middle posts, and 5 main lintels. Approximately 240 timbers in 10 cm in diameter with 3.6 m. length (Fig. 28 and 28a) and 580 pieces for the second cover in 3 m. length and 5 cm in diameter are used to cover the building (Fig. 30 and 30a). According to these estimated sizes of the wooden materials, each post is 69.6 kg, one lintel is 209 kg, and a single piece of wood used for the first cover is 20 kg when the smaller size of single wood for the second cover is 4.1 kg. The only assumption about the construction of the roof structure is the need of two or three people to place the posts and lintels and place the roof covers. One post is approximately 70 kg, which can be easily carried by two people from the southern end of the house to its functional place and be stabilized. For the placement of the lintels, the task needs at least 3 people because of its weight and the difficulties of their placement in practice. Two

workers can hold the heavy timber on its sides while another one or two assistants help by holding the timber from its middle. It is not possible to calculate the working hours on this task depending on available data because of the complicity of the activity. The roof construction is more than carrying or placing the materials in their places, it needs some organization.

Finally, with the suggested roof type and the stone wall remains of the house, another reconstruction might be proposed. The stone wall remains of House D are assumed to be elongated by again using stone material. In this situation, there has to be some more scattered stones around the wall remains, which are enough in number to elongate the walls. However, the situation during the excavation was different that the top plan of the House D made another suggestion possible. The stone wall remains might be elongated by using wooden materials. This possibility also results with a better supported roof cover. The gap between the top of the wall remains and the suggested roof might be divided into smaller parts by tucking wide wooden sticks in vertical position (Fig. 29). Then the smaller gaps between the sticks might be covered with woven-like branches (Fig. 29a) and lastly with mud (Fig. 31 and 31a). By this way, the roof structure can be supported by the additional vertical sticks between the wall remains and the roof. These sticks may help the post and lintel structure by supporting the roof covers from its sides. The other advantage of it is the usage of lighter material in the construction. The branches and the sticks for the side covers can be easily obtained from the woods carried from the other valley. There is no need of extra effort to procure these materials. The total size of the wall remains is 17.45 m^3 and most of those is calculated as collected from the digging the pit process. The rest of the weight, 4350 kg might be collected around the construction area in approximately 48 minutes, which adds up to 0.8 hours. The time-spent for the collection of wood materials can be calculated in more detail with the additional vertical sticks. These are accepted as 1 meter long sticks with 5 cm diameters. This puts the total weight of the wooden materials into 9481 kg that

needs 94.5 hours to be transported to the construction site. The total time-spent can be rounded up to 12 man/days including the branches used for side coverings.

The time spent for digging the basement is already calculated as 8.6 man/days in total. When we change the total weight of the wooden materials and the time-spent for collection of the stone materials the total time-spent for the alternative construction becomes 24.7 man/days. The Table 12 shows different time-spent for each tasks during the both construction methods.

4.4.3. *Inside Construction*

4.4.3. 1. *Separating Rooms: Differentiation in Activity Area*

As the last stage of the process, the separating walls and the furnitures used in the building are constructed by defining the different activity areas in the dwelling. Repairs and modifications are also part of construction process because these also affect the structure. These later additions and changes are also included in the last stage of the construction process in order to explain the structure completely.

Examining the arrangements of activity areas and the archaeological materials used is one of the necessities to interpret the structures as a whole. The distribution pattern of the artifacts and the furnitures in the building indicate specific sets of tasks and operations that took place.

The activity areas in the House D are not separated by full size walls but by stone linings composed of one or two rows of stone in couple of courses. The remains of these separations are collapsed and dispersed on the floor, which makes it hard to identify their exact height. However, the amount of these dispersed stones indicates the impossibility of having complete walls at these points. There might be wooden separations based on these stone lines

but this cannot be proved by any evidence. Because of this reason the divisions between different activity areas are presumed as single course of lines and walls with couple of rows.

4.4.3. *2. Covering Floor*

Generally, the floors of the domestic structures are covered with additional materials in order to obtain a harder and smooth surface. This is made to have better insulation and a good walking surface while the cleaning effort is also reduced by covering the floor. The nature of the soil in Udabno III is clay-lime; however the floor might be covered with same type of material as well. The resemblance of the natural earth and the covering makes it difficult to determine the covered and non-covered parts. In some parts of the house, small pebbles are used with additional white lime which covers them. These parts of the house might be leveled up by this way to prevent differences in floor level or there might have been a need of some harder materials as floors due to the features of the household activity which took place at these parts of the house. The remains of such floor covering cannot be evidence to prove any regular floor pattern.

4.4.3. *3. Building Furniture*

After the construction of the House D and separating the activity areas, the construction of the furnitures is undertaken as the next process. There are three basic activity areas that need furniture for household activities. These are the oven, the clay platform in the kitchen and the pavement area. The function of the pavement in the House D is still imponderable; however the pavement is constructed obviously by placing the partially flat stones on the ground until it covers the whole area separated from the other activity areas. The construction of the oven and the clay platform is more complicated. The oven in the kitchen must be constructed before the clay platform next to it. The

method to build these furnitures is more or less the same which is giving their form by using clay material outside while the small stones fill the inside. The stone fill is covered with clay again on the top. The oven is smaller in size than the clay platform. Both of these have elongated frame-like clay barriers around their sides. The sides of the oven and the clay platform might be raised up for practical reasons. The reconstruction of these furnitures are given in the drawings while the time-spent and the labor force for building these are not included in the calculations on the construction process.

5. DISCUSSION

The Reconstruction of House D

There is one certain reason that affects the decisions about the particular characteristics of this dwelling and its construction methods. The selection of the site, house type and the placement of the structure are definitely influenced by environmental reasons, which are also effective on the construction method itself. For example the materials used in the structure have to be present in this environment and have to be chosen as appropriate to the construction of the building. The limestone material is obviously the most logical choice because of its existence at the site abundantly. The total weight of the roof cover is remarkably heavy because of the dimensions of the house, which makes wood the most conformable choice for the post and lintel skeleton. The wooden materials are suitable for such roof and post constructions with their reasonable weight to be transported in addition to their capability of resistance to high loads. The wooden posts placed next to the side walls are carrying the roof covers with the help of the back wall of the house. Because the back wall is better supported with the natural walls of the pit, it might be capable of supporting the roof cover while the side walls are standing with less support. The height of the side walls are accepted as 2 m. in reconstruction and mostly free standing in dry stack method, which reduces

the resistance of these walls to high loads. In this scenario, the posts next to the side walls are required to support the roof cover. In the second alternative construction method, the roof is also supported by the vertically placed wooden sticks in between the stone wall remains and the roof. By this way, the weight of the roof cover can be carried by the post and lintel skeleton even with the additional mud covering the roof that might be possibly used against leakage and to maintain insulation. The slightly sloping roof structure might be the result of the need to drain the water on the roof.

The primary concern of the main materials and the construction techniques used to build the House D is the climate of the area that might be quite drastic in winters. In addition to the natural insulation of being into the ground, the stone walls and the possible mud cover over the roof are used to regulate the temperature inside. The walls defining the different activity areas in the house might be built as short separation walls instead of full height walls for the same reason. The warmth and the light of the oven placed at the north end of the house can be used in the other activity areas of the house by this way.

The placement of the kitchen area and the storage might be results of the weather conditions in this region. As different from the other pit house examples, the oven is placed on the northern end of the house instead of in the middle. This part of the house has the most depth in the ground, which might create humidity problems. The existence of an oven at this part of the house might reduce the amount of humidity. The reason to have the storage not close to the kitchen area might again be the possible humidity problems at the north end of the house. Keeping the food away from the humidity might prevent them from being spoiled in a short period of time.

The scenario here is set up to indicate one of the possibilities on the construction method by one worker with a horse as the transportation vehicle,

the tools for digging and one or two assistants for particular tasks. By this way, all stages of the construction in two different methods except the roof construction takes 22.7-22.9 man/days in total. The estimated time for the roof construction is 2 man/days for each scenario.

The assumptions and the suggestions about the building method of House D are not claimed as the perfect simulation of the construction activity. These are just possible techniques applied to solve organizational problems, and probable quantities of used materials and man/days to achieve such construction. The scenario for the activity can be varied in many different ways. Eventually the reconstruction of the process suggested in this study does not show how it was built but how it could have possibly been built. At this point this simulation and the methods used for the particular tasks during the construction process are open to discussion and the validity of those cannot be proved. Some other might simulate the construction process of House D in different ways and reach a final reconstruction of the dwelling in variable forms. However this would be again another effort to quantify the remains of the architectural elements in order to put this architectural work into a common terminology and unit of comparison. These calculations might be applied to the all structures on the site and the result indicates the whole construction process of the complete settlement made of dwellings.

6. CONCLUSION

The House D from Udabno III is chosen because of its good preservation quality which presented a potential for presenting a possible reconstruction for this type of structure. The method is simulating a feasible construction process according to the suggested reconstruction of the building, which is the main aim of this study.

The architectural elements are quantified by defining the amount of the materials used to reach for a conclusion. The total volume and the weight of

the materials are estimated and calculated and then combined with the estimated amounts of labor force and time-spent for the construction of House D. This method is used to suggest a possible scenario for the construction process and to reconstruct the building as are both based on factual information coming from the remains of architectural elements.

As a result, the reconstructed House D posing enabled a detailed examination of its construction process and basic questions. The reconstructed house confirms the suggestions on the reasons to build such structures with sunken floors and with these construction materials. The entrance facing south, and the stone used for the walls improve the capacity of the pit house in terms of regulating the inside temperature. The climate of the area, especially with harsh weather conditions in winter, increase the necessity of keeping the interior as warm as possible, which is also the reason for covering the wooden parts of the walls and the roof with a mud-like material. It is necessary to keep all surfaces, including walls and roofs coated to provide a better insulation.

The dry stack method used for the walls and the limited number of the post bases with few additional suggestions indicate the necessity to have lighter materials for the roof construction. The calculations of the weights of the materials, the suggested amounts of time consumed to transport and use them in the construction, enable a visual reconstruction of the House D. The reconstructed house demonstrates a “pit house” with stone walls supporting the natural side walls of the pit and raised till the roof level which is constructed with wood. The roof construction exhibits 5 lintels, which are supported by 8 posts and the northern back wall of the house. The roof must be slightly sloped towards south to prevent water accumulation on it. The separation walls were possibly not in full height unlike the outer walls of the house. The reason to have shorter inner walls to separate the activity areas might have been to take the advantage of the light and the warmth coming from the fire place in the kitchen. These division walls create 5 different activity areas including a kitchen, living-working room, entrance, storage

room and a paved area. The kitchen is typical having a hearth on one side with the cooking pots were scattered around. The cooking place is set in the northern end of the house, which is possibly the most humid quarter; the fire place set on this spot might lessen the humidity there. The working-living room is characterized by the large grinding stone and the tools scattered around the working place. The size of the room, which is much more than enough for a working room, and the absence of any other area in the house for other household activities like sleeping makes this activity area a multifunctional one used for both living and working. The storage area is characterized with the remains including several storage jars, but is unusual in terms of its placement. As contrary with the usual storage rooms placed as close as possible to the cooking area, the rooms next to the entrance on the south is used as the storage area in this house. The reason may demonstrate an effort for keeping the stored food away from the increasing humidity on north end of the house. The entrance of the house on the south end of the house is clearly visible in the plan but the function of the paved area extended from the entrance to the kitchen is still unknown. The absence of any finds in the pavement makes it impossible to describe the context here. The completely paved buildings in Udabno settlements are described as animal quarters in previous studies, however the paved area in House D must have been used for another purpose because of the general context of the building which defines its function as an ordinary dwelling with activities.

The architectural context of House D makes it completely differ from the similar type of buildings found in other sites. First of all, the Udabno buildings including House D are different from the conventional pit houses described in previous studies, these examples dug directly into the ground. The Udabno pit houses however were dug into the hill slopes, which provide a general form to the pits as different from the usual examples. These buildings might be called semi-pit houses compared to the completely dugout dwellings. Secondly, the Udabno houses are also different in terms of use of space.

Unlike the other pit dwellings, the Udabno houses contain several activity areas. The pit houses known in literature have simple circular or square forms, a central fire place with an opening at the top of the roof, which is used as an entrance and the ventilation hole. This might be a reason for using these buildings in shorter duration than those in Udabno. Finally, the other examples of pit houses are generally used in short period of time by nomadic groups of people. The geomagnetic images of Udabno settlements do not indicate any previous settlements, however the occupation period of these settlements must have been for at least two or three generations to be in conformity with the complexity of the house and the settlement plans.

A possible construction method coherent with the architectural context of the House D is suggested showing each step of the process. Additionally; the transportation, organization and use of the materials are included together with the time spent to conduct each task. The organization scheme for the construction of the House D is divided into three general sections as prospection and selection, main construction and finally the inside construction. The first part includes the site selection, organizing the settlement structure, and the selection of the house type, direction and its placement, which are basically based on the environmental conditions like topography, material sources and the climate. The main construction process is defined with tasks like collecting the materials, digging the pit, building the walls, and constructing the roof structure. Since making calculations on the tasks concerning the inside construction would be too hypothetical, the basic calculations in this study are generally focused on the main construction parts of the process. As a result of these estimated weights of the materials and the time spent to use these materials in the construction are calculated, a general time schedule is prepared for each task of the construction process. In total, if the time consumed for the roof construction is assumed as 2 man/days without any certain calculation, the whole construction process is estimated to be 24.7-24.9 man/days in total. The activities, which are not taken into account in this

process are the manufacturing of the wooden materials by chopping them down and cutting them into pieces to make them portable and making them ready for the construction and secondly building the division walls and t e furniture in the house.

In addition to the results of this study, the total amount of the wood needed for the construction of the whole settlement and the square meter of the forested area used as the source can be computed whenever the research on the exact species of the wood is resulted. The number of same type of structures visible in the geomagnetic prospection in Udabno III are 36 and the amount of the wooden material used in House D of UIII is 8981 m^3 excluding the thinner branches used for side covers. The calculation might be done by using this information even without knowing the exact species of the wooden material by accepting an average size for the woods; however this might be also too hypothetical with the already estimated amount of the materials used for the construction of a single house, again estimated number of the same kind of buildings counted from the results of the geomagnetic prospection, which are not clear enough and does not even cover the whole settlement.

With the quantified architectural elements of the structure and the construction process, the House D is transformed into a common terminology rather than being a simple pit dwelling in subjective terms. This kind of quantifications can be applied to the other examples of pit houses, which are rarely examined in literature. Finally a common terminology for this kind of architectural structure can be composed as a contribution for further scholar studies.

REFERENCES

Abrams E. 1998 Structures as Sites: The Construction Process and Maya Architecture. "Function and Meaning in Classic Maya Architecture" ed. S. D. Houston Washington, D.C. Dumbarton Oaks Research Library and Collection: pp. 123-140

Bertram, J. K. and İlgezdi, G.
2006 "Kafkasya'da Yaşam ve Ölüm". *Arkeo-Atlas 5*: 169-173.

Bertram, J. K. 2008 Ceramics in Transition: Chalcolithic through Iron Age in Highlands of the Southern Caucasus and Anatolia. *Ancient Near Eastern Studies 27*: 235-266.

Green, R. C. 1956 A Pit House of the Gallina Phase. *American Antiquity* 22 (2): 88-193.

Rice G. E. 2003 A Research Design for the Study of Hohokam Houses and Households. P- MIP Technical Report No. 2003-05.

Gilman, P. 1987 Architecture as Artifact: Pit Structures and Pueblos in the American Southwest. *American Antiquity* 52: 538-564.

Voigt, M. M and Henrickson, R. C.
2000 Formation of the Phrygian State: The Early Iron Age at Gordion. *Anatolian Studies* 50: 37-54.

Tsetskhladze, G.R., 2004 "*On the Earliest Greek Colonial Architecture in the Pontus."* Pontus and the Outside World: Studies in Black Sea, Historiography and Archaeology. (ed. Tuplin C. J.)BRILL: Boston: 225-278.

Omura S. 2005 Peliminary Report on the 19th Excavation Season at Kaman-Kalehöyük. Vol. XIV:

-------- 2006 Preliminary Report on the 20th Excavation Season at Kaman-Kalehöyük. Vol. XV: 1-37.

-------- 2007 Preliminary Report on the 21st Excavation Season at Kaman-Kalehöyük. Vol. XVI.

Sams G. K., Burke R. B., and Goldman A. L.
2007 Gordion 2005. *28. Kazı Sonuçları Toplantısı* : 365-381.

Ökse, A.T, Görmüş A., and İnal N.
2007 Ilısu Baajı 2005 Yılı Kurtarma Kazısı. *28.Kazı Sonuçları Toplantısı* : 51- 61.

Wright G.R.H. 1985 Ancient Building in South Syria and Palestine. Vol.1. Leiden : E.J. Brill

Solovyov, S.L., 2004 "*Berezan Island: The Main Features for Archaeology."* Bilkent Newsletter of the Department of Archaeology and History of Art. (ed. Coockson B.C.) Bilkent University: Ankara: 17-20.

Günay, A. 2005 Sebze Yetiştiriciliği. Uğurer Tarım Kitapları: İzmir: 95.

Deniz, V., Erkan, D. and Alyıldız, V.

2001 Kalker ve Klinker Örneğinde Kırılma Kinetiği Üzerine Bilya Çapının Etkisi. *4 Endüstriyel Hammaddeler Sempozyumu 118-19 Ekim 2001,* İzmir, Türkiye: 274.

Seeher 2007 A Mudbrick City Wall at Hattusa. Ege Yayınları, İstanbul: 219.

Küçük, O. 2006 Koşu ve İş Atlarının Beslenmesi. Erciyes Üniv Vet Fak Dergisi 3(1) 43-51, 2006. Kayseri: Erciyes Üniversitesi Veteriner Fakültesi, Hayvan Besleme ve Beslenme Hastalıkları Anabilim Dalı: 43.

Ataç, E. 2007 Dokuz Eylül Üniversitesi-Mühendislik Fakültesi- Makine Mühendisliği Bölümü- Diz Protezinin Modellenmesi ve Gerilme Analizi Bitirme projesi: pg.4.

Küçükkalay, M and Elibol, N.

2003 Osmanlı İmparatorluğu'na Avrupa'dan Karayolu İle Yapılan İhracatın Değerlendirilmesi: 1795-1804. Sosyal Bilimler Dergisi 2003/2: 160.

Nabokov, P. and Easton, R.

1989 Native American Architecture. Oxford University Press: New York: 353.

FIGURES

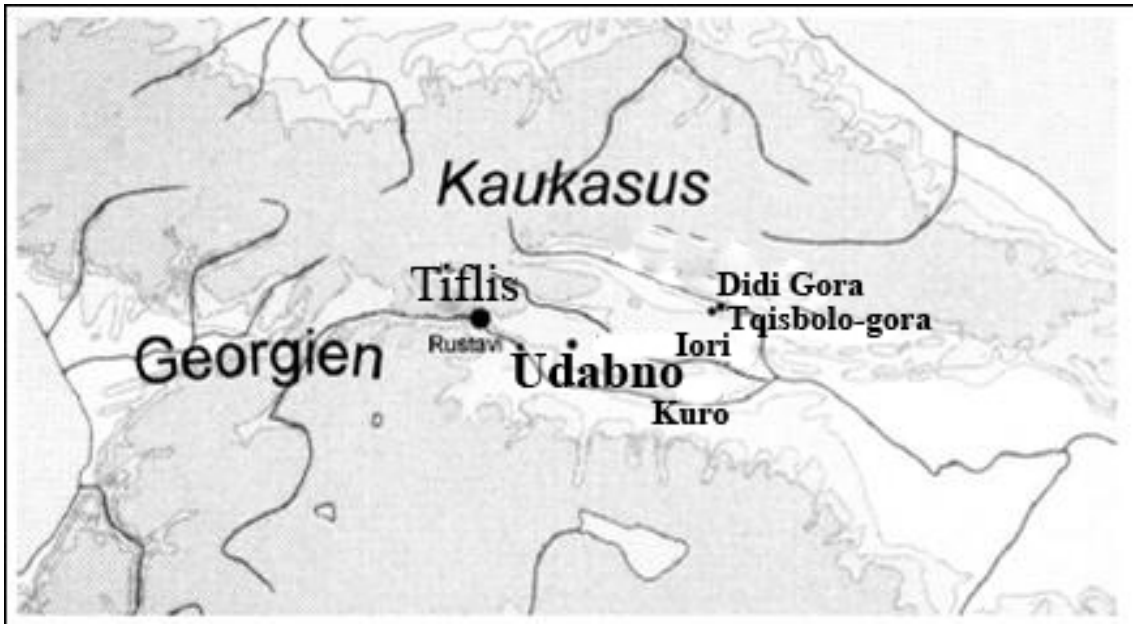

Fig. 1 The map of Georgia.

Fig. 2 Aerial photo showing the Udabno settlements.

Fig. 3 Udabno II and III- View from Udabno I.

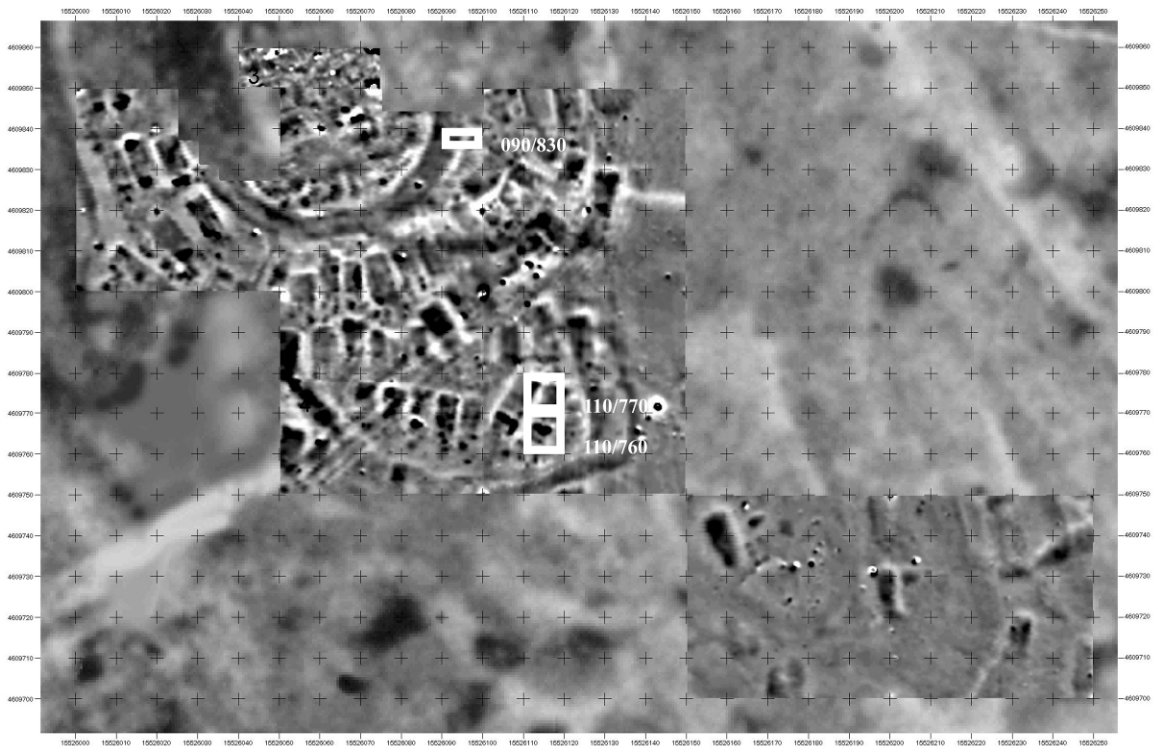

Fig. 4 Placement of House D in Udabno III.

Fig. 5 View from the working-living room to the entrance.

Fig. 6 Detail photo: part of the pavement.


Fig. 7 View from the working-living room to the kitchen.

Fig. 8 House B (on the right) and House C (on the left) from Udabno III (View from south)

Fig. 9 The plan of House D in trenches 110-760 and 110-770.

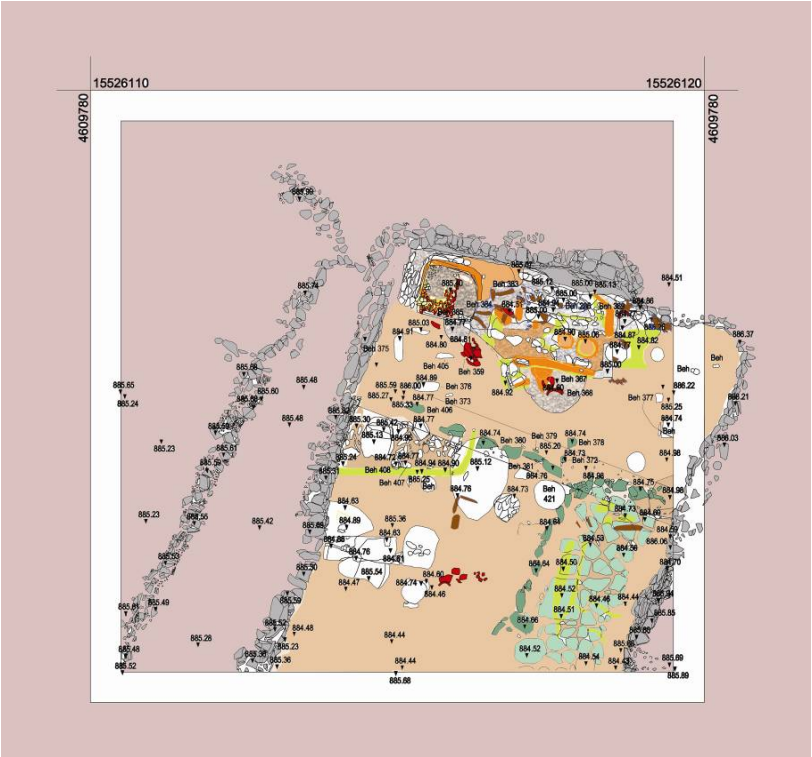

Fig. 10 The plan of House D in the trench 110-770.

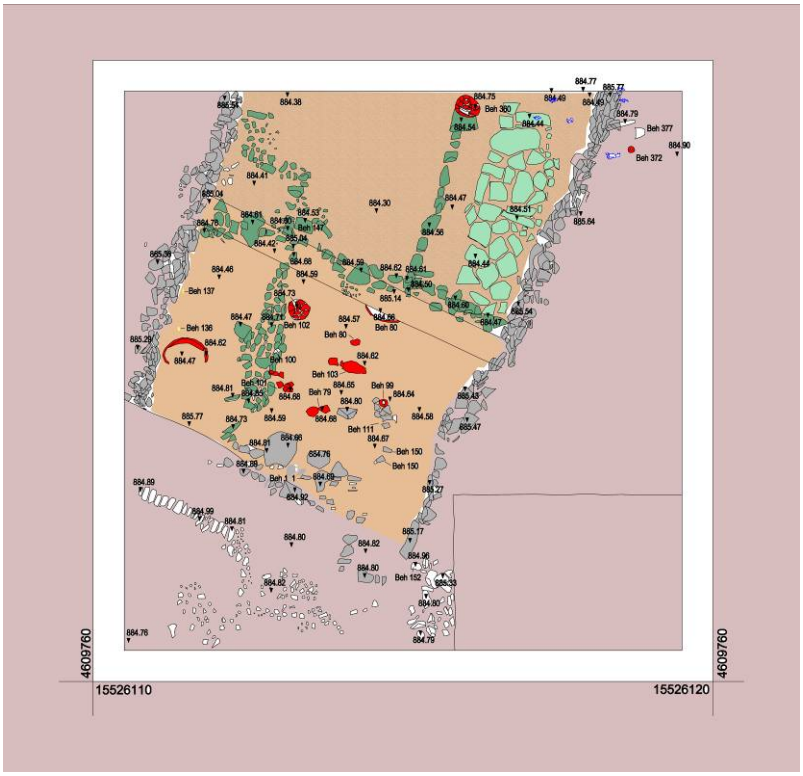

Fig. 11 The plan of House D in the trench 110-760.

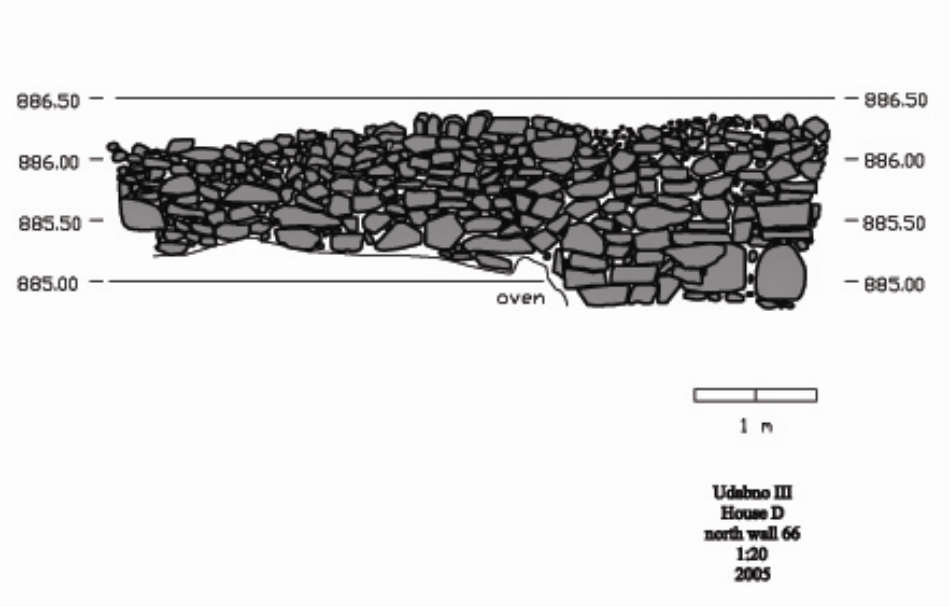

Fig. 12 The profile of the north wall.

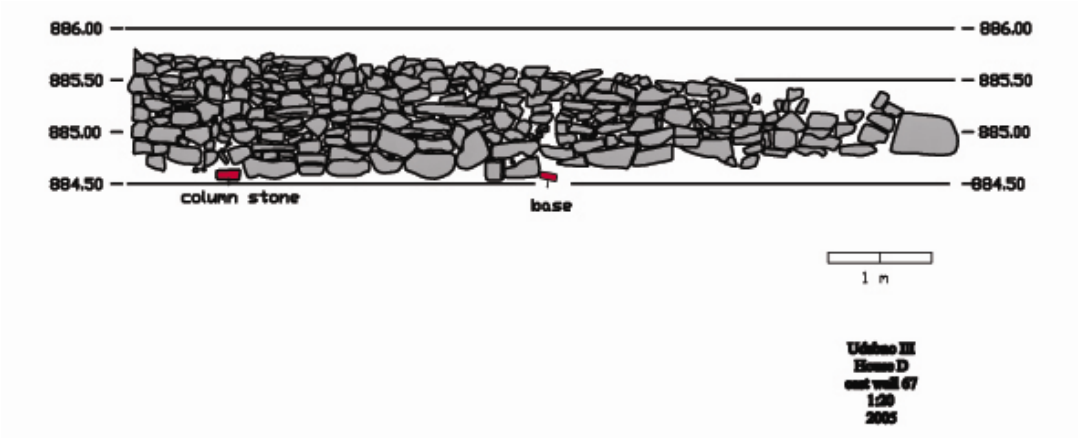

Fig. 13 Profile of the east wall in the trench 110-760.

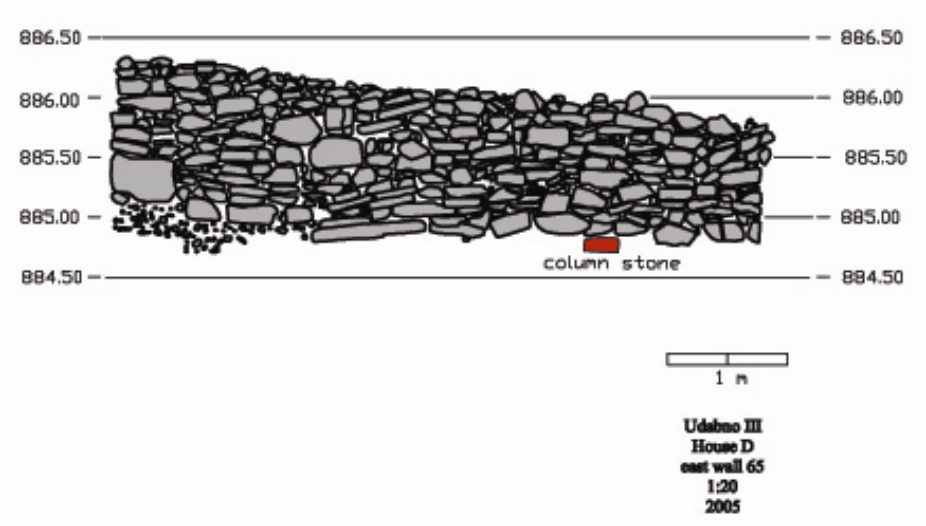

Fig. 14 Profile of the east wall in the trench 110-770.

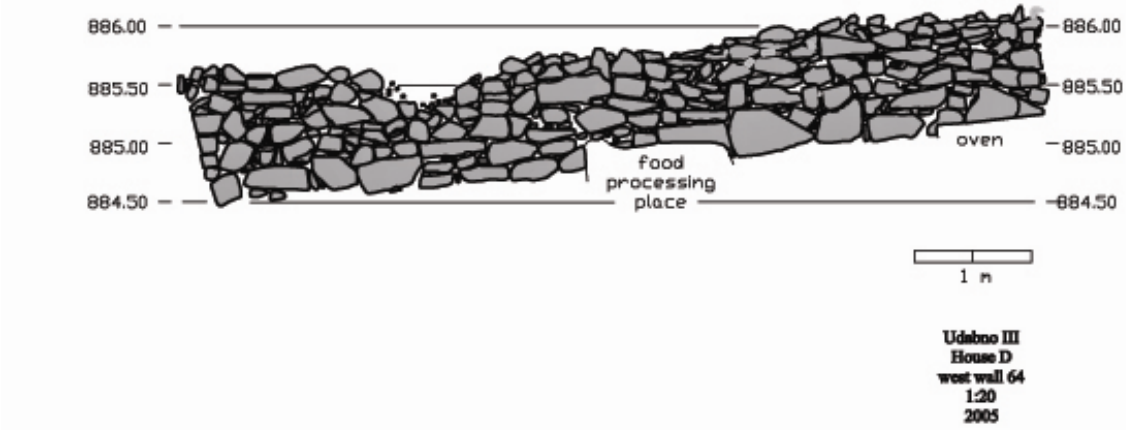

Fig.15 Profile of the west wall in the trench 110-760.

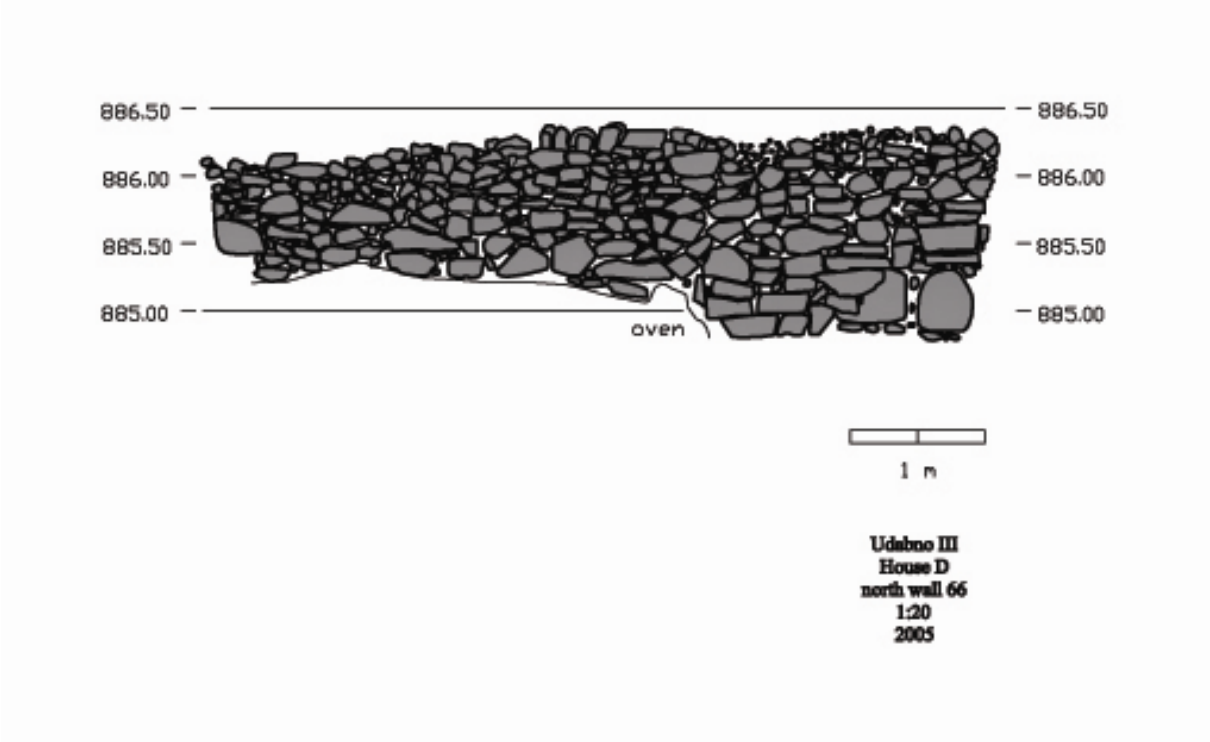

Fig. 16 Profile of the wall in the trench 110-770.

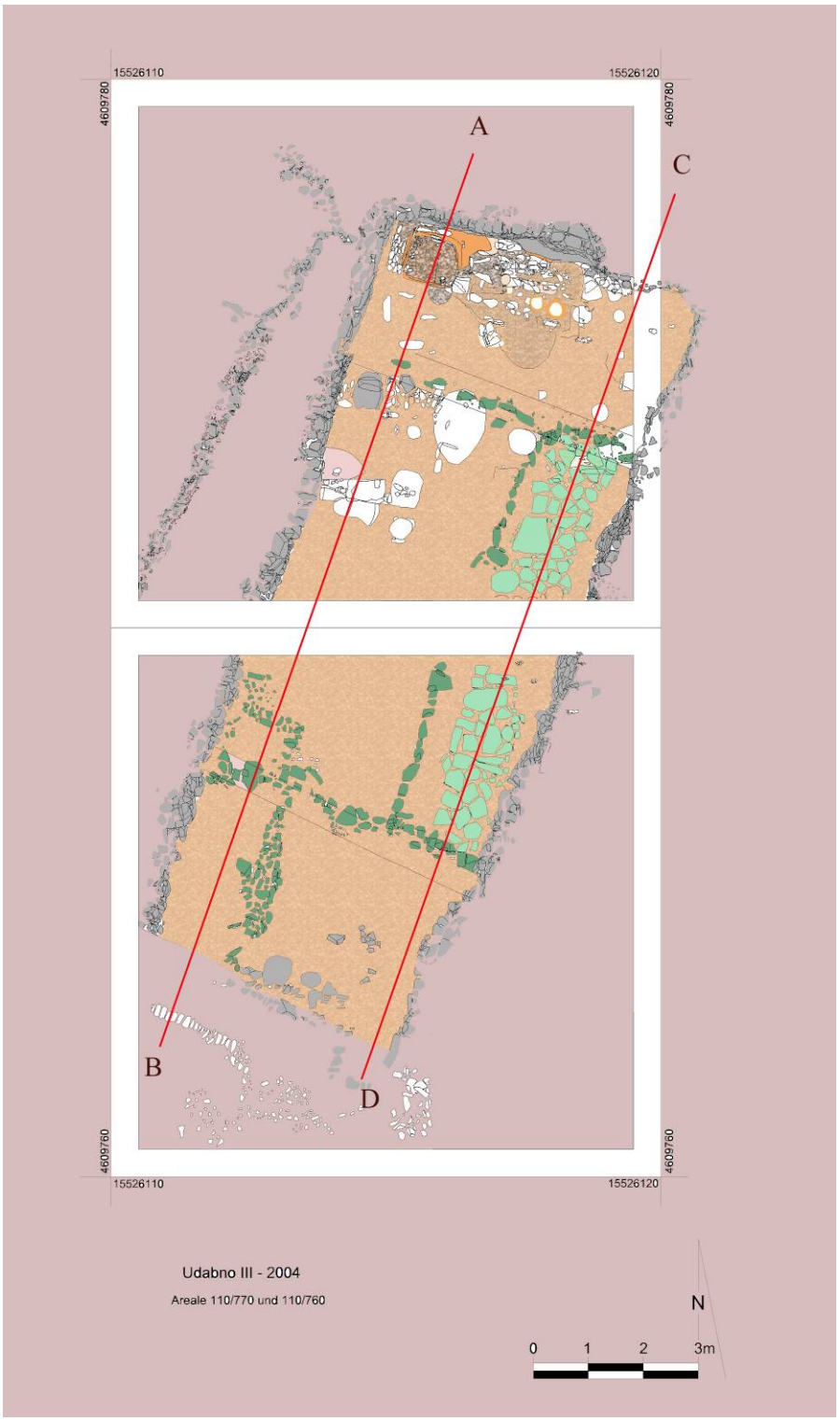

Fig. 17 The top plan of the House D showing the sections took to show the floor levels of the different activity areas.

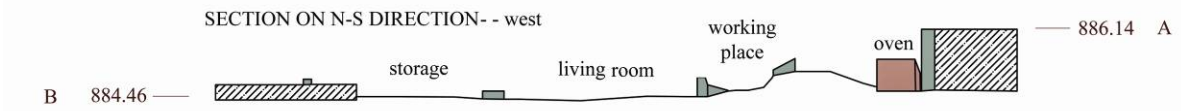

Fig. 18 The section taken in the north-south direction on the western half of the house showing the floor levels of the storage, living-working room and the kitchen.

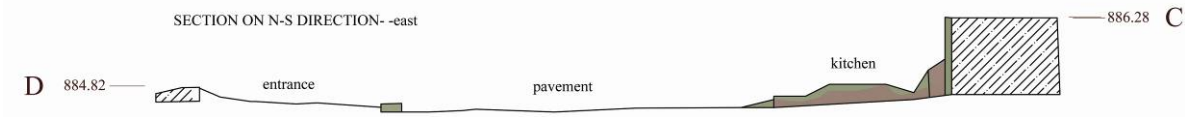

Fig. 19 The section taken in the north-south direction on the eastern half of the house showing the floor levels of the entrance, pavement area and the kitchen.

Fig. 20 One of the possible tools used in the construction process: a “tochi”.

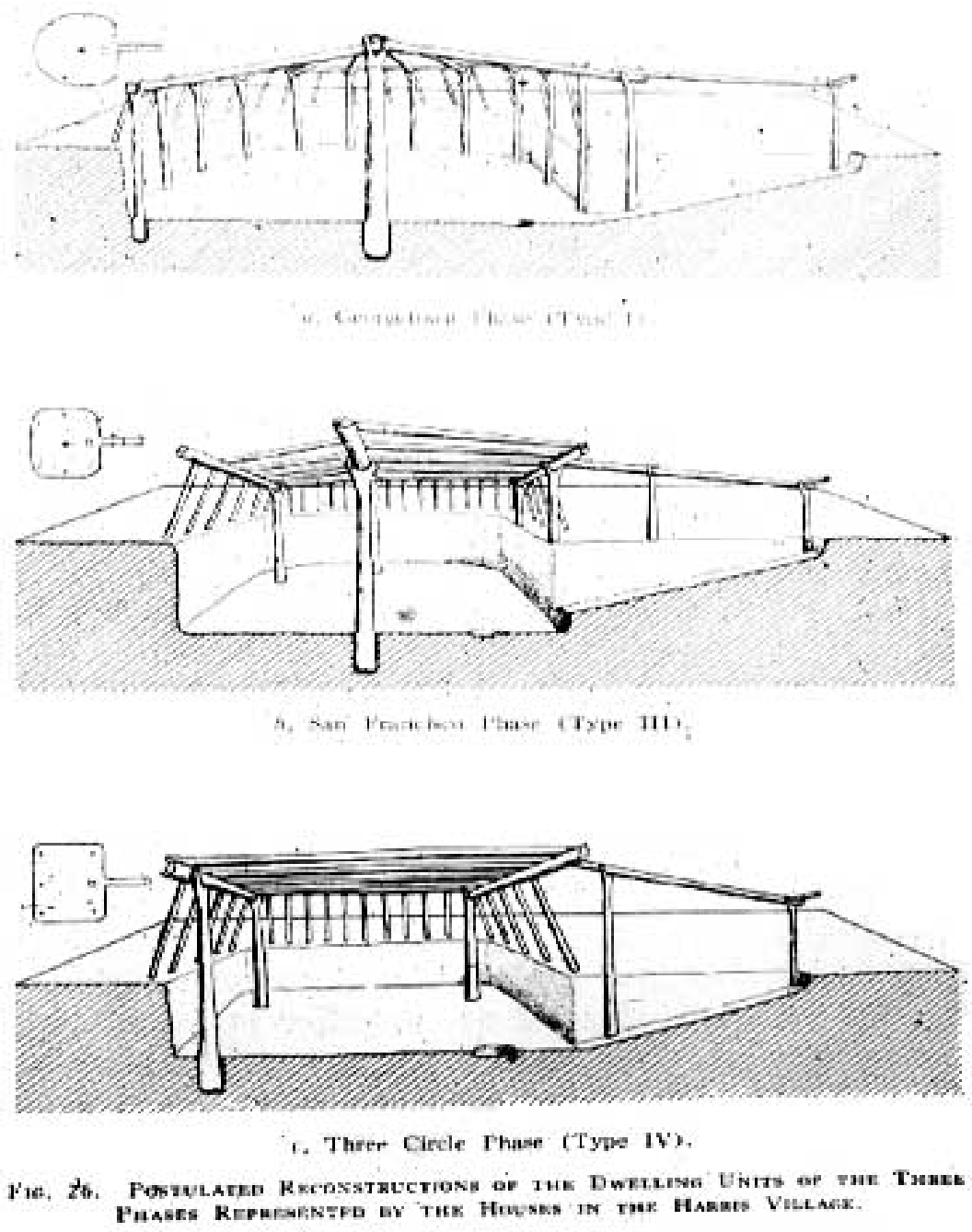

FIG. 26. POSTULATED RECONSTRUCTIONS OF THE DWELLING UNITS OF THE THREE PHASES REPRESENTED BY THE HOUSES IN THE HARRIS VILLAGE.

Fig. 21 Reconstruction drawings showing possible roof constructions in Mogollon village in southern America (Nabokov and Easton 1989: 353).

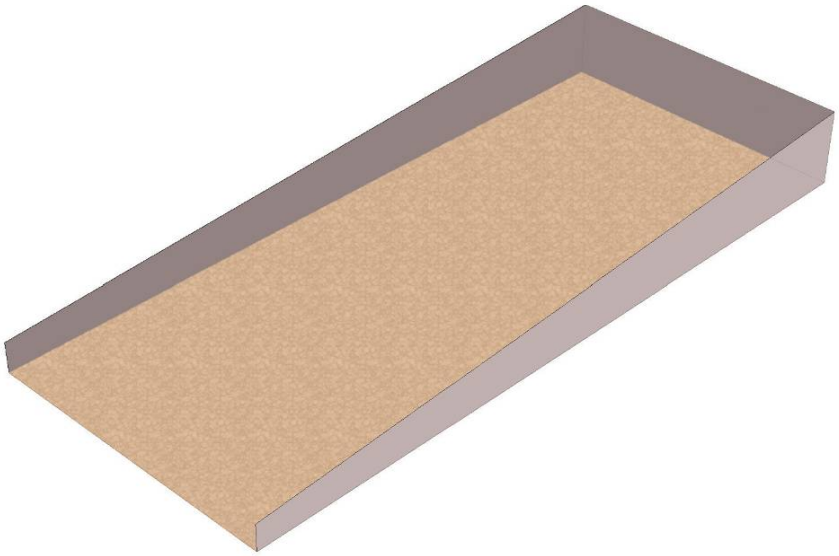

Fig. 22 Construction process-step 1: digging the pit (General layout of the pit).

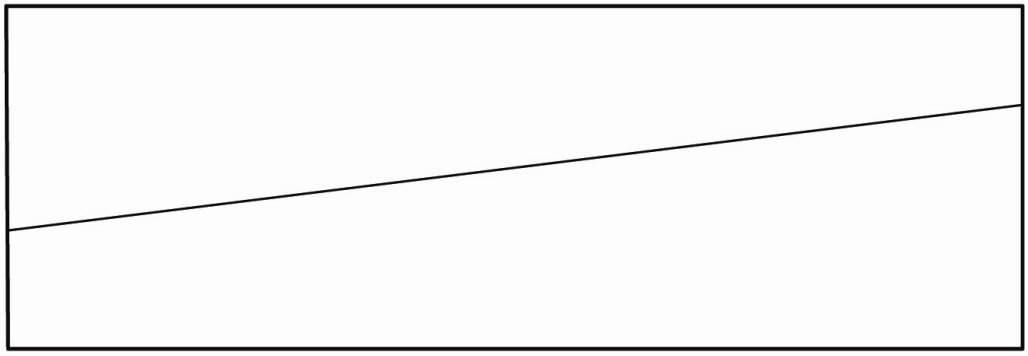

Fig. 22.a. The possible layout of the hill side before the construction started.

Fig. 22.b. View from east- the section of the House D showing the layout of the dugout.

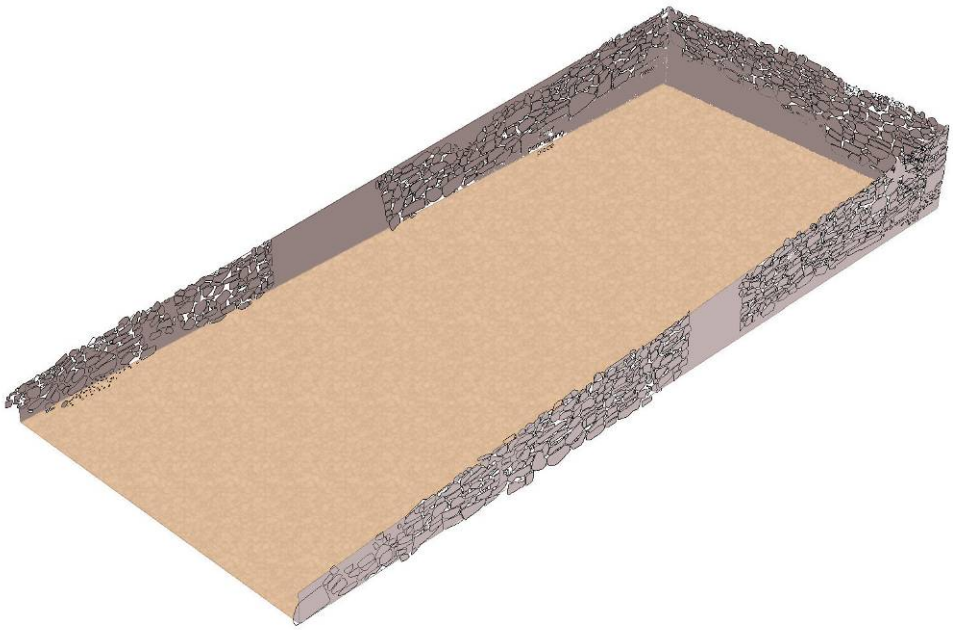

Fig. 23 Construction process-step 2: Building the stone walls

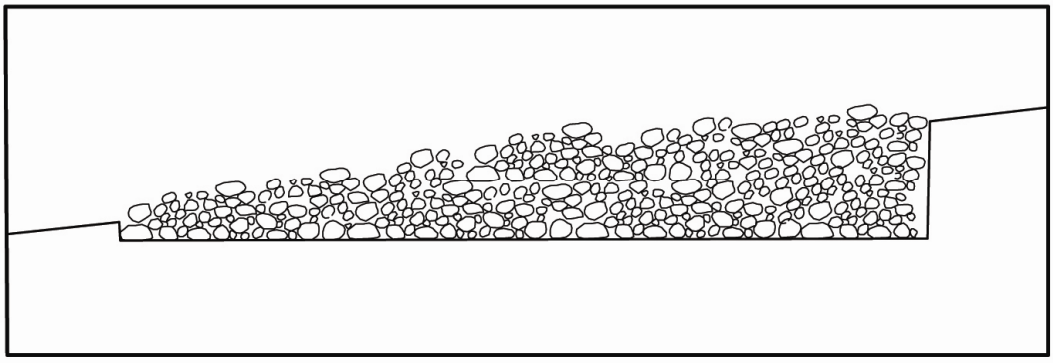

Fig. 23.a. View from east- the section of the House D showing the stone walls.

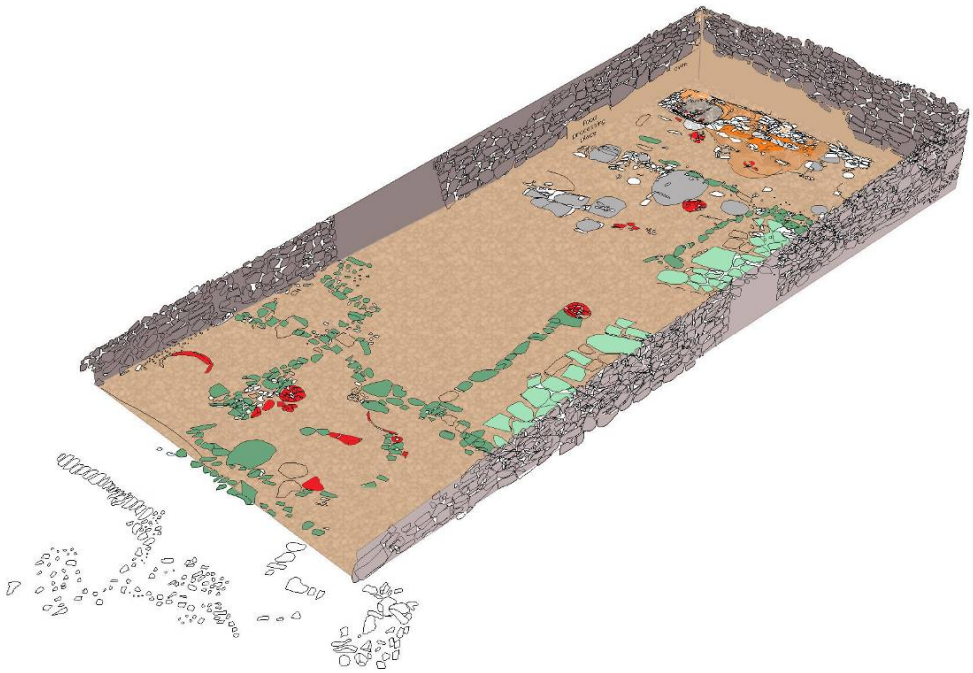

Fig. 24 The top plan of the interior House D is matched with the stone walls in the form of the pit to indicate the placement of the post bases.

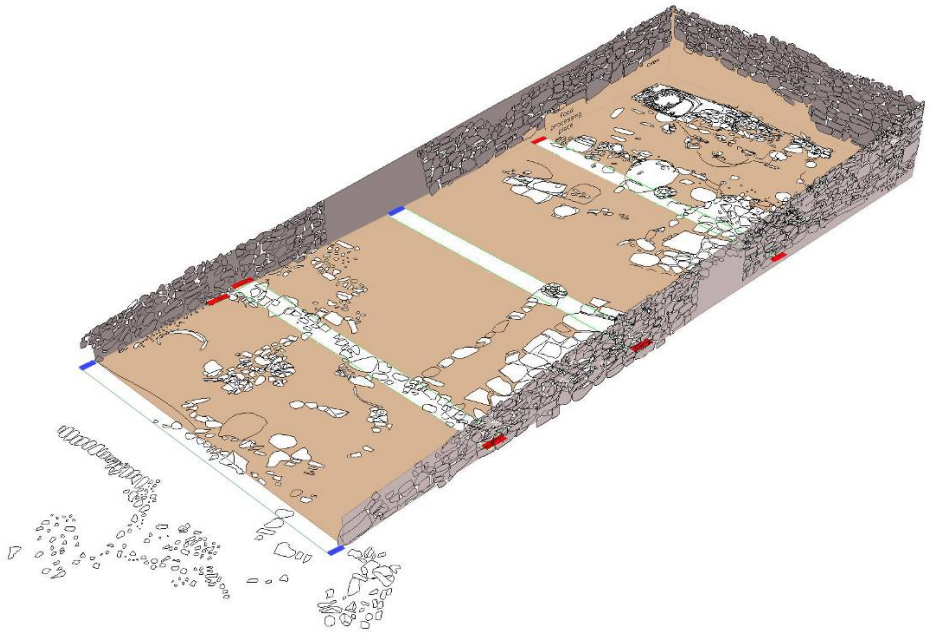

Fig. 25 Location of the post bases: the red signs indicate the placement of the real post bases when the blue ones show the additional post bases which are added according to the general plan.

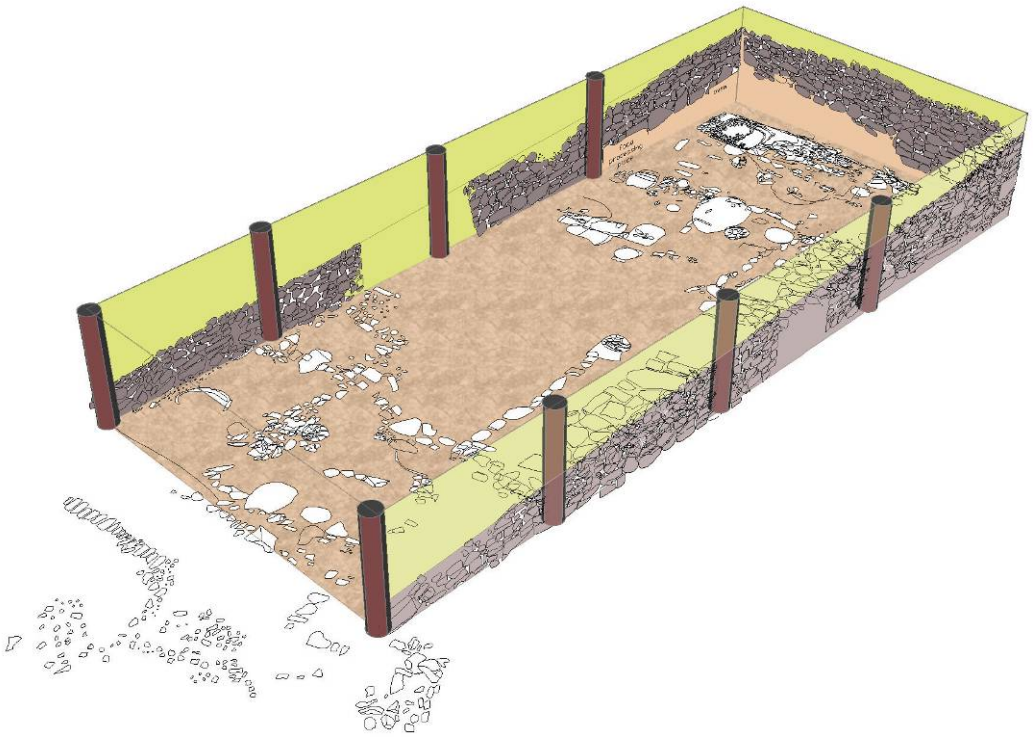

Fig.26 Construction process-step 3: Placement of the posts (The plan shows the walls in their reconstructed sizes up to 2 meters with the posts. The reconstructed parts are shown in yellow instead of referring any specific material because there are two possibilities on the material used for these parts. Both stone and wood construction methods are taken into accounts in the study).

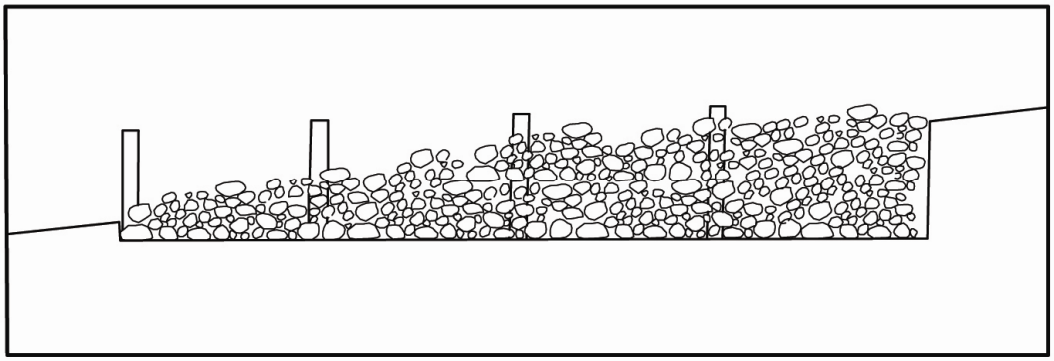

Fig. 26.a. View from east- the section of the House D showing the placement of the posts.

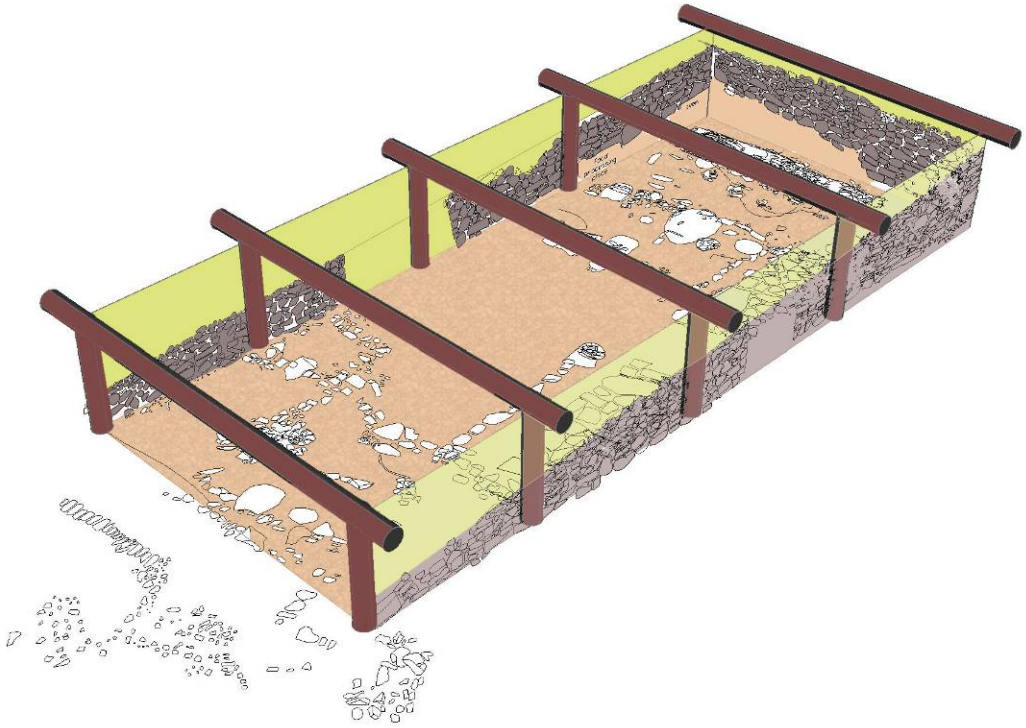

Fig. 27 Construction process-step 4: Placement of the lintels supported by the posts: the bearer frame of the roof construction.

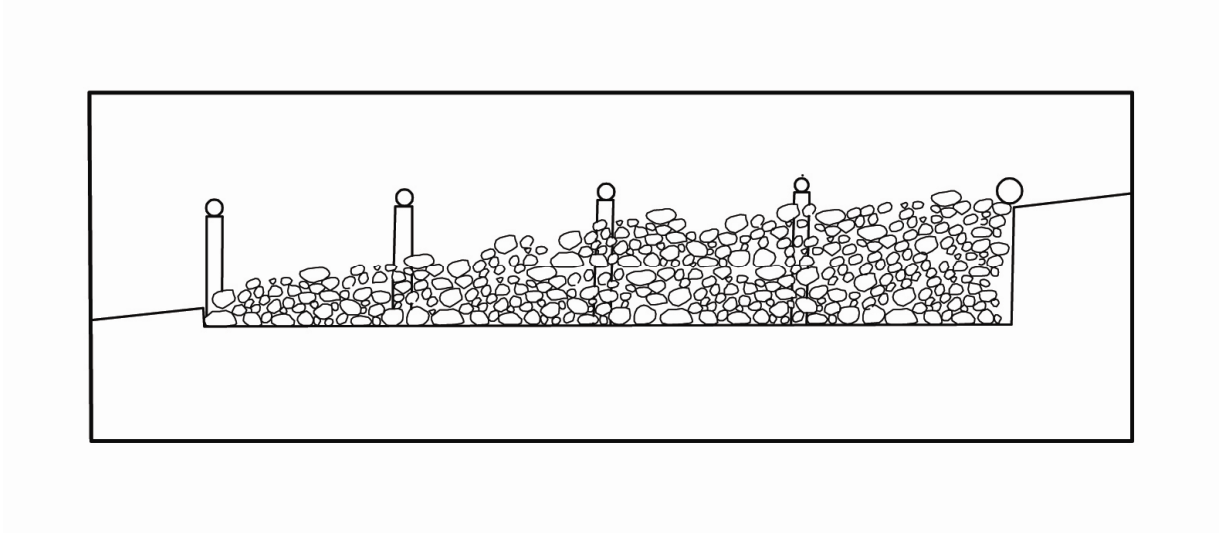

Fig. 27.a. View from east- the section of the House D showing the placement of the lintels.

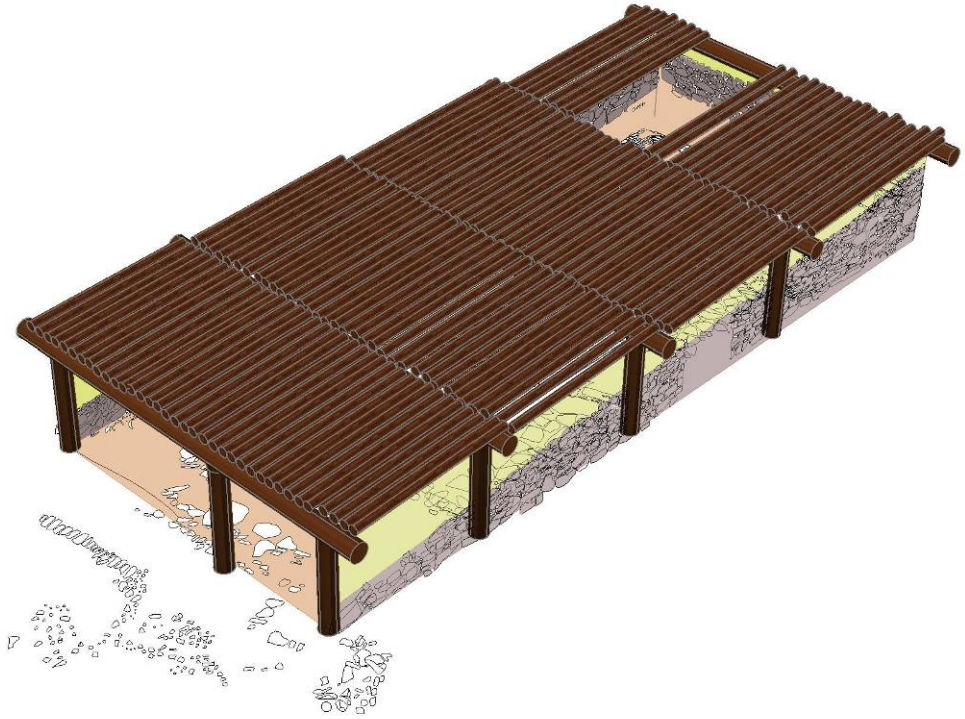

Fig. 28 Construction process-step 5: Building the first cover of the roof (The first cover over the post-lintel frame

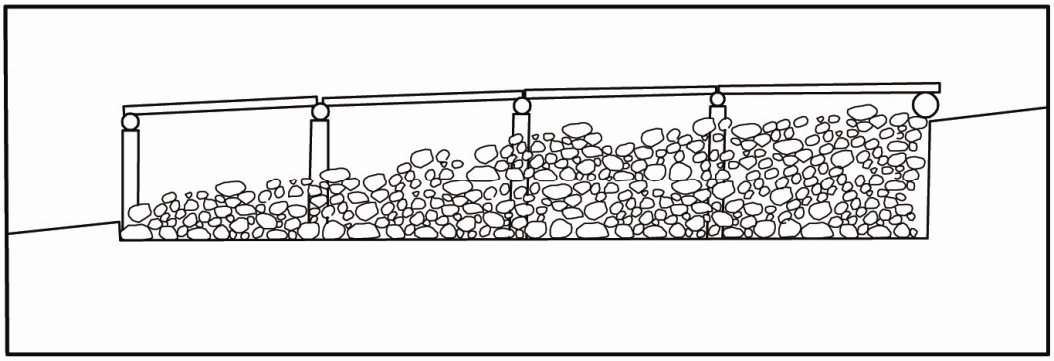

Fig. 28.a. View from east- the section of the House D showing the placement of the posts.

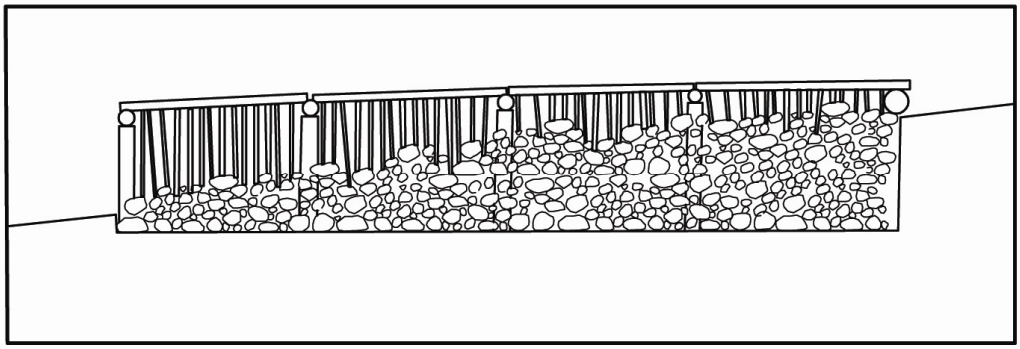

Fig. 29 Construction process-step 6: Covering the side openings (View from east- the section of the House D showing the placement of thinner branches on the sides in order to both cover the side openings and to support the roof construction).

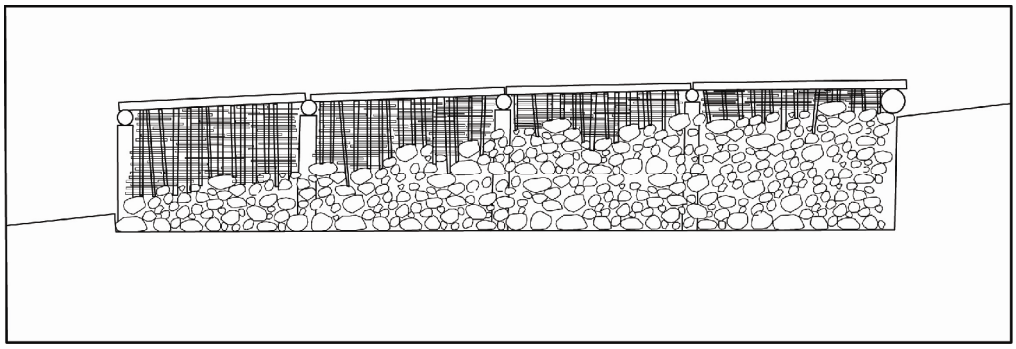

Fig. 29.a. View from east- the section of the House D showing the placement of knitted thinner branches to complete the side covers.

Fig. 30 Construction process-step 7: Building the second cover of the roof (The second cover over the first one).

.

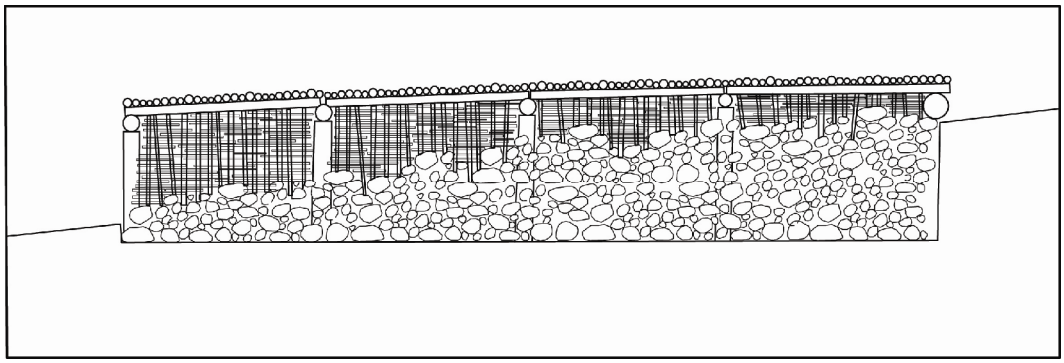

Fig. 30.a. View from east- the section of the House D showing the placement of second cover of the roof construction.

Fig. 31 Construction process-step 8: Covering the roof and the sides with mud in order to have better insulation inside (The drawing shows the complete roof structure covered with mud. The opening at the top must be partly closed like a chimney, which is not shown here).

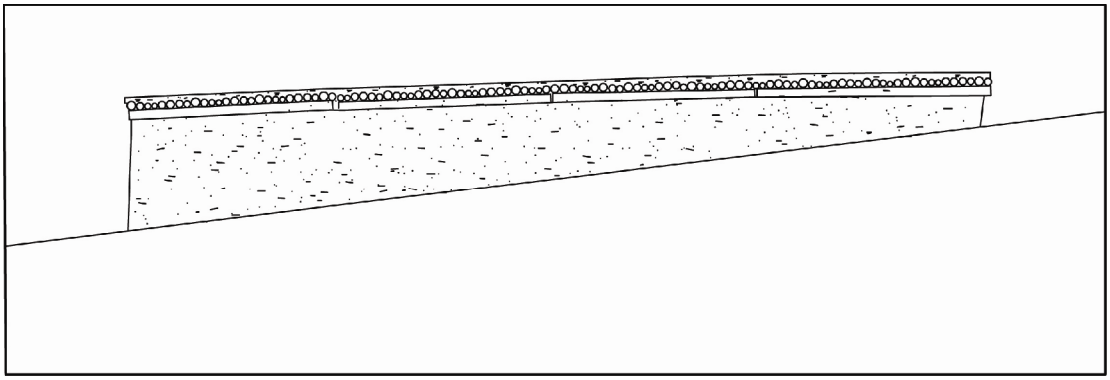

Fig. 31.a. The House D's view from eastern outside. The dwelling is covered with mud on its sides and the roof.

Fig. 32 The top view of the House D.

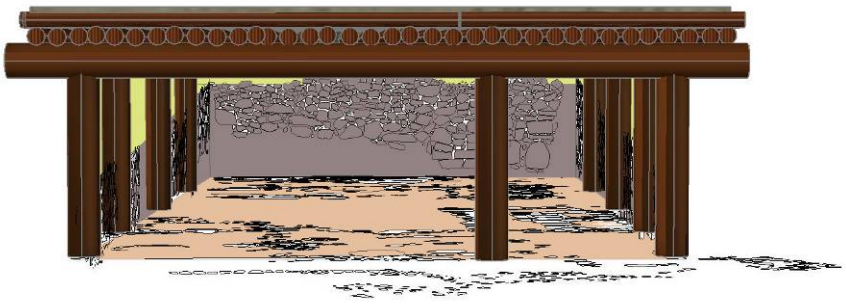

Fig. 33 The frontal view of the House D.

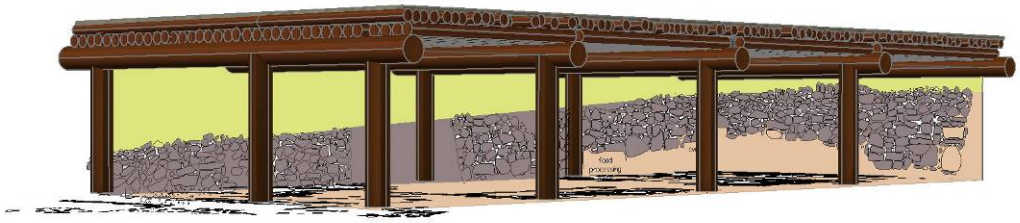

Fig. 34 View from south-east corner of the house showing the inside of the House D.

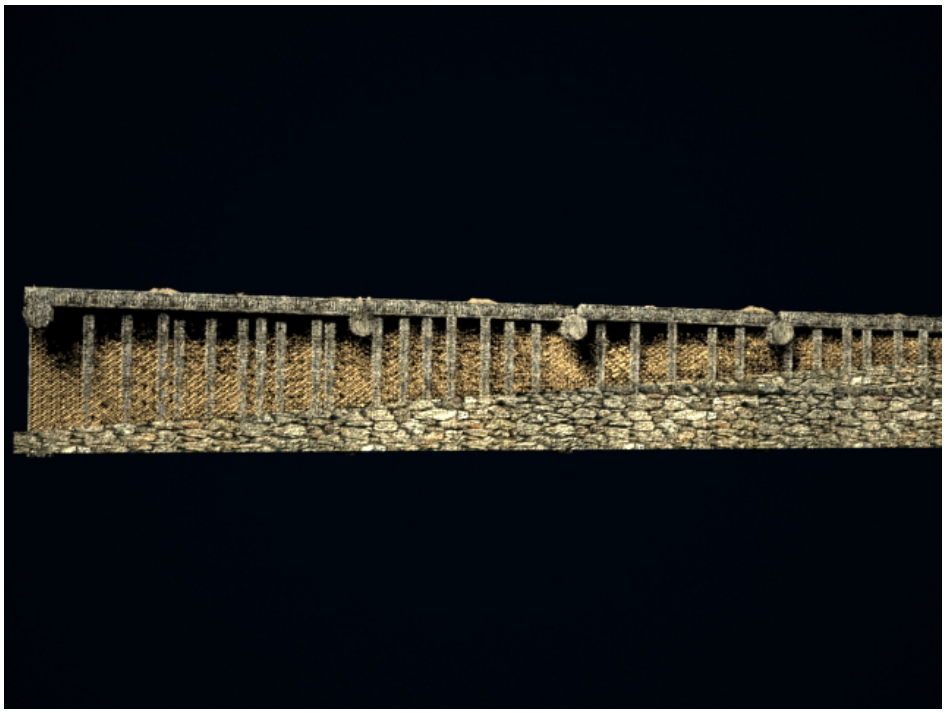

Fig. 35 View from east without topography.

Fig. 35 View from east with topography.

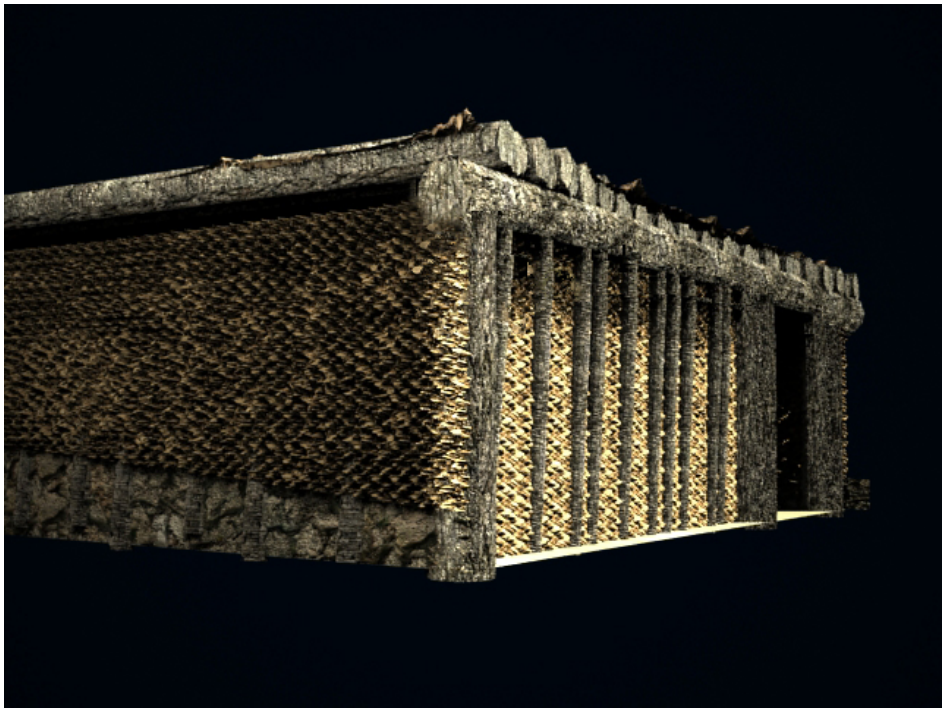

Fig. 36 SW isometric view without topography.

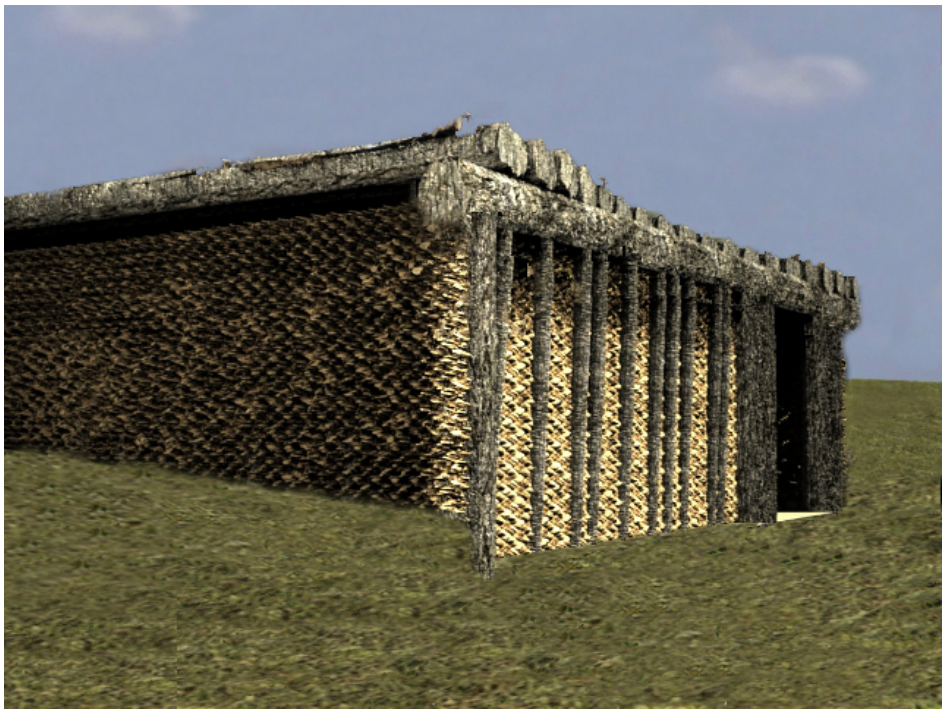

Fig. 37 SW isometric view with topography.

Fig. 38 Interior view of the house from north.

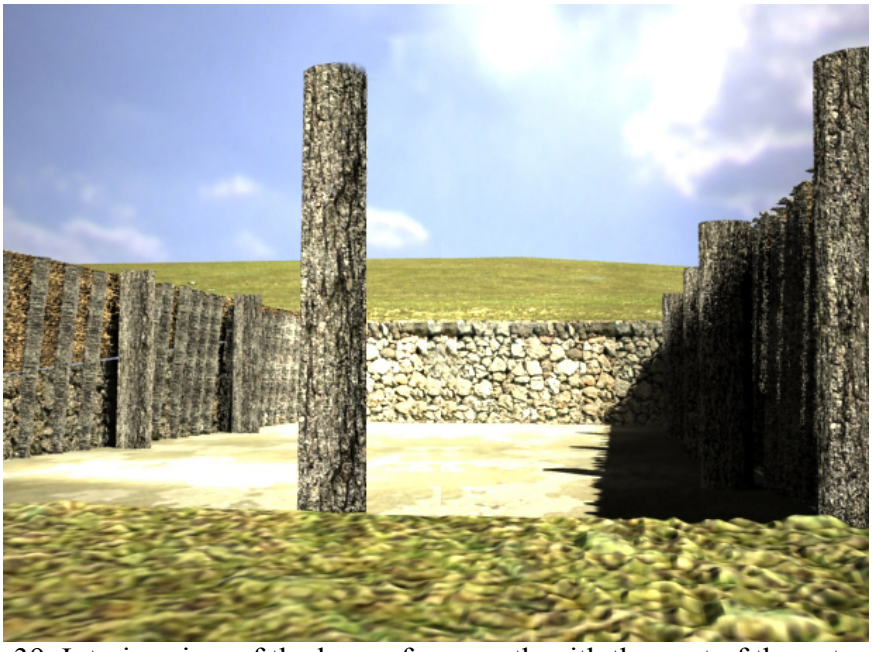

Fig. 39 Interior view of the house from north with the post of the entrance.

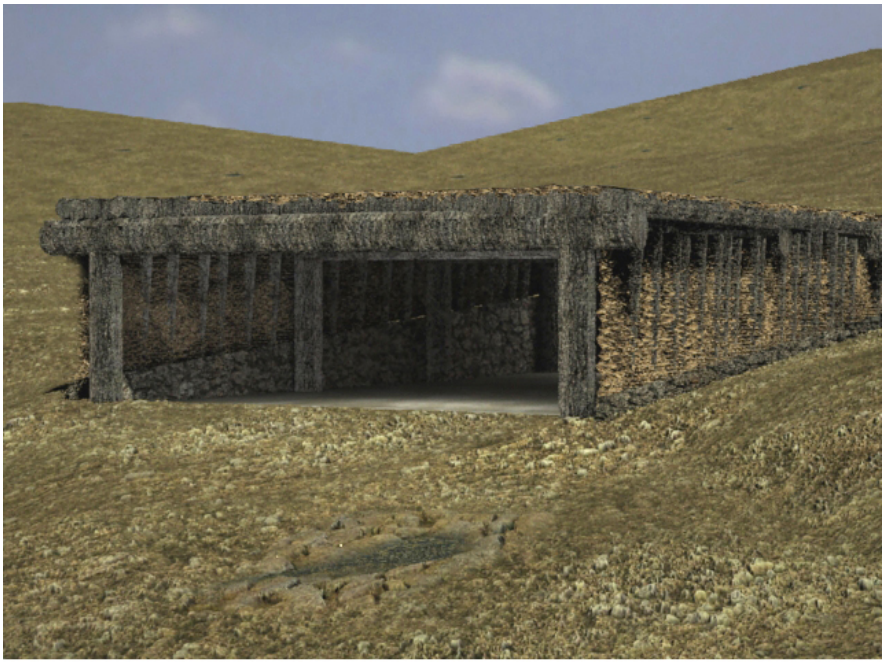

Fig. 40 SE isometric view of the house without the entrance.

Fig. 41 Final view of the house from north.

TABLES

Table 1. Dimensions of the House D

WALLS	DIMENSIONS
length of east and west walls:	approx. 14.5 m
length of north and south walls:	approx. 6.0 m
height of the highest wall remains:	approx. 1.5 m (reconstructed to 2 m)
height of the lowest wall remains:	approx. 0.50 m (reconstructed to 2 m)
width of the walls:	approx. 0.46 m

Table 2. M³ and Kg of materials used:

MATERIAL	VOLUME	WEIGHT
- loam:	90.00 m³ loam dug out	135.0 t
- limestone wall remains:	17.45 m³	45.0 t
- limestone walls reconstructed	31.28 m³	81.3 t
- single stone average:	0.02 m³	37.8 kg
- wood for posts:	0.98 m³	696.0 kg
- wood for lintels:	1.47 m³	1045.0 kg
- wood for roof cover:	10.19 m³	7240.0 kg
-wood for side covers:	707.20 m³	502.0 kg

Table 3. Specific gravities of the materials used in House D:

MATERIAL	SPECIFIC GRAVITY
loam	1.50 gr/cm³
limestone	2.5-2.70 gr/cm³
wood	0.71 gr/cm³

Table 4. Number and dimension assumptions for the roof construction:

Number of Timbers	Length of timbers	Diameter of timber	kg each	kg total
10 posts	2.0 m	25 cm diameter	69.6 kg	696.0 kg
5 lintels	6.0 m	25 cm diameter	209.0 kg	1045.0 kg
240 pieces first cover	3.6 m	10 cm diameter	20.0 kg	4800.0 kg
580 pieces second cover	3.0 m	5 cm diameter	4.1 kg	2378.0 kg

Table 5. Size and number of stone wall remains:

Wall No.	Total stones	Maximum size	Minimum size
West wall 66	total 98 stones	max.0.50/0.17 cm	min. pebbles 0.05/0.02 cm
West wall 64	total 260 stones	max.0.73/0.42 cm	min. pebbles 0.05/0.02 cm
North wall	total 320 stones	max.0.52/0.39 cm	min. pebbles 0.05/0.02 cm
East wall 65	total 280 stones	max.0.52/0.36 cm	min. pebbles 0.05/0.02 cm
East wall 67	total 247 stones	max.0.62/0.38 cm	min. pebbles 0.05/0.02 cm
	Total: 1200	**Max. 0.73 / 0.42 cm**	**Min. pebbles 0.05 / 0.02 cm**
Reconstruction	**Total: approx. 2150**	**Approx. max. 0.59/ 0.35 cm**	**min. pebbles 0.05 / 0.02 cm**

Table 6. Digging the Pit

Total loam weight	Tool- capacity	Hours	Work days
74.46 m³	Handful etc.- 0.76 kg	41 hours	5.1 work days

Table 7. Removing Dugout Loam and Stones

Total Weight	Tool- capacity	Hours	Work days
Loam: 111540 kg **Stone: 40650 kg**	Buckets, cases etc.- x kg*	29 hours	3.5 work days

* This calculation is made by using the equations in Seeher 2007: 219: "...one man can carry 525 kg (0.35m³ loams) over a distance in an hour."

Table 8. Collecting Wood from 15 km Distance

	Vehicle-speed	Load	Hours	Work days
Each unloaded process	Running horse: 60-70 km/h	----------	0.5 hours	1/16 work days
Each loaded process	Walking man: 80 m/min	350 kg	3 hours	3/8 work days
TOTAL	----------	8981 kg	3.5 x 26 times 91 hours	11.3 work days

---

Table 9. Collecting Stones

Distance and times	Weight	Hours	Work days
10 m - x times*	5250 kg*	1.0 hours*	1/8 work days*
10 m - x times	40650 kg (half of stones needed)	7.7 hours	Approx. 1 work days

* This calculation is made by using the equations in Seeher 2007: 219: "...one man can carry 525 kg (0.35m³ loams) over a distance in an hour."

Table 10. Building Walls

Distance and times	Weight	Hours	Work days
10 m.- x times*	5250 kg*	1.0 hours*	1/8 work days*
10 m- x times	81300 kg (for total 31.28 m³ stone)	15.48	Approx. 2 work days

* This calculation is made by using the equations in Seeher 2007: 219: "...one man can carry 525 kg (0.35m³ loams) over a distance in an hour."

Table 11. Comparison of two suggestions

The Pit (digging and removing)	Collecting wood	Collecting stones	Building stone walls	Preparing wooden side covers	Roof	TOTAL
8.6 man/days	11.3 man/days	Approx. 1 man/days	Approx. 2 man/days	----------	(2 man/days)?	**199.2 hours 24.9 man/days**
8.6 man/days	Approx. 12 man/days	0.1 man/days	Approx. 1 man/days	Approx 1 man/days	(2 man/days)?	**197.6 hours 24.7 man/days**

Table 12. The chart showing the stages of the construction process.