

## CHAPTER IV

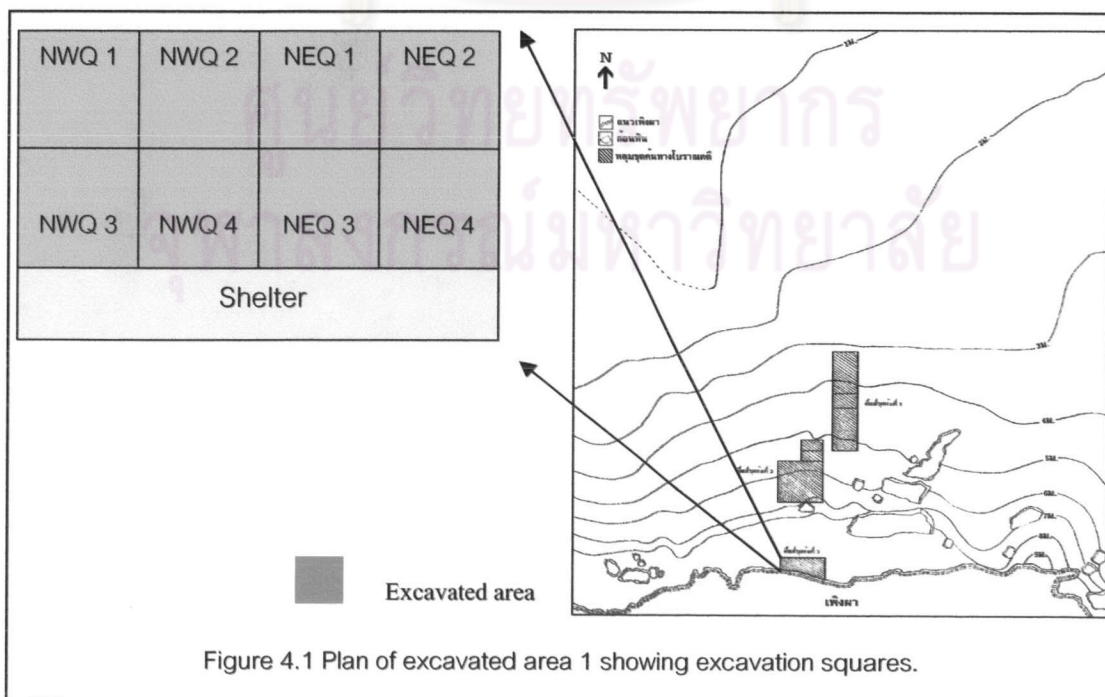
### RESULT I : STRATIGRAPHY AND SEDIMENTOLOGY

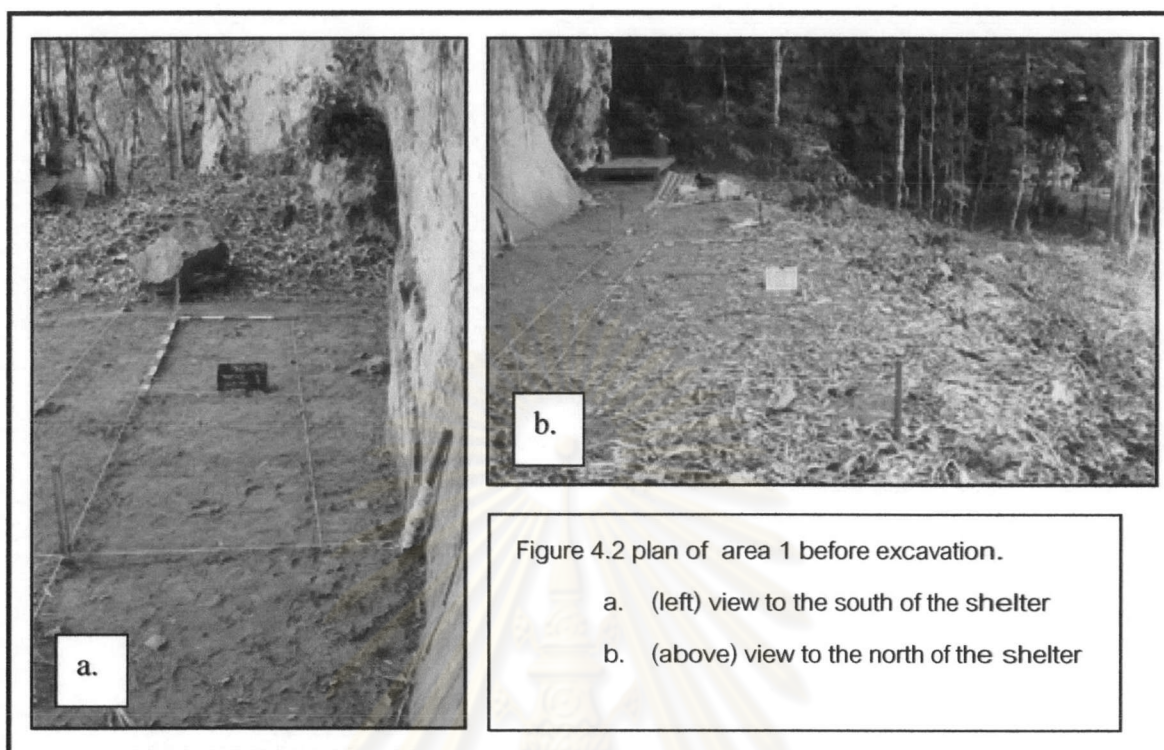
The stratigraphy and sedimentology analyses from the excavation have been preliminary observed and labeled according to major visible unconformities that separate apparently continuous episodes of accumulation. Subsequently, soil sampling from each layer was collected for sedimentology analysis, and then correlate with each stratigraphic and archaeological remains.

#### 4.1 The result from excavation

##### 4.1.1 Area Excavation 1

The excavation was made in the flat floor of the shelter. The excavated pit was in a medium open area with a floor has a flat area that is approximately 10 meters across and extended about 4 meters from the base of the cliff to the dripline, and interspersed with large boulders, covered by powdery silt and talus (Figure 4.1). The 1.5 x 4 meters trial trenching excavation was undertaken (Figure 4.2).





Excavation area 1, archaeological evidence from this area was complicated and composed of many relative layers vertically intersected by numerous of archaeological remains especially stone tools and animal remains along the deposit of about 4.5 m. depth. The significance of the layer deposit was inter-bedded of natural process and cultural process, discontinuity of the deposit was observed in some parts. The remain of human activities was found. Archaeological evidence includes a lot of stone tools, animal remains, potsherd, shellfish and burial.

According to excavation, the natural units were generally excavated in split of 10 cm. depth. In practice, it was difficult to locate precisely the boundary of stratigraphy units at this site. The combination of natural leaching and the great amount of disturbance from occupation, burial activity and geological process was recorded effectively in much microstratigraphy. However, it was generally possible to identify the boundaries of the main stratigraphic units within discussion next section.

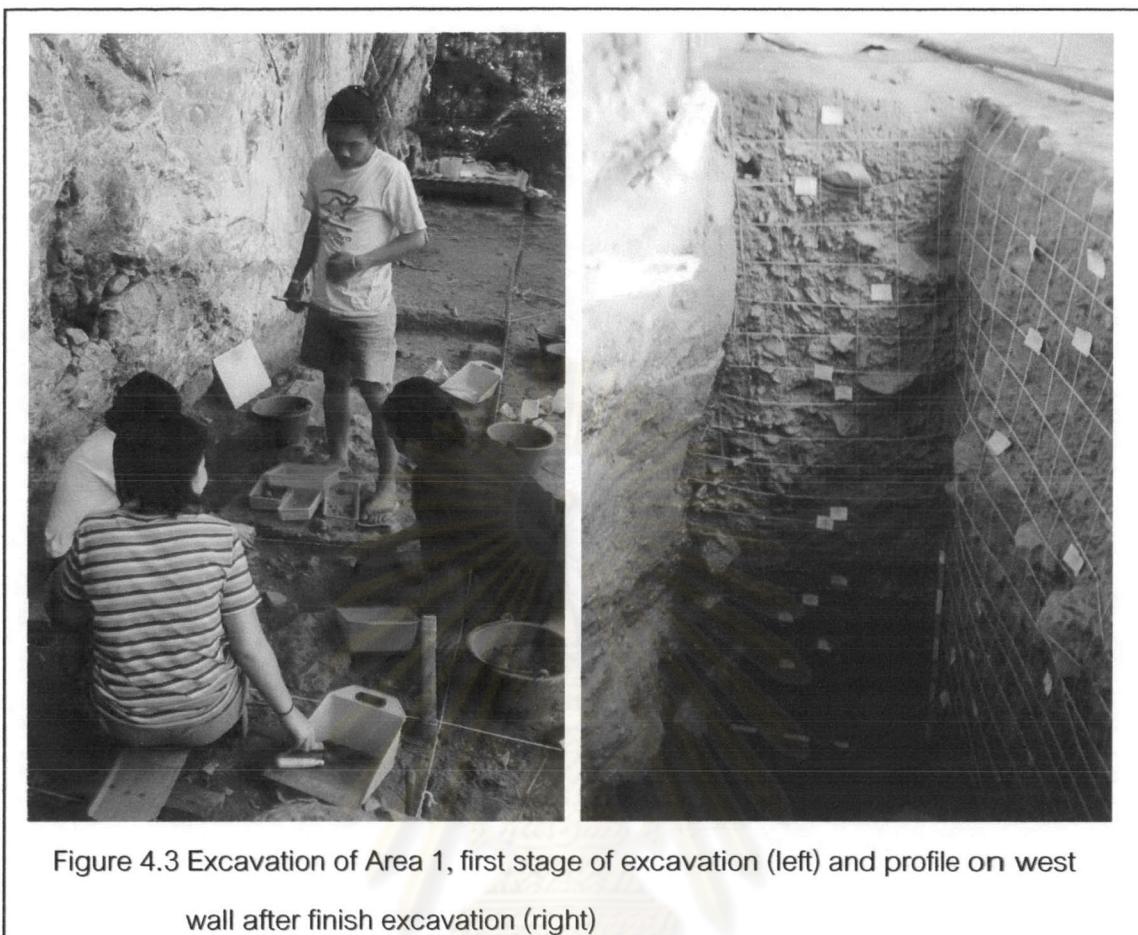


Figure 4.3 Excavation of Area 1, first stage of excavation (left) and profile on west wall after finish excavation (right)

#### 4.1.2 Area excavation 2

This area was excavated on the talus slope deposit between area1 and area 2 of the rockshelter with slope about  $25^{\circ}$  to  $30^{\circ}$ , and is interspersed with large boulders of limestone rock fall, covered by talus sediment (Figure 4.5). The 2 x 6 meters trial trenching excavation was undertaken (Figure 4.4).

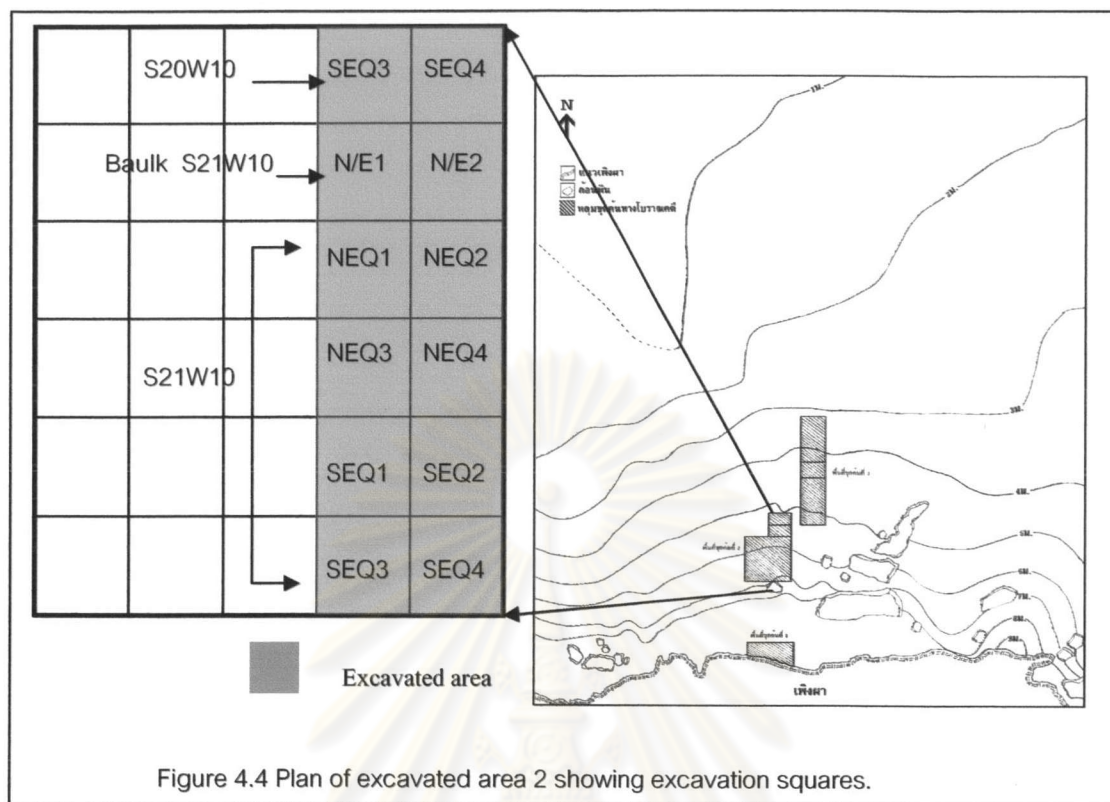


Figure 4.4 Plan of excavated area 2 showing excavation squares.

Stratigraphy of excavation area 2 shows complexity similar to area 1. It is composed of many relative layers vertically intersected by the natural process and cultural process (Figure 4.5). The significance of the layer deposit was inter-bedded of natural process (limestone rock fall) and cultural process. From the excavation, the remains of human activities were also found. Archaeological evidence include a lot of stone tools, animal remains, potsherd and shellfish.

According to excavation, the natural units were generally excavated in split of 10 cm. depth or more. In some layers there were almost of rock falls and were then excavated in splits of 20 cm. depth. Like area I, it was difficult to locate precisely the boundary of stratigraphy units especially where the mixing of natural process and cultural process occurred. The combination of natural leaching and the great amount of disturbance from occupation, geological process was observed by using

microstratigraphy records .However, it was more clearly possible to identify the boundaries of the main stratigraphic units than area 1.

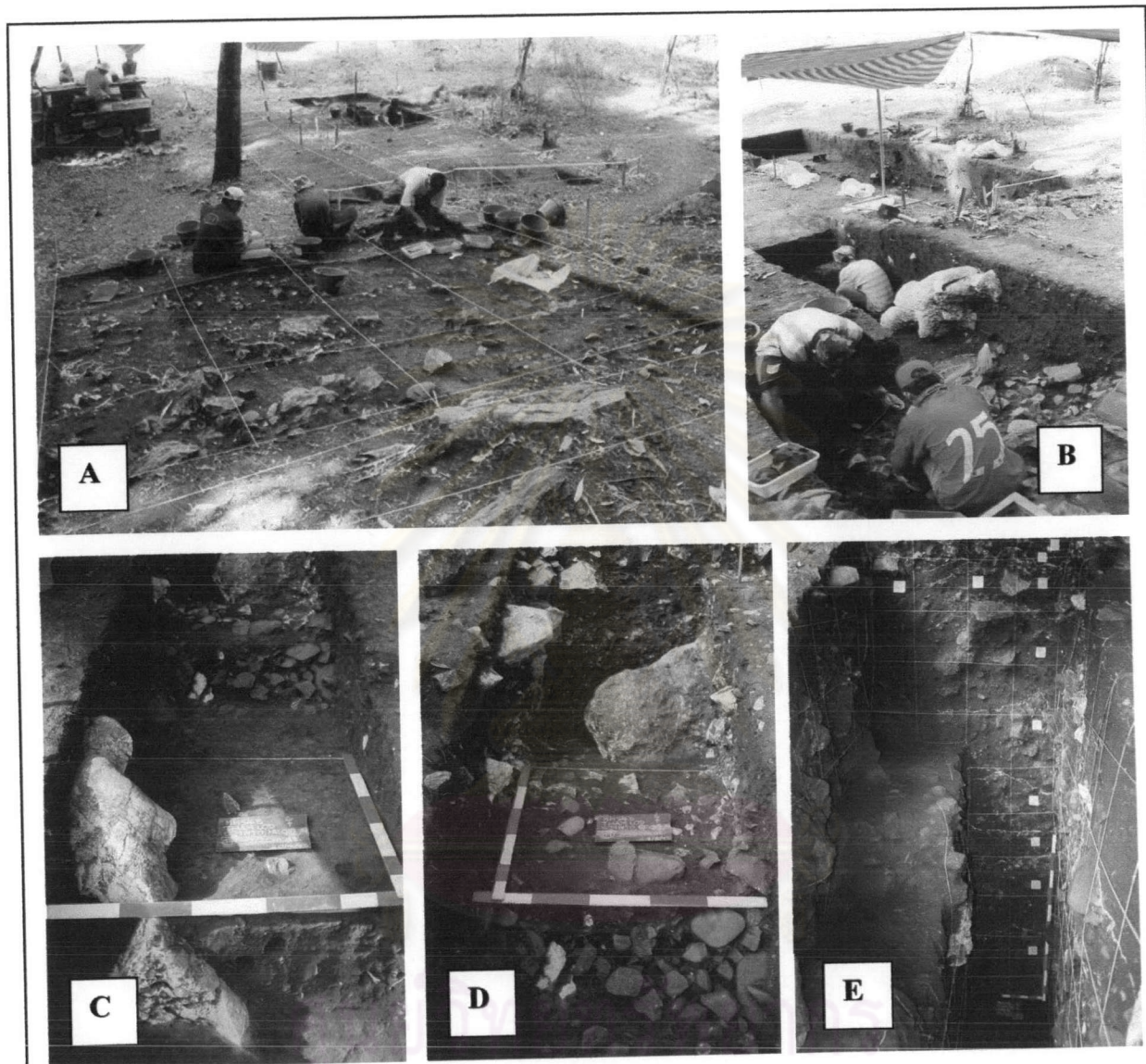
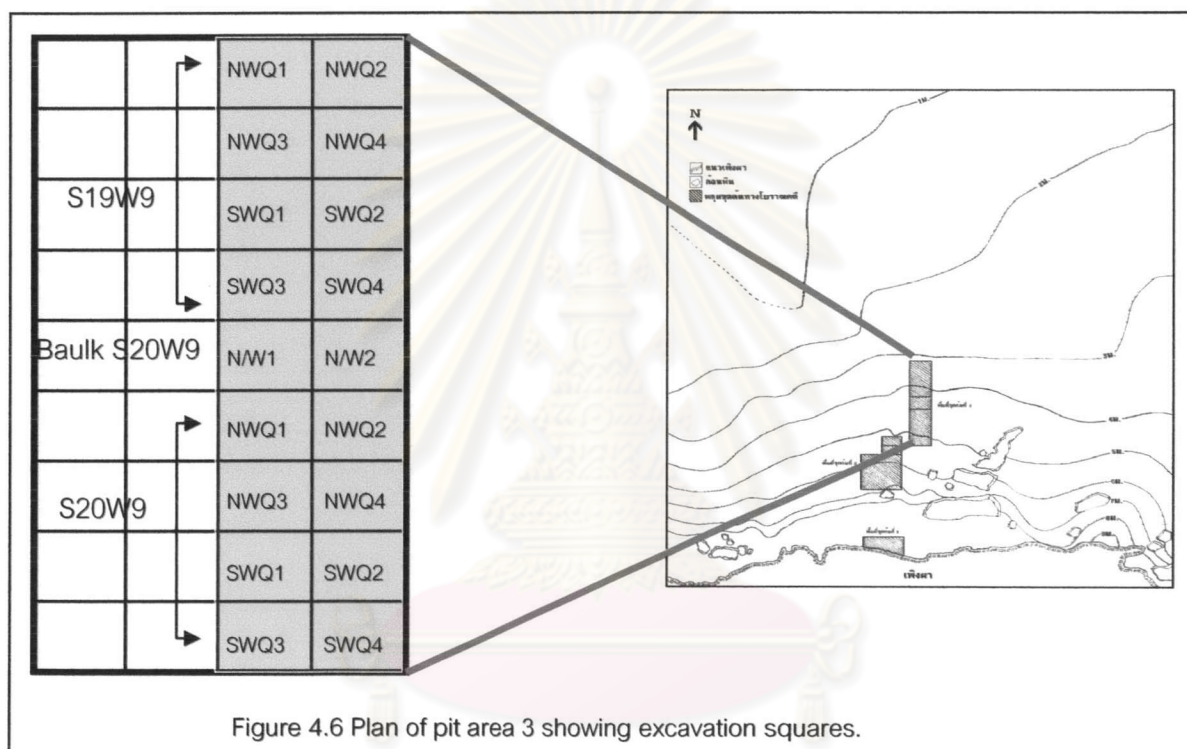


Figure 4.5 Excavation Area 2

- A. Excavated on surface, exposed limestone rock fall
- B. Locations of area 2 and area 3
- C. Close up of stone tools discovered from upper rock fall
- D. South wall profile after finish excavated
- E. West wall profile after finish excavated that rock fall appear clearly

### 4.1.3 Area Excavation 3

The excavation of area 3 was carried out on the foot slope of the rockshelter, and was interspersed with a small amount of limestone rock falls, covered by talus deposit. The 2 x 9 meters trial trenching excavation was undertaken (Figure 4.6).



Stratigraphy of excavation was complicated just like area 1 and area 2, and is composed of many relative layers vertically intersected by the natural process and cultural process. From the excavation, the remains of human activities were found. Archaeological evidence includes a lot of stone tools, animal remains, potsherd, shell similar to area 1 and area 2.

In practice, it was obvious to locate precisely the boundary of stratigraphy units more than area 1 and 2, especially the deposit of stone tools layer discontinuity in the deposit with the upper layer, leaving a gap in the site's chronology.



Figure 4.7 Excavation area 3

A. Numerous of stone tools layers were discovered (View to the north)

B. Numerous of stone tools layers were discovered, about 50 cm. from the surface (view to the south)

C. Trench after finish excavated (view to north)

## 4.2 Stratigraphical and Sedimentary Layers Analyses

In order to evaluate the proper stratigraphical and sedimentological relationships among materials discovered from across the site, some means had to be devised to compensate for the varying thickness and inclination of geologic strata from different points the overhang and on the foot slope. Strata were usually analysed in the field describe natural layer from each area in the first step. The next was to correlate the same keys layer from each layer by sedimentary analysis for grouping the stratigraphic sequence of the site.

### 4.2.1 Analysis of Excavation Area 1

The focus of sedimentary analysis was on 14 soil samples from each layer of the west profile. Physical sedimentary diagnostics were analysed on both field observed and basic property of sediment in laboratory.

By drawing on result of the physical analysis, chemical analysis, field observation of site stratigraphy, and material remains from each layer, the depositional history can be summarized by dividing depositional layers into 10 natural layers (Figures 4.8 and 4.9).

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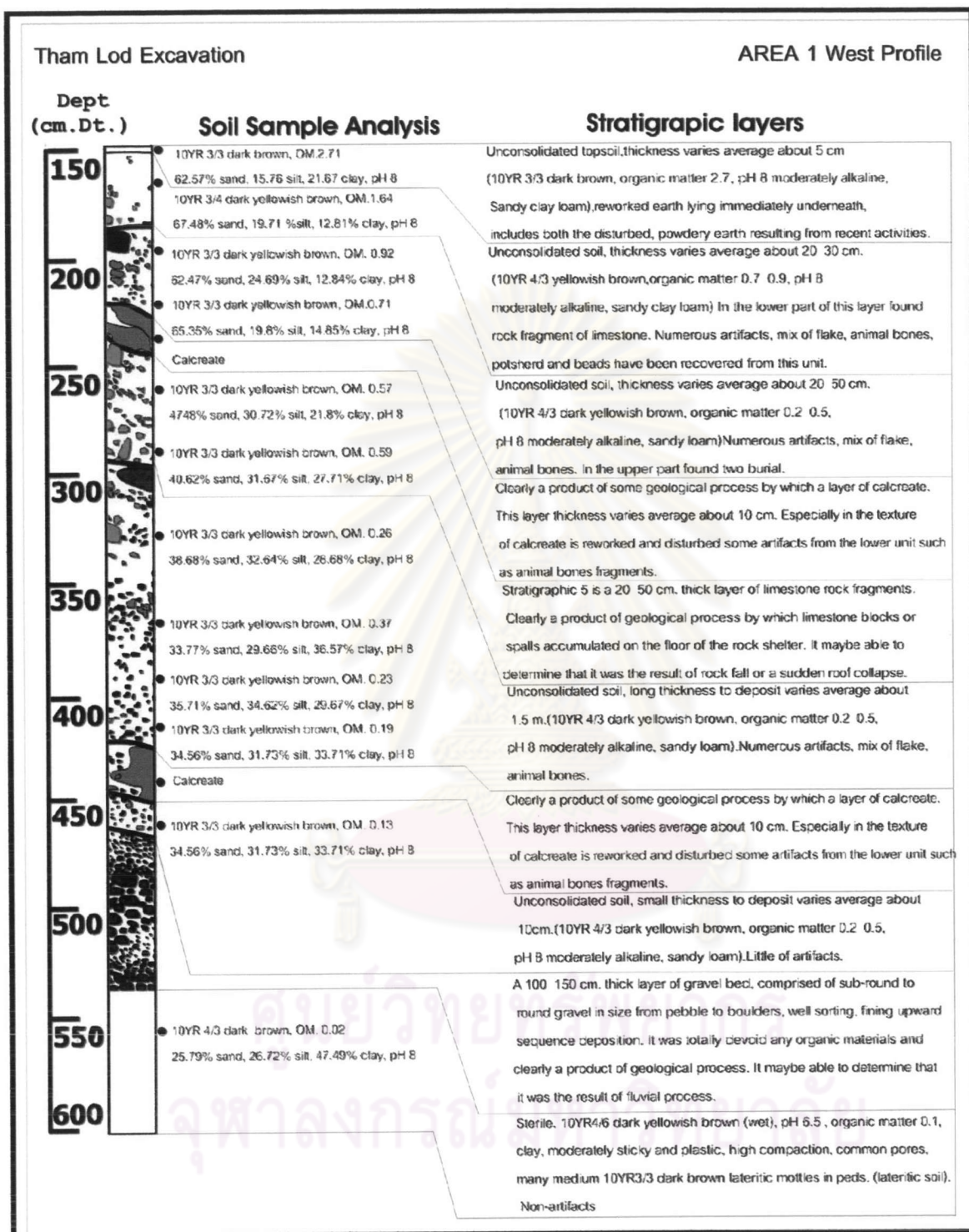


Figure 4.8 Soil sample analysis of Area 1 from west profile

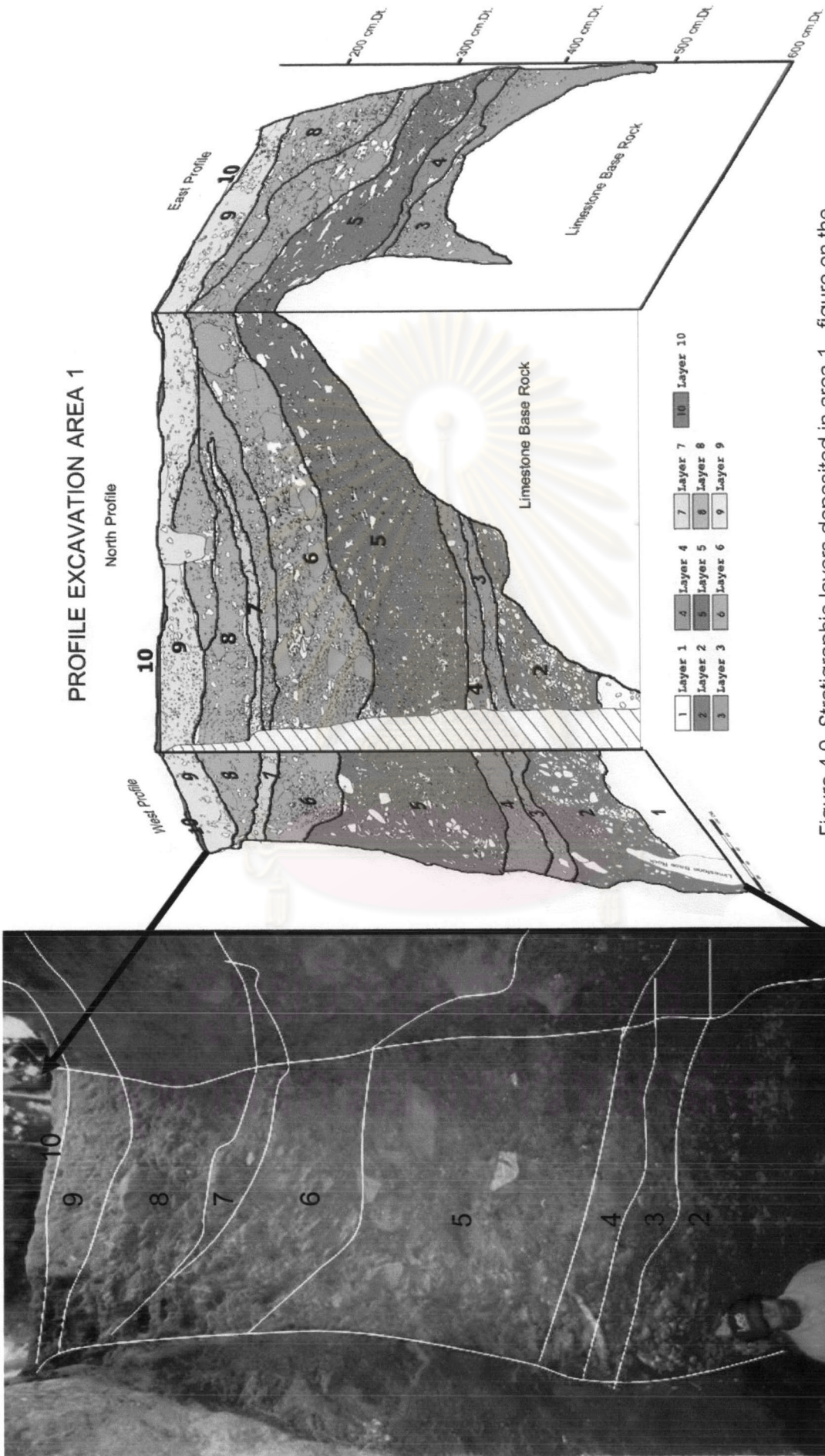


Figure 4.9 Stratigraphic layers deposited in area 1 , figure on the left show west profile

Layer 1 is the sterile layer, deposited in the bottom of pit area. It is characterized in term of soil properties by lateritic soil 10YR4/6 dark yellowish brown, pH 6, low of organic matter 0.1%. Nonee of archaeological remains was found.

Layer 2 is the layer of gravel deposition that varies 100 – 150 cm. in thickness. It is represented by granule – pebble – cobble particles grain size grading upwards into 2 sequences, mostly well sorted and sub rounded to rounded that indicating their deposited once from an old stream passing through the rockshelter. Nonee of archaeological remains was found.

Layer 3 represents the shape contact boundary with layer 2. This layer varies from 10 -20 cm. in thickness. It is characterized in term of soil properties by 10 YR 4/3 dark yellowish brown, organic matter 0.2 – 0.5 %, pH 8, sandy loam. This layer is composed of a few archaeological remains as flake and fragment of animal bones.

Layer 4 is the layer of calcrete deposited that varies 10 – 15 cm. in thickness. It is characterized by calcium carbonate soluble deposition, very hard in texture and shows reworked flake and animals bone in its textures.

Layer 5 is layer that varies 150 – 200 cm. in thickness. It is characterized by homogenous sedimentary deposited near layer 3 which average 10YR 4/3 dark yellowish brown, organic matter 0.2 – 0.5, pH 8, sandy loam. Numerous of archaeological remains were found in this layer as stone tools both core and flake, animal remains and, shell indicating the long term deposit of human occupation.

Layer 6 is formed by geological process and represented by thick layer of limestone rock fall varying from 20 – 100 cm. in thickness. Granule to boulder sizes of limestone were found with inclination of the deposit and mixed of rock fall and archaeological remains.

Layer 7 is a thin layer of calcrete deposited similar to layer 4.

Layer 8 is the thin to medium layer which varies 20 – 50 cm. in thickness. It is characterized by homogenous sedimentary deposited near layer 3 and 5 with average 10YR 4/3 dark yellowish brown, organic matter 0.2 – 0.5, pH 8, sandy loam. Numerous of archaeological remains were investigated in this layer such as stone tools (core and flake), animal remains and shells. The significance of this layer is the occurrence of two human skeletons in different burial characters. Burial 1 is an “extended burial” that deposited overlying burial 2 which is a “flexed burial”.

Layer 9 is the layer that difference in soil property and shape contact from layer 8. It is characterized by unconsolidated soil, varies 20 – 30 cm. in thickness, 10YR 4/3 yellowish brown, increasing of organic matter 0.7 – 0.9 %, pH 8, increasing of %clay in sandy clay loam. Archaeological remains such as potsherds and beads were recognized. Stone tools and animal remains were also found but decreasing in their amount.

Layer 10 is the thin layer of top soil which varies 2 – 5 cm. in thickness. It is characterized by 10YR 3/3 dark brown, high in organic matter 2.7 %, pH8, sandy clay loam.

#### 4.1.2 Analysis of Excavation Area 2

The excavation area 2 was conducted on talus slope deposit. The inclination of strata was the main problem to correlate the stratigraphic units because the deposition in this pit area was complicated by mixing of natural and cultural processes, especially from limestone rock fall. For sedimentology analysis, three block samplings were chosen to collect soil samples from each layer of the west profile. *Block S20W10 SEQ3*: this block is the upper part of talus slope deposit. 10 soil samples were analysed and described (Figure 4.10). *Block S21W10 SEQ3*: this block is in the middle area of talus slope deposit 10 soil samples were analysed and described (Figure 4.11). *Block S21W10 NEQ1*: this block is the lower part of talus slope deposit. 10 soil samples were analysed and described (Figure 4.12).

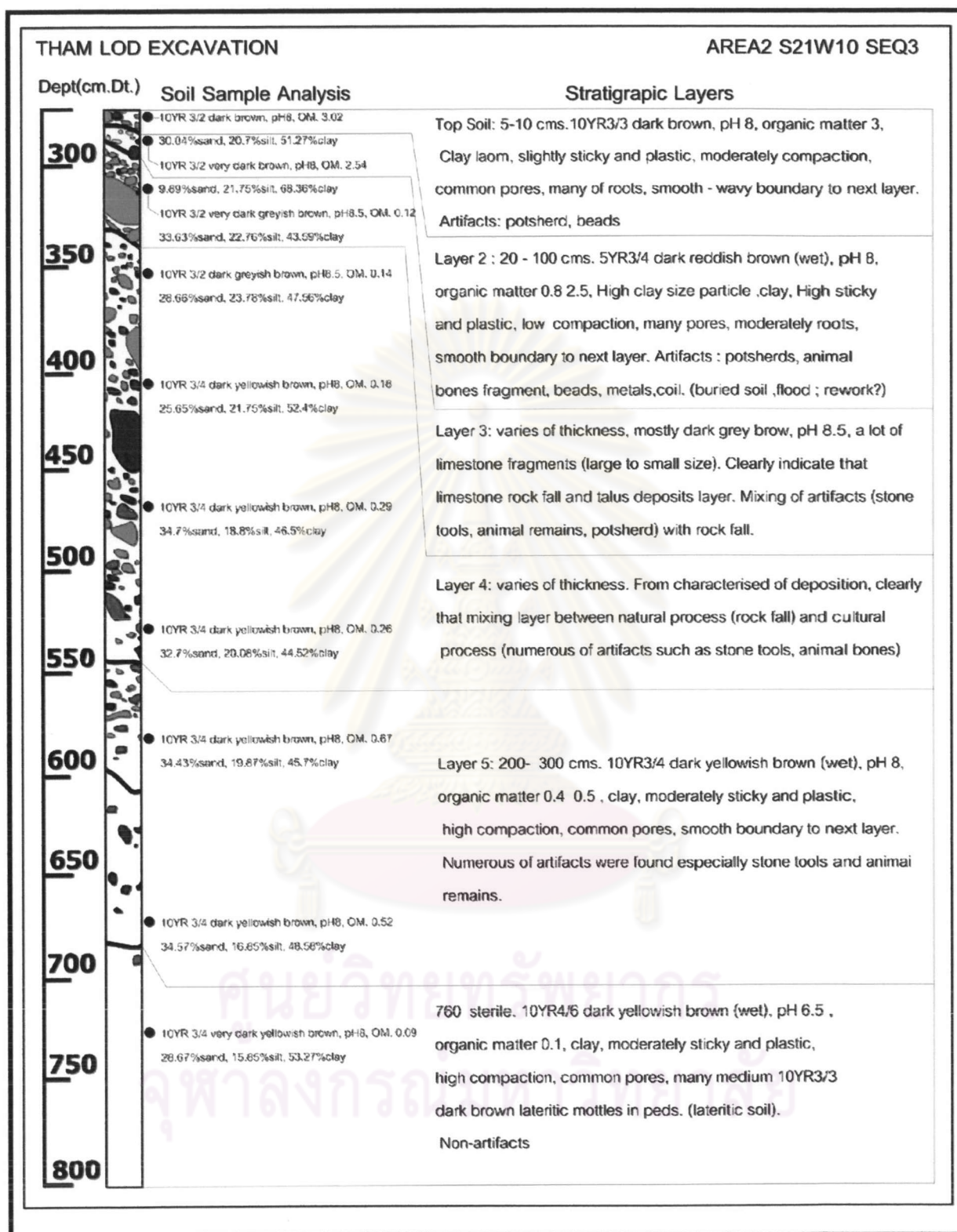


Figure 4.10 Soil sample analysis of Area 2 S21W10 SEQ3

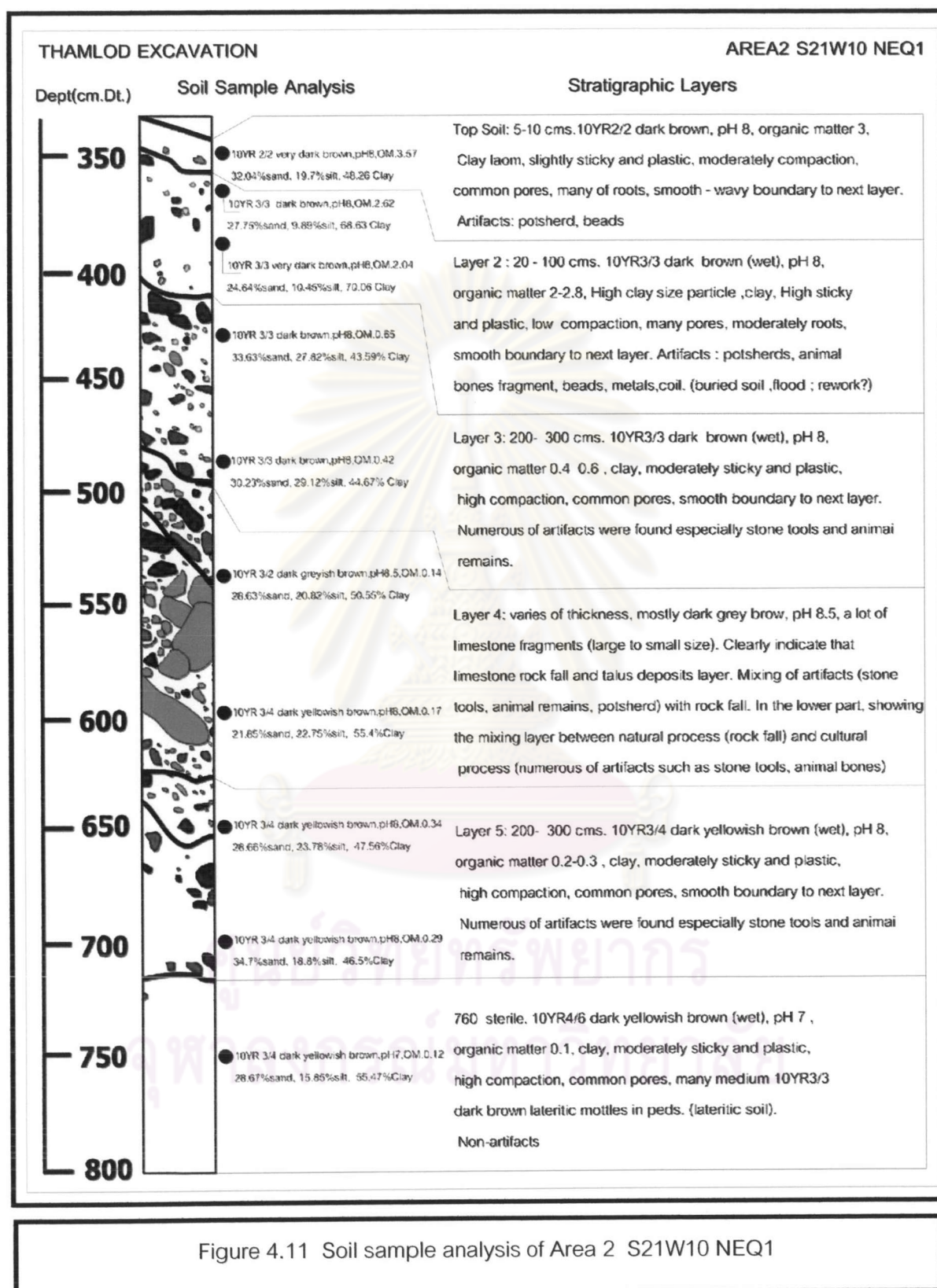


Figure 4.11 Soil sample analysis of Area 2 S21W10 NEQ1

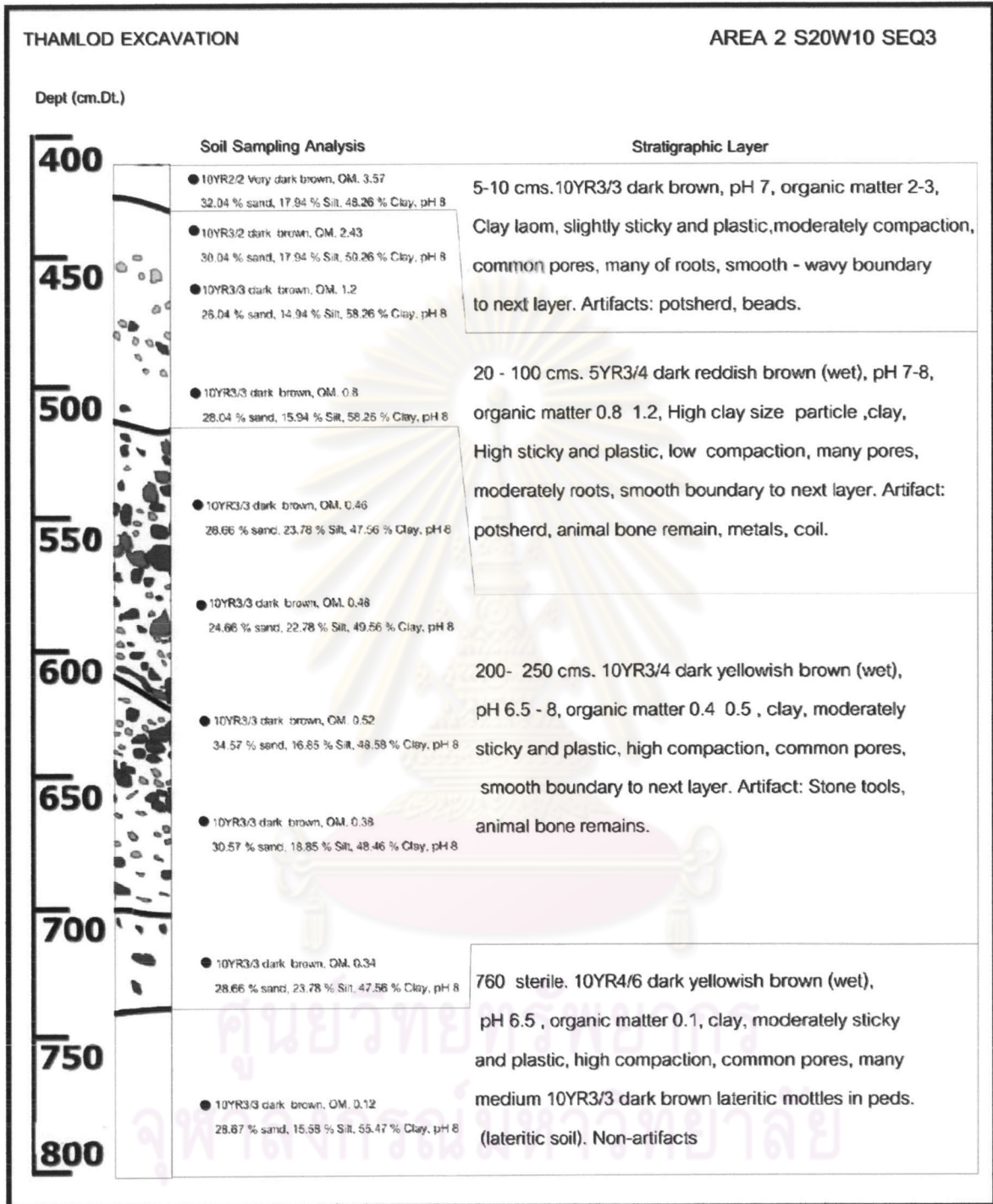


Figure 4.12 Soil sample analysis of Area 2 S20W10 SEQ3

By drawing on result of the physical analysis, chemical analysis, field observation of site stratigraphy, and material remains from each layer, the depositional history can be categorized into 7 natural layers (Figure 4.13)

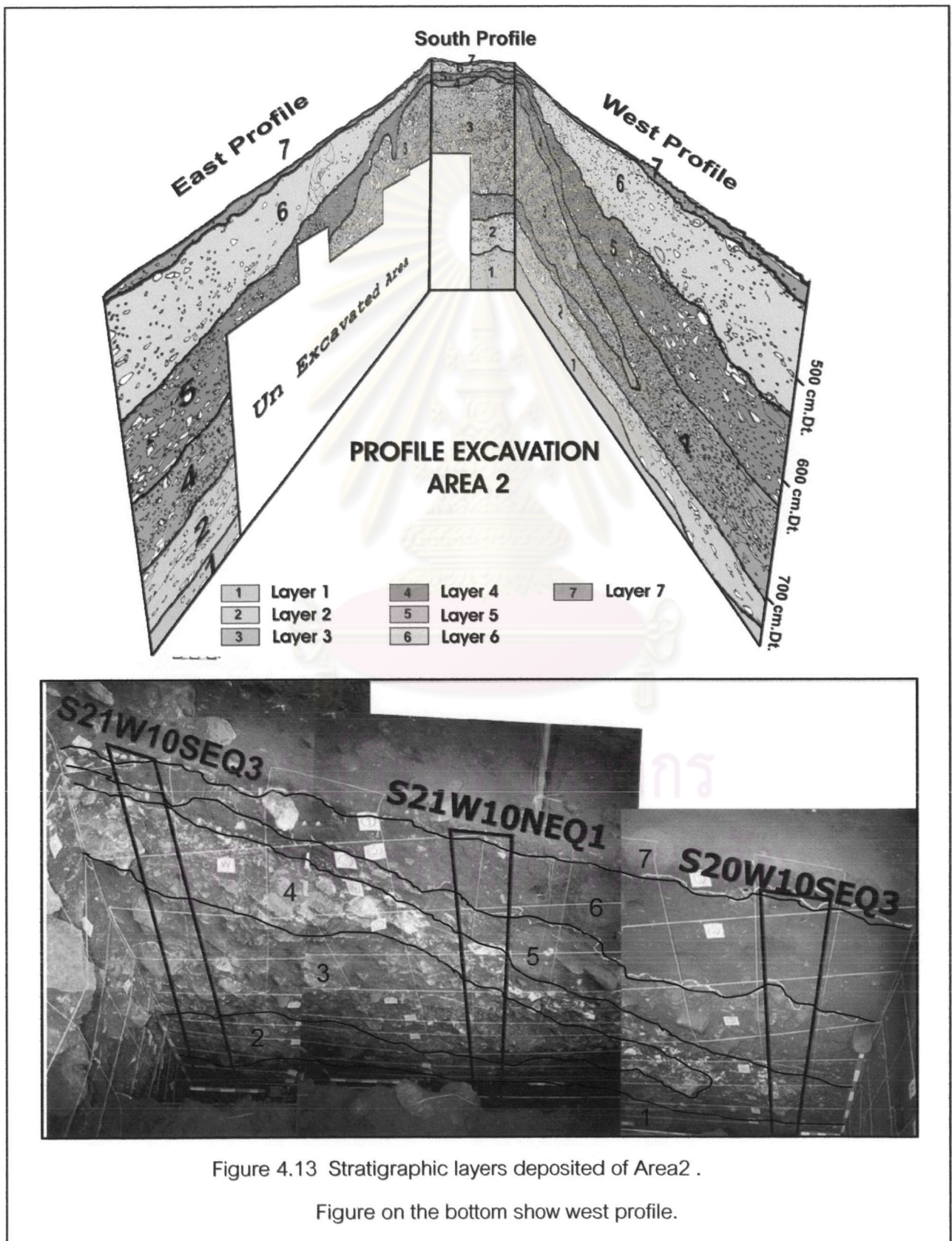


Figure 4.13 Stratigraphic layers deposited of Area2 .

Figure on the bottom show west profile.



Layer 1 is the sterile layers, deposited in the bottom of pit area. Its character is similar to layer 1 of area 1 in terms of soil properties by lateritic soil 10 YR 4/6 dark yellowish brown, low of organic matter 0.1 %, high compaction. Nonee of archaeological remain.

Layer 2 represents the shape contact boundary from layer 1. It is a thin layers and varies from 10 -20 cm. in thickness and characterized in term of soil properties by 10 YR 3/4 dark yellowish brown, organic matter 0.3 – 0.4 %, pH 8, clay. This layer composes of a few archaeological remains as flake and fragment of animal bones.

Layer 3 is formed by geological process and represented by thick layer of limestone rock fall varies from 20 – 100 cm. in thickness. Granule to boulder sizes of limestone were found with inclination of the deposit. It is deposited between layer 4 and layer 5 in Block S21W10 SEQ3, NEQ1 and characterized by dark grayish brown, pH 8.5 high alkaline condition and high weathered of limestone rock fall mixed of rock fall and archaeological remains.

Layer 4 is similar in physical properties as near layer 2 and 5. Its characteristic of soil properties are 10 YR 3/4 dark yellowish brown, pH 8 - 8.5, clay loam. Limestone rock fall and archaeological remains as stone tools, animal remains and shells were mixed.

Layer 5 is the layer deposited overlying limestone rock fall layer and varies from 10 – 50 cm. in thickness and clear to classify in block S21W10 NEQ1 to S20W10 SEQ3. It is characterized by homogenous sedimentary deposited near layer 2 and 4 with average 10YR 3/3 dark brown, organic matter 0.4 – 0.6, pH 8, clay. Numerous of archaeological remain were investigated in this layer as stone tools (core and flake) ,animal remains and shells.

Layer 6 is the layer that difference in soil property and shape contact from layer 5. It varies 10 – 50 cm. in thickness and is characterized by 10YR 3/3 dark brown, increasing of organic matter 0.8 – 2.8 %, pH 8, increasing of %clay in clay, high sticky and plastic, low compaction, many pores and moderately roots. Archaeological remains such as potsherds and beads were recognized. Flake and animal remains were also found but decreasing in amount.

Layer 7 is the top soil layer deposited and varies 5 – 10 cm. in thickness, It is characterized by 10 YR3/3 dark brown, pH7, clay, wavy boundary.

#### 4.1.3 Analysis of Area 3

The excavation area 3 was done on foot slope deposit that a little bit incline to gentle of strata. The sediment from two block samplings was chosen. Soil samples from each layer of the west profile were collected for sedimentary analysis: *Block S20W9 SWQ3* : this block is continue from area 2 that 8 soil samples were analysed and described (Figure 4.14). *Block S21W10 SEQ3* : 8 soil samples were analysis and described (Figure 4.15).

By drawing on results of the physical analysis, chemical analysis, field observation of site stratigraphy, and material remains from each layer, the depositional history can be summarized by dividing depositional layers into 5 natural layers (Figure 4.16)

Layer 1 is the sterile layer appeared in the bottom of pit area similar layer 1 in area 2. It is characterized in term of soil properties by lateritic soil 10 YR 4/6 dark yellowish brown, low of organic matter 0.1 %, high compaction. Nonee of archaeological remain was found.

Layer 2 is layer that varies 200 – 250 cm. in thickness. It is similar character with layer 2, 4 and 5 in area 2 which is characterized by 10YR3/4 dark

stone tools and animal remains were found. The significance of this layer is thick of gravel assemblage deposited that most of them are stone tools.

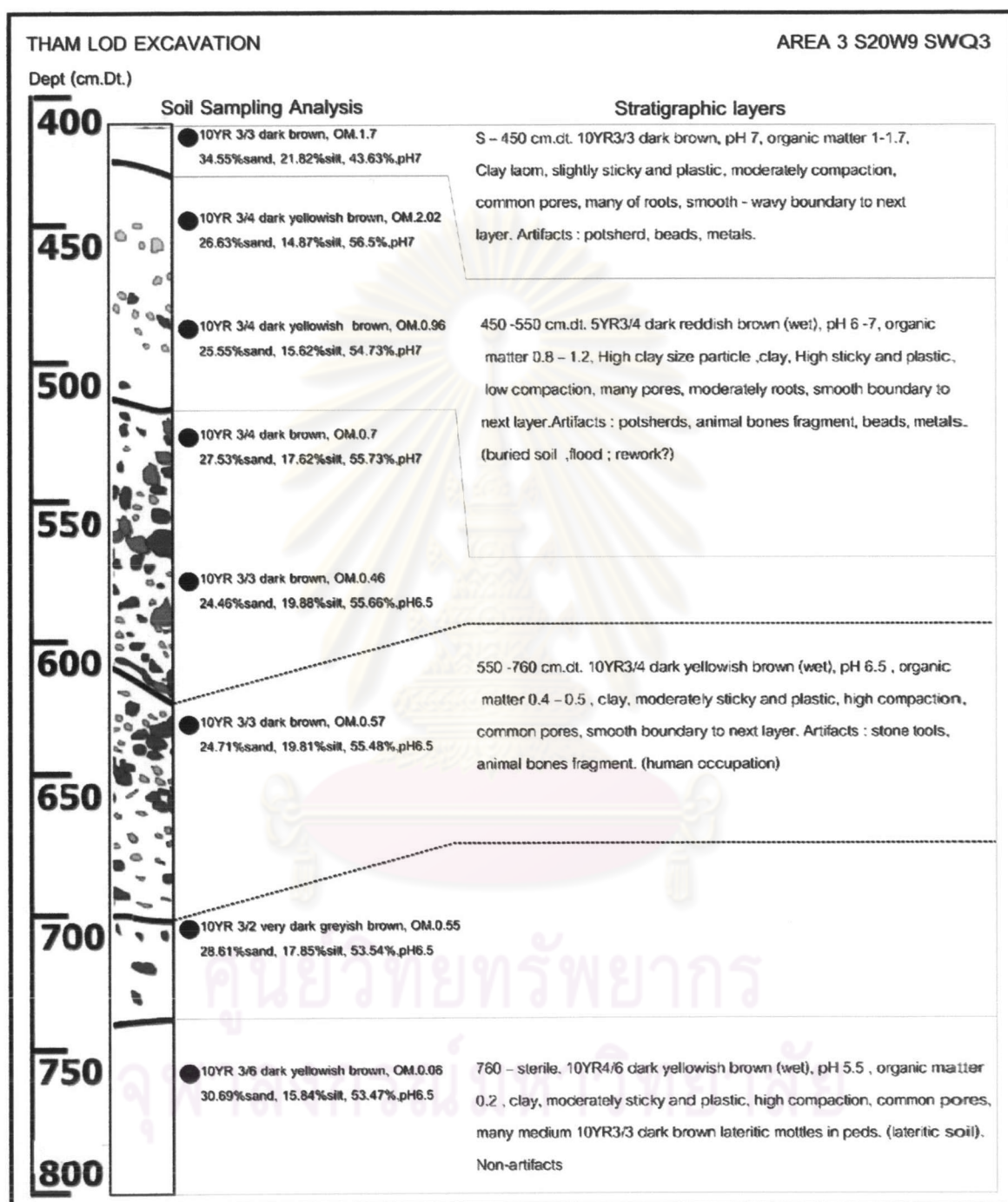


Figure 4.14 Soil sample analysis of area 3 S20W9 SWQ3

## THAMLOD EXCAVATION

## AREA3 S19W9 NWQ1

Dept (cm.Dt.)

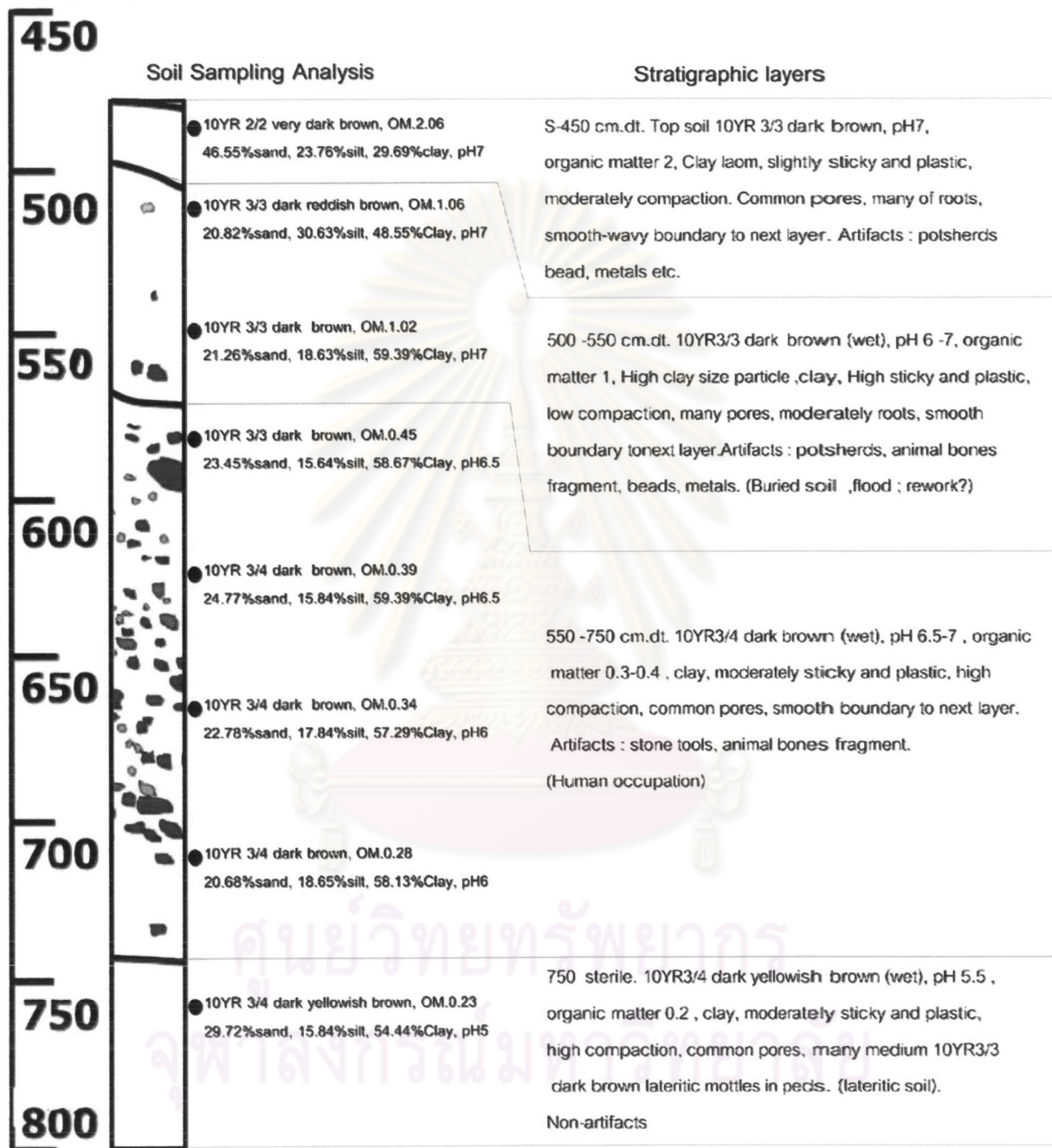
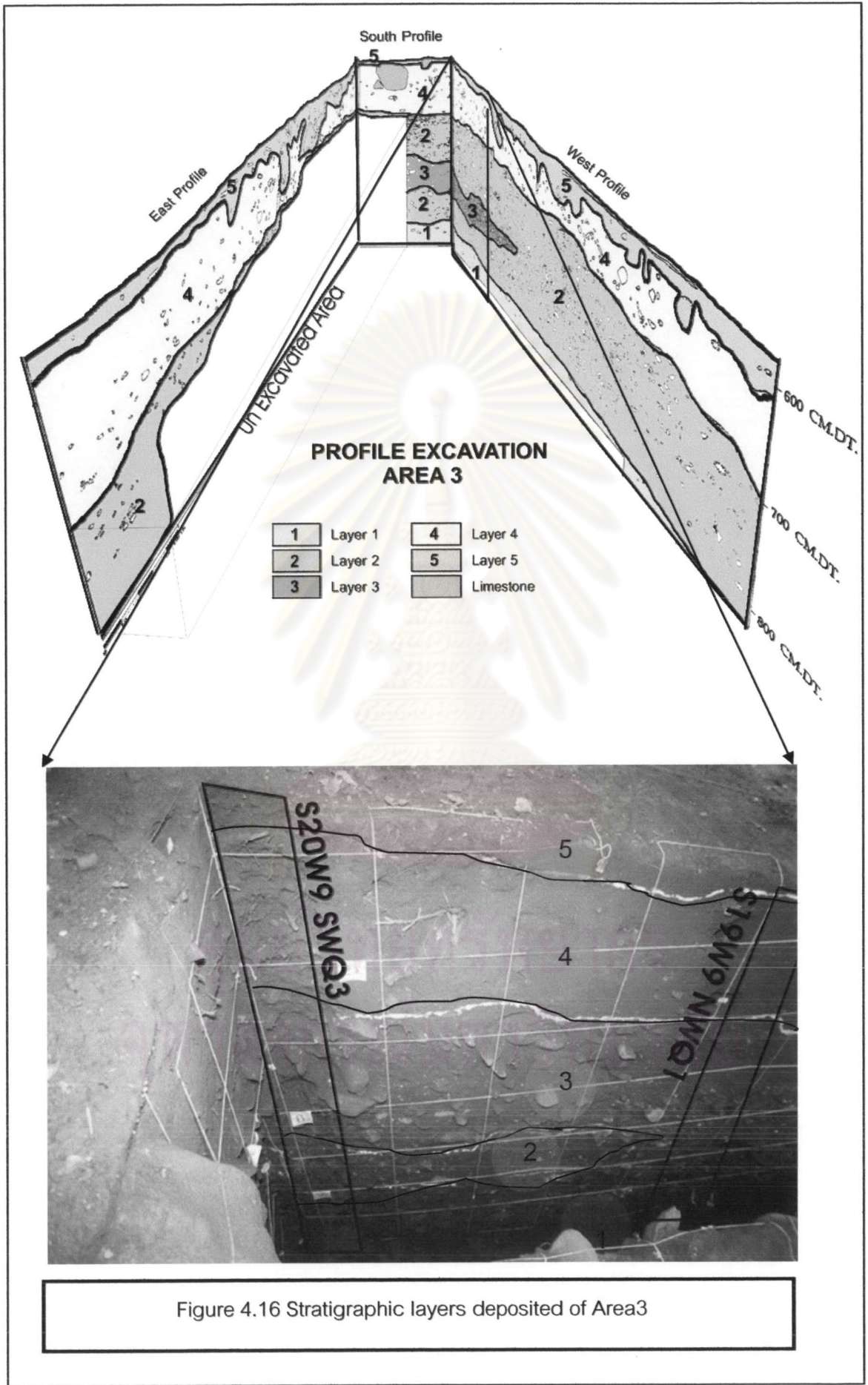


Figure 4.15 Soil sample analysis of area 3 S19W9 NWQ1



Layer 3 is the layers that mixing with ayer 2. The physical property is similar to layer 2 but it is characterized by a numerous of fragment of animal bones was found in this layer.

Layer 4 is the layer that difference in soil property and shape contact from layer 3. It is characterized by unconsolidated soil, varies 10 – 50 cm. in thickness, 10YR 3/3 dark reddish brown, increase of organic matter 0.8 – 1.2 %, pH 7, increasing of %clay, clay, high sticky and plastic, low compaction, many pores and moderately roots. Archaeological remains were found as potsherds and beads. Stone tools and animal remains were also found but decreasing in their amount. This layer is similar to layer 6 in area 2.

Layer 5 is the top soil layer deposited and varies 5 – 10 cm. in thickness. It is characterized by 10 YR3/3 dark brown, pH7, clay, wavy boundary.

### 4.3 Dating Analysis

The dating of organic and inorganic sediments from the excavated area was done by radiocarbon dating (Accelerator Mass Spectrometric (AMS.) from Beta Analytic, Inc.) (Table 4.1). Six thermoluminescence datings (TL dating from Research Institute of Materials and Resources, Faculty of Engineering and Resource Science., Akita University) were analysed based on sediments and calcrete samples (Table 4.2) (see detail in Appendices III).

Table 4.1 Radiocarbon (AMS) determination from Tham Lod rockshelter (Shoocongdej and other 2002).

Sample Data	Measured Radiocarbon Age	<sup>13</sup> C/ <sup>12</sup> C Ratio	Conventional Radiocarbon Age (*)
<p>Beta - 168223</p> <p>SAMPLE : MHSTLAR1-402</p> <p>ANALYSIS : Radiometric-Standard delivery (bulk low carbon analysis on sediment)</p> <p>MATERIAL : organic sediment, dept 190 cm.dt.</p>	12100 +/- 60 BP	-25.0* o/oo	12100 +/- 60* BP
<p>Beta - 168224</p> <p>SAMPLE : MHSTLAR1-710</p> <p>ANALYSIS : Radiometric-Standard delivery (bulk low carbon analysis on sediment)</p> <p>MATERIAL : organic sediment, dept 210 – 234 cm.dt.</p>	13640 +/- 80 BP	-25.0* o/oo	13640 +/- 80* BP
<p>Beta-17227</p> <p>SAMPLE: MHSTLAR1-1526</p> <p>ANALYSIS: Radiometric-Standard delivery</p> <p>Material/Pretreatment: (organic sediment): acid washes, dept 350 – 360 cm.dt.</p>	16730 +/- 70 BP	-23.7 o/oo	16750 +/- 70 BP
<p>Beta-17226</p> <p>SAMPLE: MHSTLAR1-1526</p> <p>ANALYSIS: Radiometric-Standard delivery</p> <p>Material/Pretreatment: (Shell): acid etch: 420 – 430 cm.dt.</p>	21860 +/- 160 BP	-5.0 o/oo	22190 +/- 160 BP

Table 4.2 Thermoluminescence (TL dating) determination from Tham Lod rockshelter.

Sample (West profile)	U (ppm.)	Th (ppm.)	K (%)	%W	Annual dose (mGy/yr)	Paleo dose (Gy)	Age (BP.)
TL 4 Area 3: Quartz dated from 530 – 540 cm.dt	6.424	19.478	4.733	2.36	2.37	25.08	10,582 ± 49
TL 5 Area 3: Calcite dated from 460 -470 cm.dt.	11.824	25.872	9.933	2.2	6.014	17.64	2,933 ± 83
TL 6 Area 3: Quartz dated from 690 – 700 cm.dt.	3.424	15.778	1.733	5	1.08	15.18	14,055 ± 47
TL7 Area 1 : Calcreate dated from 230 -240 cm.dt.	2.783	3.987	1.864	5.6	0.768	10.32	13,422 ± 541
TL10 Area 1: Calcreate dated from 450 – 460 cm.dt.	0.837	1.957	0.525	4.1	0.378	12.24	32,380 ± 292

From tables 4.1 and 4.2, result of AMS and TL datings suggested that human in the past were occupied in this rockshelter approximately during Late Pleistocene to Holocene periods.

#### 4.4 Correlation of Layers

According to the analysis from each block excavated, the correlation in each layer was carried out based on preliminary stratigraphic observed during field work, sedimentary analysis from each layers, archaeological remains and dating analysis. These correlative units lump together a series of arbitrary layers from different



block squares that are judged to be stratigraphically contemporaneous, based on their relative vertical positions within a geologic stratum (Figure 4.17).

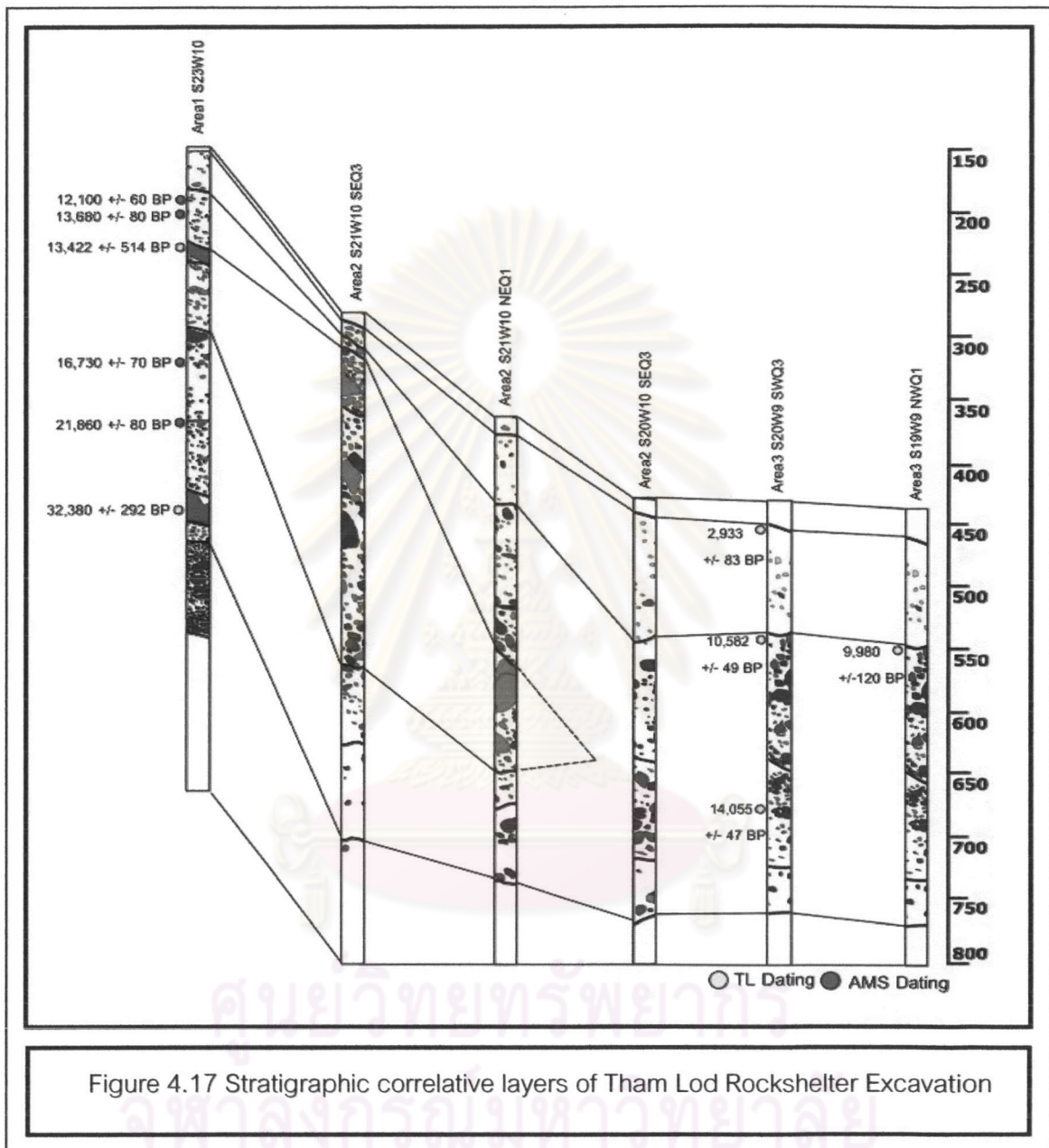


Figure 4.17 Stratigraphic correlative layers of Tham Lod Rockshelter Excavation

The classification of the stratigraphic sequences is made on the basis of physical analysis, chemical analysis, field observations of site stratigraphy and correlation layers. Suggestions of absolute dating for each unit are based on the series of AMS and TL dates (Table 4.3).

Table 4.3 Stratigraphic sequences at Tham Lod excavation.

Stratigraphic Unit	Layer Deposition			Dating	Site Process	Environment	
	Area1	Area 2	Area 3				
D	10	7	5		Natural + Cultural	Habitation	
HOLOCENE	C	9	-	-	2,933 +/- 83 BP	Cultural	Habitation
	C1	-	6	4		Natural + Cultural	Flooding
					9,980 ± 120 BP and 10,582 ± 49 BP		
PLEISTOCENE	B	8	4, 5	3	12100 +/- 60 BP 13,640 +/- 80 BP	Cultural	Habitation
	B3	7	-	-	13,422 +/- 514 BP	Natural	Calcrete
	B1	6	3,4	-		Natural	Rock fall
	B	5,3	2	3	14,055 +/- 47 BP 16,750 +/- 70 BP 22,190 +/-160 BP	Cultural	Habitation
	B2	4	-	-	32,380 +/- 292 BP	Natural	Calcrete
LATE	A1	2	-	-		Natural	stream
	A	1	1	1		Natural	Groundwater

# THAM LOD ROCKSHELTER PROFILE PROFILE OF WEST FACE

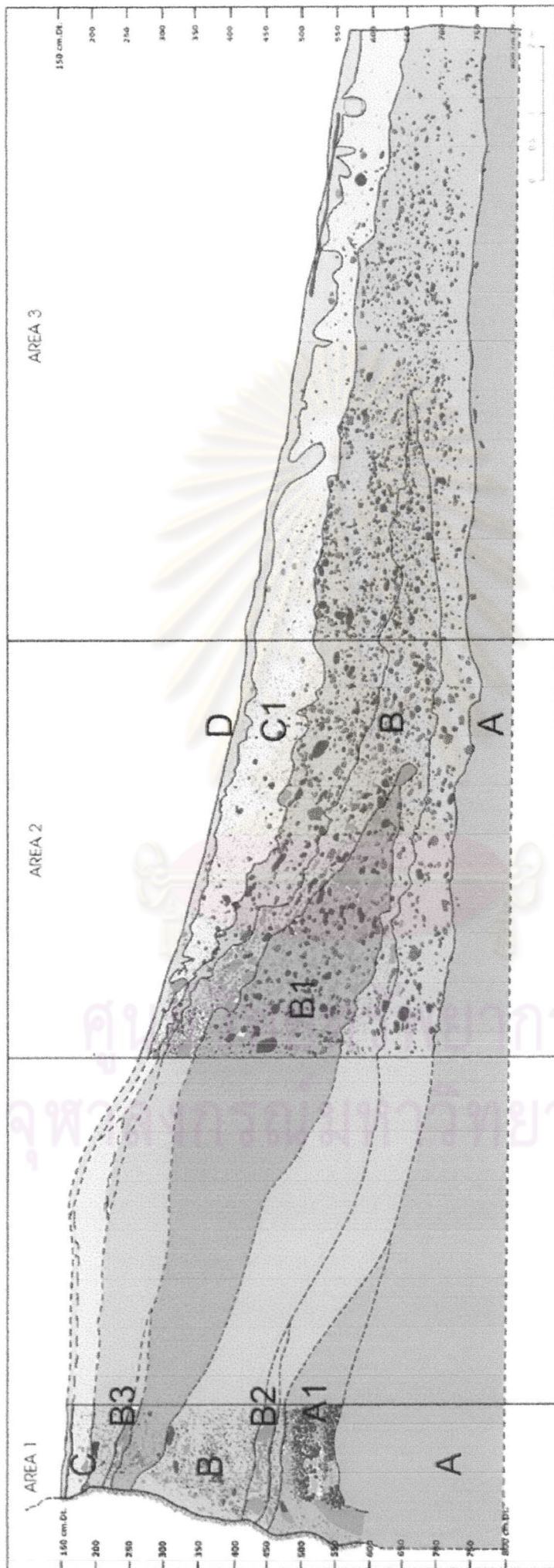


Figure 4.18 Stratigraphy unit of Tham Lod Rock shelter

According to table 4.3, the stratigraphic sequence can be grouped and described into 3 series of geological timescale (Table 4.3 and Figure 4.18):

1. **Older than Late Pleistocene Period:** It comprises *Unit A* from layer 1 of area 1, 2 and 3 and *Unit A1* from only layer 2 of area 1.

2. **Late Pleistocene Period:** It comprises *Unit B* from layer 3,5,8 of area 1, layer 4,5 of area2 and layer 3 of area3. *Unit B1* extends from layer 6 of area 1 and layer 3,4 of area 2. *Unit B2* extends from only layer 4 of area 1. *Unit B3* occurs from only layer 7 of area 1.

3. **Holocene Period:** It comprises *Unit C* from layer 9 of area1, layer 6 of area 2 and layer 4 of are 3. *Unit C1* is from only layer 9 of area 1. *Unit D* extends from layer 10 of area1, layer 7 of area 2 and layer 5 of area 3.

## 4.5 Stratigraphic Sequence

The stratigraphic sequence was segregated into 9 units from 3 series of geologic timescales at Tham Lod rockshelter. It can be described from oldest to the youngest in detail as follows:

### 4.5.1 Older than Late Pleistocene Age

**Unit A:** stratigraphic unit A rests directly on the bottom of all excavation area, beneath a depth of about 3 – 5 m. from surface. The unit is characterized by a 10YR4/6 dark yellowish brown color, pH 6.5 to 7, organic matter 0.1 to 0.3 , clay, moderately sticky and plastic, high compaction, common pores, many medium 10YR3/3 dark brown lateritic mottles in peds which formed a lateritic soil. None of archaeological remain was found in this layer (Figure 4.19).

**Unit A1:** stratigraphic unit A1 appears only in area 1 and is characterized by the deposit directly overlying unit A which shows granule – pebble – cobble particles grain size grading upwards, mostly well sorted and sub rounded to rounded (Figure 4.20). It can be assumed that during this time, the area has once had an old stream passing through the rock shelter. From dating of calcrete layer which deposited overlying this unit by TL technique, the age ranges approximately  $32,380 \pm 292$  BP, suggested that this unit is older than other units.

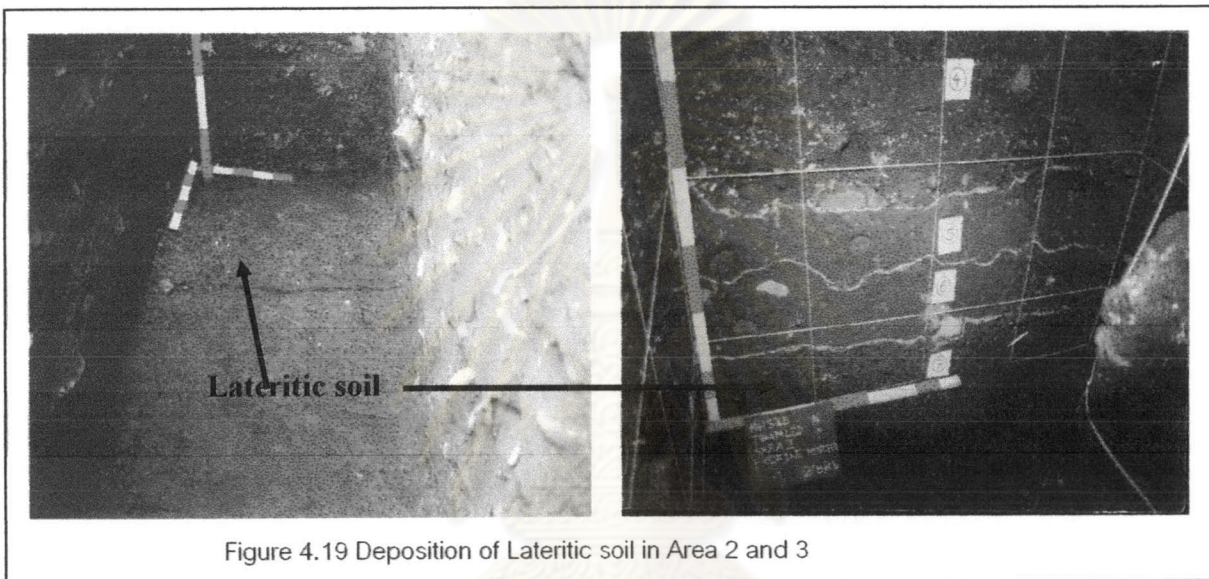


Figure 4.19 Deposition of Lateritic soil in Area 2 and 3

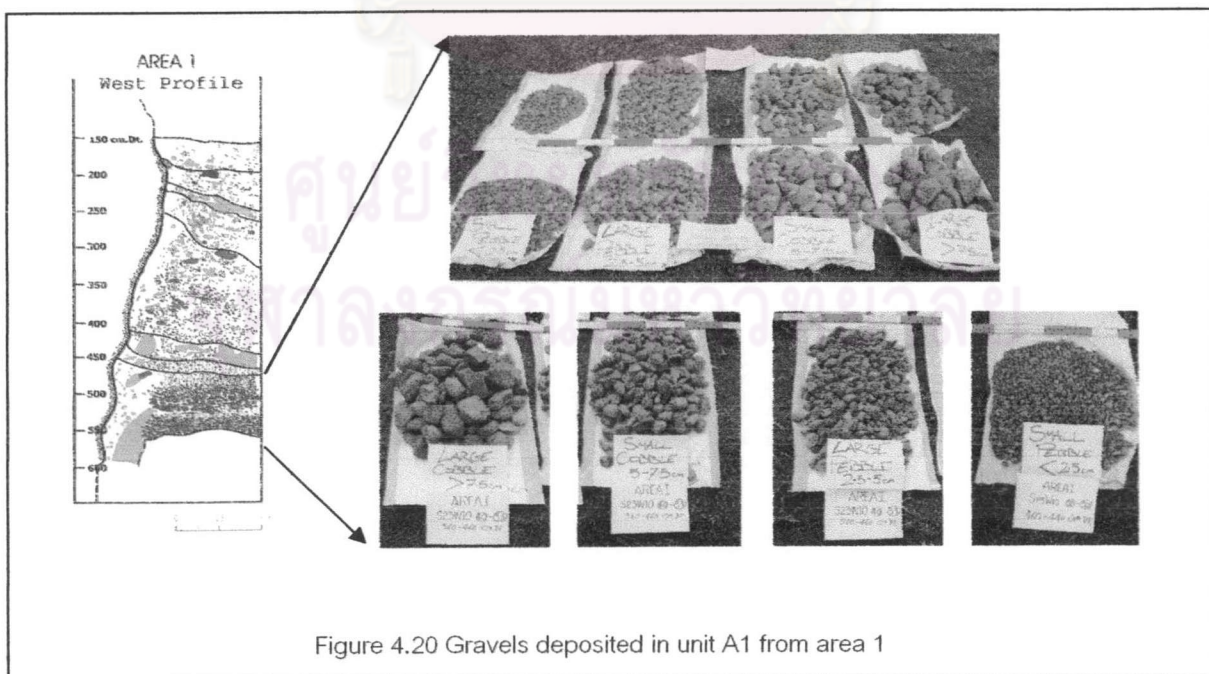


Figure 4.20 Gravels deposited in unit A1 from area 1

#### 4.5.2 Late Pleistocene Period

**Unit B2** appears in only area 1, overlying Unit A and A1. Based on the characteristic and sedimentary analysis, it was clear that this unit was a product of some geological processes by which a layer of calcrete found extensively on excavation floor. This layer thickness varies in average about 10 cm. Especially, calcrete is probably reworked and disturbed some artifacts from the lower unit such as animal bones fragments. Calcrete layer was dated by TL dating, suggested the age of deposition approximately  $32,380 \pm 292$  BP.

**Unit B** rests directly on the upper of unit A and A1. The unit is mainly characterized by a 10YR3/4 dark brown color, pH 7 to 8, organic matter 0.3 to 0.6, clay, moderately sticky and plastic, medium to high compaction, common pores, shape contact boundaries with stratigraphic unit A. The significance of this unit is the occurrence of high density of occupational layers of Prehistoric human in Late Pleistocene. Numerous of archaeological remains were found including stone tools, animal remains, shell and human skeletons.

*In area 1* (Figure 4.21), this stratigraphic unit B is approximately varied 2 – 2.50 m. in thickness, consisting of numerous archaeological remains as stone tools, animal remains, shell and human skeletons. The sedimentary analysis of soil sample from the upper to lower parts indicated the long terms deposition of this unit due to the extension of the same characteristic of soil from the upper to lower of this unit. However, a little sub-unit of geological process was found as inter-bedded within this unit. In the lower part, a little of stone tools and animal remains was found but was increased in amount of archeological remains through the middle part. Stone tools and animal remains including organic sediment and shell were dated by AMS and given the age approximately ranging from 16,000 to 22,000 BP. In the top of level, the important evidence was 2 burial of human skeletons (the upper burial was an “extended burial”

dated approximately 12,000 BP and the lower was an “flexed dated” approximately 13,000 BP) (Figure 4.22).

*In Area 2*, this stratigraphic unit B is approximately varied from 2 to 4.5 m. in thickness, consisting of numerous archaeological remains similar to area 1 such as stone tools, animal remains and shell. The stratigraphic description represented the complexity and mixed of sedimentary deposited made which difficult to separate especially in the mixing part between rock fall deposited and cultural remains deposited.

*In Area 3*: this stratigraphic unit B is approximately varied from 2 to 2.5 m. in thickness, consisting of numerous archaeological remains same as area 1 and 2 such as stone tools, animal remains, shell. This unit is clearly visible in stratigraphic field description and sedimentary analysis. It shows shape contact boundaries between the lower and upper units and a little effected from limestone rock fall. The significance of this unit is the appearance of thick gravels assemblage (Figure 4.23 and 4.27). The analysis of this assemblage represented that it was poorly sorted of gravel particle size (pebble to boulder size), mostly seen as percussion evidence based on numerous of complete core tools and flake tools. In this assemblage, gentle orientation of gravel deposit and high compaction in soil layer were characterized. This evidence may be indicated that this assemblage was processed by human in the past (cultural process) not by natural process because there were no source of country rock, especially limestone found in this assemblage. Alternatively, if they were formed by fluvial process, particle size should be moderately to well sorted and mostly of complete stone tools should be occurred in highly weathered or the edge of stone tool should be nearly rounded to sub rounded. On the other hand, most of the edges of the complete stone tools still shows moderately shape and little weathered. It is suggested that this assemblage was in situ deposited by human in the past which occupied this area for stone tools production.

Three samples of the sediment were dated by TL dating that one sample among those was picked up from the middle layer which contains a lot of animal bones fragment. The age was suggested approximately 14,000 years BP. Two samples taken from the upper part of layer in the contact boundaries between unit B and unit C, were dated and given approximately 9,980 years BP and 10,500 years BP.

**Unit B1** appears in area 1 and 2 which is characterized by a thick layer varying from 20 to 100 cm. in thickness, comprising weathered angular blocks ranging in size from gravel to boulders and clearly occurred as appeared incline orientation. It was totally devoid any organic materials and clearly a product of geological process by which limestone blocks or spalls accumulated on the floor of the rockshelter (Figure 4.24). The limestone rock fall appeared in the middle part of unit B and may be able to determine that it was the result of rock fall during this period. The sedimentary analysis from block S21W10 SEQ3 can be separated unit B1 from unit B. Unit B is characterized by a lot of size of limestone fragments (pebble to boulder size), highly weathered of limestone that show grey to grayish brown color (different from cultural deposited which mostly yellowish brown to brown color), high alkaline condition (pH 8 – 8.5), low of organic matter. The result from x-ray powder diffraction (Figure 4.25) shows the composition of calcite more than other parts in this unit. This formation process was mainly effected by leading to the mixing of the layer between occupation layer and rock fall depositional layer. None of dating was undertaken in unit B1. However, this unit is overlying unit B which was dated from organic sediment by AMS and overlain by calcrete layer which was dated by TL dating. Therefore, it is suggested that rock fall was deposited sometimes between 13,000 years BP and 16,000 years BP.

From the evidence of characteristic of roof fall and talus deposit, it is suggested that earthquake hazards or neo-tectonic may the main process making rock fall. According to Charusiri and other (1998) Thailand has long been recognized as situated in the low seismicity region and there were not very much earthquake damaged events in her past history, there are more than 4,000 small to moderate quakes detected in Thailand and nearby since the installment of the worldwide seismograph network in



1902. Figure 4.26 represented the high density of earthquake in the study area since 1983 to 2000 indicating that, in the past during late Pleistocene epoch may have intensive of earthquake event seemed to occur in the area. If they were occurred high quakes, earthquake hazards may affect for limestone rock fall and talus deposit.

**Unit B3** appears only in area 1 which overlying unit B1. The characteristic and sedimentary analysis were revealed that unit B3 was a product of some geological processes by a layer of calcrete similar to unit B2. Thickness varies from about 10 -20 cm. The texture of calcrete is reworked and disturbed some artifacts from the lower unit such as animal bones fragments, stone tools and limestone fragments. Calcrete layer was dated by TL dating and given the age approximately years 13,000 BP.

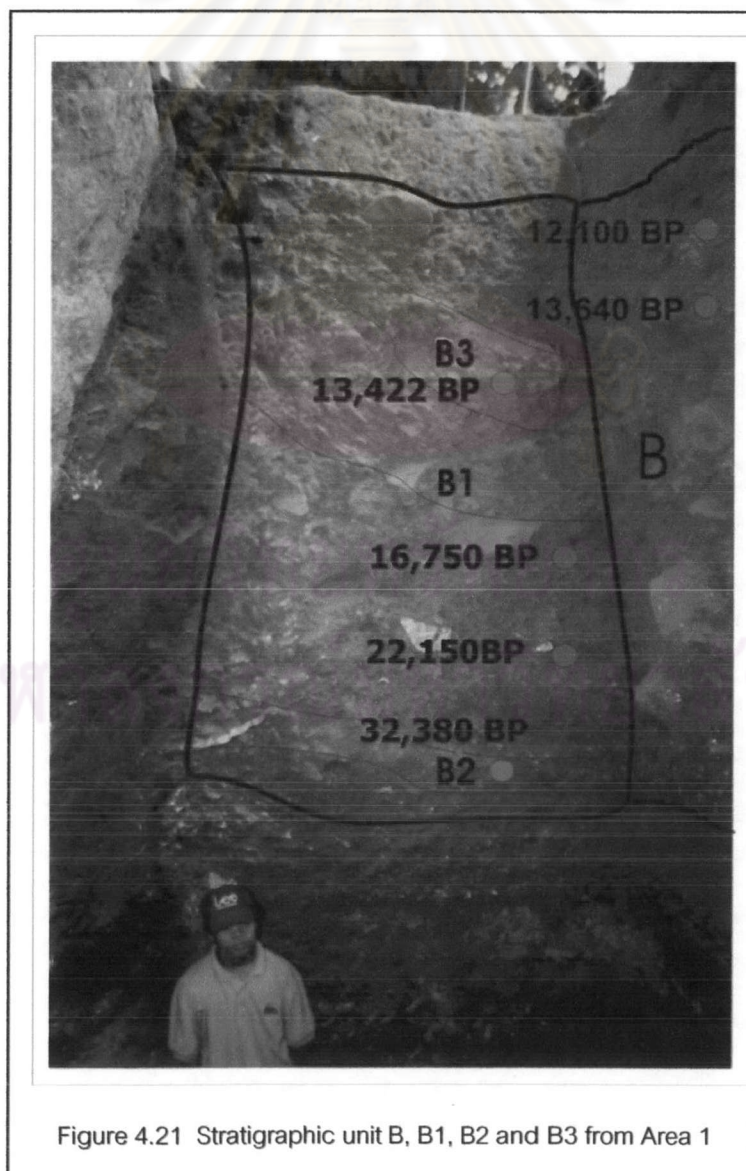


Figure 4.21 Stratigraphic unit B, B1, B2 and B3 from Area 1

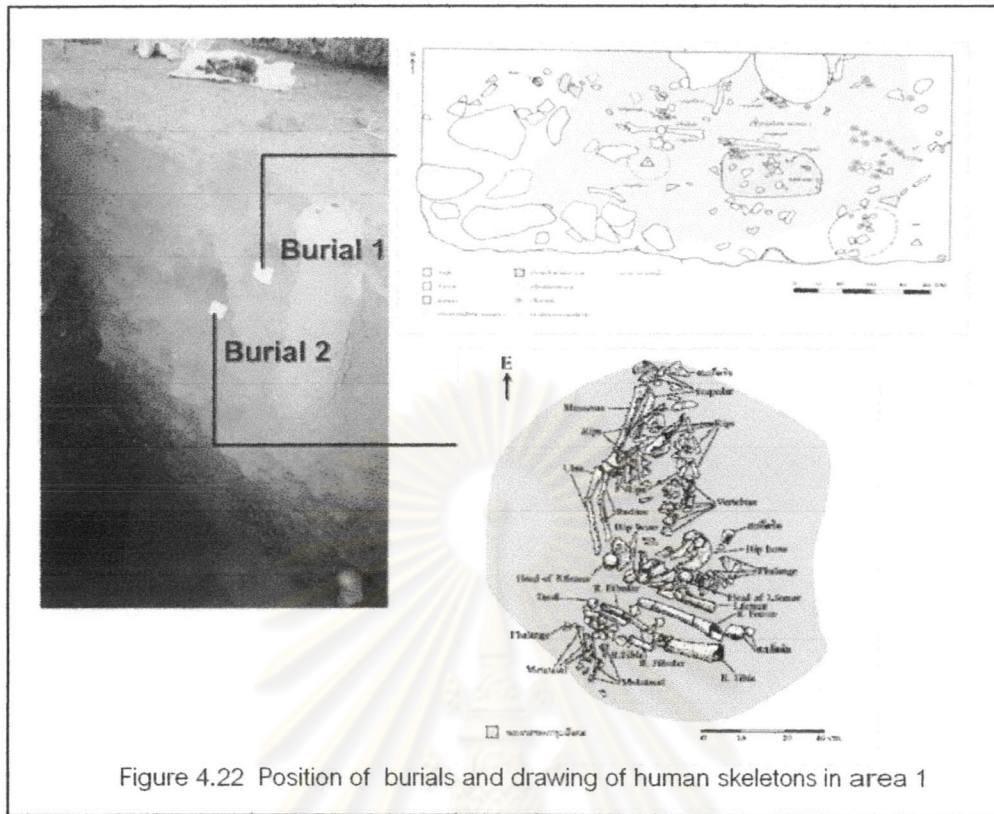


Figure 4.22 Position of burials and drawing of human skeletons in area 1

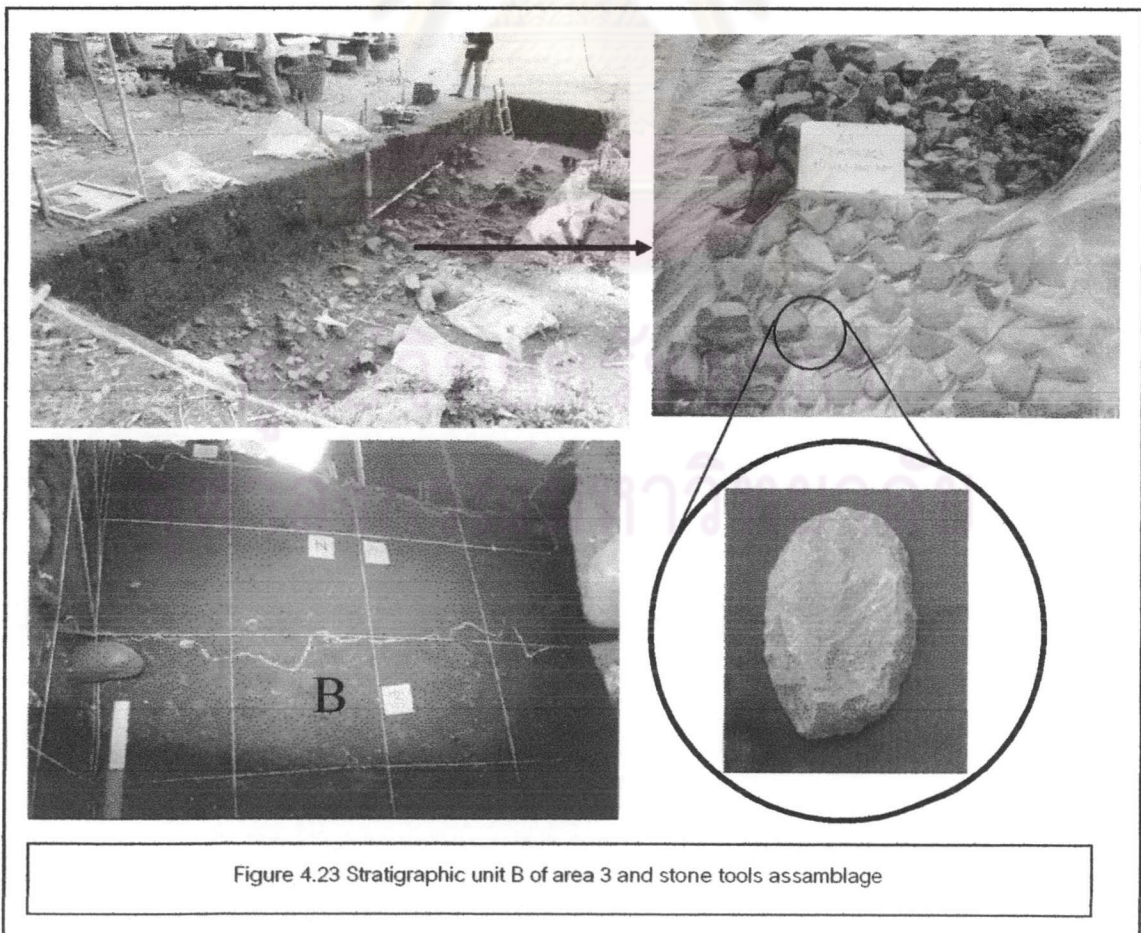


Figure 4.23 Stratigraphic unit B of area 3 and stone tools assemblage

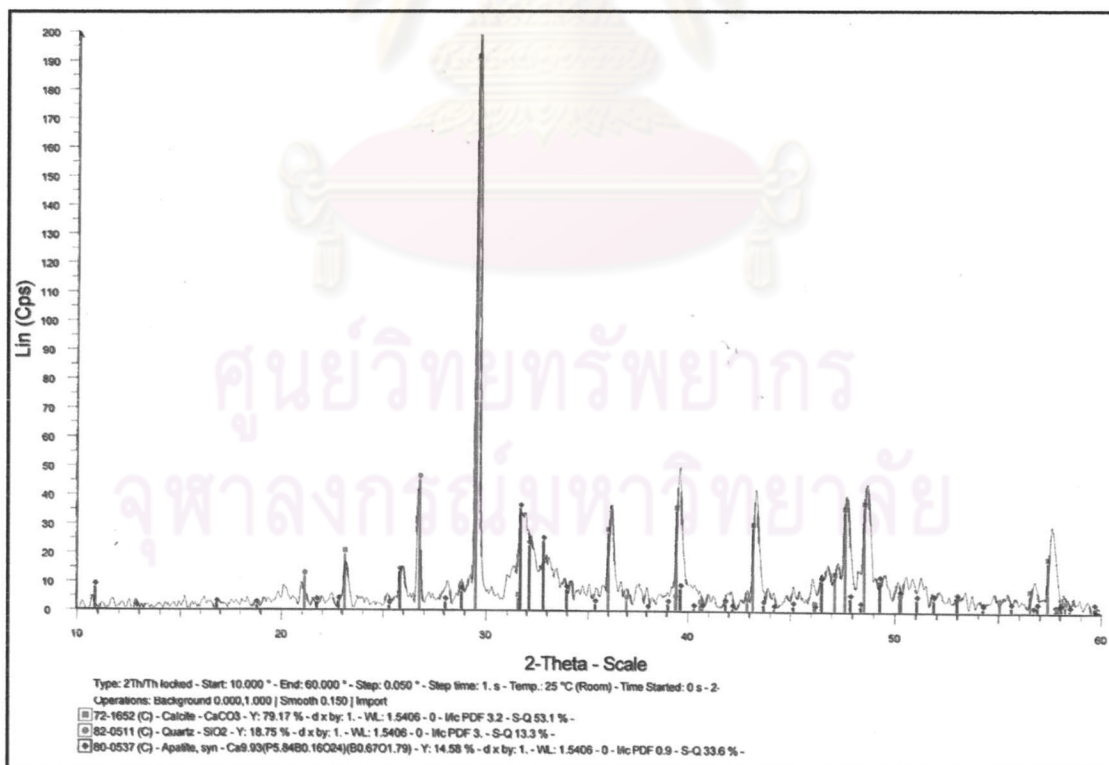
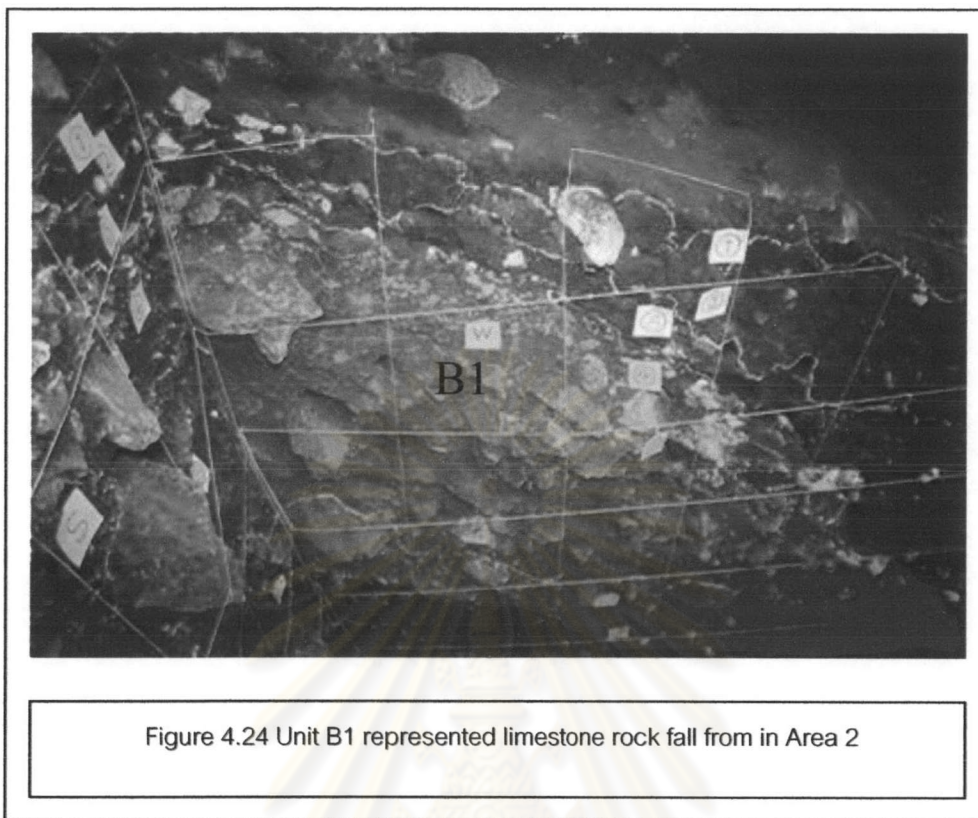
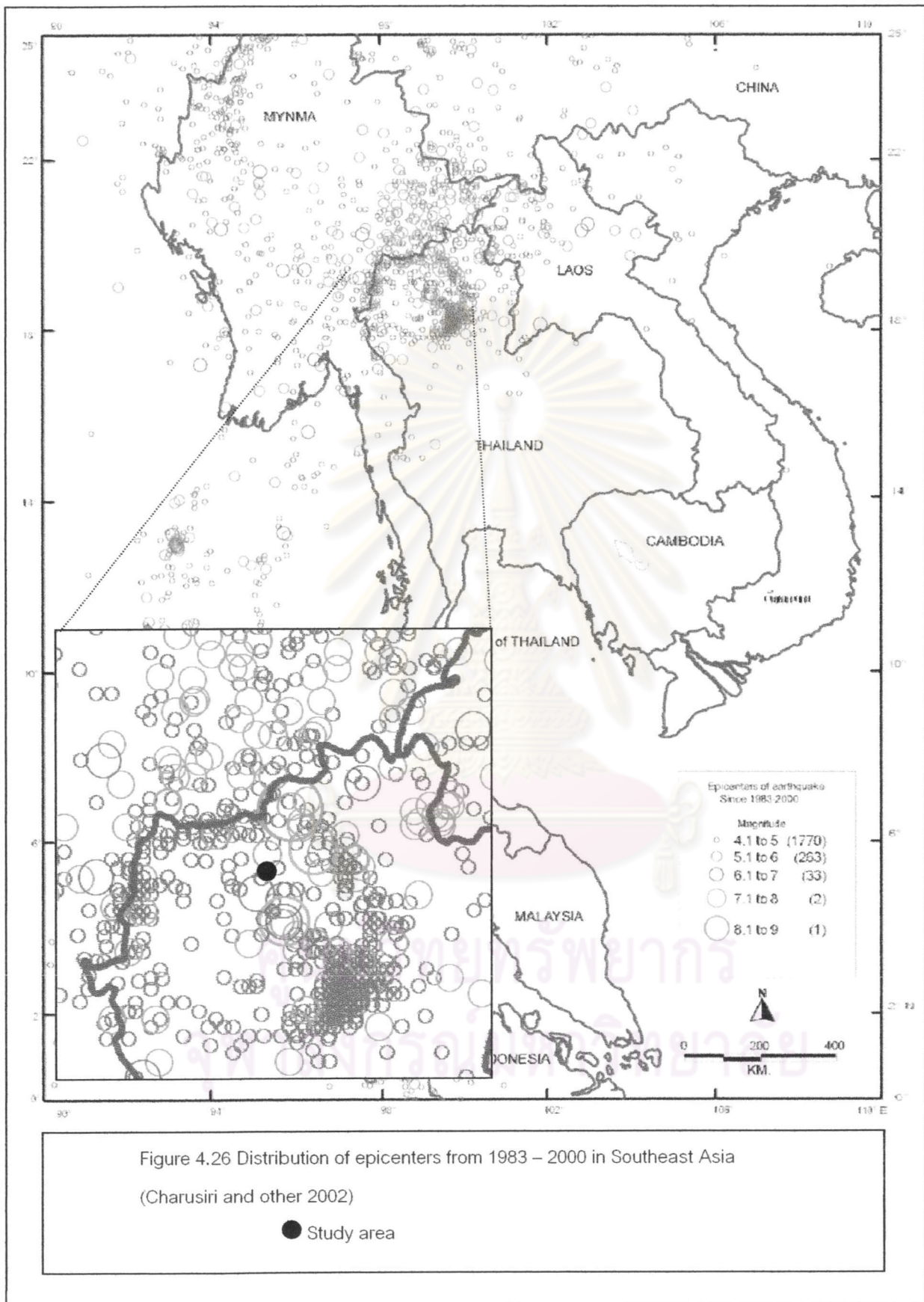


Figure 4.25 X-ray powder diffraction of soil sample from Unit B1.  
 (mostly composed of calcite and quartz)



### 4.5.3 Holocene Period

**Unit C1** rests directly on the upper of unit B. This unit is mainly appeared in area 2 and 3, characterized mostly by 10YR3/3 brown to dark brown color, pH 7 , organic matter 1 to 3 ,very high clay particle size, sticky and plastic, low compaction, moderately to high pores, shape contact boundary with unit B. The material deposited in this stratigraphic unit was different from unit B on which a few of stone tools and animal remains was found. Moreover, new archaeological remains were also found such as potsherd, beads.

The significance of this stratigraphic unit C1, based on field observation of site stratigraphy is that it displays soil forming process differ from soil forming in unit B. The straight line shape contact boundaries can be identified unconformably between stratigraphic unit B and unit C1 (Figure 4.27 and 4.28). The sedimentary analysis of this unit confirms that the physical property of soil differs from unit B due to rapid increasing of clay particle size, very high organic matter. Analysis from x-ray powder diffraction between soil deposited in unit B and C indicated that soil deposited in unit B is mainly composed of calcite and quartz (Figure 4.29) but soil deposited in unit C is mainly represented by quartz and clay mineral (montmorillonite) (Figure 4.30). The archaeological remains deposited in this unit represent the combination of several artifacts from several periods such as potsherds, beads, flakes, fragment of animal bones, iron tools or small fine artifacts etc. The characteristic of all artifacts was observed as small pieces. For example, potsherds are characterized by small fragment, sub – rounded to rounded shape, morderately to highly weathered and animal bones are characterized by small pieces fragments, highly weathered.

From several evidence, it is suggested that severe flooding may have played an important role sometimes during this period. The flooding was the main process making unconformable layer between unit B and unit C and reworked or mixed archaeological remains. This made a problem for the classification of cultural layers due to lack of keys artifacts for interpreting the difference between Early Holocene and

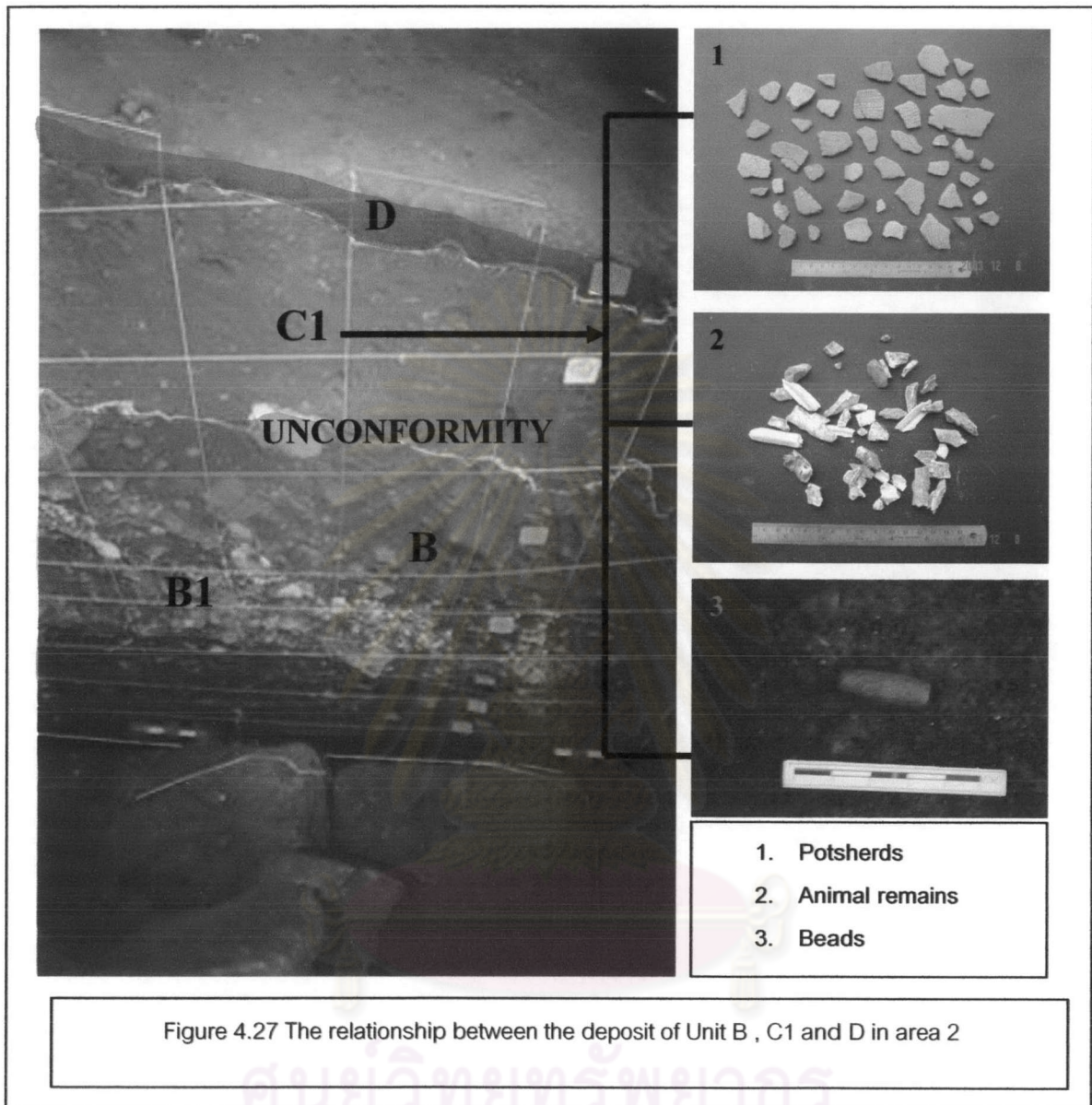
Middle Holocene layers. Stratigraphic unit C1 is represented the mixing of cultural occupation varying from Early Holocene to Middle Holocene.

The dating by TL from the top and lower part of this unit which is the contact boundary between unit C and unit D in area 3, was given the age of the deposition occurred after approximately 9,980 years BP until 2,933 years BP.

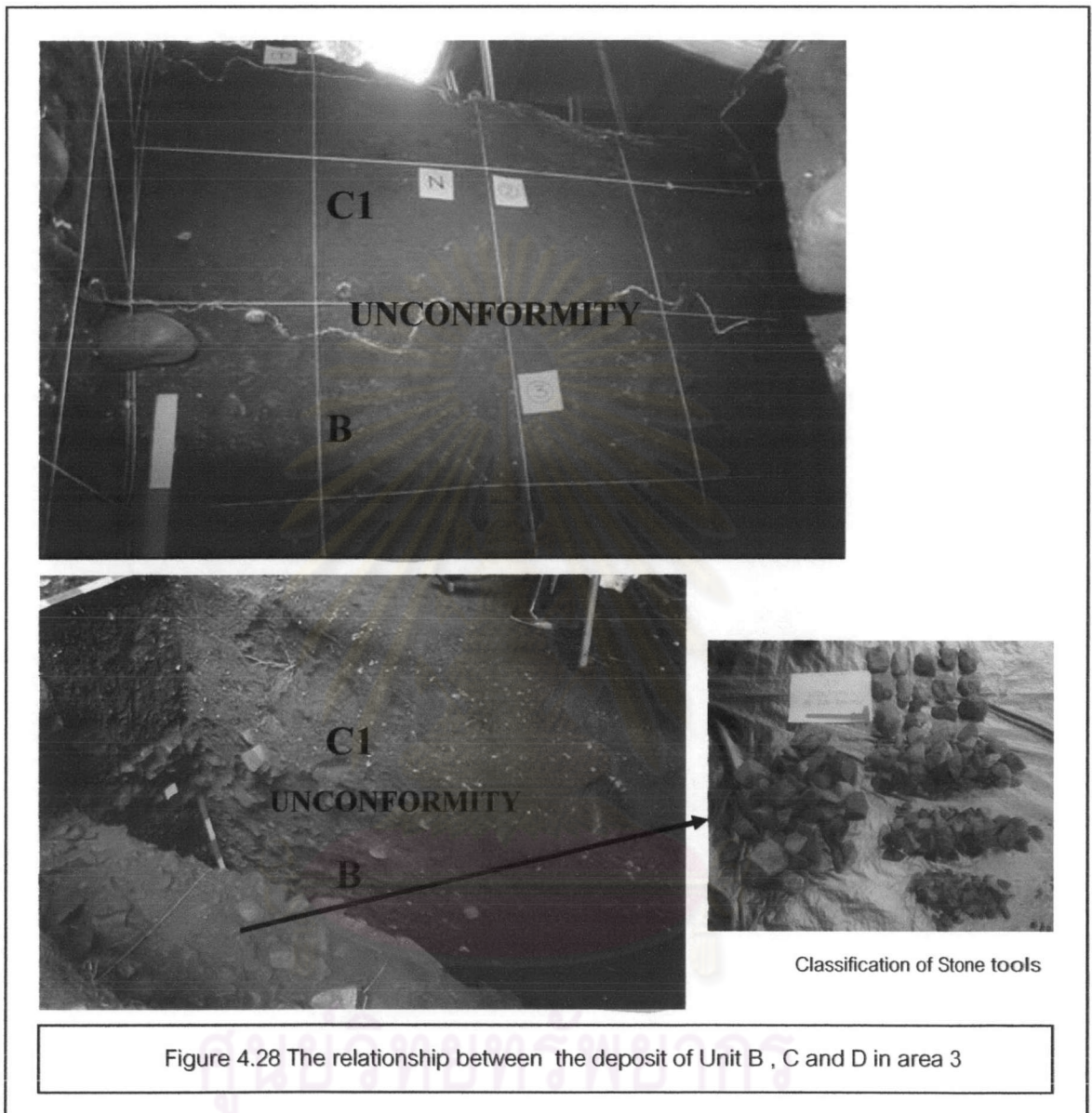
**Unit C** appears in only area 1 which overlying unit B. The characteristic and sedimentary analysis show the layer differs in soil property and shape contact from unit B. Unconsolidated soil varies from 20 – 30 cm. in thickness. It is characterized by 10YR 4/3 yellowish brown, increase of organic matter 0.7 – 0.9 %, pH 8, increase of % clay that sandy clay loam. Archaeological remains were found including potsherds and beads. Stone tools and animal remains were also found but decreasing in amount.

The new archaeological remains including potsherd, beads or iron tools can be determined the age by using relative dating from artifacts that most of them came from late Holocene artifacts. This evidence suggested a gap between late Pleistocene to late Holocene without clear evidence from early Holocene and middle Holocene.

**Unit D** appears in all area of excavation, comprises unconsolidated topsoil with thickness varying from about 5 cm. (10YR 3/3 dark brown to brown, organic matter 2.7- 3.5, pH 8 moderately alkaline, sandy clay loam). This unit was disturbed from recent activities. A few artifacts such as flake, animal bones, potsherd and beads have been discovered mixing with recent materials.



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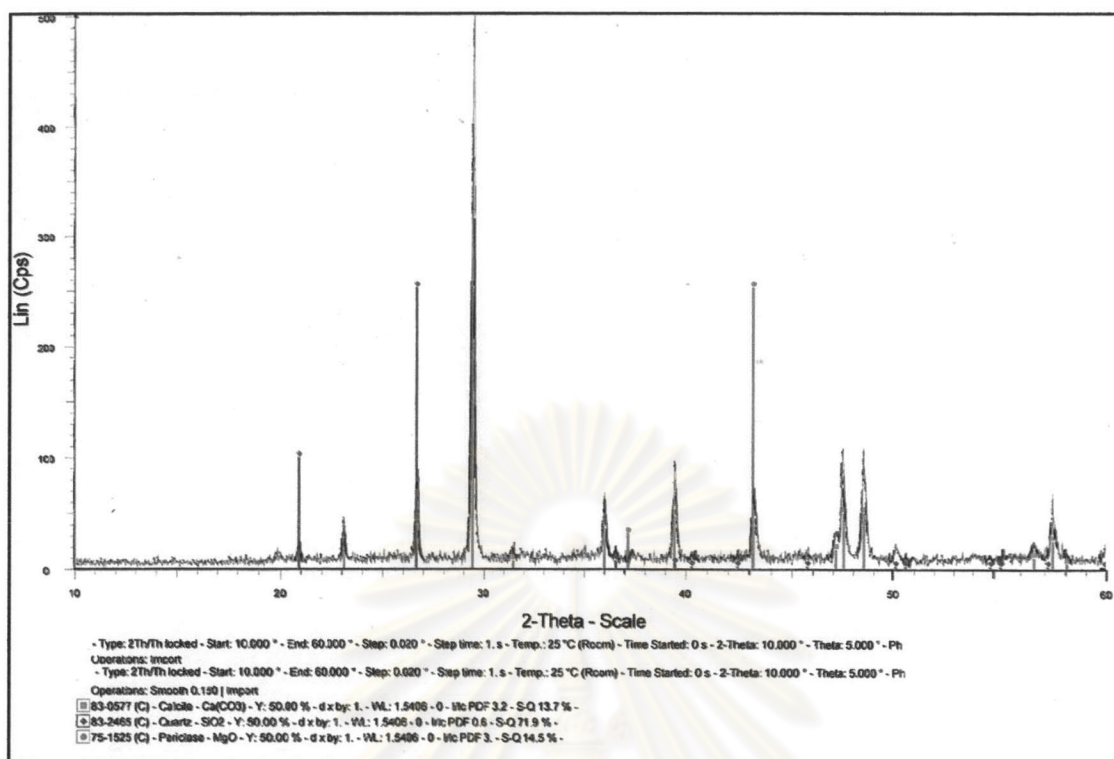


Figure 4.29 X-ray powder diffraction of soil sample from Unit B of area 3.  
 (mostly composed of calcite, quartz)

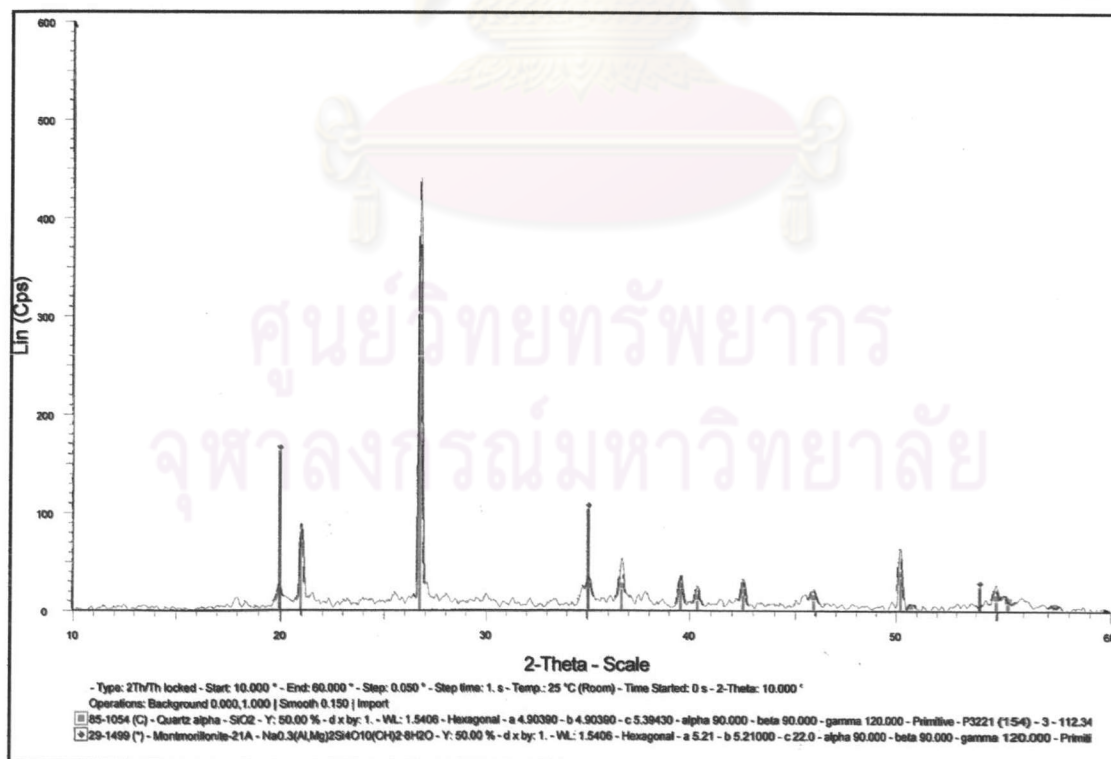


Figure 4.30 X-ray powder diffraction of soil sample from Unit C1 of area 3.  
 (mostly composed of quartz and montmorillonite)