ธรณีโบราณคดีบริเวณทุ่งเศรษฐี ตำบลนายาง อำเภอชะอำ จังหวัดเพชรบุรี

นางสาวประอร ศิลาพันธุ์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาโลกศาสตร์ ภาควิชาธรณีวิทยา
คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2548
ISBN : 974-17-4352-1

GEOARCHAEOLOGY OF THUNGSETTHI, TAMBOL NAYANG, AMPHOE CHA-AM, CHANGWAT PHETCHABURI

Miss Praon Silapanth

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Earth Sciences
Department of Geology
Faculty of Science
Chulalongkorn University
Academic Year 2005

ISBN : 974-17-4352-1

Thesis Title	Geoarchaeology of Thungsetthi, Tambol Nayang, Amphoe Cha-Am, Changwat Phetchaburi
By	Miss Praon Silapanth
Field of study	Earth Sciences
Thesis Advisor	Assistant Professor Titima Charoentitirat, Ph.D.
Thesis Co-advisor	Mr. Montri Choowong, M.Sc.

Accepted by the Faculty of Science, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

..... Dean of the Faculty of Science
(Professor Piamsak Menasveta, Ph.D.)

THESIS COMMITTEE

..... Chairman
(Associate Professor Punya Charusiri, Ph.D.)

T. Charoentitirat ..... Thesis Advisor
(Assistant Professor Titima Charoentitirat, Ph.D.)

Montri Choowong ..... Thesis Co-advisor
(Mr. Montri Choowong, M.Sc.)

S. Nakpaadyt ..... Member
(Assistant Professor Somchai Nakapadungrat, Ph.D.)

..... Member
(Associate Professor Surapol Natapintu, M.Sc.)

ประอร ศิลาพันธุ์ : ธรณีโบราณคดีบริเวณทุ่งเศรษฐี ตำบลนายาง อำเภอชะอำ จังหวัดเพชรบุรี (GEOARCHAEOLOGY TAMBOL NAYANG, AMPHOE CHA-AM, CHANGWAT PHETCHABURI) อ. ที่ปรึกษา : ผศ.ดร.ฐิติมา เจริญฐิติรัตน์, อ.ที่ปรึกษาร่วม : อ.มนตรี ชูวงษ์ 98 หน้า. ISBN 974-17-4352-1.

หลักฐานทางโบราณคดีที่ค้นพบบริเวณทุ่งเศรษฐี ตำบลนายาง อำเภอชะอำ จังหวัดเพชรบุรี แสดงให้เห็นว่าพื้นที่นี้มีความสำคัญมาตั้งแต่ยุคประวัติศาสตร์ในช่วงพุทธศตวรรษที่ 12-16 ในฐานะที่เป็นเมืองซึ่งอยู่ในเส้นทางการคมนาคมสำคัญเส้นทางหนึ่งในสมัยโบราณซึ่งเชื่อมต่อระหว่างภาคกลางและภาคใต้ของประเทศไทย

งานวิจัยนี้มีจุดประสงค์เพื่อวิเคราะห์ความสัมพันธ์ระหว่างธรณีสัณฐาน ลำดับชั้นตะกอนและหลักฐานทางโบราณคดีโดยใช้วิธีการทางธรณีโบราณคดี ซึ่งเริ่มจากการแปลรูปถ่ายทางอากาศ จากนั้นจึงทำการศึกษาในภาคสนาม การศึกษาในภาคสนามประกอบด้วยการสำรวจและการทำแผนที่ด้านธรณีสัณฐานวิทยาและด้านโบราณคดี รวมทั้งการเจาะตะกอนด้วยเครื่องเจาะตะกอนแบบกระแทกและการศึกษาหน้าตัดชั้นตะกอน ส่วนงานในห้องปฏิบัติการประกอบด้วยการบันทึกลักษณะของตะกอน การวิเคราะห์ขนาดของตะกอนด้วยวิธี laser granulometric และการวิเคราะห์โบราณวัตถุ

จากผลการศึกษาพบว่าพื้นที่บริเวณนี้มีการเปลี่ยนแปลงตั้งแต่สมัยโฮโลซีนตอนกลาง และแหล่งโบราณคดีทุ่งเศรษฐีตั้งอยู่บนแนวชายหาดเก่าและแนวสันทรายเก่าใกล้กับเชิงเขาหินปูนยุคเพอร์เมียนและมีร่องรอยของทางน้ำเก่าที่เชื่อมต่อกับชายฝั่งทะเลโบราณ การสะสมตัวของตะกอนไปทางทิศตะวันออกในช่วงการลดระดับลงของน้ำทะเลช่วงหลังสมัยโฮโลซีนตอนกลางน่าจะมีบทบาทสำคัญในการทำให้เกิดการเปลี่ยนแปลงสภาพภูมิสัณฐานของพื้นที่ เช่น การเปลี่ยนทางเดินของทางน้ำ อย่างไรก็ตามการเปลี่ยนแปลงสภาพภูมิสัณฐานบริเวณชายฝั่งก็ยังคงเกิดขึ้นอย่างต่อเนื่องจนถึงปัจจุบัน การศึกษาลำดับชั้นตะกอนบริเวณชายฝั่งแสดงให้เห็นขอบเขตของชายฝั่งทะเลโบราณอย่างชัดเจน นอกจากนี้หลักฐานเกี่ยวกับสภาพภูมิสัณฐานโบราณโดยเฉพาะแนวชายหาดเก่าและแนวสันทรายโบราณยังแสดงให้เห็นว่าชุมชนโบราณบริเวณทุ่งเศรษฐีและชุมชนโบราณอื่นๆร่วมสมัยที่ตั้งอยู่ในแนวสันทรายโบราณมีการเลือกใช้แนวสันทรายด้านในสุดในการตั้งถิ่นฐานและใช้เป็นเส้นทางคมนาคม เนื่องจากแนวสันทรายดังกล่าวเป็นพื้นที่สูงและคงตัวกว่าพื้นที่ที่อยู่ติดชายฝั่งทะเลในช่วงเวลานั้น และมีทางน้ำเชื่อมต่อกับชายฝั่งทะเลจึงสะดวกในการคมนาคม นอกจากนี้หลักฐานทางโบราณคดีที่ค้นพบในแหล่งโบราณคดีทุ่งเศรษฐียังสามารถนำไปเปรียบเทียบกับหลักฐานทางโบราณคดีที่พบในแหล่งโบราณคดีสมัยทวารวดีอื่นๆในภาคกลางของประเทศไทย จึงเป็นหลักฐานยืนยันอีกทางหนึ่งว่ามีการติดต่อกับชุมชนโบราณอื่นๆโดยใช้เส้นทางคมนาคมตามแนวสันทรายสมัยโฮโลซีนนี้

ภาควิชา.....ธรณีวิทยา.....ลายมือชื่อนิสิต.....ประอร ศิลาพันธุ์.....

สาขาวิชา.....โลกศาสตร์.....ลายมือชื่ออาจารย์ที่ปรึกษา.....

ปีการศึกษา.....2548.....ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.....มนตรี ชูวงษ์.....

4572613123 : MAJOR EARTH SCEINCES
KEYWORD:GEOARCHAEOLOGY/QUATERNARY/PALEOENVIRONMENT/THUNGSETTHI
PRAON SILAPANTH: GEOARCHAEOLOGY OF THUNGSETTHI, TAMBOL NAYANG, AMPHOE CHA-AM, CHANGWAT PHETCHABURI. THESIS ADVISOR : ASST.PROF. TITIMA CHAROENTITIRAT,Ph.D., THESIS COADVISOR : MR. MONTRI CHOOWONG, M.Sc, 98 pp. ISBN 974-17-4352 -1.

Thungsetthi, a locality in Changwat Phetchaburi reveals its archaeological significance in historical period (6-10 C.E.). According to archaeological evidence, it can be assumed that Thungsetthi is situated on one of the ancient communication networks between central and southern regions of Thailand. The research aims to analyze the relationship among geomorphology, sedimentology and archaeological evidence by using geoarchaeological techniques. The investigation by aerial photographs was the first approach, then, followed by ground reconnaissance and detail field survey. Field work includes geomorphological and archaeological mappings, coring with Precision Clement Sediment Corer and test pitting. Laboratory works include the detail log description of sediments, grain size analysis of sediments by laser granulometric technique, and detail analysis in archaeological remains. A result reveals that the change of landscape here has been occurring since the middle Holocene. The propragation of the land in eastward direction can be referred relatively to the mid-Holocene marine regression. Based on the archaeological sites and remains, the Dvaravati habitation site (6-10 C.E.) at Thungsetthi had been located on a beach ridge and barriers close to Permian limestone hills and surrounded by palaeo-channels connecting to the palaeo-shoreline. The progradation of the land during marine regression after the mid Holocene might have played a significant role in controlling coastal landform pattern i.e. the change in direction of palaeo-channels. However, the morphological changes of the coastal area have been occurring until the present time. The investigation on coastal stratigraphy supports the evidence about the boundary of palaeo-shoreline. Furthermore, these palaeo-landforms especially beach ridges and sand barriers also represent that the people at Thungsetthi and other Dvaravati sites in adjacent areas selected the innermost sand barrier for their settlements and communication route since this sand barrier was stable and higher than the areas where were close to the shoreline at that time. Moreover, there are some channels that might be used as the transportation way to the sea. According to the archaeological evidence discovered from Thungsetthi, they can be correlated with major Dvaravati communities in central Thailand and suggest the idea that the Holocene sand barriers were suitable for using as the communication route during Dvaravati period.

Department.....Geology.....Student's signature.....Praon Silapanth.....
Field of study.....Earth Sciences.....Advisor's signature.....T.Charoentitirat.....
Academic year.....2005.....Co-advisor's signature.....Montri Choowong.....

ACKNOWLEDGEMENTS

The author feels very grateful to Assistant Professor Titima Charoentitirat, Ph.D., thesis advisor and Mr. Montri Choowong, Ms.C., thesis co-advisor who gave recommendations and suggestions throughout this research and provided their kind assistance in the field.

Thanks are also to the committee: Associate Professor Punya Charusiri Ph.D, Assistant Professor Somchai Nakapadungrat, Ph.D. and Associate Professor Surapol Natapintu Ms.C.for their comments and suggestions.

The author would like to acknowledge Miss Phayung Wongnoi and Mr. Decha Sudsawat, the archaeologists of the 1st Regional Office of Fine Arts, Ratchaburi, who providing the archaeological data. Special thanks also due to Mr. Ratthakorn Songmuang, Mr. Peerasit Surakiatchai, Mr. Chanwit Lunsai, Mr. Wasan Punyadee, Mr. Teerasak Laokor, Mr. Santi Pailoplee, Mr.Sumet Phantuwongraj, Mr. Chawalit Khaokhiew, Prasit Auatrakulwit,Ph.D., Mr.Kristhorn Srikhanapati, Mr.Amnaj Konmeg as well as the students from Department of Archaeology, Silpakorn University for their assistance during the field work. Thanks are also to Mr. Pasakorn Bunchalee, Mr. Sakboworn Toompeesuwan, Mrs. Kanlaya Sripratheep, Mr. Sawangpong Wattanapitaksakul, Miss Theerarat Napradit, Miss Preeyanuch Senghaphan, Miss Anchalee Weerahong Mr. Akaneewooth Chabangbon, Mr. Rothana Ladachart, Mr. Preecha Saithong, Mr. Kitti Khaoviset, Miss Rattana Tulthaweewat and Vichai Chutakositkanon, Ph.D for their support.

The author thanks her family and her best friends: Mr. Kamnoonvit Vorapoo, Miss Supiengpitch Bhuyatorn, Miss Apinya Tanthaweewong, Mr. Aree Hayeewangoh, Mr. Thiwawat Phadrakulwanit and Mr. Suphot Phornreukngam for their encouragement and support.

Many thanks to the Commission on Higher Education for financial support during the study. The fieldwork was made possible through the financial support of Ratchadaphisek Somphot Foundation and NRC-EHWM, Chulalongkorn University and Thailand Research Fund (TRF Project no. MRG4680091).

Last but not least, thanks to all of her teachers at Department of Geology, Chulalongkorn University as well as her teachers and colleagues at Department of Archaeology, Silpakorn University for their encouragement and support.

CONTENTS

LIST OF TABLE

Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

1.1 Background

Changwat Phetchaburi is situated in the lower part of the Central Plain of Thailand and it is the beginning way to the south. The ancient settlements since prehistoric period to recent have been reported in Phetchaburi. Both archaeological and documentary evidences support not only the traces of settlements in Phetchaburi but they also represent the importance of this province in the past such as the former port and military important town especially in Ayutthaya period (13-18 C.E.*). However, the archaeological researches in Phetchaburi are still in initial state. Most of them are preliminary investigations and no detailed archaeological works have been done in some districts of Phetchaburi at all. Meanwhile, the destruction of archaeological sites happens continuously by the land use of recent settlements as well as the looting.

Thungsetthi is a locality in Phetchaburi which was discovered to have the human activities in Dvaravati period (6-10 C.E.). It is assumed that Thungsetthi is an important ancient route connecting the central and southern part of Thailand (Vallibhotama, 1990). At the foot of Khao Chomprasat, an isolated Permian limestone hill, a Dvaravati monument is one significant archaeological relict evidences. It was restorated by Fine Arts Department in 1998. Furthermore, there are some traces of brick monuments in Dvaravati period on the top of this hill as well as on the top of Khao Ta Chin, another Permian limestone hill (Fine Arts Department, 1998). These relict archaeological monuments may have some means to be related to the way that ancient people decided to construct them in relation to the changes of the land morphology.

---

*C.E. is an abbreviation for Common Era. It is an alternative notation used by many non-Christian for A.D.

A Dvaravati habitation site has been unearthed at Ban Khok Setthi, the local community located nearby the monument. Moreover, the archaeological site of Ayutthaya period has also been found in the adjacent area such as Ban Don. However, there is still no intensive study in this area although there are excavations done at Thungsetthi monument and habitation site at Ban Khok Setthi. The aim of the excavation at Thungsetthi monument was to restore and conserve the monument as well as to gain some knowledges on architectural, archaeological and art history. The aim of the excavation at Ban Khok Setthi was to investigate the cultural layers which represent the relationship between the ancient settlement of Ban Khok Setthi and the Dvaravati monument. But Fine Arts Department team could excavate only a small area because the appropriate areas were changed by land adjustment and due to the budget and time limited. In archaeological perspective, the conclusions of their excavations revealed that a Dvaravati cultural layer was discovered and the people of the ancient community constructed the monument.

1.2 Objectives

One important question is still unknown on how the ancient people care about the change in paleo-environment in term of site selection. Thus, this research will partly be concerned with the history of the changes in paleo-channel patterns and the position of paleo-shoreline. One assumption was arisen that the archaeological site should be related with the Holocene paleo-shoreline which was a result from the changing in geomorphology caused by the progradation at the same time of the marine regression (e.g., Choowong et al., 2003; Silaphanth et al., 2004;). Therefore, the geoarchaeology which using the similar concept and methodology of earth sciences should help us to get more insights about the human settlement, land use as well as paleo-environmental changes of this area. The prime objectives and the context of this research are as follows:

1. To study the landscape context or the land use and the palaeo-environment of Thungsetthi archaeological site and the adjacent areas. It will be the site meso-environment study*.
2. To study the sedimentary stratigraphy, especially from the former marine landforms of Thungsetthi archaeological site and the adjacent area.
3. To study the site formation processes and the landscape modification.

The increasing activities of people who live in Thungsetthi and adjacent areas are gradually affected archaeological sites. Thus, the urgent study should be done in order to find the resolution for conservation.

1.3 Scope and Output

The scope of the research is, generally, to investigate Thungsetthi archaeological site and adjacent areas in detail both in archaeological and geological perspectives. The study area covers around 100 km^2. The outputs of this research are as follows:

1. The ancient land use and palaeo-environment in Thungsetthi area can be explained.
2. The sediment stratigraphy will be confirmed the changes in paleo-environment, particularly concerning with the Holocene sea-level changes history in this area.
3. The site formation process and the change of landforms caused by natural process as well as human activities can be relatively explained.

1.4 The Study Area

The study area covers approximately 100 km^2in Tambol Nayang, Amphoe Cha-Am, Changwat Phetchaburi. The area is located at approximately of 12^o 50 ‘47” N and 99^o 57’

---

* Site meso-environment can be defined as a primary study in the topographic setting and landforms of the area utilized directly for subsistence. This geomorphic information, combined with bio-archaeological inputs, helps in defining the adjacent environmental mosaic (Butzer, 1982).

24” E. It appears in the reference topographic map at a scale of 1: 50,000 series L7017 number 4934 I (Amphoe Tha Yang) and map sheet seriesL7017 number 5034 IV (Ban Tanod Noi) (Figure1.1).

Thungsetthi archaeological site is located approximately 184 km in southwestern part of Bangkok. It can be accessed by highway no. 4 (Phetchakasem road) from Amphoe Muang, Changwat Phetchaburi to Amphoe Cha-Am, Changwat Phetchaburi and approximately 3 km on local road to Thungsetthi archaeological site (Figure 1.2).

Figure 1.1 Topographic map showing the study area (Royal Thai Survey Department, 1972).

Figure1.2 The study area and its accessibility (modified from www.clickthai.de/Bilder/Karten/THMZ80.gif).

1.5 Literature Reviews

1.5.1 Relevant geoarchaeology researches in Thailand

One of the remarkable projects in northeastern Thailand is a part of archaeological project concerning the Iron Age sites (c. 2,500- 1,700 B.P.*) in the Upper Mun river valley. The project involved the geoarchaeological investigation at Noen U-Loke, Non Muang Kao, Ban Non Khrua Chut, Ban Non Ngiu, Ban makham Thae and Ban Non Wat. These sites are characterized by encircling earthworks which were used to interpret as ancient moats and ramparts. The researchers investigated these features by excavating trenches across the moat complexes with a backhoe, followed by the examination and mapping of the lithology, stratigraphy and cross sectional morphology as well as collecting samples for pollen and sedimentological analysis. The results of their study indicated that the sites were located on floodplain and the moats were recently formed by local farmers in the 20th century. The archaeological sites are intimately linked with the fluvial regime and the buried channels which appeared in stratigraphy were probably natural ones, except a few channels. The various types of stream and river channels also represented. They suggested that the change in fluvial system caused the abandonment of these Iron Age sites (Higham and Thosarat, 1998; Boyd, McGrath and Higham, 1999; McGrath, 2000).

Palakawongse Na Ayudhya (1982) applied geoarchaeological methods to examine the environmental factors which affected on the Dvaravati ancient settlement at Khu Bua, Changwat Ratchaburi. For physical environmental investigation, the stratigraphy of 9 excavating pits at the ancient settlement was examined as well as sedimentological and geomorphology, flora, fauna, mineral and water resources were analyzed. The conclusion wat that the physical environmental factors are favorable for the settlement since it is located on the floodplain. Thus, it is much appropriated for agriculture because of the deposition of alluvial sediment. There are two tributaries of streams which can be connected

---

*B.P. is an abbreviation for Before Present. It refers to raw radiocarbon ages and dates referenced to the BP Scale origin in the year 1950 C.E.

Figure 1.3 The aerial photograph showing the Non Muang Kao archaeological site and old channels (Higham and Thosarat, 1998).

to Mae Klong River. They played an important role as the water supply, the source of food as well as communication and trade routes with local communities as well as inter-regional ones. Furthermore, the results of faunal and floral analysis revealed that this area is abundance for animals and vegetation. Moreover, the site is not far from the mineral resources, e.g. Tenisserim ranges which can be provided the raw materials for utensil and craft productions.

Stargardt (1983) investigated Stingpra peninsula, southern Thailand. The purpose of her research was to study the environment and the economy of an early historic civilization. For environmental approach, she interpreted the aerial photographs, then, followed by the fieldworks. The studies of stratigraphy of the excavation pits as well as pollen from some canals were conducted. In the first part of the research, she discussed the environment of Satingpra and the Isthmus of the Malay Peninsula, the literary evidence of ancient trade and suggested that the agriculture was the important factor of the ancient settlements' economic which led to the development of Satingpra urbanization by the beginning of the 6th century.

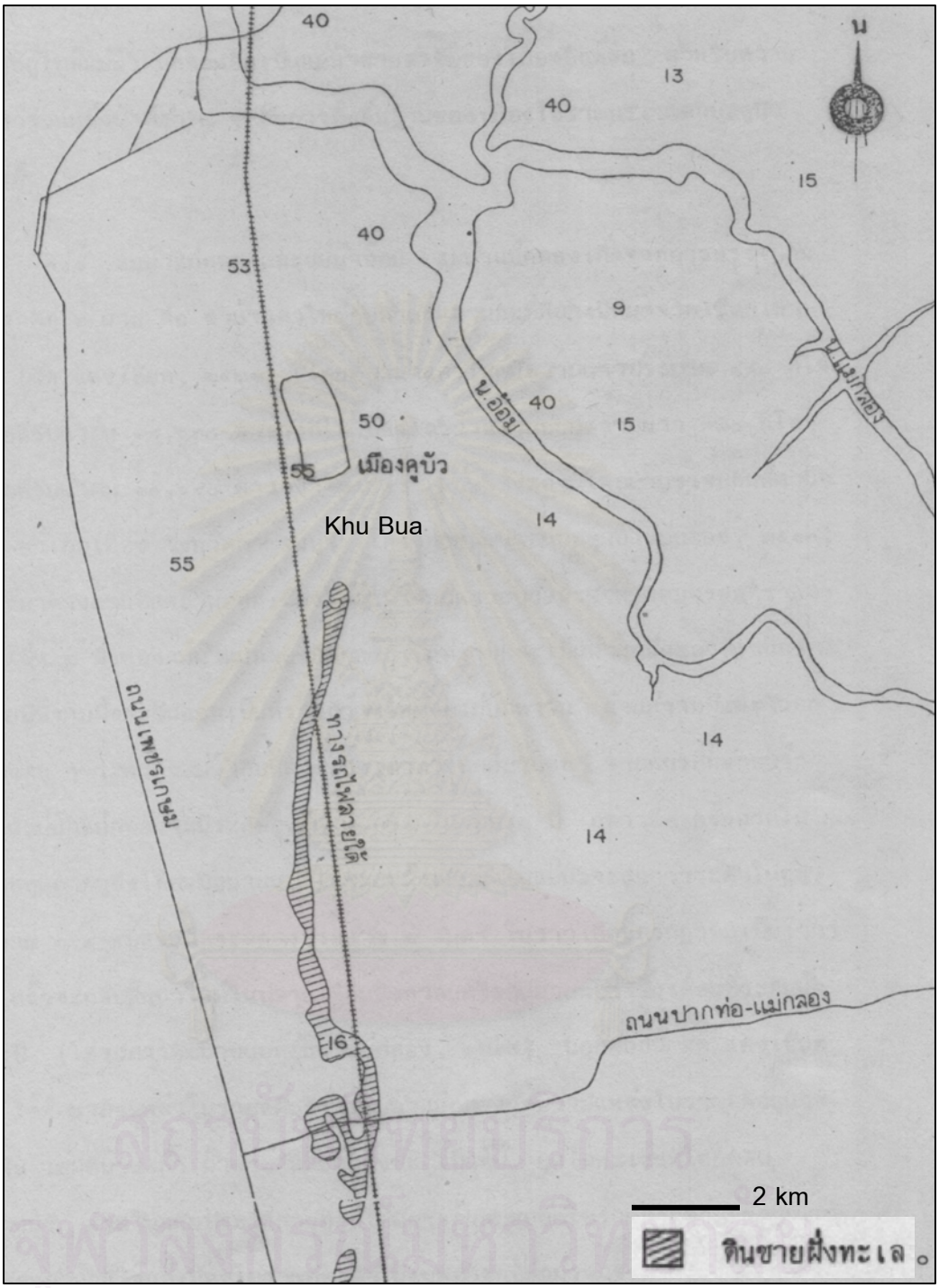

Figure 1.4 The ancient settlement at Khu Bua and its soil classification (Office of Soil Survey, 1972, cited in Palakawongse Na Ayudhya, 1982).

She also suggested the ancient hydraulic system of Stingpra was constructed, including tanks and canals in the ancient cultivated area. However, there are still some arguments arisen. Allen (1990) argued that Stingpra's urbanization did not base on floodplain agriculture as Stargardt suggested since the geoarchaeological evidence of that area revealed that environmental factors which appropriated for floodplain agriculture occurred after the urbanization of Stingpra.

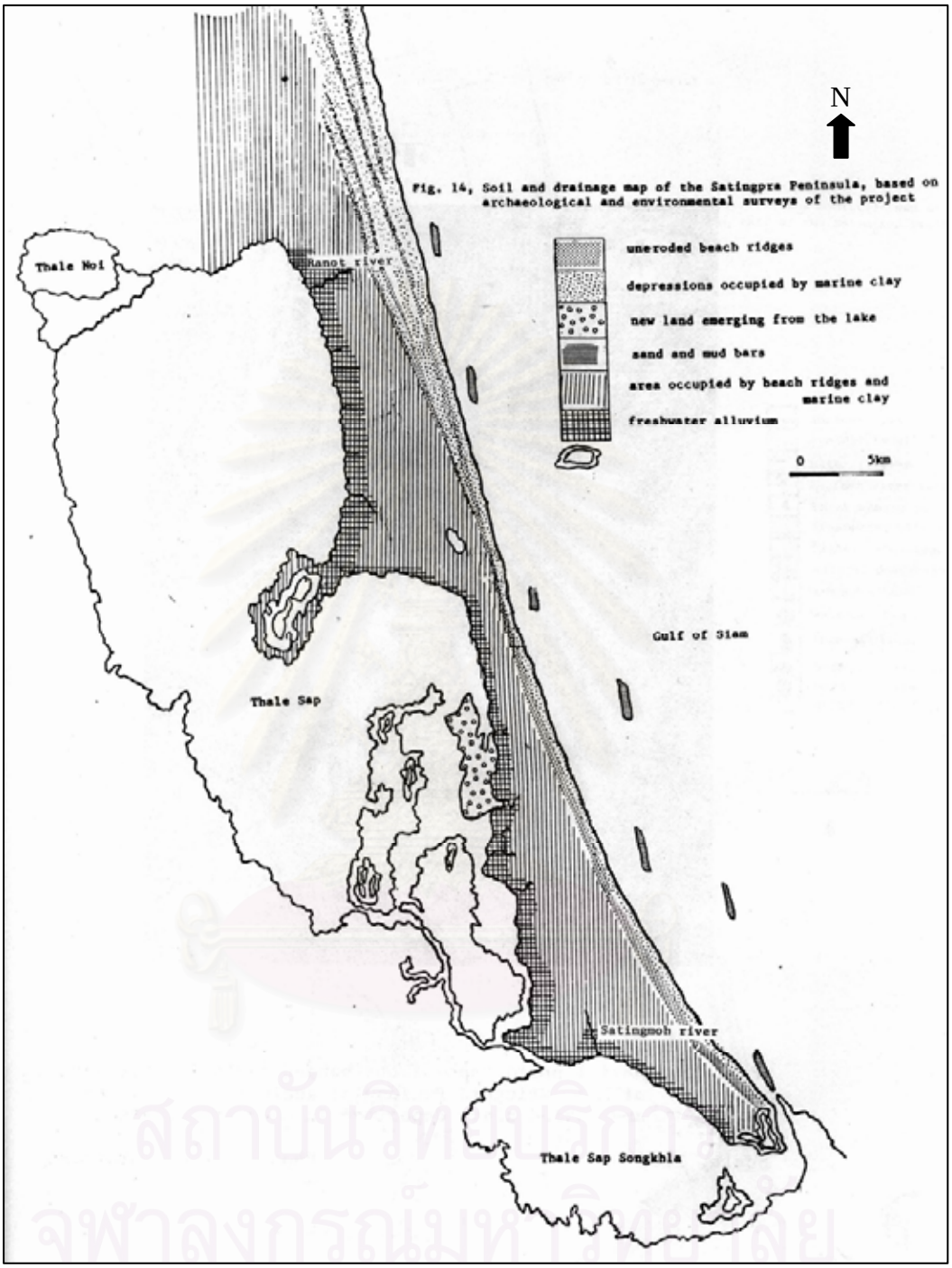

Figure 1.5 Soil and drainage map of Stingpra peninsula (Stargardt, 1983).

1.5.2 Previous investigations in Phetchaburi Province

1.5.2.1 Relevant geological investigations

It can be stated that all of geological study is in general. No detailed research has been done particularly in Thungsetthi area.

Vanasin and Supajanya (1981) discovered, based on the aerial photography interpretation that the maximum paleo-shoreline level, 3.5 - 4 m above the present mean sea level was related to site selection of ancient settlement in Lower Chao Phraya floodplain. They correlated those settlements to have constructed with Dvaravati communities. They also complied the list of names and locations of ancient communities in Lower Chao Phraya floodplain which can be identified by aerial photography. Ancient Phetchaburi town at Tambol Tharab Amphoe Muang Phetchaburi was also mentioned (Figure1.6).

The National Research Council of Thailand (1995) published a book concerning geomorphology and some ideas concern about geomorphology in Changwat Phetchaburi interpreted from satellite images. Phetchaburi geomorphology is occurred by the fluvial process of Phetchaburi river and coastal geomorphology occurred by former coastal processes (Figure 1.7).

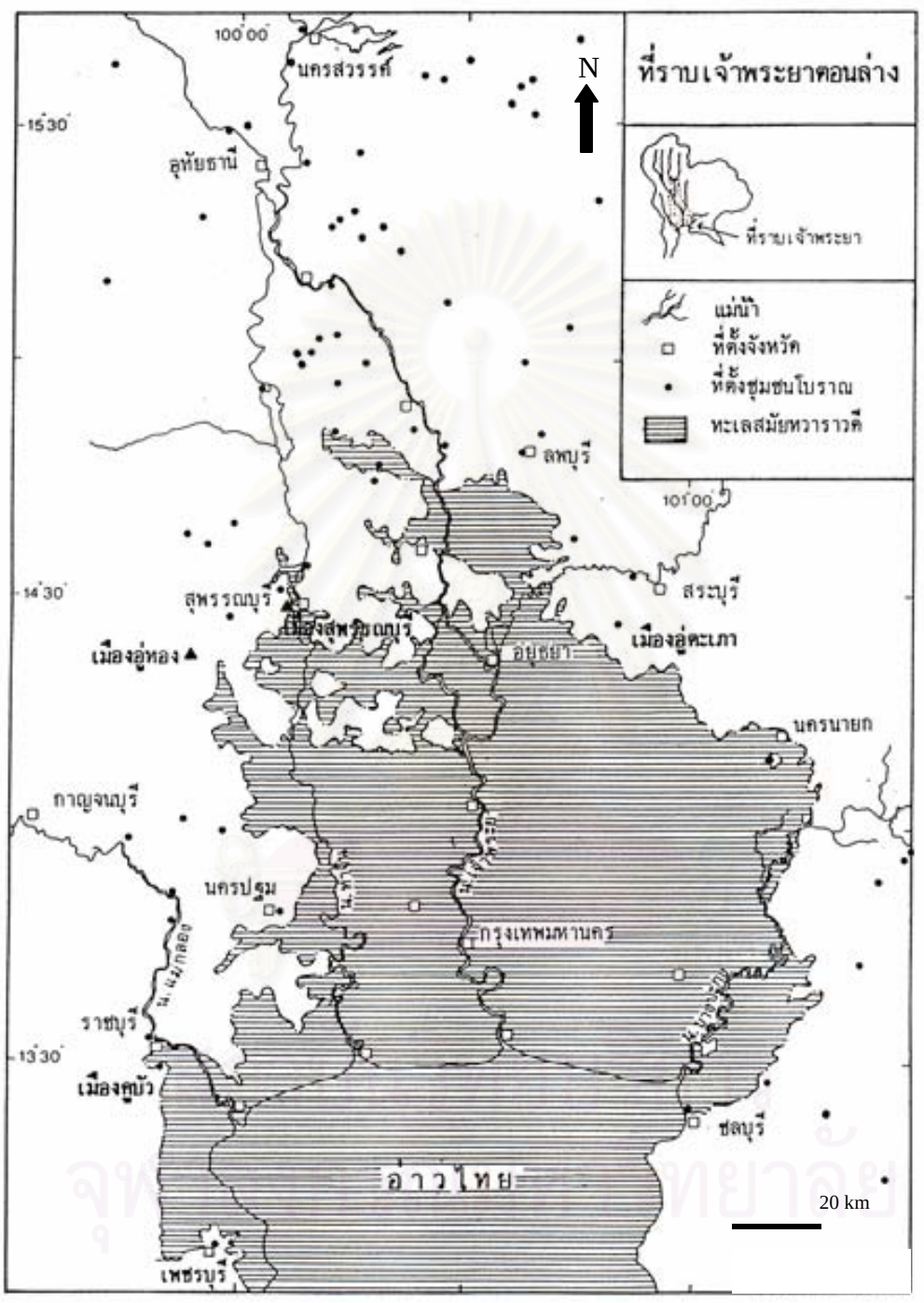

Figure 1.6 Map showing the lower Chao Phraya floodplain and ancient settlements(Vanasin and Supajanya, 1981).

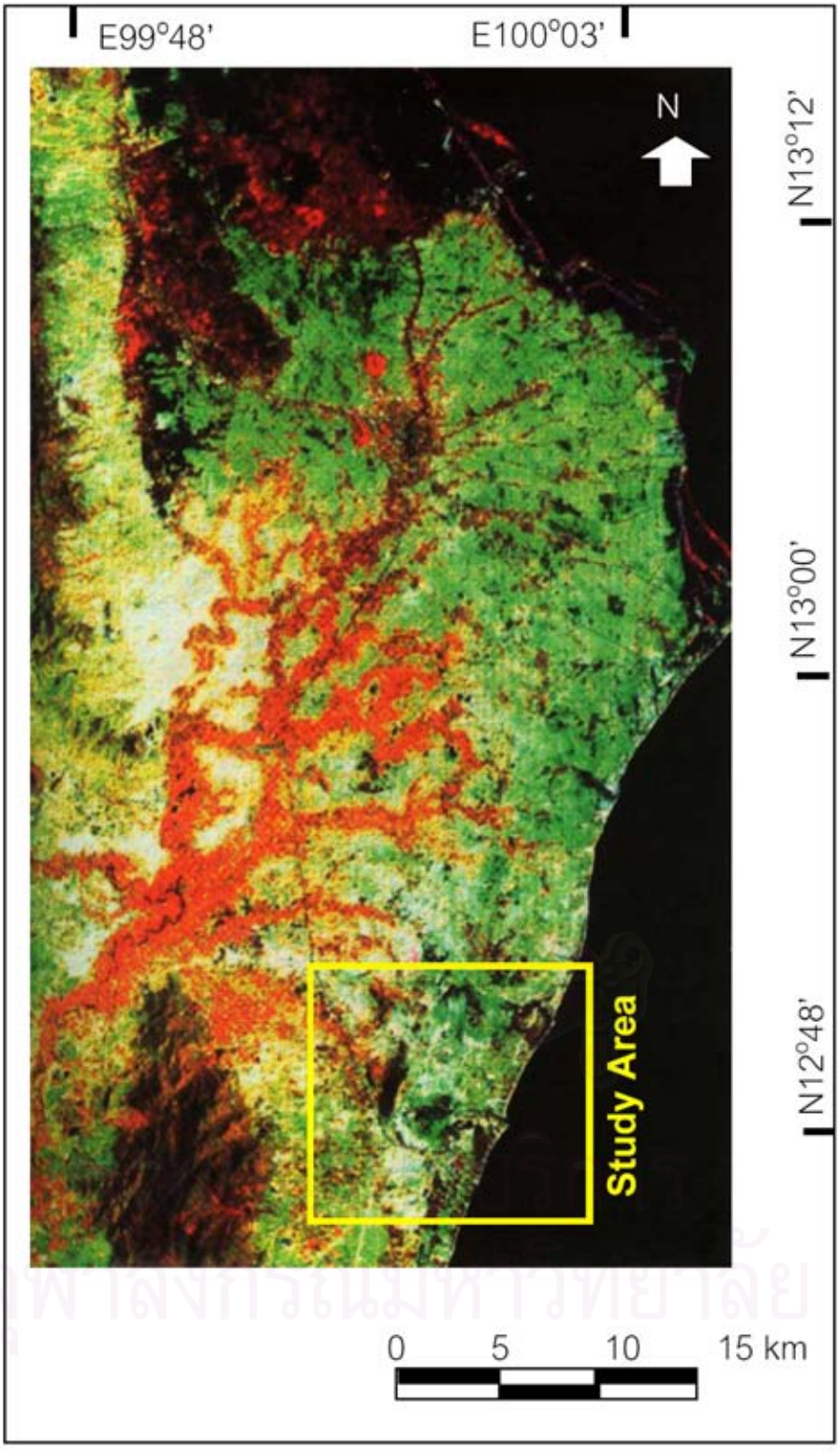

Figure 1.7 Satellite image of Changwat Phetchaburi (the National Research Council of Thailand,1995).

Sinsakul et al. (2002) studied the changing of coastal area in the eastern part of Petchburi, and concluded that the oldest Petchaburi coastal landform is series of sand barriers occurred from the sediment deposition during the transgression about 6,000 years ago. The height of marine highstand is about 4-5 m. from recent mean sea level.

Robba et al. (2002) studied the mollusks in Phetchaburi. They recorded and described the mollusks from Bangkok Clay in several locations in the lower central plain and from the Phetchaburi coastal plain as far south as Cha Am.

1.5.2.2 Archaeological investigations

Some archaeological researches of Thungsetthi, except from Fine Arts Department's work in 1998 as mentioned above, have been done as follows:

Vallibhotama (1990) wrote an article about the ancient settlements along the old sand barriers. He also mentioned about the importance of Thungsetthi archaeological site as an important settlement on the communication route in coastal area. It is also the connection to the southern peninsular Thailand such as Chumphon and the ancient communities in the west such as Mergui and Tenniserim in Myanmar. In the following year, he also wrote about the importance and development of Phetchaburi in ancient times. He concluded that Phetchaburi developed from Dvaravati settlement since 7 C.E. and developed as port polity in12 C.E. (Vallibhotama, 1991).

Aksornsilp et al. (1991) discovered 6 Dvaravati archaeological sites in Changwat Phetchaburi including Nongchik, a craft production site in Amphoe Khao Yoi, some traces of habitation sites in Amphoe Thayang as well as Thungsetthi in Amphoe Cha-Am.

1.6 Methodology

The geomorphological and sedimentological analyses are applied to this research. The topographic and landforms of the study area are also discussed. The first step of the study is the literature reviews and aerial photography interpretation followed by field investigations. Subsequently, the sediment samples from the study area were collected for detail analysis aiming to explain the major geological process and stratigraphic sequences. Finally, the correlation between stratigraphic sequences and archaeological evidence was carried out. Research methodology can be described as follows:

1.6.1 Data Collection in Office Work Study

1.6.1.1 Study Literature Reviews

The previous works of the study areas both geological and archaeological researches have been reviewed.

1.6.1.2 Collecting the Geological Data

The source of regional geological data is mainly from the geological map of Thailand with 1: 2,500,000 scale of the Department of Mineral Resources published in the year 1985. The aerial photographs interpretation provides the detailed data of geology and geomorphology of the study area. The aerial photographs used in the study are the approximately 1: 50,000 scale of Worldwide Survey 1954 number 8982, 8983, 8977, and 8978.

1.6.2 Fieldwork

Though, the fieldwork is divided into 2 parts: geological study and archaeological study, but both are studied together in the field. Ground reconnaissance was the first step and followed by archaeological data collecting by doing the field survey, taking photos and recording archaeological data (Figure 1.8). Geomorphological field check was carried out and examined the accuracy of air-photos interpretation. Some relict landforms observed from air-photos were also examined by ground survey as well as coring. Sediment samples were taken from different landforms by using Precision Clement Sediment Corer (ESP Plus) (Figure 1.9) and numbers of sediment samples were also collected from several well and inlet profiles.

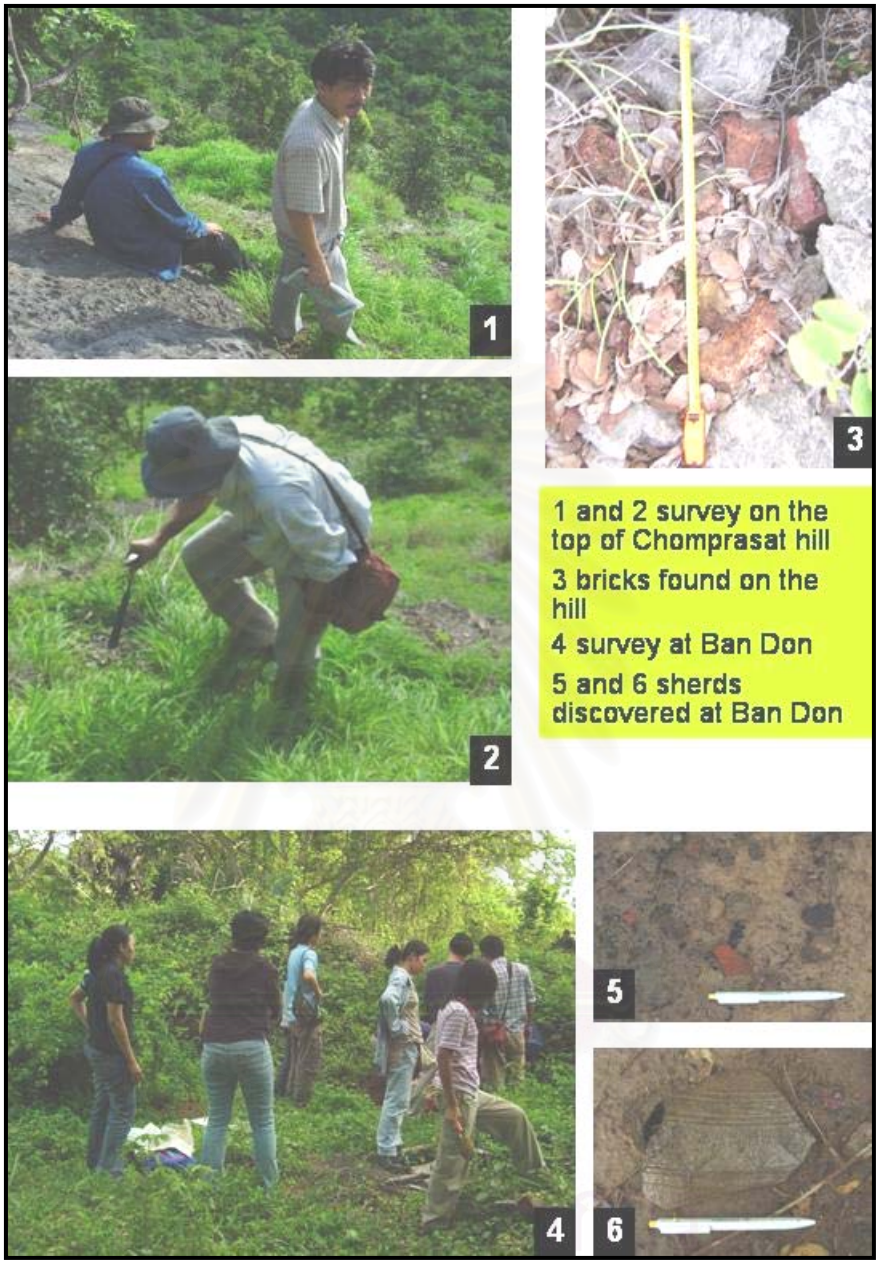

Figure 1.8 Archaeological survey on the top of the Chom Prasat Hill and the Ban Don archaeological site.

Figure 1.9 Taking sediment samples by using Precision clement sediment corer (ESP Plus).

1.6.3 Laboratory Work

1.6.3.1 Description of Sediment

Description of sediment was carried out by observing the difference of sediment layers in terms of their physical characteristics (Figure 1.10). The standard references of sediment were systematically applied as follows:

1.6.3.1.1 Layer Observation

The description of different sedimentary layers is carried out in the term of representative strata.

1.6.3.1.2 Color

The Munsell soil color charts were used to describe the color of sediment samples.

1.6.3.1.3 Texture

Field determination of sediment texture is made by hand that major and minor sediment composition will be noted together for the identification of sedimentary types such as sand, silt and clay.

1.6.3.1.4 Mottle or Concretion

The pisolitic concretion is abundantly observed in several parts of the sediment samples, indicating chemical alteration occurrence.

1.6.3.1.5 Layer Contact

The deposition of the unconsolidated sediments was, very often, not continuously accumulated. The record of depositional layer contact can indicate the continuity of the deposition. The general description in layer contact can be divided into sharp contact, gradual contact and unclear contact.

Figure 1.10 Description of sediment sample.

1.6.3.6 Particle Size Analysis

Particle size analysis was examined by using Laser Particle Size Analyzer (COULTER LS 230) of Scientific Equipment Center, Prince of Songkhla University, Hat-Yai Campus, Songkhla.

1.6.4 Data Analysis, Interpretation and Conclusion

The analysis and discussion will rely on the fact evidence from field and laboratory works. However, the first analysis will be pretty much focused on the checking of geological and archaeological sites mappings. The combination of air-photos, Sedimentology will help to better understanding of paleo-environmental analysis of the study area. After that, the correlation and comparison of the geological and archaeological data will be done carefully in order to create a paleo-environmental model and come up with the final research conclusion.

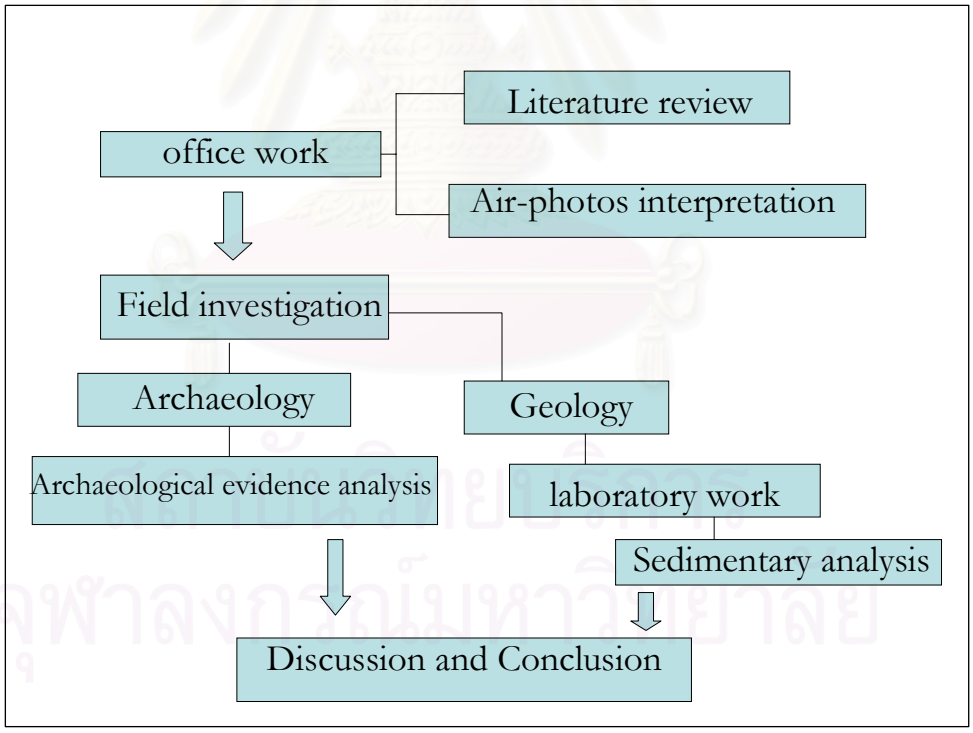

Figure 1.11 Flow chart showing the methodology of this research.

CHAPTER II

GEOLOGY AND GEOMORPHOLOGY

2.1 Regional Geology

Changwat Phetchaburi is situated in the southwestern part of Thailand. Rock units in this area are characterized by Carboniferous, Permian and Quaternary sediments which can be described as follows (Figure2.1):

2.1.1 Precambrian Rocks

The Precambrian rocks in Changwat Phetchaburi are called Hua Hin Block Group. It can be divided into Khao Tao Formation and Pran Buri Formation. The distribution of these rocks are found almost continuously from Amphoe Pranburi to Amphoe Hua Hin and Amphoe Cha-Am. The rock in this group comprises of metamorphic rocks such as marble, calc-silicate, quartzite, quartz mica schist and augen gneiss (Department of Mineral Resources, 1999).

2.1.2 Silurian-Devonian Rocks

The Silurian-Devonian Rocks distributed in the western mountain range of Hua Hin Block in Amphoe Hua Hin and Amphoe Cha-Am. Most of them are brown and yellowish brown quartzite and gray slate (DMR, 1999).

2.1.3 Carboniferous Rocks

Kaeng Krachan Group is the Carboniferous rock in Changwat Phetchaburi. Pebbly mudstone is the main characteristic of the rock in this Group. The type section of this group is in Kaeng Krachan dam, Amphoe Tha Yang, Changwat Phetchaburi. It can be concluded that Kaeng Krachan Group is underlain below the Ratchaburi Group, Permian limestone (DMR, 2001).

According to Raksaskulwong and Wongwanich(1993), Kaeng Krachan Group can be divided into 4 Formations. The lowest is Khao Wang Kadat Formation, Spillway Formation, Ko He Formation and Khao Phra Formation, respectively (DMR, 2001).

1) Khao Wang Kadat Formation

Khao Wang Kadat Formation comprises of greywacke and mudstone which occurred mainly under the influence of turbidity current.

2) Spillway Formation

Spillway Formation is composed of siltstone. A lot of worm burrows and bioturbation are found in this layer. As well as lone-stone or dropstone-like structure. In general, hummocky cross bedding of quartzitic sandstone is also found. This type of sedimentary structure represented the deposition under the influence of the storm.

3) Ko He Formation

Ko He Formation comprises of pebbly mudstone or diamictite with channel-filled structure.

4) Khao Phra Formation

Khao Phra Formation is composed of grayish black shale, poor-sorted black sandstone and grayish black pebbly shale. The fossils found in this Formation are brachiopod: *Spirifer* sp. and bryozoa: *Fenestella* sp. and *Polypora* sp. The thickness of this formation is about 520 m.

2.1.4 Permian Rocks

The Permian rocks in Changwat Phetchaburi are called Ratburi Group. It is composed of Limestone, gray to blackish gray, yellowish and white, massive and bedded limestone with fossils, indicating reef limestone interbeded with light brown feldspathic and calcareous sandstone at the base in places (DMR, 2001).

2.1.5 Tertiary Rocks

The Tertiary basin in Phetchaburi is occurred in Amphoe Nong Ya Plong. It covers around 80 km^2. The average elevation of the basin is about 80-100 MSL. It is flanked by faults in western and eastern part of the basin. There is a coal mine in this basin; it is benefit from the fault in the western part of the basin which uplifted the coal deposit to shallow layer. The fish fossils discovered from this area can be dated in Miocene (DMR, 2001).

2.1.6 Quaternary Sediment

Quaternary sediment in Changwat Phetchaburi is deposited in rivers, foot of the hills and coast. The deposits consist of colluvium, piedmont, talus, terrace, alluvium, marsh, tidal flat, coastal plain and beach.

2.1.7 Igneous Rock

An igneous rock of Changwat Phetchaburi includes granite. Putthapiban and Suensilpong studied the HubKapong granite in 1978 (cited in Nakapadungrat et al., 1984), there are 3 phases of granitoids; very coarse grained porphyritic biotite gneissis granite, medium grained equigranular to coarse grained porphyritic biotite gneissic granite and the non-foliated granite.

Nakapadungrat et al. (1984) presents Rb-Sr whole rock data and K-Ar ages for separated biotites of the biotite gneissic granite. The Rb-Sr whole rock isochron age for the biotite gneissic granite is 210.2 $\pm$ 3.9 Ma. with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7237$\pm$ 0.0006. The K-Ar biotite age is extremely discordant to the Rb-Sr whole rock isochron age. They trend to fall into two grups; first group of samples give average ages of about 67Ma. whereas the other group yields average ages of 59 Ma. It can be seen clearly that the younger unfoliated granite which exposed in the western flank of the pluton has not been responsible for resetting the biotite K-Ar ages. Hydrothermal activity provided by a tectonic structure such deep fracture system could be the cause since there are many outcrops of large veins of very pure quartz which might have formed in a hydrothermal circulation system.

Most of the biotite gneissic granite samples compose of low sodium content averaging c. 2.4% Na_2o at c. 5.3% k_2o whereas the strongly deformed granite contains high sodium (i.e. N_2o3.4%at c. 3.6%K_2o).This might support Pongsapich and others' (1980) view that the strongly deform granite or mylonite is different from the coarse grained porphyritic biotite gneissic granite (Nakapadungrat et al., 1984).

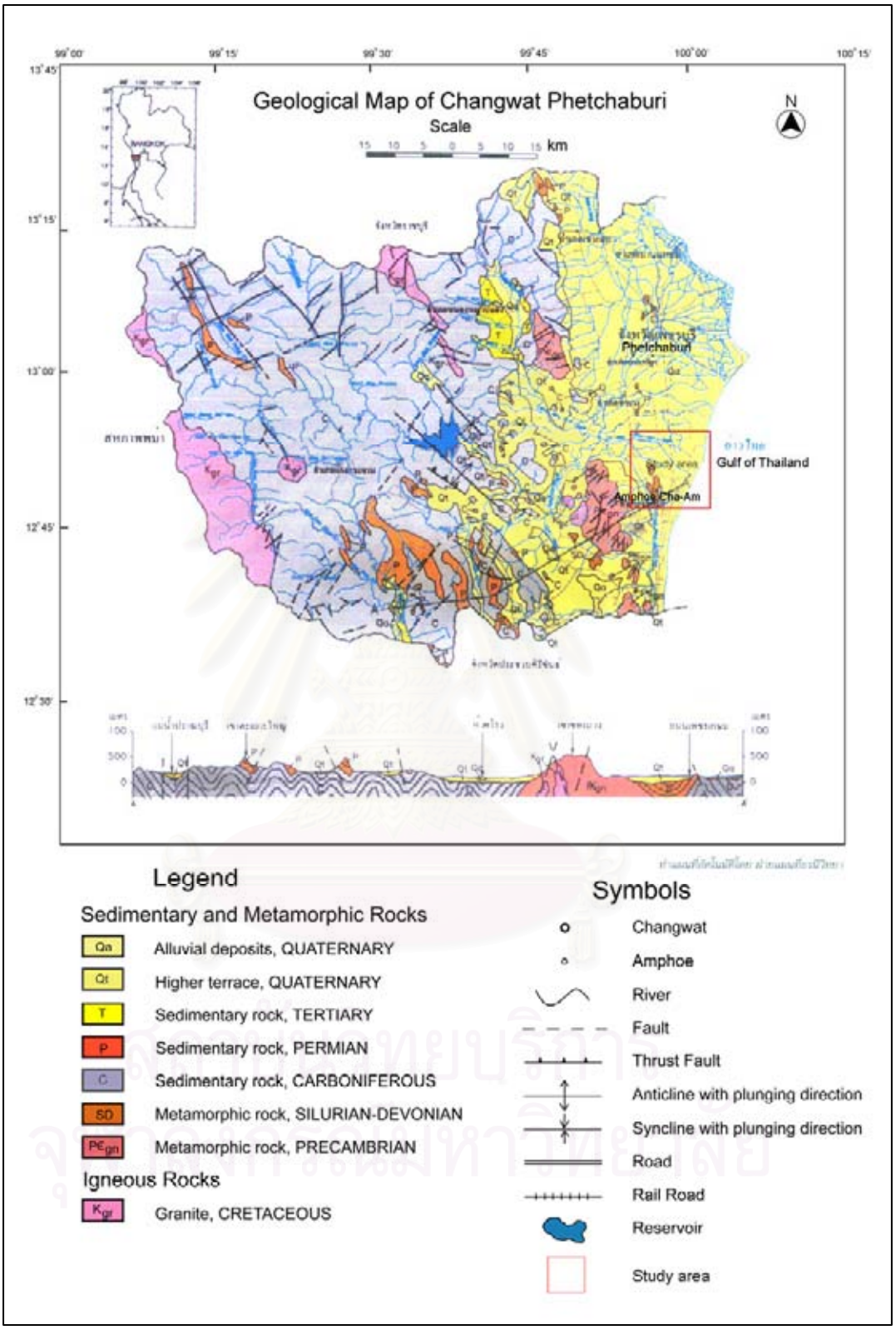

Figure 2.1 Geological map of Changwat Phetchaburi (DMR, 1999).

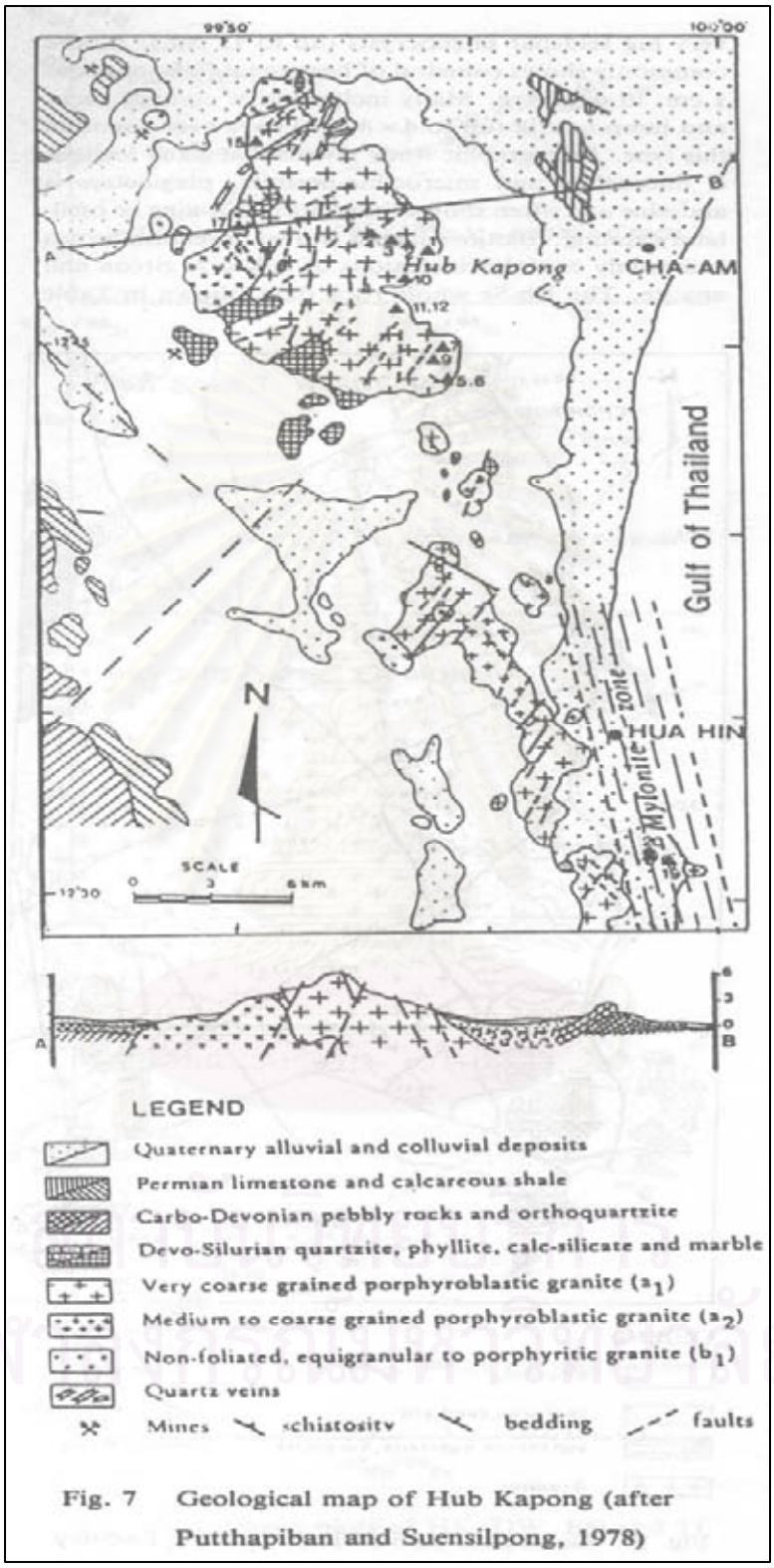

Fig. 7 Geological map of Hub Kapong (after Putthapiban and Suensilpong, 1978)

Figure 2.2 Geological map of the Hub Kapong (Putthapiban and Suensilpong, 1978 cited in Nakapadungrat et al., 1984).

2.2 Economic Geology

Various types of economic minerals are discovered in Changwat Phetchaburi such as fluorite, quartz, wolfram, coal and industrial rock etc. (DMR, 1999).

2.2.1 Fluorite

Changwat Phetchaburi used to be one of the most important fluorite deposits in central part of Thailand. The main fluorites deposits can be divided in 3 parts as follows:

2.2.1.1 Fluorite deposits in igneous rocks

These fluorite veins intruded in igneous fissure and cavity filling. Most of them are green, white to light brownish white. They can be found from Khao Bai Lan to Khao Nong Khaw which are located in Amphoe Nong Ya Plong and Amphoe Tha Yang.

2.2.1.2 Fluorite deposits in Precambrian metamorphic rocks

The purple and green fluorite deposits are found along with quartz veins in southern part of Khao Den, Khao Pongdaeng and Khao Khok which are located in Amphoe Ban Lad. They are found at Khao Hua Waen, Amphoe Tha Yang as well.

2.2.1.3 Fluorite deposits in Kaeng Krachan Group

This group of fluorite deposits can be found in sandstone, schist and mudstone of Kaeng Krachan Group at Khao Takieb, Khao Samplaeng, Khao Poom-Khao Moo, Khao loiand Khao Din. Most of them are green and white.

2.2.2 Quartz

Most of quartz veins in Phetcahburi are found in granite and gneiss. They also found in sandstone and shale of Kaeng Krachan Group. The distribution of quartz is between the boundary of Amphoe Tha Yang and Amphoe Cha-Am.

2.2.3 Wolframite

There are only 2 wolframite deposits in Phetchaburi are discovered at Ban Tha Mai Ruak, Amphoe Tha Yang and Huai Khong, Amphoe Ban Lad respectively. The characteristic of wolframite at Ban Tha Mai Ruak is the veins intruding in Carboniferous rocks. Whereas the wolframite at Huai Khong occurred with quartz veins in granite.

2.2.4 Coal

The coal deposits can be found in Nong Ya Plong Basin, Amphoe Nong Ya Plong and Nong Phub Basin, Amphoe Cha-Am. The coal deposits at Nong Ya Plong basin occurred in the middle Tertiary rocks which composed of mudstone, shale, sandstone and conglomerate. Several layers of coals are found in 2-3 mm thickness to 20-30 cm thickness.

The coal deposits at Nong Phub occurred in the lower layer of Tertiary rock basin which comprises of sandstone and conglomerate. The coal is discovered only 2 layers.

2.2.5 Industrial Rock

The industrial rock in Changwat Phetchaburi is Permian limestone. It occurred in the eastern and western part of Changwat. It can be used in cement industry.

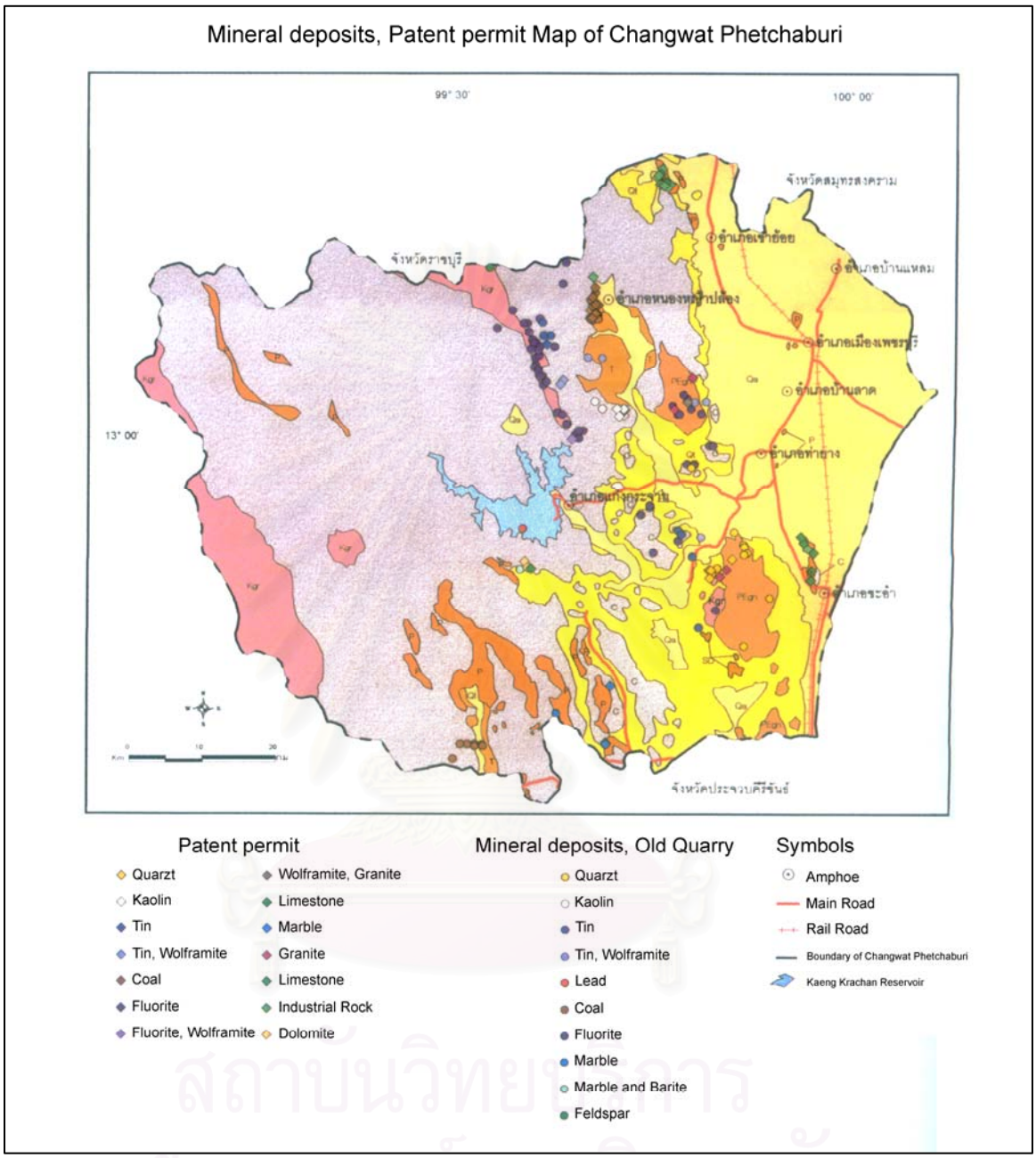

Figure 2.3 Mineral deposits and patent permit map of Changwat Phetchaburi (DMR,1999).

2.3 Regional Geomorphology

The origin of geomorphic landforms in Changwat Phetchaburi is associated with geological origins. The geomorphological units can be classified mainly into three units as unit of mountainous area, undulating area and coastal area (Figure 2.4).

2.3.1 Mountainous Area

The mountainous area is situated in western part of Changwat Phetchaburi. It comprises high mountain ranges about 300-1500 m above mean sea level. One of the most important mountain ranges in this area is Tenasserim (Tanaosi) range which is located at Thai-Myanmar border. The rocks of the mountainous area are sedimentary rocks and granite. Permian limestone hills occasionally occur in the eastern part of this area and display as karst topography. It is suggested that the karst topography in those limestone hills such as caves are among favorable landforms for prehistoric settlements discovered in Tha yang, Kaeng Krachan and Cha-Am districts (Wongnoi and Sudsawat, 2001).

2.3.2 Undulating Area

The undulating area is located on the central part of the area. It can be indicated by rivers and tributaries, natural levee, terraces, floodplains and alluvial fans. The most important river in this area is Phetchaburi River.

2.3.3 Coastal Area

The coastal area of Phetchaburi is situated in the eastern part of the province on the western part of the Gulf of Thailand. The total length of the shoreline in Phetchaburi province is around 75 km (Sinsakul et al., 2002). The coastal landform evolution in Thailand including Phetchaburi affected from the sea level change in Holocene epoch (10,000 years to present) (Choowong et al., 2003). The landforms of coastal area in Changwat Phetchaburi can be classified to headland, beach, barrier beach, beach ridges, tidal flat, salt marsh, lagoon and delta. Furthermore, there are several landforms which are possibly related to ancient settlements in historical period such as old sand barriers and old beach ridges in Amphoe Khao Yoi and Amphoe Cha-Am.

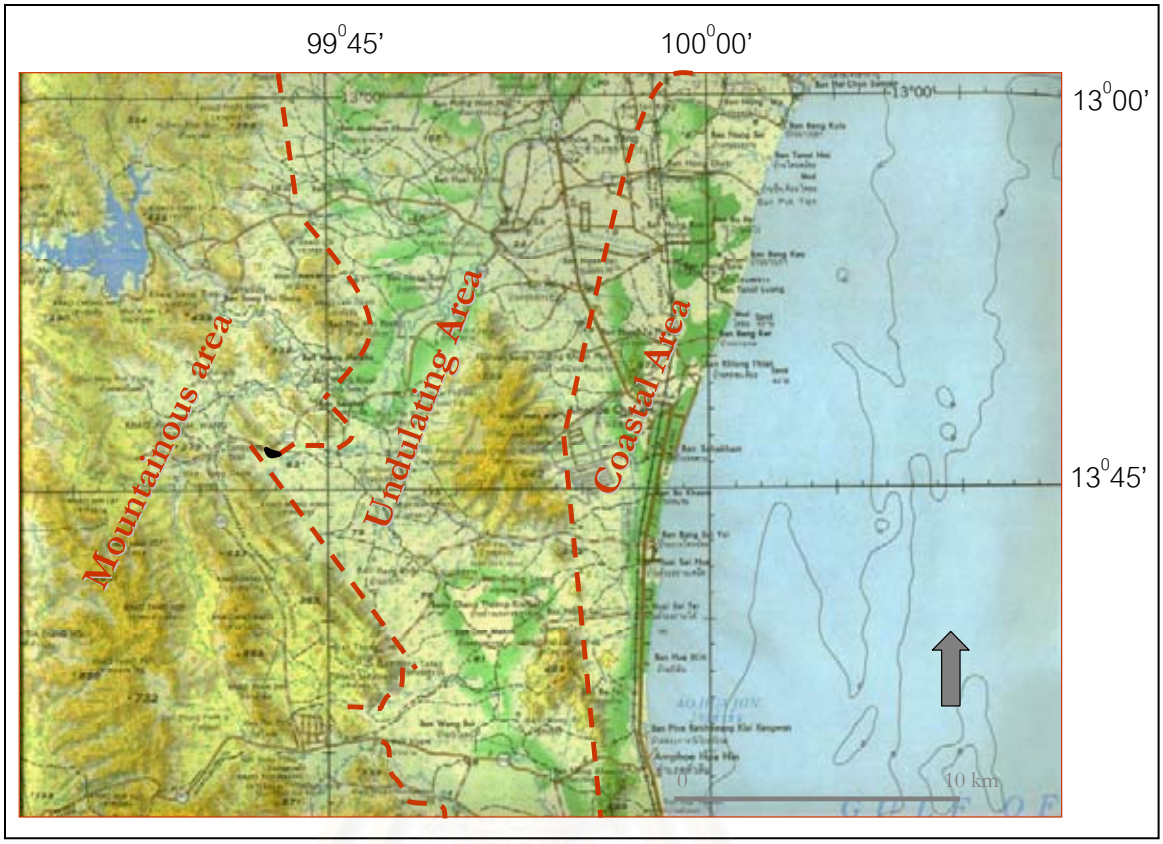

Figure 2.4 Regional geomorphological units in the study area (Royal Thai Survey Department, 1973).

2.4 A Geographical Overview

The topography of the study area displays mostly as coastal plain approximately 90 % and other topography10 %(Figure1.1). The area is characterized by a moderate topography with elevation ranging 3 to 377m above mean sea level. The highest mountain in this area is Khao Chao Lai Yai, about 377m above mean sea level. This area forms part of the coastal plain that extends along the Gulf of Thailand.

From a geographical perspective, Thungsetthi monument is located at the east of Khao Chom Prasat, at the foot of Permain limestone hill, which is approximately 175 meters high (Figure 2.5). Thungsetthi habitation site is situated on a mound around 500 m to the east.

Figure 2.5 Khao Chom Prasat, isolated Permian limestone hill in this area.

In relevance of flora and fauna, generally, mixed deciduous forest is found in on the higher elevation and outcrops of limestone. Within this habitat, the dominant species of bamboo *(Thyrsostachys siamensis* Gamble*)* are found, as well as *Lannea coromandelica Merr.*, *Diospyros mollis* Griff, Legumninosae, *Bombax ceiba* L. etc (Figure 2.6a). At lower elevation the dry evergreen forest occurs around the depressions and streams. The dominant species of this area are *Streblus asper* Lour., *Ficus, Millingtonia hortensis* L.F. etc. (National Park, Wildlife and Plant Conservation Department, n.d.).

Mangrove forest is located along the inlets. The scrubs are found mostly on the eastern part of the area (Figure 2.6b). However, around 80% of the study area has been modified to rice fields and plantations (Figure 2.6c).

The fauna species such as monkeys, *Presbytis cristata*, squirrels, *Cervus porcinus*, birds, mountainous tortoises etc are found in the high elevation (National Park, Wildlife and Plant Conservation Department, n.d.).

Figure 2.6 The habitat diversity of the study area: a) mixed deciduous forest; b) mangrove; c) rice fields.

CHAPTER III

QUANTITATIVE ANALYSIS IN GEOMORPHOLOGY AND SEDIMENTOLOGY

This chapter explains the results of field investigation and laboratory works only related to geological perspective. It includes the interpretation of geomorphology, sedimentology and stratigraphy that become very important for geoarchaeologists in order to better understand the relationship between the human and environment in the past. In this research, geological data are beneficial for correlating archaeological evidence and the data from each study can be crossed check. In this chapter, the description of sedimentology and stratigraphy will be carried out based on a relation with landforms. This description will bring insight into the understanding of geological setting that might have some significance to archaeological site selection or some means for evaluating the relationship among the other archaeological sites nearby.

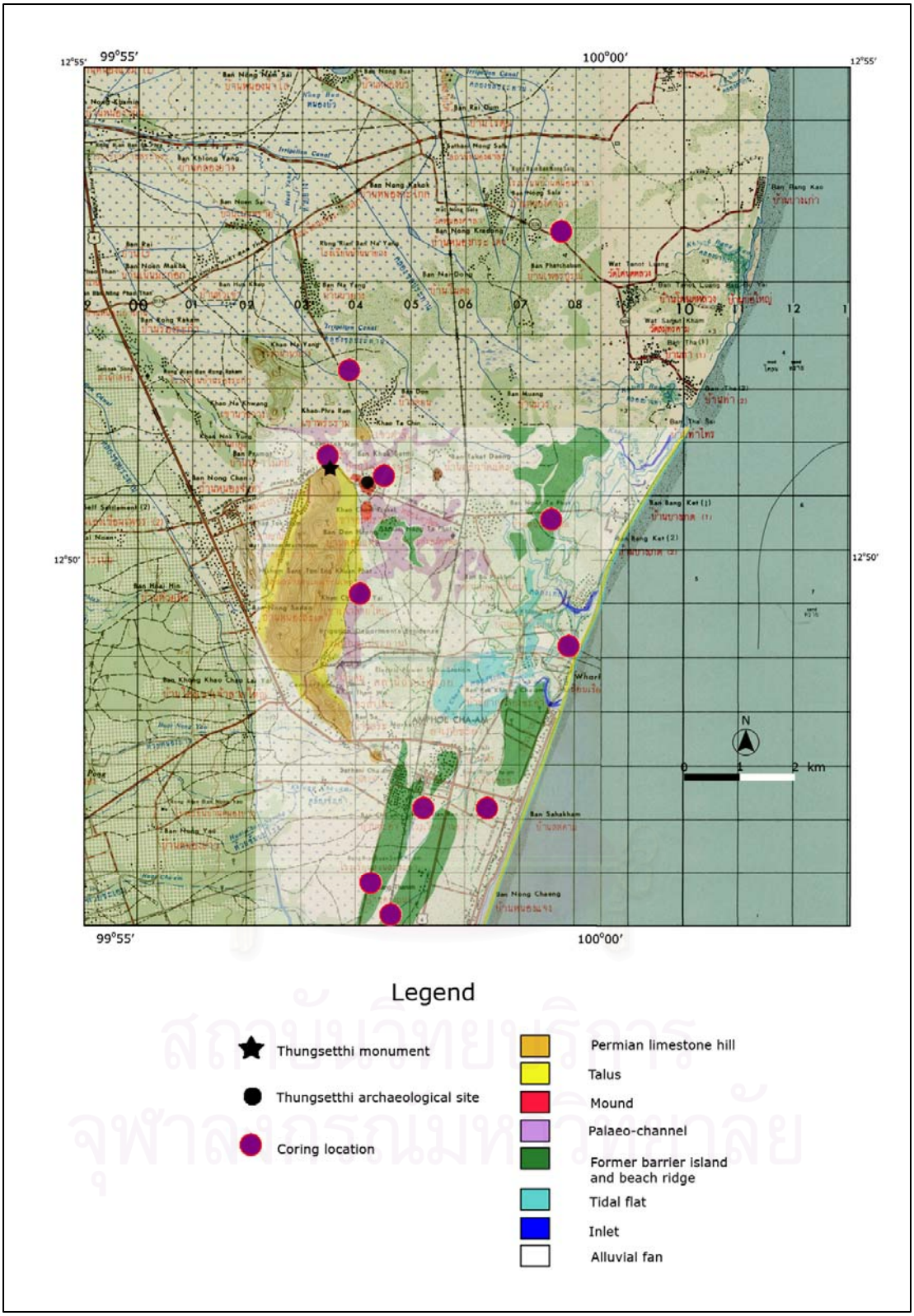

Figure 3.1 Topographical map of the area showing locations of coring and archaeological sites (Royal Thai Survey Department, 1972).

3.1 Geomorphological Description

The geomorphological landforms in this area were firstly classified by using aerial photographs, and then, the correction of interpretation was checked in the field. The geomorphological map of recent surface landforms (Figure 3.6) shows discontinuity of landforms because they were strongly eroded and changed their original features a lot from land development and cultivation. However, some relict landforms indicating former beach deposits, paleo-channel, and former inlet were preserved well and can be classified as shown in the map (Figure 3.2).

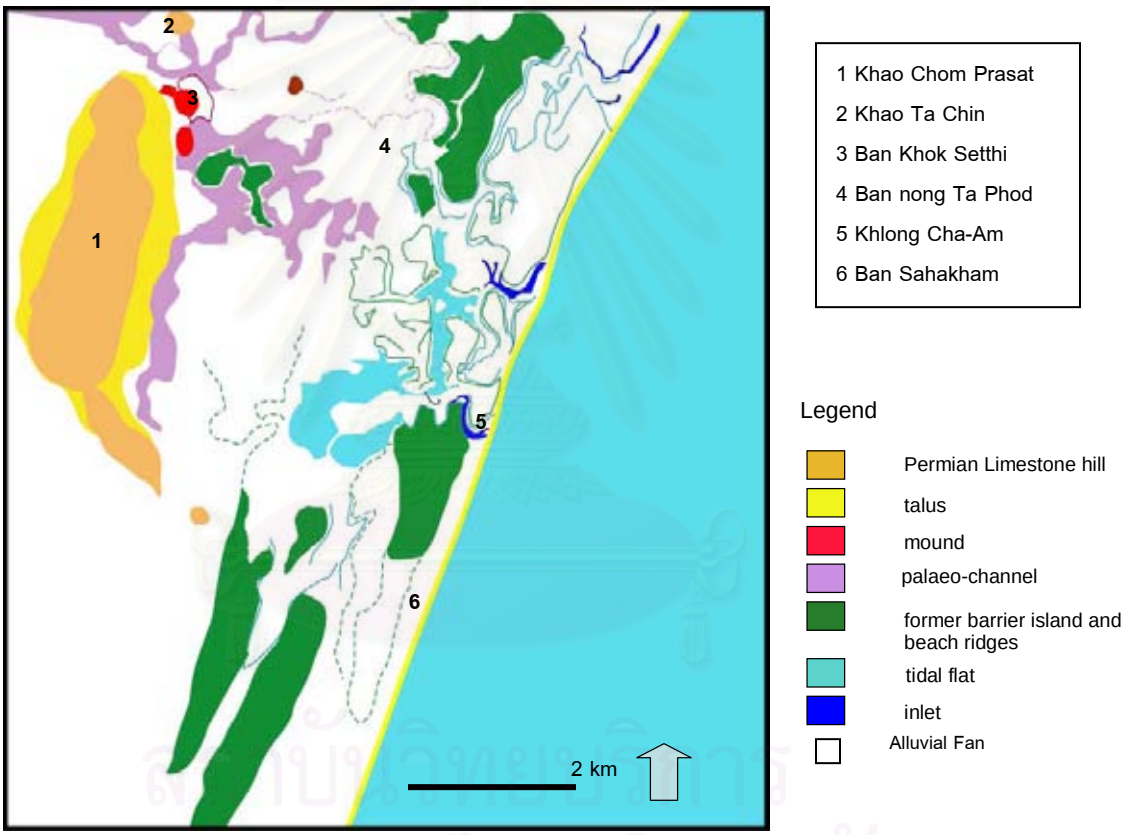

Figure 3.2 Geomorphological map of the study area showing relict coastal landforms.

3.1.1 Classification of landforms

As seen in Figure 3.2, the geomorphological landforms of the study area can be divided into 6 units as follows:

3.1.1.1 Permian Limestone Hill

Physiographically, the limestone hills in this area display as isolate/monad nocks. The range of Permian limestone hills adjacent to the Thungsetthi monument is situated in north-south direction. It is called Khao Chao Lai Yai or Khao Nang Phanthurat. There is also an isolated hill called Khao Ta Chin which is located to the north of the monument.

1. Permian Limestone Hill

Figure 3.3 Recent scene of Permian Limestone Hill situates in the middle part of the area.

3.1.1.2 Talus

Talus appears at the foot of Khao Chao Lai Yai and Khao Ta Chin. Most of the talus has been adjusted for the construction purpose because it contains limestone debris and some carbonate soils.

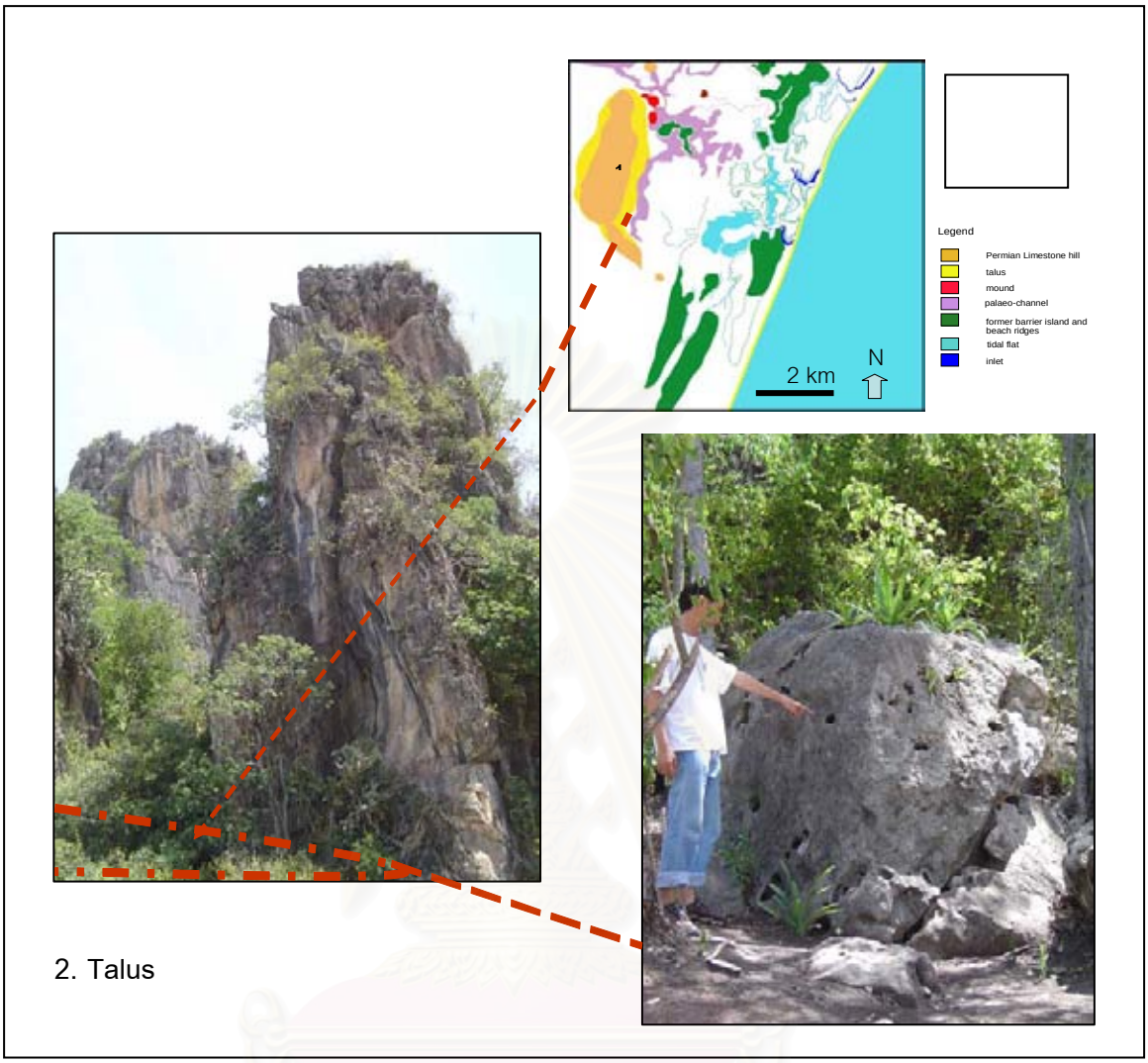

Figure 3.4 Talus contains limestone blocks extending at the foot of limestone hill and highly weathered carbonate soil deposit as debris.

3.1.1.3 Former barrier island and beach ridges

The former barrier island and beach ridges can be recognized by dark gray tone in the aerial photograph. They can be seen in the eastern part of the study area. These landforms are extensively distributed in north-south direction and partly eroded, but they are still preserved well.

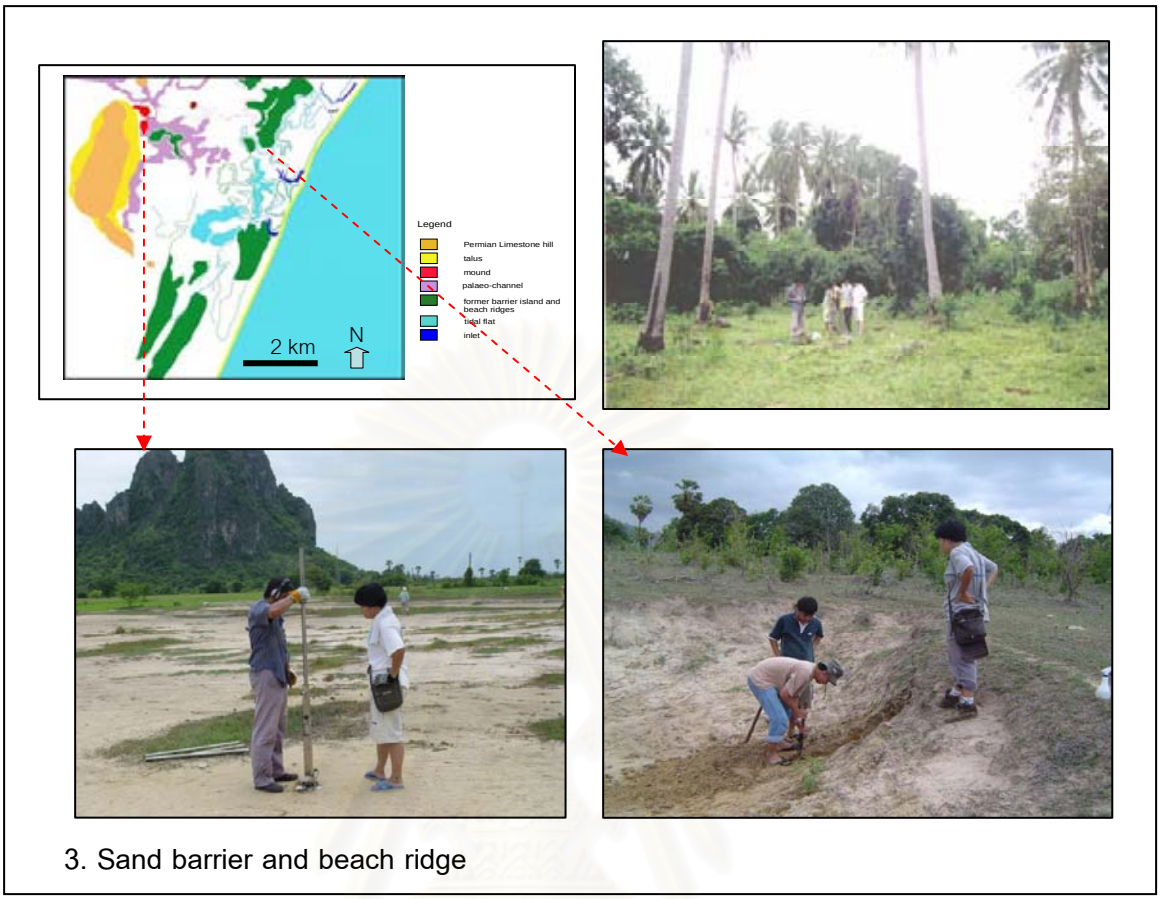

Figure 3.5 Former barrier island and beach ridges in the study area.

3.1.1.4 Palaeo-channel

The north and the eastern areas of the Thungsetthi monument represent extensively as flat low-lying area. It can be seen clearly from the aerial photograph as palaeo-channels with meandered patterns as similar as recent estuaries. Through, it is used for the paddy fields, but some abandoned channels can still be observed. This development of paleo-channels in eastward direction can be used as landform evidence of shoreline progradation as well.

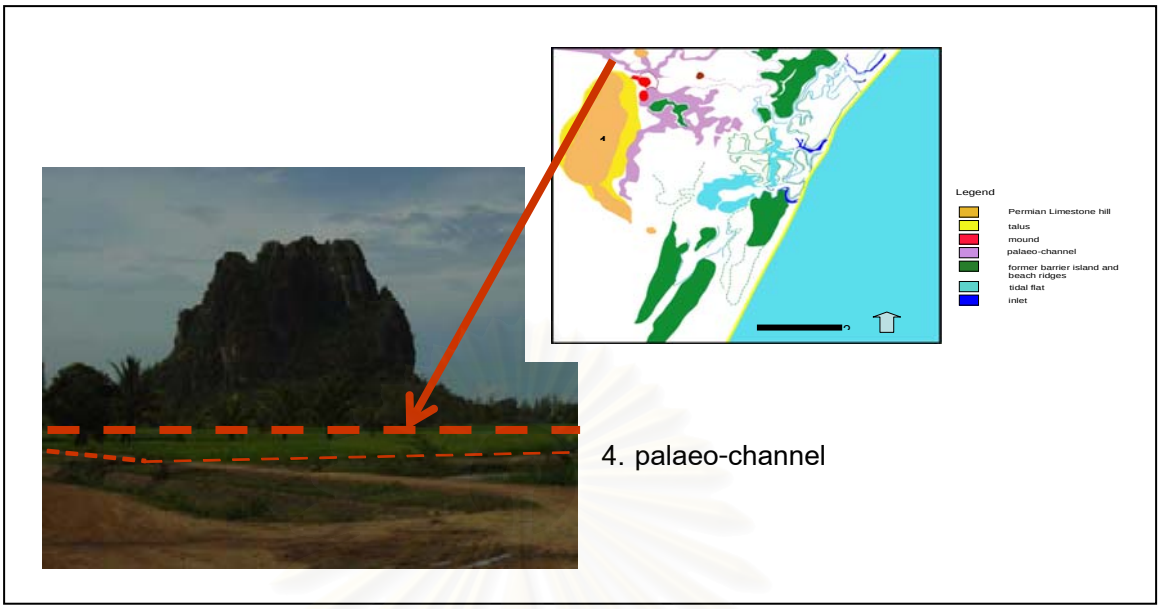

Figure 3.6 Recent scene of palaeo–channels in the study area.

3.2.1.5 Tidal flat

The tidal flat can be seen clearly from the aerial photograph as dark gray areas nearby the recent shoreline. Tidal flat is a part of small recent estuary system in this study that also contains inlet/outlet.

3.1.1.6 Alluvial fan

The alluvial fan appears in the western part of the study area. It can be recognized by white to light gray tone in the aerial photographs. The white tone in the aerial photographs characterized clay to sand sediments which no plants covered and the light gray tone represent the alluvial fen that covered by plants.

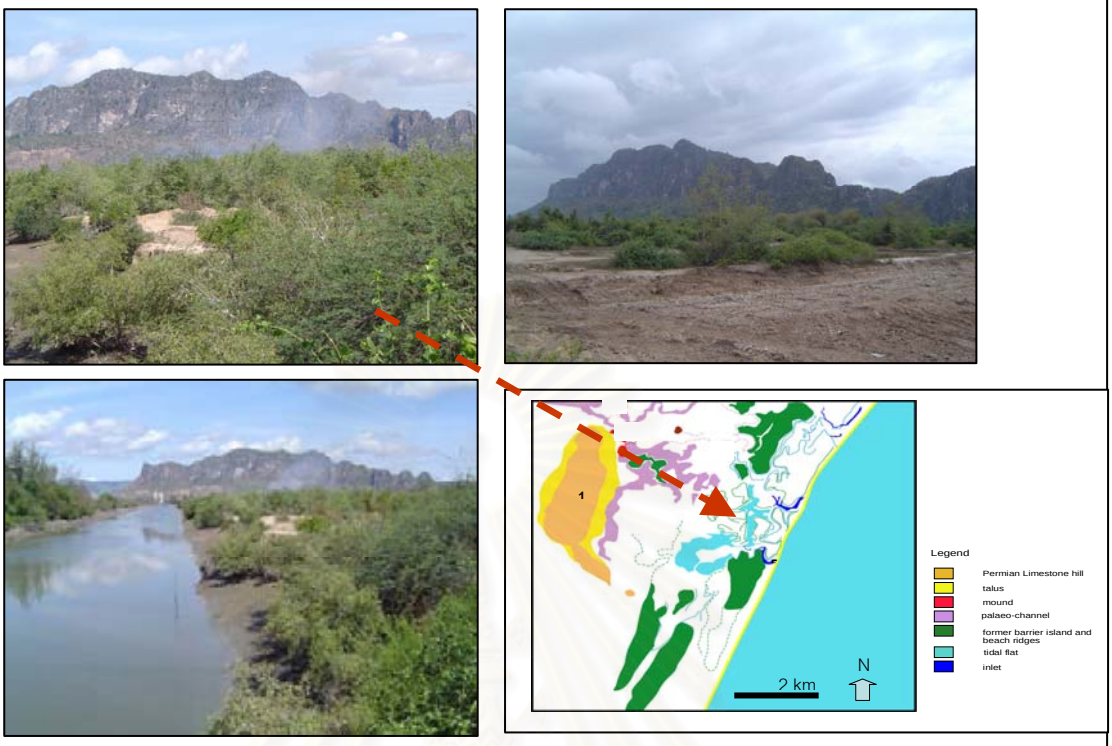

Figure 3.7 Recent scene of tidal flat containing inlet/outlet in the eastern part of the area.

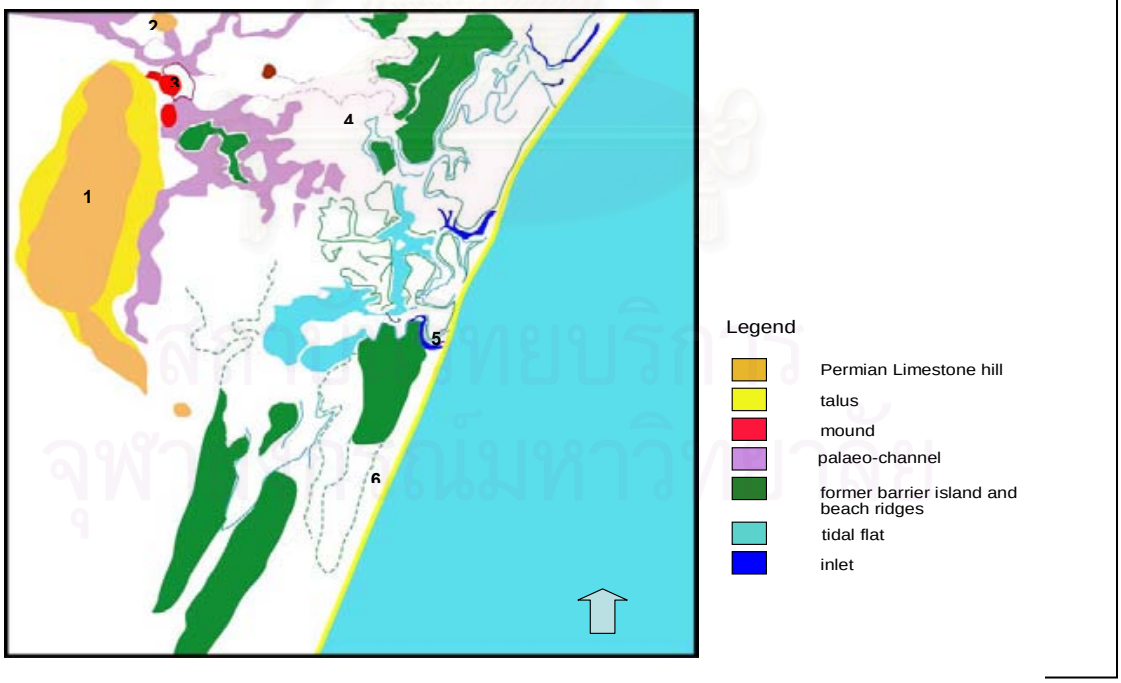

Figure 3.8 Alluvial fan (indicate by white color in the map) extends in the western part of the study area and being as substrate underlying former beach sediments.

3.2 Sedimentological Description

The sedimentological study in Thungsetthi area has been done by collecting samples from 12 locations in different landforms: sand barriers, inter- barriers, former beaches and palaeo-channels. As well as the archaeological site which is situated on former beach, 9 corings are carried out by using Precision Clement Sediment Corer (PCSC) (Figure 3.1). The average depth of the drillings is approximately 180 cm. It is due to the characteristic of sediment such as clay layer which is very sticky or sand layer which is very loose when reaching the groundwater level. In those conditions, the samples cannot be collected. Alternatively, the profiles of 2 sand pits and 1 inlet were selected. The basic description of each sediment samples has been recorded during the fieldwork in case of sand pits and inlet profiles whereas the samples from coring have been recorded in the laboratory after the samples have been taken out of the tubes. The physical criterias such as color and texture have been used to classify the sediments into different layers.

3.2.1 Lithological Description from Coring and Profile

The lithology of sediments from coring and profile was described in detail from each landform by following the ascending order from the lowest layer to the top soil. Then, sediments from each layer were quantitatively analyzed the grain size distribution using laser granulometric technique. However, the description in this section was selected from the coring site that locates in different landforms, the whole log description of coring can be seen in appendices.

3.2.1.1 Inner Former Beach Ridge in the Middle Part of the Area (Ban Khok Setthi (TS 1))

The location of station 1 is located at Ban Khok Setthi, UTM grid of 47 603248 E 14 20795 N on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 138 cm. It can be classified into 5 layers as follows:

Layer 1 is characterized in term of soil properties by 7.5 YR 5/2 brown, clayey loam, pH 5.0. The thickness of this layer is 37 cm.

Layer 2 is the layer of brown clayey loam (7.5 YR 4/2) deposited with 32 cm in thickness. pH 5.0.

Layer 3 is the thin layer of sandy loam. The color is 7.5YR 4/1 dark gray, pH5.5. The thickness is 11 cm. The uppermost of this layer is composed of 1 cm of organic matters such as grass and chaff.

Layer 4 is characterized by 10YR5/2 grayish brown sandy loam with brownish yellow mottles, pH 8.5. The thickness is 48 cm.

Layer 5 is the thin layer of sandy loam (10YR 4/1 dark gray), pH8.5. The thickness is 10 cm.

TS 1

Layer	Thickness (cm)	Lithology	Description	Legend
5	10		sandy loam,10YR 4/1 dark gray, pH8.5.	Sandy loam
4	48		sandy loam,10YR5/2 grayish brown with brownish yellow mottles, pH 8.5.	Clay loam
3	11		sandy loam,7.5YR 4/1 dark gray, pH5.5. The uppermost of this layer is composed of grass and chaff.	Grass/shaft
2	32		clayey loam, 7.5 YR 4/2 brown, pH 5.0.	
1	37		clayey loam, 7.5 YR 5/2 brown, pH 5.0.	

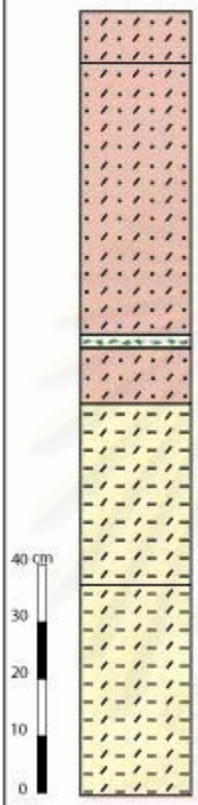

Figure 3.9 The lithostratigraphical columnar section of inner former beach ridge in the middle part of the area (Ban Khok Setthi(TS1)).

3.2.1.2 Inner Former Beach Ridge in the Northern Part of the Area (Ban Don (TS 3))

The location of station 3 is situated at Ban Don, 47 603814 E 14 22347 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 196 cm. It can be classified into 7 layers as follows:

Layer 1 is characterized by 10YR 6/4 light yellowish brown, loamy sand, pH 8.0. A few peat can be seen in this layer. The total thickness of this layer is 25 cm.

Layer 2 is the layer of loamy sand deposited with a few peat and 1% of reddish yellow mottles. The color of the sediment is 10YR 6/2light brownish gray, pH 8.0.. The thickness is 27 cm.

Layer 3 is composed of loamy sand. The color of the sediment is 10YR 6/1 gray with pH 8.5. The thickness is 30 cm.

Layer 4 is the deposition of sandy clay (10YR 5/2 grayish brown) with a lot of peat, pH 8.5. The thickness is 34 cm.

Layer 5 is characterized by 10YR 5/2 grayish brown, sandy clay loam, pH 8.5. Few rootlets also found in this layer. The thickness is 23 cm.

Layer 6 is the layer of sandy clay loam (7.5YR 4/2 brown) with few rootlets, pH 8.5. The thickness is 17 cm.

Layer 7 composed of 7.5YR 3/2 dark brown, sandy clay loam with rootlets, pH 7. The thickness is 40 cm.

TS 3

Layer	Thickness (cm)	Lithology	Description	Legend
7	40		sandy clay loam, 7.5 YR 3/2 dark brown, with few rootlets. pH 7.	Sandy Clay loam
6	17		sandy clay loam , 7.5YR 4/2 brown with fewrootlets. pH 8.5.	Loamy sand
5	23		sandy clay loam,10YR 5/2 grayish brown, pH 8.5 with few rootlets.	Root
4	34		sandy clay,10YR 5/2 grayish brown with a lot of peat, pH 8.5.	Peat
3	30		loamy sand,10YR 6/1 gray. pH 8.5.	
2	27		loamy sand,10YR 6/2light brownish gray, with a few peat and 1% of reddish yellow mottles . pH 8.0.	
1	25		loamy sand, 10YR 6/4 light yellowish brown, pH 8.0. A few peat can be seen in this layer.	

Figure 3.10 The lithostratigraphical columnar section of inner former beach ridge in the northern part of the area (Ban Don (TS 3)).

3.2.1.3 Palaeo-Channel (the Rice Field, east of Khao Chao Lai Yai (TS 2))

The location of station 2 is located at 47 604439 E 14 18333 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 99 cm. It can be classified into 3 layers as follows:

Layer 1 is composed of sandy clay loam (5YR 4/1 dark gray), pH 5.5. The thickness is 9 cm.

Layer 2 is characterized by 10YR 6/4 light yellowish brown, sandy clay loam, pH 8.5. The thickness is 50 cm.

Layer 3 is the layer of brown sandy clay loam (10YR 5/3 brown), pH 8.5. The thickness is 40 cm.

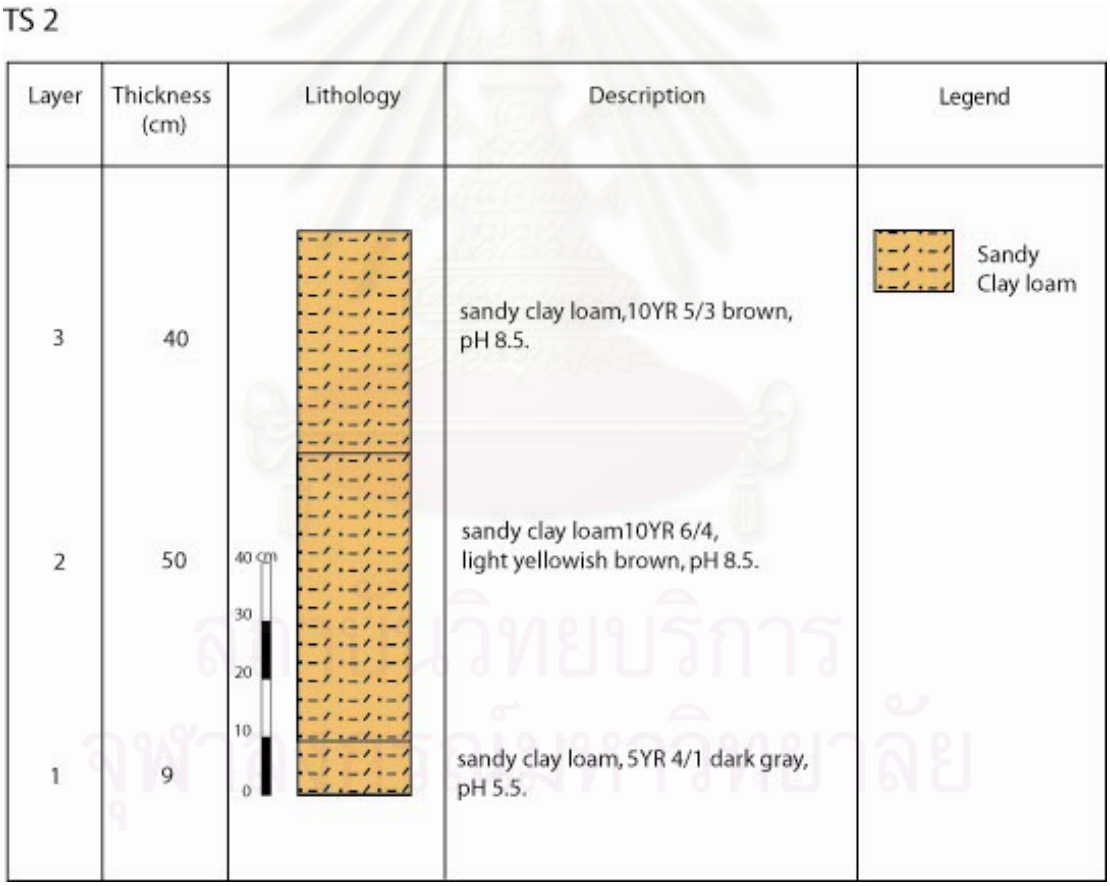

Figure 3.11 The lithostratigraphical columnar section of palaeo-channel (the rice field, east of Khao Chao Lai Yai (TS 2)).

3.1.1.4 Mixed Former Beach Ridge and Human Activities (Thungsetthi monument (TS 4))

The location of station 4 is situated close to the monument at 47 603579 E 14 20321 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 156 cm. It is interpreted to be cultural layers mixed with former beach deposits and can be classified into 6 layers as follows:

Layer 1 is characterized by 7.5YR 4/3 brown, clay loam with a lot of charcoals. pH 8.5. The thickness is 50 cm.

Layer 2 is composed of clay loam, 7.5YR 4/3 brown, pH 6.5. But none charcoals are found. The thickness is 10 cm.

Layer 3 is the layer of clay loam (5YR 4/3 reddish brown) with weak red mottles and few charcoals. pH 5.5. The thickness is 62 cm.

Layer 4 is characterized by 5YR 3/1 very dark gray of sandy clay loam.pH 8.0. The thickness is 14 cm.

Layer 5 is composed of 5YR 4/3 reddish brown, sandy clay loam, pH 6.0. The thickness is 14 cm.

Layer 6 is the layer of sandy clay loam, 10YR 3/1 very dark gray, pH 8.0.. At 0-15 cm from the surface, small fragment of bricks, some gravels and some rootlets are found. A small piece of plastic bag is also found at 15 cm from the surface. The total thickness of this layer is 60 cm.

TS 4

Layer	Thickness (cm)	Lithology	Description	Legend
6	60		sandy clay loam, 10YR 3/1 very dark gray, pH 8.0. small fragment of bricks and some rootlets are found.	Sandy Clay loam; Clay loam; Brick fragment; Root
5	14		sandy clay loam, 5YR 4/3 reddish brown, pH 6.0	
4	14			
3	62		clay loam, 5YR 4/3 reddish brown with weak red mottles and few charcoals. pH 5.5.	
2	10		clay loam, 7.5YR 4/3 brown, pH 6.5.	
1	50	40 cm 30 20 10 0	clay loam,7.5YR 4/3 brown,with a lot of charcoals. pH 8.5.	

Figure 3.12 The lithostratigraphical columnar section of mixed former beach ridge and human activities (Thungsetthi monument (TS 4)).

3.2.1.5 Middle Former Beach Ridge in the Middle Part of the Area (Thungsetthi habitation site TS 5)

The location of station 5 is situated at the football field in Khok Setthi village (Thungsetthi habitation site), 47 604124 E 14 20317 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 175 cm. It can be classified into 6 layers as follows:

Layer 1 is of 10YR 7/2 light gray, sandy clay loam with weak red and brownish yellow mottles.pH 8.5. The thickness is 25 cm.

Layer 2 is composed of sandy clay loam, 7.5YR 5/1 gray, pH 8.5. The weak red and brownish yellow mottles are also found. The thickness is 30 cm.

Layer 3 is the layer of clay loam (10R 4/4 weak red) with red mottles. pH 8.5. The thickness is 30 cm.

Layer 4 is characterized by clay loam, 7.5YR 4/2 brown with red mottles and some rootlets. pH 8.5. The thickness is 46 cm.

Layer 5 is composed of 7.5YR 3/2 dark brown, clay with some rootlets. pH 8. The thickness is 30 cm.

Layer 6 is the thin layer of clay loam, 5YR 4/1 dark gray, pH 8. Some rootlets are also found in this layer. The thickness is 14 cm.

TS 5

Layer	Thickness (cm)	Lithology	Description	Legend
6	14		clay loam, 5YR 4/1 dark gray, pH 8.	Clay loam
5	30		clay, 7.5YR 3/2 dark brown with some rootlets. pH 8.	Clay
4	46		clay loam, 7.5YR 4/2 brown with red mottles and some rootlets. pH 8.5.	Sandy Clay loam
3	30		clay loam,10R 4/4 weak red with red mottles. pH 8.5.	
2	30		sandy clay loam, 7.5YR 5/1 gray, pH 8.5. The weak red and brownish yellow mottles are also found.	
1	25		sandy clay loam, 10YR 7/2 light gray with weak red and brownish yellow mottles. pH 8.5.	

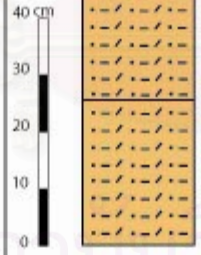

Figure 3.13 The lithostratigraphical columnar section of middle former beach ridge in the middle part of the area (Thungsetthi habitation site TS 5).

3.2.1.6 Middle Former Barrier Island in the Southern Part of the Area (the entrance of 15th engineering office, National Park, Wildlife and Plant Conservation Department (TS 6))

The location of station 6 is situated at 47 604481 E 14 12015 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 125 cm. It can be classified into 3 layers as follows:

Layer 1 is characterized by 5YR 4/1dark gray, loamy sand, pH 7.0. Very few rootlets can be seen in this layer. The total thickness of this layer is 87 cm.

Layer 2 is the layer of very fine sand, 5YR 4/1dark gray, pH7.0. The thickness is 25 cm.

Layer 3 composed of 7.5 YR 3/1very dark brown of very fine sand, pH 6.0. The thickness is 13 cm.

TS 6

Layer	Thickness (cm)	Lithology	Description	Legend
3	13		very fine sand, 7.5 YR 3/1 very dark brown. pH 6.0.	Sand
2	25		very fine sand, 5YR 4/1dark gray, pH7.0.	Loamy sand
1	87	40 cm 30 20 10 0	loamy sand, 5YR 4/1dark gray. pH 7.0	

Figure 3.14 The lithostratigraphical columnar section of middle former barrier island in the southern part of the area (the entrance of 15th engineering office, National Park, Wildlife and Plant Conservation Department (TS 6)).

3.2.1.7 Outer Former Barrier Island in the Middle part of the Area (Ban Sahakham (TS 7))

The location of station 7 is situated at 47 604481 E 14 12015 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 348 cm. It can be classified into 3 layers as follows:

Layer 1is the layer of sandy clay, 7.5 YR 3/1 very dark brown. The thickness is 25 cm.

Layer 2 is characterized by thick layer of 5 YR 4/1 dark gray, fine to very fine sand. The thickness is 240 cm.

Layer 3 composed of 5 YR 4/1 dark gray, very fine sand. The thickness is 83 cm.

TS7

Layer	Thickness (cm)	Lithology	Description	Legend
3	83		very fine sand,5 YR 4/1 dark gray.	Sand Sandy clay
2	240		fine to very fine sand. 5 YR 4/1 dark gray.	
1	25		sandy clay, 7.5 YR 3/1 very dark brown.	

Figure 3.15 The lithostratigraphical columnar section of outer former Barrier Island in the Middle part of the Area (Ban Sahakham (TS 7)).

3.2.1.8 Inter-Barrier Depression (the East of Ban Cha-Am(TS 8))

The location of station 8 is at 47 605082 E 14 14015 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 182 cm. It can be classified into 8 layers as follows:

Layer 1 is characterized by 7.5 YR 3/1 very dark brown, sandy loam. pH7. The thickness is 31 cm.

Layer 2 is the very thin layer of loamy sand (5 YR 4/3 reddish brown) with 10% of red mottles.pH 6.5. The thickness is 7 cm.

Layer 3 is composed of thin layer of sandy clay loam, 7.5YR 5/2 brown with few rootlets.pH 6.0. The thickness is 9 cm.

Layer 4 is characterized by 10 YR 4/1dark gray, sandy loam with few rootlets.pH7. The thickness is 55 cm.

Layer 5 is the layer of loamy sand, 10 YR 4/1dark gray.pH8.0. The thickness is 14 cm.

Layer 6 is composed of 10 YR 5/1 gray, loamy sand.pH8.0. The thickness is 33 cm.

Layer 7 is characterized by 10 YR 5/1 gray, very coarse sand with gravels and Fe concretion.pH8.0. The thickness is 20 cm.

Layer 8 is the layer of 10 YR 5/1 gray, loamy sand with gravels and Fe concretion.pH 8.5. The thickness is 13 cm.

TS8

Layer	Thickness (cm)	Lithology	Description	Legend
8	13		loamy sand,10 YR 5/1 gray with gravels and Fe concretion.pH 8.5.	Loamy sand
7	20		very coarse sand, 10 YR 5/1 gray with gravels and Fe concretion.pH8.0.	Sand
6	33		loamy sand,10 YR 5/1 gray.pH8.0.	Gravel
5	14		loamy sand, 10 YR 4/1dark gray.pH8.0.	Root
4	55		sandy loam,10 YR 4/1dark gray, pH7.	Sandy loam
3	9		sandy clay loam,7.5YR 5/2 brown. pH 6.0.	Sandy Clay loam
2	7		loamy sand, 5 YR 4/3 reddish brown. pH 6.5.	
1	31		sandy loam, 7.5 YR 3/1 very dark brown. pH7.	

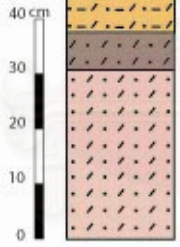

Figure 3.16 The lithostratigraphical columnar section of inter-barrier depression (the east of Ban Cha-Am (TS 8)).

3.2.1.9 Inner Former Barrier Island in the Southern Part of the Area (Ban Plai Don (TS 9))

The location of station 9 is situated at 47 604386 E 14 12712 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the core is 201 cm. It can be classified into 7 layers as follows:

Layer 1 is composed of medium to fine sand (7.5 YR 4/3 brown). pH7.0. The thickness is 48 cm.

Layer 2 is characterized by 5 YR 4/2 dark reddish gray, medium to fine sand. pH 5.5. The thickness is 25 cm.

Layer 3 is the layer of medium to fine sand, 7.5 YR 4/3 brown. pH 5.5. The thickness is 39 cm.

Layer 4 is characterized by 7.5 YR 3/2 dark brown, medium to fine sand.pH5.0. The thickness is 24 cm.

Layer 5 is composed of 7.5YR 3/4dark brown, fine sand. pH 5.5. The thickness is 18 cm.

Layer 6 is the layer of fine sand, 7.5YR 3/2 dark brown. pH 5.0. The thickness is 38 cm.

Layer 7 is the thin layer of very fine sand, 7.5 YR 3/1 very dark gray. pH 6.5. Very few rootlets are found in this layer. The thickness is 9 cm.

3.2.1.10 Inner Former Barrier Island in the Northern Part of the Area (Ban Phetchabun (TS 10))

The location of station 10 (Ban Phatchabun) is situated at 47 607687 E 14 24282 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the section is 151 cm. It can be classified into 4 layers as follows:

Layer 1 is the layer of 2.5 Y 5/3 light olive brown, clayey sand with Fe concretion. The thickness is more than 25 cm.

Layer 2 is composed of lateritic sand, 10 YR 3/4 dark yellowish brown. The thickness is 43 cm.

Layer 3 is the layer of fine sand (10 YR 4/3brown). The thickness is 48 cm.

Layer 4 is the top soil. The thickness is 35 cm.

TS9

Layer	Thickness (cm)	Lithology	Description	Legend
7	9		very fine sand, 7.5 YR 3/1 very dark gray. pH6.5.	Sand
6	38		fine sand, 7.5YR 3/2 dark brown. pH5.0.	
5	18		fine sand,7.5YR 3/4dark brown,pH5.5.	
4	24		medium to fine sand,7.5 YR 3/2 dark brown. pH5.0.	
3	39		medium to fine sand, 7.5 YR 4/3 brown. pH 5.5.	
2	25		medium to fine sand, 5 YR 4/2 dark reddish gray. pH5.5.	
1	48	40 cm 30 20 10 0	medium to fine sand, 7.5 YR 4/3 brown. pH7.0.	

Figure 3.17 The lithostratigraphical columnar section of inner former barrier island in the southern part of the area (Ban Plai Don (TS 9)).

TS10

Layer	Thickness (cm)	Lithology	Description	Legend
4	35		top soil.	Top soil
3	48		fine sand,10 YR 4/3brown.	Sand with Fe concretion
2	43		lateritic sand, 10 YR 3/4 dark yellowish brown.	Clayey sand with Fe concretion
1	25		clayey sand, 2.5 Y 5/3 light olive brown,	

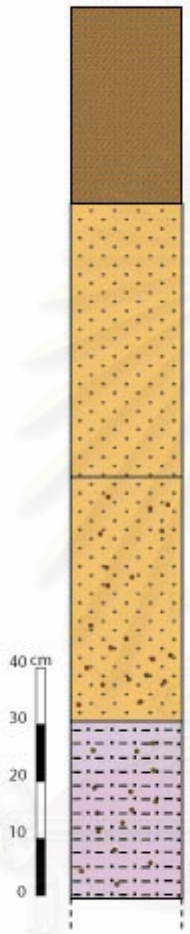

Figure 3.18 The lithostratigraphical columnar section of inner former barrier island in the northern part of the area (Ban Phetchabun (TS 10)).

3.2.1.11 Middle Former Barrier Island in the Middle Part of the Area (Ban Nong Ta Phod (TS 11))

The location of station 11 (Ban Nong Ta Pod) is situated at 47 607721 E 14 19723 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the section is 176 cm. It can be classified into 6 layers as follows:

Layer 1 is the layer of 2.5 Y 4/3 olive brown, clay. The thickness is 58 cm.

Layer 2 is composed of thin sandy clay layer with shells, 2.5 Y 4/2 dark grayish brown. The thickness is 8 cm.

Layer 3 is the layer of very fine sand with Fe concretion (2.5Y4/3 olive brown). The thickness is 30 cm.

Layer 4 is characterized by fine sand with Fe concretion, 2.5Y 5/2 grayish brown. The thickness is 52 cm.

Layer 5 is composed of 10 YR 3/2 very dark grayish brown, fine sand. The thickness is 20 cm.

Layer 6 is the thin layer of topsoil. The thickness is 8 cm.

3.2.1.12 Former tidal inlet at Pak Khlong Rong Poon (TS 12-1)

The location of station 12-1 is situated at 47 607112 E 14 17209 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the section is 256 cm. It can be classified into 4 layers as follows:

Layer 1 is the layer of 5 Y 5/2 olive gray, clay. The thickness is more than 100 cm.

Layer 2 is composed of lateritic sandy clay, 2.5 Y 4/2 dark grayish brown. The thickness is 80 cm.

Layer 3 is the layer of coarse to fine sand (2.5 Y 5/2 grayish brown). The thickness is 40 cm.

Layer 4 is the top soil. The thickness is 36 cm.

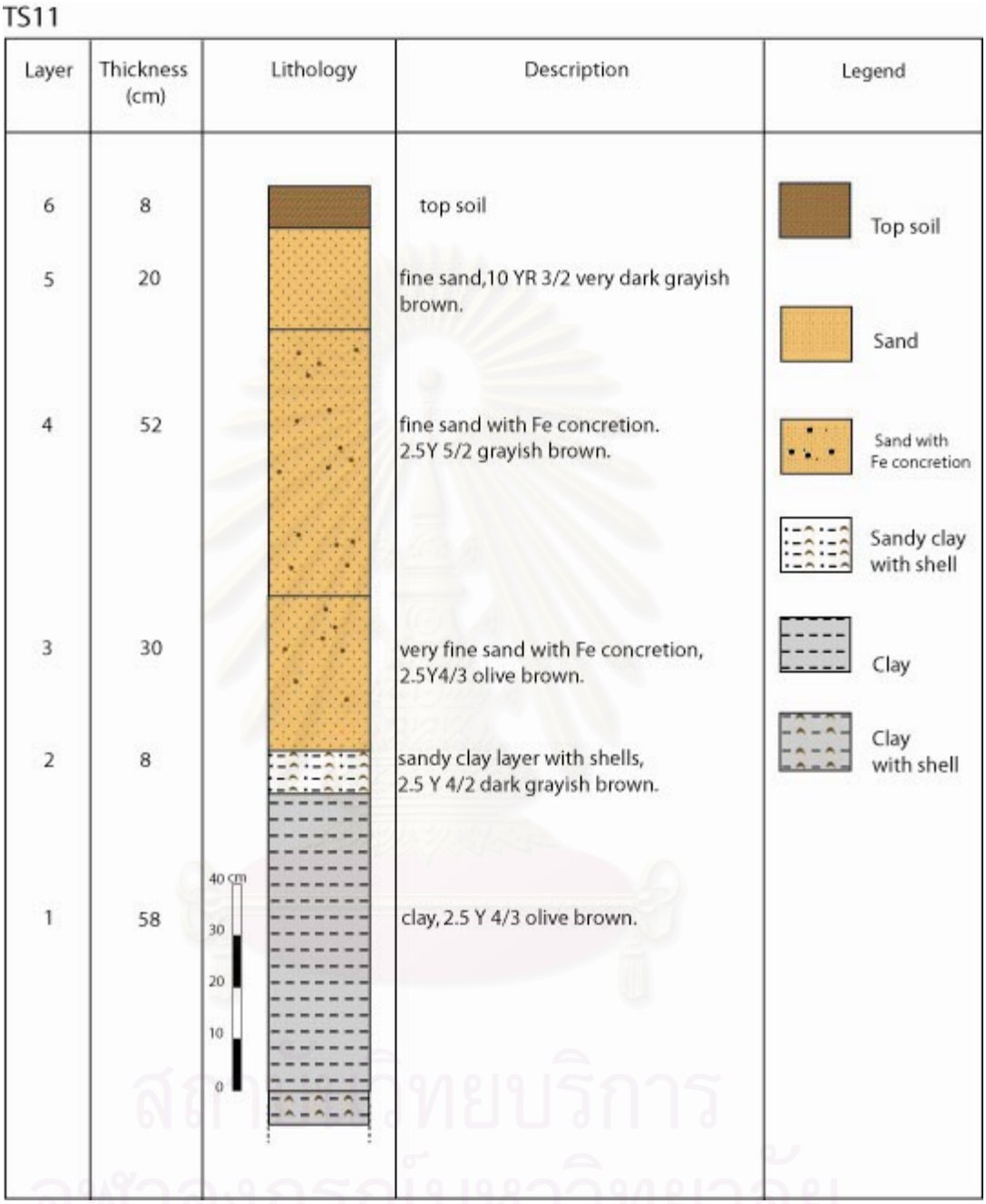

Figure 3.19 The lithostratigraphical columnar section of middle former barrier island in the middle part of the area (Ban Nong Ta Phod (TS 11)).

TS12-1

Layer	Thickness (cm)	Lithology	Description	Legend
4	36		top soil.	Top soil
3	40		coarse to fine sand,2.5 Y 5/2 grayish brown.	Sand Sherd Sandy clay with Fe concretion
2	380		lateritic sandy clay, 2.5 Y 4/2 dark grayish brown.	Clay
1	100	40 cm 30 20 10 0	clay, 5 Y 5/2 olive gray,.	

Figure 3.20 The lithostratigraphical columnar section of former tidal inlet at Pak Khlong Rong Poon (TS 12-1).

3.2.1.13 Former Tidal Inlet at Pak Khlong Rong Poon (TS 12-3)

The location of station 12-3 is situated at 47 607086 E 14 17209 N UTM on map sheet number 4934 I (Amphoe Tha Yang). The total depth of the section is 304 cm. It can be classified into 6 layers as follows:

Layer 1 is the layer of 5 Y 5/2 grayish brown, clay. The thickness is more than 8 cm.

Layer 2 is composed of clayey sand with shells, 2.5 Y 4/4 olive brown. The thickness is 34 cm.

Layer 3 is the layer of medium to fine sand (10 YR 4/4 dark yellowish brown). The thickness is 64 cm.

Layer 4 is characterized by fine to coarse sand, 10 YR 4/4 dark yellowish brown. The thickness is 24 cm.

Layer 5 is composed of 10 YR 4/4 very dark yellowish brown, fine to coarse sand. The thickness is 110 cm.

Layer 6 is the layer of top soil. The thickness is 64 cm.

TS12-3

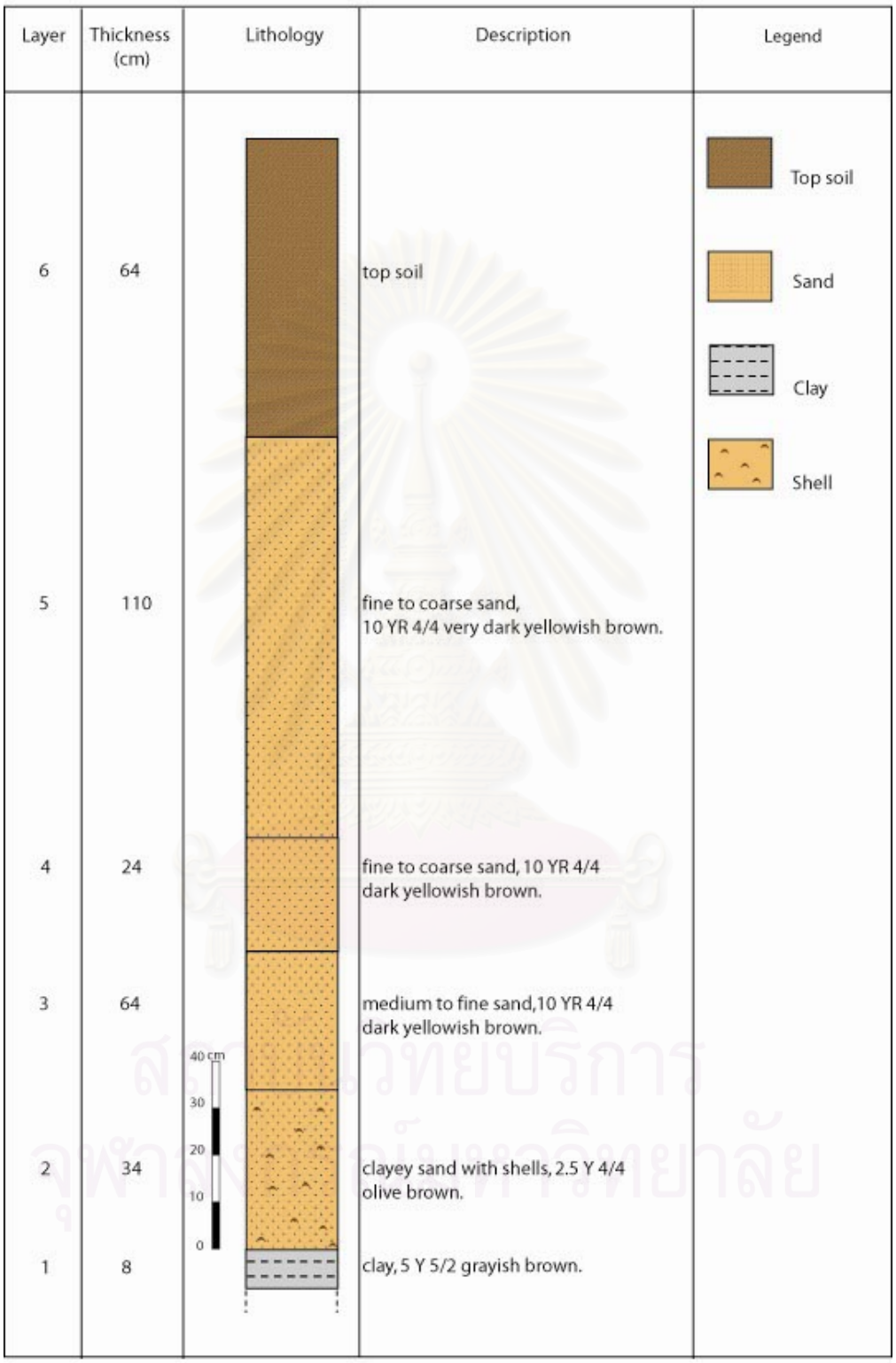

Figure 3.21 The lithostratigraphical columnar section of former tidal inlet at Pak Khlong Rong Poon (TS 12-3).

3.2.2 Grain Size Analysis

The analysis of grain size is very useful key for geoarchaeological work because it provides the information of sedimentary characteristic on the agent of deposition, the process and environment of deposition and diagenesis (Shackley, 1981:17). In this section, grain size analysis by laser granulometric technique was applied. Each layer of sediment from different locations was examined and the result will be calculated statistically and then plotted into various statistic diagrams. Those statistic plots will represent the result of quantitative analysis, in particular, grain size analysis in this area. However, the statistic plots will be compared with standard quantitative analysis. The classification of depositional environment in this research is based on Friedman and Sanders (1978). Grain size distribution and the other statistic values of the sediment were summarized (Table 3.1).

Table 3.1 Results of grain size analysis from laser granulometric technique.

Station	Layer	Mean(mm)	S.D.(mm)	Skewness	Kurtosis
station1					
1(1-1-1)	1	0.1795	0.0249	0.0107	0.502
1(1-1-1)	2	0.1742	0.2121	0.071	0.557
1(1-1-2)	3	0.01219	0.02702	0.101	0.816
1(1-1-2)	4	0.01281	0.03629	0.476	5.573
1(1-1-2)	5	0.153	0.2124	0.034	0.065
station2					
2(2-2-1)	1	0.07492	0.09691	0.067	0.455
2(2-2-1)	2	0.2555	0.2218	0.08	0.263
2(2-2)	3	0.016	0.03468	0.015	0.153
staion3					
3(3-3-1)	1	0.1069	0.1607	0.058	0.697
3(3-3-1)	2	0.08452	0.1118	0.061	0.317
3(3-3-1)	3	0.08206	0.1143	0.087	0.661
3(3-3-2)	4	0.07809	0.1044	0.061	0.323

Table 3.1 Results of grain size analysis from laser granulometric technique (Cont.).

Station	Layer	Mean(mm)	S.D.(mm)	Skewness	Kurtosis
3(3-3-2)	5	0.194	0.2339	0.041	0.233
3(3-3-3)	6	0.1574	0.1861	0.249	1.654
3(3-3-3)	7	0.2572	0.3124	0.039	0.149
station4					
4(4-1-1)	1	0.06727	0.09959	0.046	0.269
4(4-1-1)	2	0.05796	0.08648	0.05	0.517
4(4-1-2)	3	0.05381	0.07671	0.15	1.811
4(4-1-2)	4	0.04689	0.05579	0.011	0.03
4(4-1-2)	5	0.0387	0.05435	0.033	0.135
4(4-1-3)	6	0.04152	0.07119	0.064	0.33
station5					
5(5-1-1)	1	0.03172	0.05664	0.148	1.706
5(5-1-1)	2	0.03224	0.07282	0.022	0.128
5(5-1-1)	3	0.02042	0.04919	0.079	0.611
5(5-1-2)	4	0.06888	0.1347	0.104	0.624
5(5-1-2)	5	0.2817	0.3346	0.069	0.16
5(5-1-2)	6	0.171	0.2137	0.064	0.409
station6					
6(6-1-1)	1	0.2138	0.1527	0.125	0.648
6(6-1-1)	2	0.1619	0.1555	0.044	0.181
6(6-1-2)	3	0.2102	0.201	0.014	0.276
station8					
8(8-1-1)	1	0.2983	0.3573	0.042	0.143
8(8-1-1)	2	0.4573	0.4074	0.054	0.118
8(8-1-1)	3	0.3153	0.3276	0.021	0.053
8(8-1-2)	4	0.1789	0.2753	0.101	0.461

Table 3.1 Results of grain size analysis from laser granulometric technique (Cont.).

Station	Layer	Mean(mm)	S.D.(mm)	Skewness	Kurtosis
8(8-1-2)	5	0.09344	0.128	0.024	0.145
8(8-1-2)	6	0.1404	0.1573	0.051	0.269
8(8-1-3)	7	0.297	0.3921	0.072	0.168
8(8-1-3)	8	0.3607	0.3149	0.025	0.108
station10					
	1	0.1597	0.1691	0.082	1.025
	2	0.1543	0.08477	0.081	0.198
	3	0.2203	0.119	0.178	0.77
station11					
	1	0.1221	0.06442	0.058	0.091
	2	0.1325	0.1582	0.035	0.953
	3	0.1068	0.04327	0.027	0.045
	4	0.2338	0.1991	0.124	0.713
	5	0.1623	0.1812	0.131	1.399
station12-1					
	1	0.1974	0.2267	0.053	0.306
	2	0.3137	0.3655	0.021	0.069
	3	0.3999	0.2652	0.029	0.056
station12-3					
	1	0.2051	0.2328	0.069	0.298
	2	0.3268	0.2205	0.029	0.278
	3	0.3811	0.3217	0.0032	0.05
	4	0.1859	0.1459	0.172	1.308
	5	0.3014	0.1482	0.14	0.602

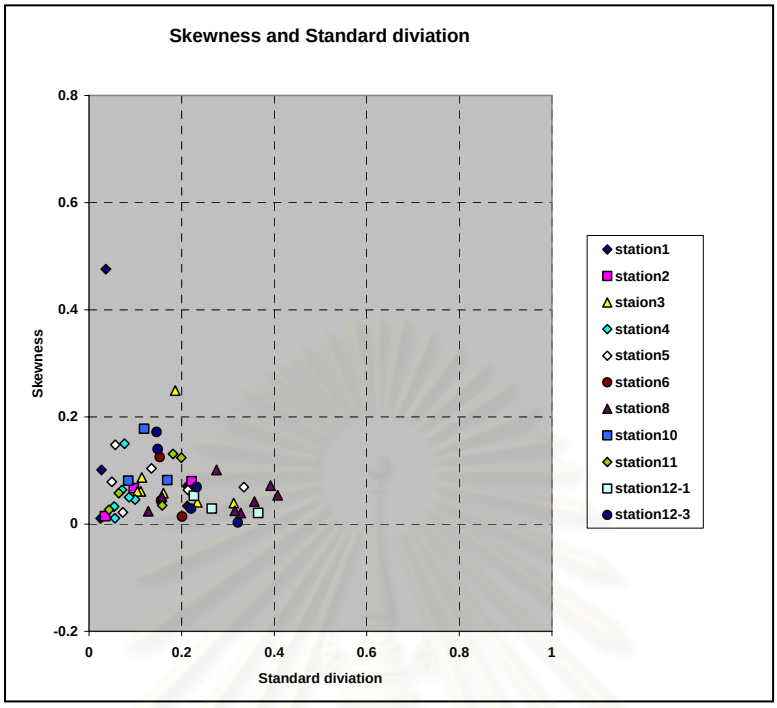

Figure 3.22 Plots between skewness and standard deviation showing the distribution of grain size analysis data from different landforms.

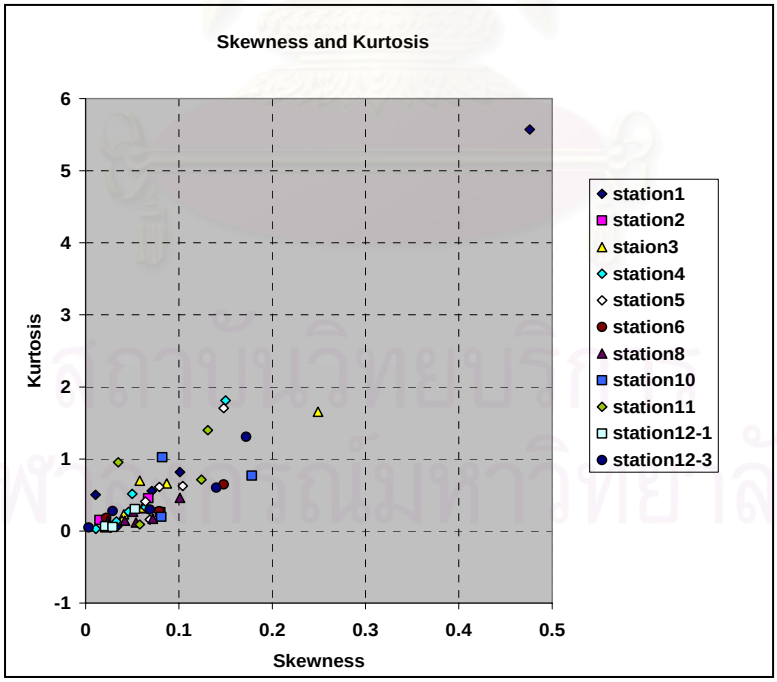

Figure 3.23 Plots between kurtosis and skewness showing the distribution of grain size analysis data from different landforms.

According to scattered plot in Figure 3.22, the relation between skewness and standard deviation shows the values of skewness are between 0.0107-0.476, and standard deviation between 0.0249-0.4074. In Figure 3.23, represents the relation between skewness and kurtosis. The values of kurtosis are between 0.065-5.573. These plots indicate marine origin, especially beach environment comparing to the plot of Friedman and Sanders (1978).

3.2.3 The Correlation between Landforms and Grain Size of Sediments

It can be concluded that landforms and grain size of sediments in the study area represent some characteristics as follows:

3.2.3.1 Former Barrier Islands and Beach Ridges

The former barrier island and beach ridges are characterized by thick layer of well-sorted sand.

3.2.3.2 Palaeo-Channel

The sediment of palaeo-channel comprises of sandy clay loam.

3.2.3.3 Inter Barrier Depression

The inter barrier depression is composed of several layers of sandy loam, loamy sand and clay.

3.2.3.4 Former Tidal Inlet

This landform is characterized by layers of clay, clayey sand and fine to coarse sand.

3.3 Fossil Evidence

The fossil evidence of the study area are the molluscan assemblages found in station11 and station12. These shells can be used as a supported evident for palaeolandform interpretation.

3.3.1 Shells from Former barrier island at Ban Nong Ta Pod (TS11)

The shells specimen of this station can be identified as *Anadara inaequivalvis* which is the habitat of coastal zone in the Gulf of Thailand (Swennen et al., 2001).

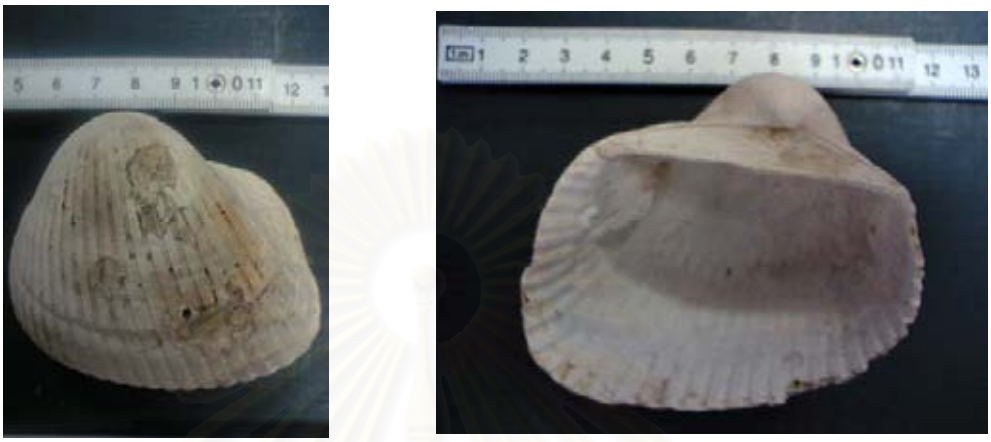

Figure 3.24 *Anadara inaequivalvis* from the Ban Nong Ta Pod (TS11).

3.3.2 Shells from Former tidal inlet at Pak Khlong Rong Poon (TS 12-3)

The shells specimen of this station can be identified as follows: *Anadara inaequivalvi*,*Gari elongata*, *Meretrix meretrix* and *Natica tigrin*a.

Figure 3.25 *Gari elongata* from Former tidal inlet at Pak Khlong Rong Poon (TS 12-3).

Gari elongate is a strictly intertidal element dwelling in sheltered sand banks and mud flats; lagoons and mangrove forests with sandy substrates are the most preferred locations (Robba et al., 2002).

Figure 3.26 *Meretrix meretrix* from Former tidal inlet at Pak Khlong Rong Poon (TS 12-3).

Meretrix meretrix is a habitat of muddy sand flats seaward of mangrove forest and down to 10 m depth (Robba et al, 2002).

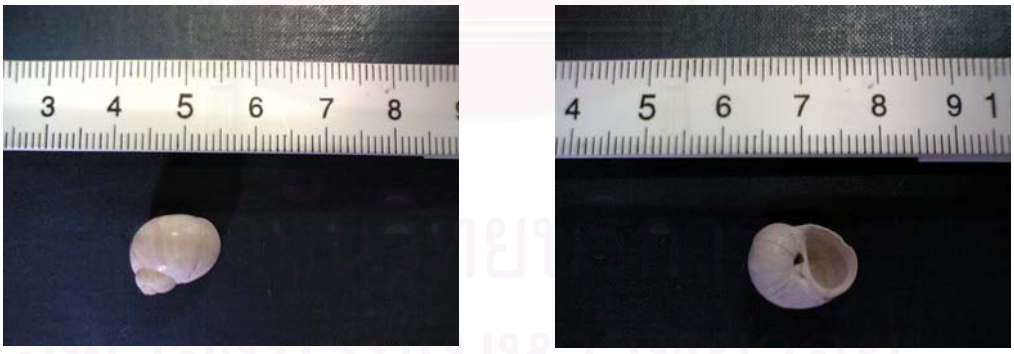

Figure 3.27 *Natica tigrina* from Former tidal inlet at Pak Khlong Rong Poon (TS 12-3).

Natica tigrina which live shells trawled near shore, empty ones found on the beaches (Swennen et al, 2001).

CHAPTER IV
ANALYSIS IN ARCHAEOLOGICAL SITES AND REMAINS

This chapter explains the other result of this research in particular concern with archaeological sites and remains analyses. The systematic description of archaeological evidence will be shown in this chapter. However in term of archaeology, this chapter will start with the description of archaeological sites and then end up with the analysis in archaeological remains.

4.1 Analysis in Archaeological Sites

The archaeological sites in Thungsetthi area can be divided into 2 groups; including monuments and habitation sites as follows:

4.1.1 Monuments

1).Thungsetthui Monument

This big monument is situated at the foot of Khao Chom Prasat which is a part of the area's Permian limestone hills. These hills are probably used as landmarks for ancient travelers. It is located at Moo 6 Tambol Nayang, Amphoe Cha-Am. The geographical reference is 12° 50' 47" N 99° 57' 24" E. It is about 4 km from the present coast. Unfortunately, the monument had been destroyed long time ago and only the 25 x 25 m base remains. It is also recognized as the biggest Dvaravati monument in Phetchaburi (Figure 4.1-4.3).

Figure 4.1 The inner part of Thungsetthi monument before restoration.

Figure 4.2 Thungsetthi monument during the restoration by Fine Arts Department in 1998.

Figure 4.3 General view of Thungsetthi monument after restoration.

1.1 The layout

The layout of this monument is in square plan which is similar to some Dvaravati stupas in the western part of Thailand; for example, Dvaravati monuments number 8 and 31 at Khu Bua, Ratchaburi province (Fine Arts Department, 2000: 56). There are some similar characteristics to the Gupta and Post-Gupta stupas of the 3-7 CE (Indrawooth, 1999).

1.2 Structure and Constructive Material

The structure of Thungsetthi monument is wall-bearing system. It made up from bricks with clay mortar. The brick dimension is approximately 18x30x9 cm. The bricks made from baked clay with high percentage of rice husks. The size and composition of the bricks found at Thunsetthi monument are typical Dvaravati bricks which can be found in every Dvavaravati sites (Figure 4.4).


a

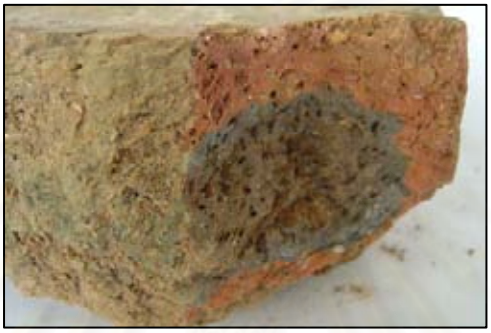
b

Figure 4.4 A typical Dvaravati brick sample from Thungsetthi monument:
a) a whole brick b) fragment of brick showing the trace of rice husks.

1.3 Decorative Materials

The monument is decorated by stucco sculptures. More than one thousand sculptures have been discovered at or around the monument. There are sculptures of wide-ranging characters, from Buddha images and deities to nobles and ordinary people to dwarves, demons and animals. In addition, a number of decorative pillars, flower motif, and other architectural decoration pieces are also discovered. The style of these stucco sculptures can be compared with those found at other Dvaravati sites such as ancient Nakhon Pathom, and Khu Bua in Ratchaburi province (Fine Arts department, 2000) (Figures 4.5 and 4.6).

Figure 4.5 Human figurines found at Thungsetthi monument (Fine Arts Department, 2000).

Figure 4.6 The deity figurines found at Thungsetthi monument (Fine Arts Department, 2000).

2). Trace of Monument on Khao Chom Prasat

There is a trace of possible brick monument on the tallest peak of Khao Chom Prasat but it is completely ruined thus we cannot identify the shape of monument. A number of fragments of bricks found in several places, both in group and scatter. The character of bricks is similar to those found from Thungsetthi monument. It can be observed that a densely group of bricks was found nearby the cliff. But most of them are broken into small pieces. However, if a monument such as a stupa was built there, the location of this monument is perfect for landmark since it probably can be seen clearly from the sea (Figure 4.7).

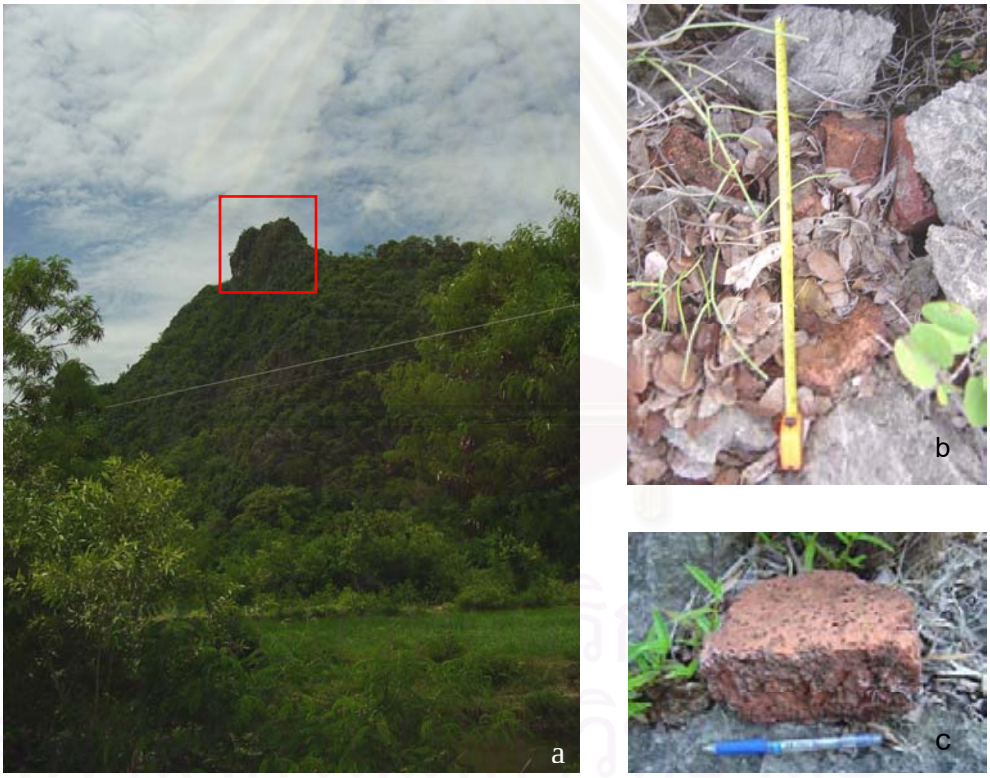

Figure 4.7 Trace of monument on Khao Chom Prasat. A) trace of monument's location on the top of the hill b) and c) Dvaravati bricks found onthetop of the hill.

3. Trace of Monument in Khao Tha Chin Cave

A few Dvaravati bricks are also found in a cave called Khao Tha Chin, a small isolated hill north of Khao Chom Prasat. It is located at Moo 7, Ban Don, Tambol Na Yang, Amphoe Cha-Am. Geographical reference is 12° 51' 12" N 99° 57" 34' E. It cannot be assumed about the type of the monument since it is completely destroyed (Figure 4.8).

Figure 4.8 Khao Ta Chin and trace of brick monument in the cave.

4.1.2 Habitation sites

4.1.2.1Thungsetthi Archaeological Site

Thungsetthi archaeological site is situated in Ban Khok Setthi, Tambol Na Yang , Amphoe Cha-Am; at 12° 50' 47" N, and 99° 57' 24" E. The village itself is on a mound. The excavation there is limited to an edge of the mound, now the village's football field. Unfortunately, the site has long been disturbed by recent human activities; it used to be the local

cemetery, which then was leveled for the construction of a football field (Figure 4.9 and figure 4.10). Evidence from a 2x2 m test pit conducted by Fine Arts department in 1998 revealed a Dvaravati cultural layer of 25cm thick, i.e. the first layer from the surface (Figure 4.11). Items found in this layer include fragments of earthenware such as carinated pots and spouted pots (*kendis*), a few marine shells, small fragments of animal bones, and small amount of charcoal (Fine Arts Department, 2000). At present, there are some sherds which can be found on the surface (Figure 4.12).

Figure 4.9 Oblique aerial view of recent Thungsetthi habitation site (in circle).

Figure 4.10 The excavation area at Ban khok Setthi (the village's football field).

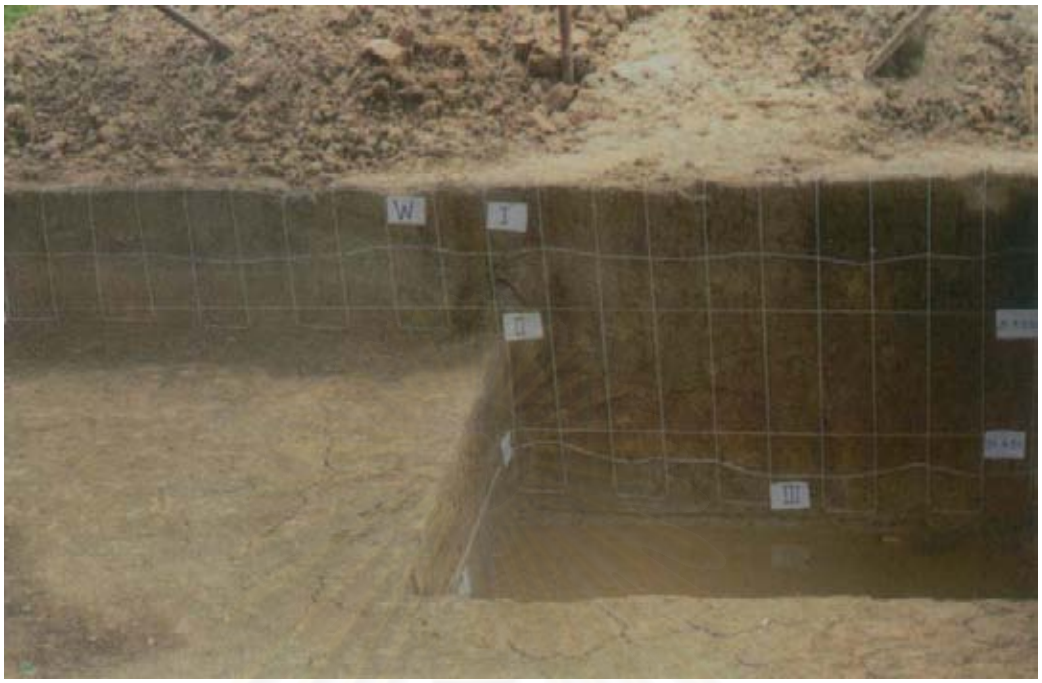

Figure 4.11 The west profile of the test pit conducted by Fine Arts department (Fine Arts Department, 2000).

Figure 4.12 Sherds found on the surface of Thungsetthi habitation site.

4.1.2.2 Ban Don

Ban Don archaeological site is situated in Ban Don, Tambol Na Yang, Amphoe Cha-am, 12° 52'00"N 100° 57'47"E . It is a big mound covering by weed and bushes. There were some sherds including earthenware and stonewares scattered on the surface of the mound. According to the sherds, it can be assumed that Ban Don is the archaeological site in Ayutthaya period (Figure 4.13).

Figure 4.13 General view of Ban Don archaeological site.

4.1.2.3 Ban Phetchabun

Ban Phetchabun archaeological site is located at Moo 4 Ban Phetchabun Tambon Nong Sala, amphoe Cha-am, at 12° 53'18"N 99° 59'40"E. The artifacts were discovered on the surface of the mound. Most of them are ceramics from Ayutthaya period including earthenware and stoneware (Figure 4.14).

Figure 4.14 General view of Ban Phetchabun archaeological site.

4.2 Analysis in Archaeological Remains

Numerous archaeological remains at Thungsetthi including potsherd, and other artifacts provide fairly direct information about human behavior in the past. Especially potsherds from the excavation at Thungsetthi habitation site and Thungsetthi monument are main artifacts and of these mostly came from the stratigraphic units which refer to occupation layers.

The majority of archaeological remains for analysis are potsherds representing human occupation in Dvaravati and Ayutthaya Period. However, other artifacts were also described here on a preliminary basis.

4.2.1 Potsherds

Most of potsherds are moderately to well preserved. Most of them are characterized by small pieces fragments, mainly found in occupation layers at Thungsetthi habitation site and Thung setthi monument. A few of potsherds are also found on the surface during the survey. Potsherd is of earthenware potsherd that most of them were characterized by a small pieces with color is brown to dark brown on the surface. Texture is mainly composed of coarse-grained to fine-grained materials. The surface finish and decorations are plain, polished plain, cord marked, incised and paddle designed.

The distribution and density of earthenware potsherds were analyzed by counting pieces.

4.2.2.1Earthenwares from Dvaravati Period

A number of Dvaravati earthenwares were discovered from THungsetthi monument and the habitation site at Ban Khok Setthi. The interesting types of Dvaravati are as follows:

1. Carineted pots

The carinated pots were found from the excavation at Ban Khok Setthi test pit. This type of pot is widely distributed in Dvaravati site (Figure 4.15).

Figure 4.15 Example of of carinated pots found in Thungsetthi area (Fine Arts Department, 2000).

2. Small shallow bowls

A number of small shalow bowls were discovered during the excavation at Thungsetthi monument. The function of these bowls was used as small lamps. It generally found at Dvaravati monuments (Figure 4.16).

Figure 4.16 Small shallow bowls (Fine Arts Department, 2000).

4.2.2.2 Earthenwares from Ayutthaya Period

Earthenwares from Ayutthaya period are found at Ban Don and Ban Phetchabun. Most of them characterized by paddle designs (Figure 4.17).

Figure 4.17 Sample of earthenware sherds from Ayutthaya period.

4.2.2.3 Stonewares from 11-17 C.E.

1.Stoneware from Si Satchanalai Kiln site (11-16 C.E.)

Two pieces of green glazed sherds which can be classified as Si Satchanalai ceramics (Pinsri et al., 1992) was also discovered at Ban Don site during the fieldwork (Figure 4.18).

2. Stoneware from Ban Bang Pun kiln site (13-17 C.E.)

A piece of ceramic from Ban Bang Pun kiln site was found at Ban Don site during the fieldwork. It is a fragment of large jar which is decorated with stamped design (Figure 4.19). This type of sherd is one of the most common ceramics produced in Ban bang Pun, Changwat Suphanburi (Fine Art Department, 1988).

Figure 4.18 Stoneware from Si Satchanalai Kiln site.

Figure 4.19 The sherd from Ban Bang Pun kiln site, discovered at Ban Don.

3.Stoneware from Chinese Kiln sites

3.1 Stoneware from Nan'an kiln, Northern Song Dynasty

A white glazed casket from Nan'an kiln, Northern Song Dynasty (960 -1125 C.E.) was discovered at the base of Thungsetthi monument during the excavation (Figure 4.20). It was used as a human bone container since some fragment of burnt bones were found inside (Fine Arts Department, 2000).

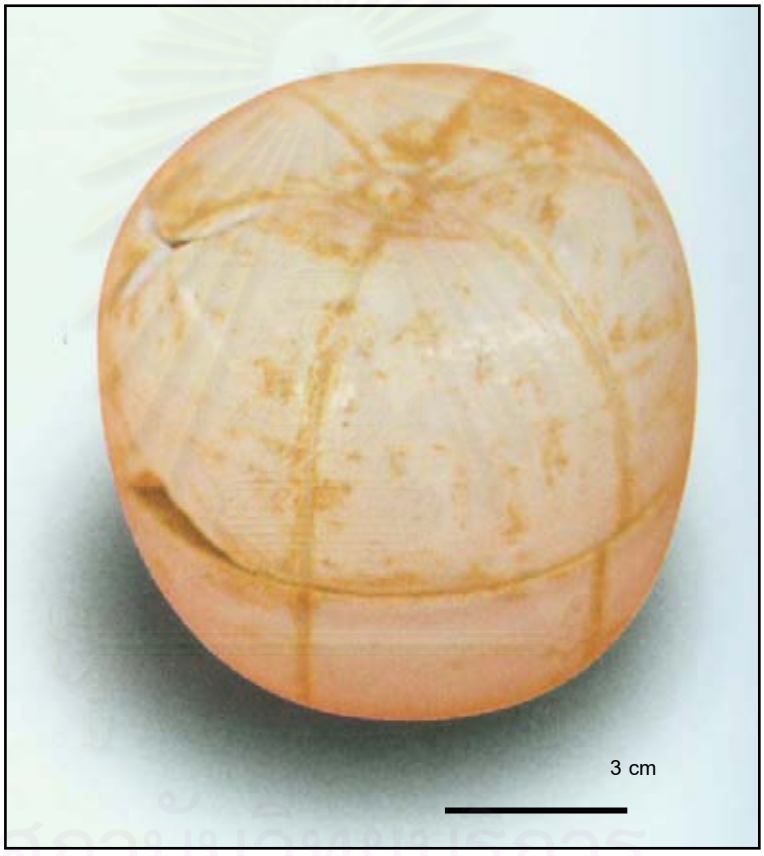

Figure 4.20 A casket from Nan'an kiln, Northern Song Dynasty (Fine Arts Department, 2000).

3.2 Stoneware from Fu Gien kiln site, Song Dynasty

A small bowl with bluish - white glazed from from Fu Gien kiln site, Sung Dynasty(10 – 13 C.E.) found from the base of Thunsetthi monument (Figure 4.21). It was a bone container (Fine Arts Department, 2000).

Figure 4.21 A small bowl from from Fu Gien kiln site (Fine Arts Department, 2000).

4.2.2 Shell remains

Only one shell remain was reported by Fine Arts department excavation at Thungsetthi monument. It is a conch, size 9 cm x14 cm which some parts was modified by human. It can be assumed that the people probably used this kind of shell in religious ceremonies (Fine Arts Department, 2000).

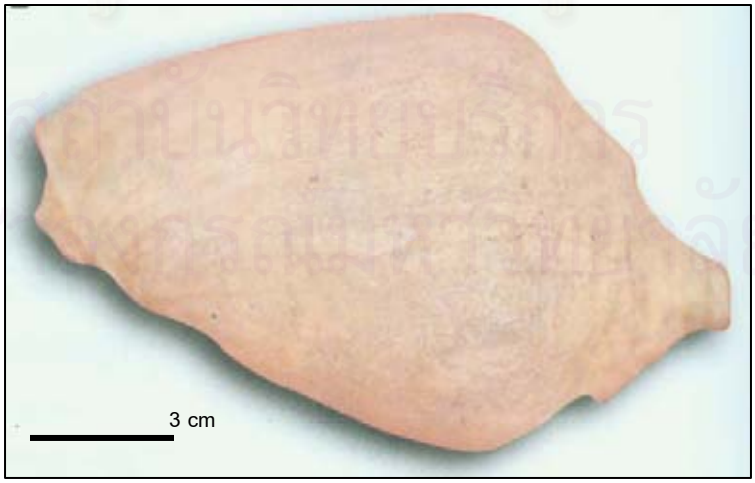

Figure 4.22 The Shell from the excavation at Thungsetthi monument (Fine Arts Department, 2000).

CHAPTER V
DISCUSSIONS AND CONCLUSIONS

5.1 Discussions

To approach the final output of this thesis, it is necessary to discuss the relation between archaeology and geology. As this research was aimed to analyze the paleo-geographical changes that may influence the selection of appropriate ancient communities, thus, the discussion will firstly draw upon the geographical setting of Thungsetthi site. In addition, as this coastal area has been reported to have related to the mid-Holocene sea-level changes, therefore, the later part of the discussion will focus on the relation between site selection and the progradation of shoreline after the mid-Holocene marine regression. Finally, the discussion will move forward to analyze the connection of the other archaeological sites observed in this province in order to propose the possibility and reason why the selection of ancient sites will relate to each other.

5.1.1 Palaeo-Geographical Settings of Thungsetthi

According to the detailed study done by aerial photographic interpretation and ground reconnaissance, the dominant palaeo-geographical features in this area include former coastal landforms such as old barrier islands, beach ridges and palaeo-channels as mentioned in previous chapter. At present, these paleo-channels have transformed into plains, most of which are used as rice fields, but some palaeo-channels connecting to the old barrier islands and beach ridges can be seen clearly from the aerial photographs. The old barrier island is mentioned to be an indicator of a Holocene transgression. The change of landscape is likely caused by land progradation during marine regression after the mid-Holocene epoch (Choowong et al., 2003). The settlements at Thungsetthi were situated on the innermost old barrier island and beach ridges. It was appropriate for the Dvaravati people to build their communities on the old barrier island and beach ridges because they had become more stable and higher than the surrounded area after the regression of the sea level.

In term of relationship between landscape evolution and ancient site settlement, the geographical settings of the sites around this research area confirm that the settings of most Dvaravati communities in the lower central plain of Thailand correlate directly or indirectly with ancient rivers, channels or plains which connected to the sea (Vanasin and Supajanya, 1980). It is still unknown whether these palaeo-channels in Thungsetthi area were used to served as transportation routes to and from the sea, or inland. Neither is it clear whether they had already been abandoned before Dvaravati people settled there. To test these issues, sediments from palaeo-channel should be dated, and some of the channels need to be excavated to look for preserved wood and other organic matter and even stone lost in transportation.

Based on sedimentological evidence in this area, it is possible to make episodic evolution of landforms. The model below shows the progradation of coastal area during the mid Holocene marine regression. Although, the carbon 14 dating has not been carried out in this research, but it is clear from aerial photographs that the coastal area here was prograded eastward (Figures 5.1 and 5.2). Morphological changes of the coastal area have continued to present days. Detailed investigation on stratigraphy brought more insights to the understanding of palaeo-geography of this area.

Figure 5.1 Recent geographical settings of Thungsetthi area showing series of beach ridge in almost north-south direction and mostly parallel to former beach ridges and barrier islands (picture was taken to the east).

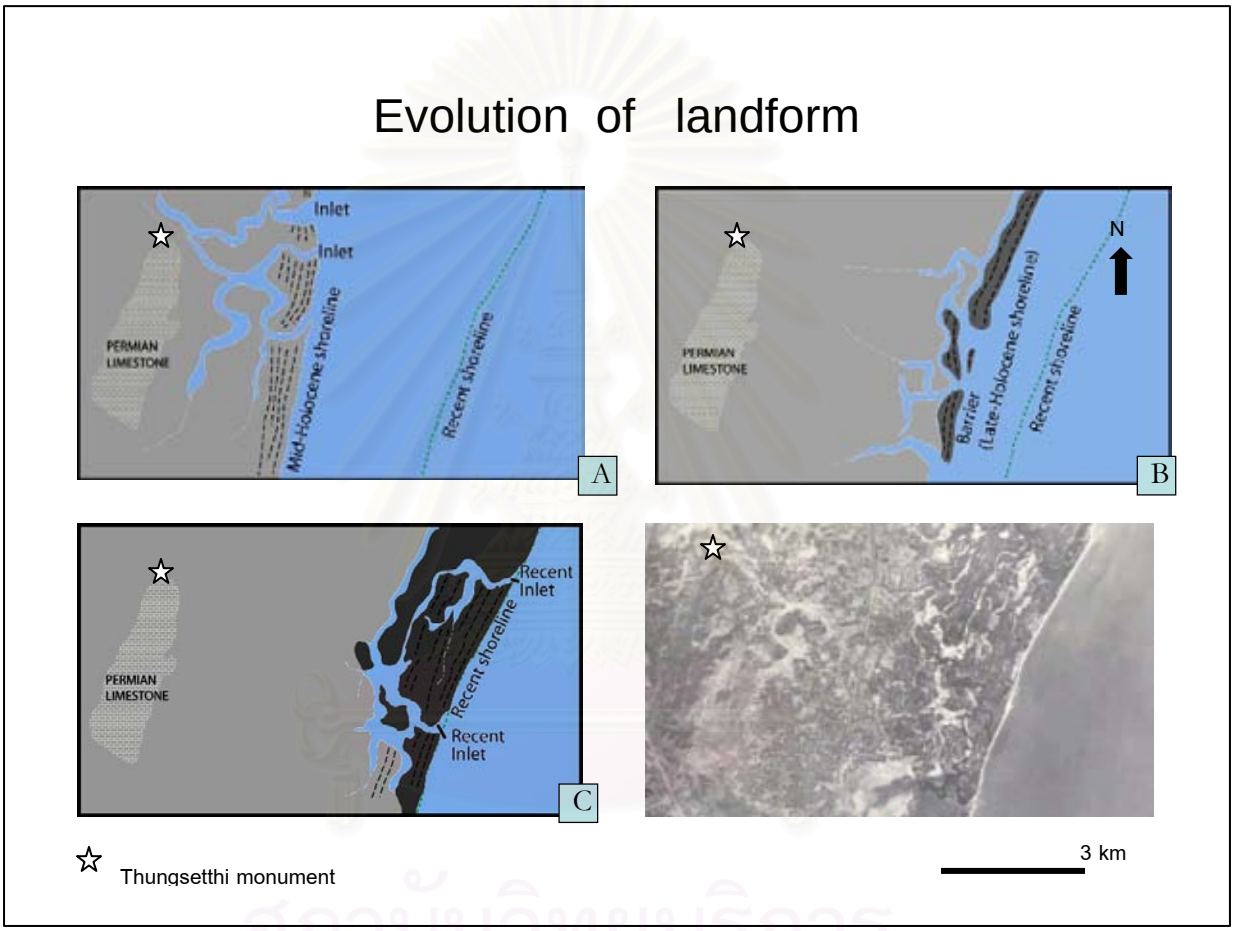

Figure 5.2 Episodic evolutional model of prograded coastal area of Thungsetthi in eastward direction. Each figure shows landscape evolution from middle Holocene (A), Late Holocene (B) to recent(C) comparison to the present coastal area in below right picture.

5.1.2 Possible Transportation Route in This Region

It is feasible, however, that the innermost old beach ridge had been used as a land transportation route during the Dvaravati period, since there are a few archaeological sites along this sand barrier from Khu Bua, Ratchaburi to Thungsetthi, Phetchaburi (Vallibhotama, 1991;Fine Arts Department, 1998). Very similar archaeological remains were discovered from Thungsetthi and some other sites nearby. This might be one clue that is able to serve the possibility of transportation route in this region during Dvaravati period. The monument and artifacts found from Thungsetthi also suggest the social interaction with the other Dvaravati communities nearby (Figure 5.3-5.4).

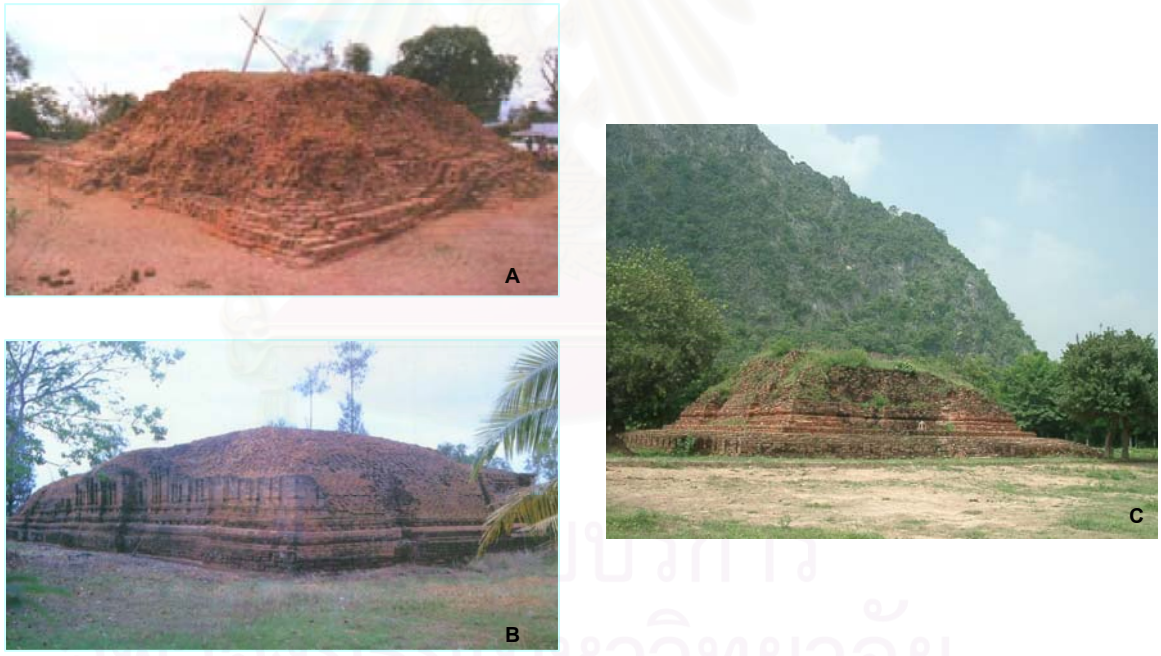

Figure 5.3 Dvaravati monuments on the transportation route. A) and B) monuments at Khu Bua, Ratchaburi (Fine Arts department, 1998) C) Thungsetthi monument. They can be compared in plan, shape and construction material.

Figure 5.4 Stucco from Dvaravati monument on transportation route. A) head of Siva from ancient Nakhon Pathom B) head of deity from Khu Bua C) head of Deity from Thungsetthi (Fine Arts department, 1998).

Aerial photographs and ground reconnaissance reveal that Thungsetthi settlement was situated on the innermost old sand ridge. Land progradation caused by marine regression after the mid-Holocene period might have played a significant role in shaping such coastal landform patterns, i.e., the changes of palaeo-channels. These palaeo-landforms especially beach ridges and sand barriers also convince the idea from some researchers (e.g. Vallibhotama,1991) that Thungsetthi seemed to have close relation with major communities on this communication route during Dvaravati period(Figure 5.5). It also

possible that Thungsetthi was one of the settlements on the communication route of the region (Figures 5.6). It is presumed that changes of landscape might have affected these Dvaravati settlements in some ways. However, excavations at Thungsetthi sites clearly show the wisdom of their inhabitants in selecting favorable landform for their settlements.

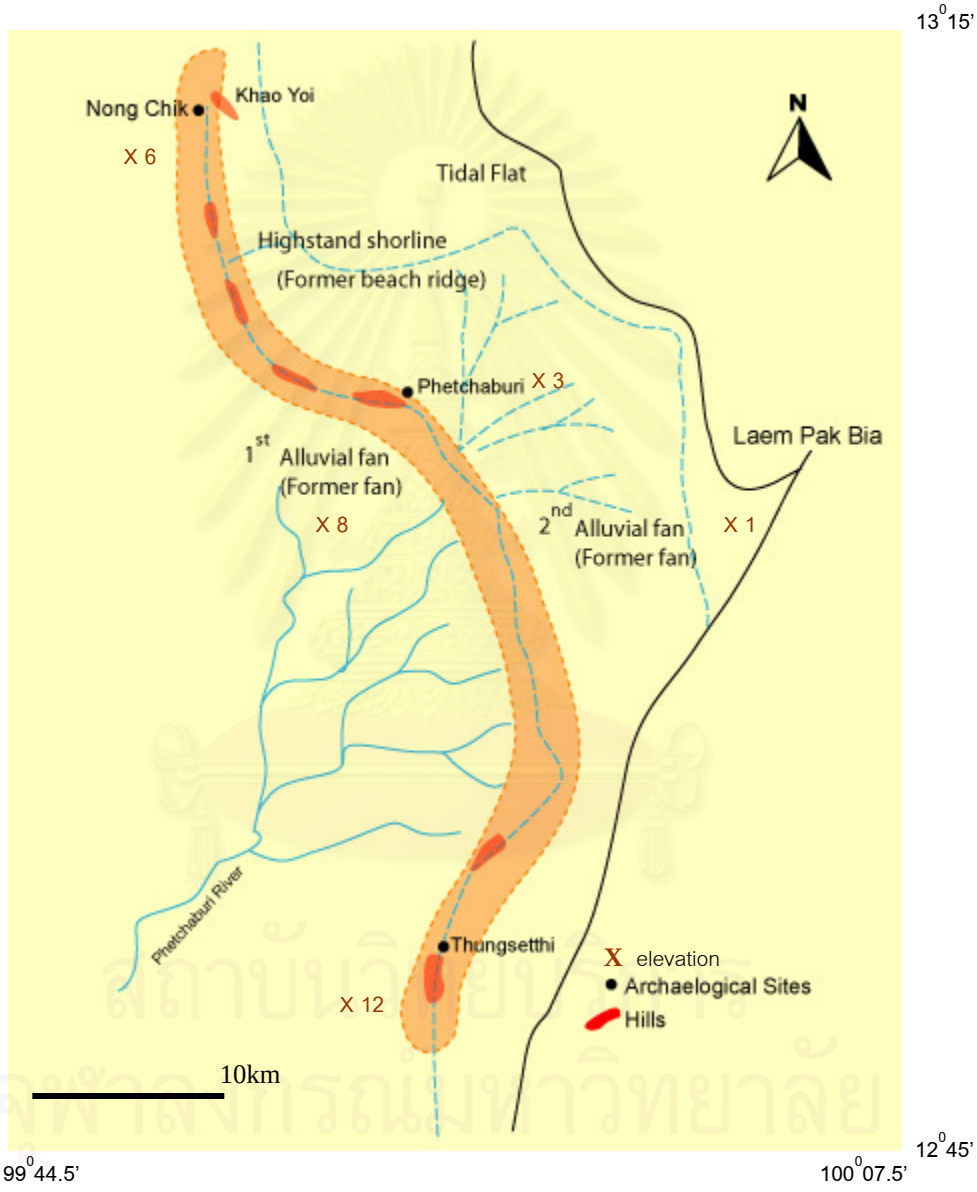

Figure 5.5 Sketch model of possible transportation route connecting Thungsetthi site and some other ancient sites in the north of Thungsetthi. The dark orange color indicates site connecting pathway that locates at the distal part of alluvial fans and on relict inner beach ridge around this area.

Figure 5.6 The trans-peninsular route of Malay peninsula showing the possible connection of Thungsetthi and ancient communities in this region. Thungsetthi is situated between Three Pagodas and Tenasserim route (in circle) (Wheatley, 1966).

5.2 Conclusions

The conclusion of this research will draw upon the integration between geological and archaeological perspectives. It is no doubt that the understanding in coastal geology in this research, i.e., evolution of landscape and sedimentology encourages to analyze and support the idea in archaeology. The integration of some other related disciplines is also recommended for further detail study, not only in this area, but also in some other ancient sites. For example, the more precise scientific results, such as radiocarbon or TL dating will increase the accuracy in interpretation of archaeological remains and sediments. However, this research can be concluded as follows:

1. The identification of palaeo-landscapes from aerial photograph in this area is one of the appropriate ways to understand the evolution of landscapes, particular during the Holocene marine regression.

2. Landforms in this area include former beach ridges, barrier islands, paleo-channels, tidal flat, inlet/outlet, talus and debris in limestone hills and alluvial fan. The coastal landforms in this area can be used to analyze the evolution of landscape.

3. Quantitative sedimentological description in this research can be used to specify various types of landform.

4. The progradation of the land during marine regression after the mid Holocene might have played a significant role in controlling coastal landform pattern i.e. the change in direction of palaeo-channels.

5. The investigation on coastal stratigraphy supports the idea that palaeo-shorelines used to locate inland and the progradation occurred in eastward until the present.

6. These palaeo-landforms especially beach ridges and sand barriers also convince the idea that Thungsetthi seemed to have close relation with major communities on this communication route during Dvaravati period. Furthermore, the archaeological evidence unearthed from some Dvararavati sites nearby such as ancient Nakhon Pathom and Khu Bua, also supported this idea. Since they represented similar style and belief of Dvavarati culture in central Thailand.

7. Thungsetthi settlement and other Dvaravati communities such as Nong Chik and Khu Bua was situated on the innermost old sand barrier which can be relatively dated approximately 6,000 years. It is presumed that changes of landscape might have affected these Dvaravati settlements in some ways. However, it clearly shows the wisdom of their inhabitants in selecting favorable landform for their settlements.

REFERENCES

Aksornsilpa, C., Ongwutthivet, T., Chaisuwan, B., Leerungnavarat, P., and Sornsong, O. 1990. The survey and study of Dvaravati settlements in Phetchaburi province. Department of Archaeology, Silpakorn University. (Unpublished Manuscript)

Allen, J. 1990. Agriculture, hydraulics, and urbanism at Satingpra. Asian Perspectives.28 (2): 163 -177.

Boyd, W. E., McGrath, R., and Higham, C. F. W. 1999. The geoarchaeology of the prehistoric ditched sites of the upper Mae Nam Mun valley northeastern Thailand, II: Stratigraphy and morphological sections of the encircling earthworks. Indo-Pacific Prehistory Association Bulletin. 18: 169-179.

Butzer, K.W. 1982. Archaeology as human ecology: Method and theory for a contextual approach. Cambridge: Cambridge University.

Choowong, M., Daorerk, V., Charusiri, P., Charoentitirat, T., and Songmuang, R. 2003. Late Holocene sea-level changes in Thailand. Proceedings of the Progress Study in Archaeology and Ancient Town in Dvaravati Culture. Suphanburi, Thailand. 24-25 July 2003.

Department of Mineral Resources. 1999. Phetchaburi earth resources. Bangkok: Department of Mineral Resources.

Department of Mineral Resources. 2001. Geology of Thailand. Bangkok: Department of Mineral Resources. (1 Celebration for the 6th Anniversary of His Majesty the King, 5 December 2001).

Fine Arts Department.1988. Ban Bang Pun kiln site. Bangkok: Fine Arts Department.

Fine Arts Department.1998. Khu Bua: A relationship with Dvaravati communities nearby. Bangkok: Fine Arts Department.

Fine Arts Department. 2000. Thungsetthi: A Dvaravati monument on the Phetchaburi coast. Bangkok: Fine Arts Department.

Friedman, G. M., and Sanders, J. E. 1978. Principles of sedimentology. New York: John Willey and Sons.

Higham, C., and Thosarat, R. 1998. Prehistoric Thailand: From early settlement to Sukhothai. Bangkok: River Books.

Indrawooth, P. 1999. Dvaravati: A critical study based on archaeological evidence. Bangkok: Aksornsamai.

McGrath, R. 2000. The Geoarchaeology of the Mun River Floodplain in Thailand. Progress report submitted to the National Research Council of Thailand. (Unpublished Manuscript)

Nakapadungrat, S., Beckinsale, R. D., and Suensilpong, S. 1984. Geochronology and geology of Thai granites. Proceedings on the Conference on Applications of Geology and the National Development. 75-93. Chulalongkorn University, Bangkok. 19-22 November 1984.

National Park, Wildlife and Plant Conservation Department. n.d. Khao Nang Punthurat Park. (Mimeographed)

National Research Council of Thailand. 1995. Landforms of Thailand from Space. Bangkok: Darnsutha.

Palakawongse Na Ayudhya, A. 1982. The environmental factors that effect on the settlement of the ancient city during the Dvaravati period at Tambol Khu Bua, Amphoe Muang Ratchaburi, Changwat Ratchaburi. Master's Thesis, Department of Environmental Science, Faculty of Sciences, Kasetsat University.

Pinsri, K., Thammapreechakorn, P., and Nguanpienpak, A. 1992. Sukhothai ceramics: The development of Thai ceramics. Bangkok: Amarin Printing Group.

Robba, E., Geronimo, I. D., Chaimanee, N., Negri, M. P., and Sanfilippo, R. 2002. Holocene and recent shallow soft-bottom mollusks from the northern gulf of Thailand area: Scaphopoda, Gastropoda, additions to Bivalvia. Bollettino Malacologico 38 (5-8): 49-132.

Silapanth, P., Charoentitirat, T., and Choowong, M. 2004. Palaeogeography and ancient settlements: A preliminary investigation at Thungsetthi, Changwat Phetchaburi, western Thailand. Proceedings of Geologic Evolution of East and Southeast Asia. Bangkok, Thailand. 8-14 February 2004.

Sinsakul, S., Tiyapirach, S., Chaimanee, N., and Aranprayoon, B. 2002. Coastal change along the gulf of Thailand coast. Bangkok: Department of Mineral Resources.

Stargardt, J. 1983. Stingpra I: The environmental and economic archaeology of south Thailand. Oxford: British archaeological Reports International Series 158.

Swennen, C., Moolenbeek, R. G., Ruttandakul, N., Hobbelink, H., Dekker, H., and Hijisamae, S. 2001. The mollusces of the southern gulf of Thailand. The Biodiversity Research and Training Program.

Vallibhotama, S. 1990. Ratchaburi: The forgotten port. Muang Boran. 16 (2): 12-48.

Vallibhotama, S. 1991. Phetchaburi: A city of history. Muang Boran. 17 (4): 17-42.

Vanasin, P., and Supajanya, T. 1981. Ancient cities on the former coastline in the central plain of Thailand: The Study of Sites and Geographical Correlation. Bangkok: Chulalongkorn University.

Wheatley, P. 1966. The golden Khersonese: Studies in Historical Geography of the Malay Peninsula before A.D. 1500. Kuala Lumpur: University of Malaya.

Wongnoi, P., and Sudsawat, D. 2001. Prehistoric settlements in Phetchaburi. Bangkok: Fine Arts Department.

BIOGRAPHY

Miss Praon Silapanth was born on 31 May 1967 at Bangkok. She obtained her Bachelor Degree in Art History from the Faculty of Archaeology, Silpakorn University in 1989. Since 1989-1994, she furthered her study in Historical Archaeology at Graduate School, Silpakorn University. At present, she works as a lecturer at Department of Archaeology, Faculty of Archaeology, Silpakorn University.