CHAPTER I

INTRODUCTION

1.1 Background

A lot of vertebrate fossils have been found in the sand pit at Amphur Chaleumprakeart Changwat Nakhon Ratchasima. Particularly, Proboscidean fossils were first found in Northeast of Thailand with high biodiversity. Many kinds of ancient elephant fossils were found such as *Gomphotherium* sp., *Prodeinotherium* sp., *Stegolophodon* sp., *Stegodon* sp. and *Elephas* sp. Besides, large mammal fossils were also found such as ancient rhinoceros, *Hipparion*, giant turtle and big sized crocodile, including fossils of both monocotyledon and dicotyledon plants. All of them show fertility of this area in the past as a vast river in Late Tertiary age (2-15 Ma) (Chaimanee *et al.*, 2003; Nakaya *et al.*, 2003). Besides, textites were found on the upper part of the sand pit they were and dated to have an age of 0.7 Ma (Bunopas *et al.*, 1999). Moreover, the discovery of vivianite mineral which covers on the surface and inside of a little bone of elephant was also reported (Sreprateep *et al.*, 2003).

However, the problem about the age of sediments and occurrence of Proboscidean fossils were still remained. This research has been studied the lithostratigraphy, paleontology, and taxonomy of Proboscidean fossils. The result from this study might be useful to gain a better understanding of paleo-depositional environment of Proboscidean fossils of this area.

1.2 Objectives

The main objectives of this research to:

1. To construct the stratigraphy of Palaeo-Mun river sediments system by using sedimentological analysis such as lithology, sedimentary structures.
2. Undertake palaeontological study of occurrences of Proboscidean fossils to describe Proboscidean fossils from sandpits in Changwat Nakhon Ratchasima.
3. Reconstruct of palaeoenvironments from sedimentological and paleontological analysis.

1.3 Methodology

The methods of study is divided into 4 steps, viz. planning and collecting data step, preparation for field survey, field survey, laboratory investigation, analysis and conclusion.

1. Planning and collecting.

The first step involves mainly data collection in order to gain preliminary available information about the regional study area and relevant information for subsequent step. After that, the geomorphological map was made by aerial

photograph interpretation studying about geomorphology by using geographical map scaled 1: 50,000 and aerial photos

2. Field investigation, geological map, and sample collection were done in March-April 2004, November-December 2004, March-April 2005 and November-December 2005. The lithostratigraphic columnar sections were made along the Mun river and fossil localities. The occurrences of fossils were checked in the outcrop both of vertical and horizontal section.

3. Laboratory

The Proboscidean fossils were collected from the Siam pit. Specimens from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima and Department of Mineral Resources were also studied. After that, the fossils were made replica for paleontological study such as fossil articulation, external morphology, measurement, description and take a photographing for identification of proboscidean fossils.

4. Evaluation

The proboscidean fossils and their occurrences in each horizon were analyzed. These results are combined with the analysis of lithology and sedimentary structure. The results were shown in geologic columns. All of them were discussed and used for reconstruction of paleo-depositional environment of Paleo Mun river.

1.4 Study area

The study area is located between latitudes 14° 53' N and 15° 30 N and longitudes 102° 07' and 102° 23 E' (Figure 1.1). It covers topographic map on the scale 1: 50,000 Series L7017 map sheet 5438 I (Ban Saraphi), 5438 IV (Changwat Nakhon Ratchasima), 5439II (Amphoe Non Sung), and 5439 III (Amphoe Non Thai), geologic map on the scale 1: 250,000 sheet ND48-5 (Changwat Chaiyaphum), geologic map on the scale 1: 50,000 sheet 5438 IV (Changwat Nakhon Ratchasima) and geologic map on the scale 1: 50,000 sheet 5439 II (Amphoe Non Sung)

The study area covers about 30 square kilometers. It can be accessed by highway No. 2 from Bangkok to Nakhon Ratchasima and then accessed another highway for survey the study area. (Figure 1.2)

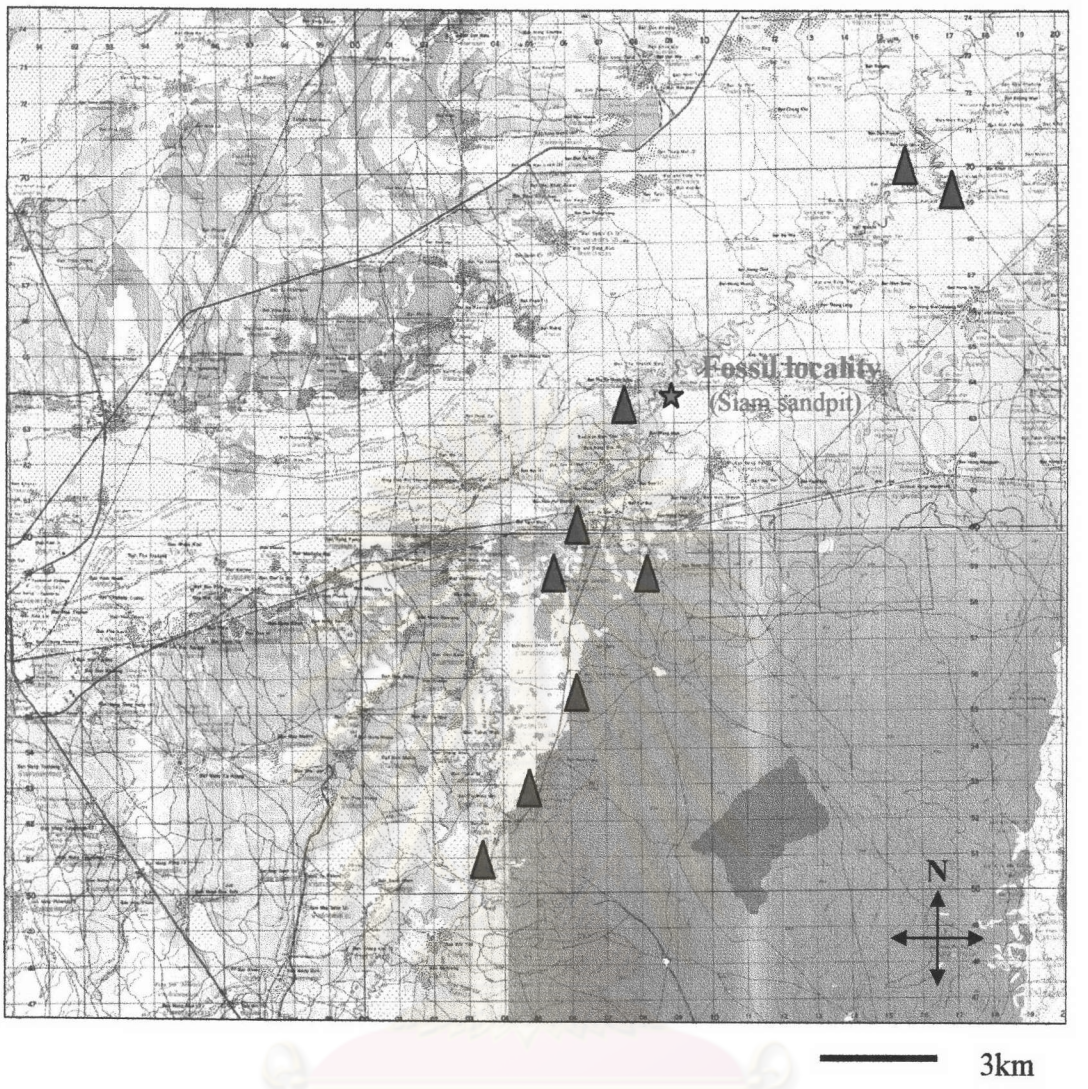

Figure 1.1 Topographic map of the study area (Series L7017, Sheet 5438 I (Ban Saraphi), 5438 IV (Changwat Nakhon Ratchasima), 5439II (Amphoe Non Sung), and 5439 III (Amphoe Non Thai) (Royal Thai Survey Department, 1969 and 1996).

Study area Fossil locality Excursion stop

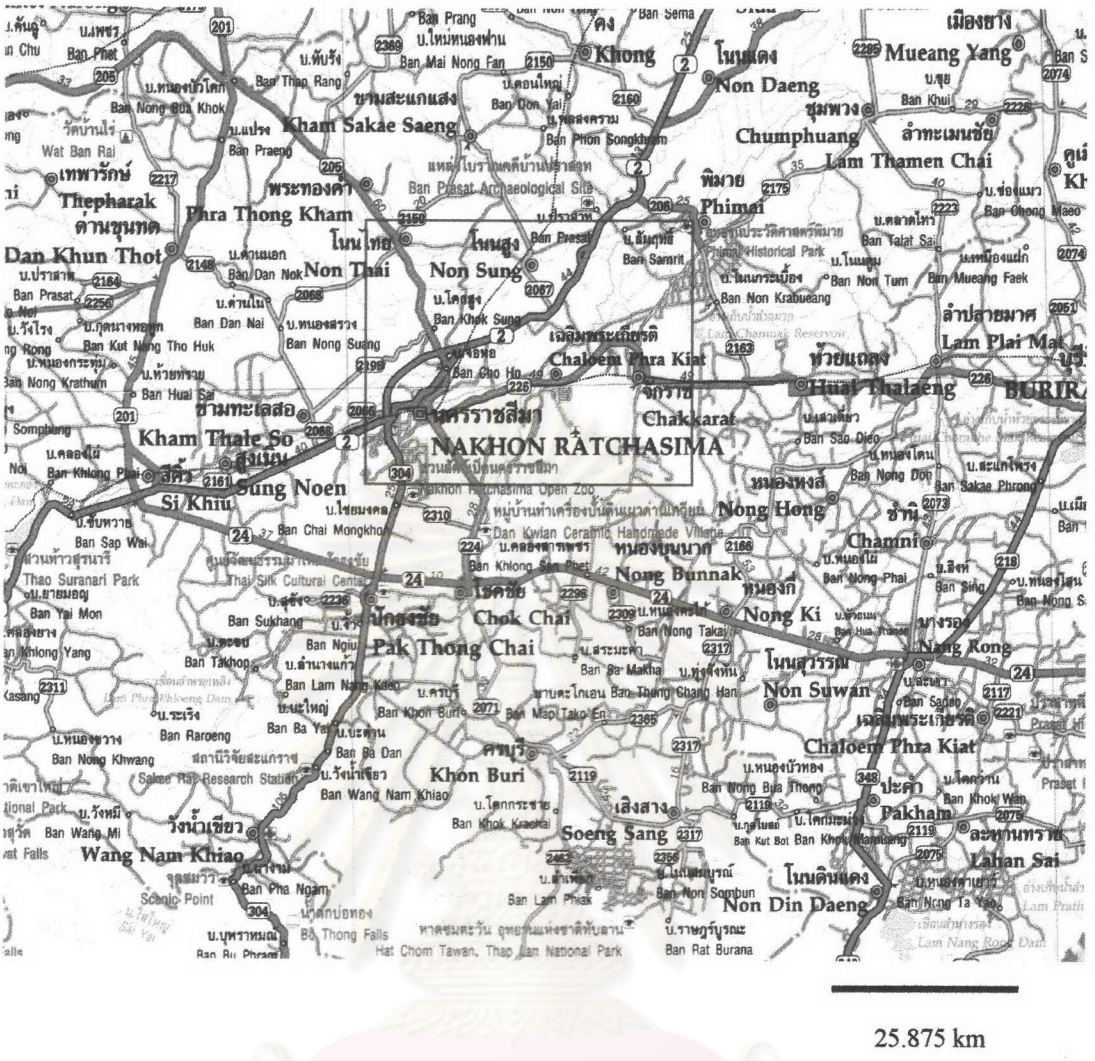

Figure 1.2 Location of the study area (PN MAP, 2003). ☐ Study area

1.5 Previous works

1.5.1 Paleontology

At Mae Moh, some incomplete teeth of Proboscidea Mastodon were discovered also in the lignite bed, and studied by von Koenigswald (1959). He concluded that it was a new species of *Stegolophodon*: *Sl. Praclatidens.* This species is, according to von Koenigswald, more primitive than *Sl. latidens* and most probably represents an ancestral form of the latter. The type of *Sl. latidens* comes either from the Lower Irrawady or the Upper Irrawady but its age is still doubtful. This species had also been reported in Dhok Pathan horizon (Siwalik, Pakistan, India) which age was then estimated to be Middle Pliocene. Then von Koenigswald (1959) thought the ancestral form, *Sl. praclatidens*, should be of Lower to Middle Pliocene age.

Ginsdurg and Tassy (1985) reviewed about the discovery some vertebrate remains in the lignite beds of Li Basin by Ukkakimapan. There are vertebra and jaws of fishes, incomplete dermal plates of turtle, a tooth fragment of a proboscidean and an antler of a deer. The proboscidia are represented by a single small fragment of tooth enamel, but its thickness is so important (up to 4 millimeters) that it can be referred to a *Mastodont* and it shows the typical shape of a cuspid with rounded part of the wear surface. Beside, they reported about the lignite sequences of Northern Thailand whichs were traditionally divided in two groups: an Eocene group (formation of Li) and an upper Miocene group (formation of Mae Moh). New discoveries of mammals were estimated to be around the upper part of the Middle Miocene.

The fossils of proboscidean and other animals of Khorat Basin were reported for the first time by Suteethorn *et al.* (1997). They comprised of *Gomphotherium* sp., *Stegolophodon* sp., *Deinotherium* sp., *Gandatherium* sp. and Suidae.

Sato (2002) studied about the occurrence of fossil mammals in Nakhon Rachasima, northeast Thailand. Extraordinal rich fauna of fossil mammal have been found i.e. *Rhinoceros* sp., *Stegodon* sp., S. (*Eostegodon*) sp., *Babalus* sp., *Cervus* sp., *Equus* sp. *Mastodon* sp. and *Stegolophodon* sp.

Nakaya *et al.* (2003) reported the discoveries of the Late Cenozoic mammalian faunas of Thailand in the following fossils sites: Mae Soi, Chiang Muan, and Sop Mae Tham; and Tha Chang. At Mae Soi. Accordingly, a primitive amebelodontid gomphothere (*Archaeobelodon*) and equids were discovered for the first time from Southeast Asia. At the Chiang Muan Lignite Mine, they found hominoid cheek teeth, as well as *Propotamochoerus* and /or *Hippopotamodon* and three individuals of the primitive tetralophodont gomphothere. The mammalian fauna from this site indicates the latest middle Miocene age. At Sop Mae Tham, they found a new late Miocene fauna including Hipparionini. Its mammalian fauna consists of tetralophodont gomphotheres, rhinocerotid, hipparionin, equids, *Listriodon*, *Propotamochoerus* or *Hippopotamodon*, tragulids, Boselaphini and primitive bovids, suggesting the early late Miocene age. From the sand pits in Tha Chang, they found three new Late Cenozoic mammalian faunas at least. Firstly, the Middle Miocene mammalian fauna consists of amebelodontid gomphothere and *Prodeinotherium* Secondly, the Late Miocene to Early Pliocene fauna contains *Hipparion*, *Stegolophodon*, and *Merycopotamus* and lastly, the early Pleistocene fauna is represented by advanced *Stegodon*.

Thasod and Ratanasthien (2005) reported on the new proboscidean fossils that were discovered from Tha Chang Sandpits, Nakhon Ratchasima. They are *Sinomastodon.* Beside, the *Merycopotamus* skull was discovered in situ from a

sand layer by Haruo Saegusa. Most details of the cranium are well preserved (Hunta *et al*., 2005).

The fossil trees of Ban Tha Chang were studied by Vozenin-Serra and Prive-Gill (1989). They were composed of *Araucarioxlyon sp., Shoreoxylon thailandense, Careyoxylon pndicherriense, Treminalioxylon coriaceum, Terminalioxylon burmese, Pahudioxylon sahnii, Cynometroxylon schlagintweitii and Albizzinium eolebekkianum.* Such a floristic assemblage is believed to represent a mixed deciduous forest Vozenin-Serra and Prive-Gill (1989) suggested that the fossil woods of the Mun River are Plio-Pleistocene in age, while the Prakash (1979) suggested that these trees are upper Tertiary in age. These trees are of like floristic assemblages to those present in Thailand and southeast Asia today. Palynomorphs collected from Ban Tha Chang are consistent with a Quaternary age but do not allow for any finer resolution (Maloney and Howard, 2000).

Charusiri *et al*. (2002) dated sand samples from Ban Tha Change using thermoluminesence techniques. Their preliminary data produced a wide scatter in thermoluminesence model ages that ranges from 0.623 to 4.338 million years (Charusiri *et al*. 2002). Radiometric dating of Australasian tektites repeatedly produces ages of about 0.8 million years (Kunz *et al*. 1995; Yamei *et al*., 2000). The position of a deep-sea microtektite horizon confirmed that the Australasian tektites was formed about 0.012-0.0165 million years prior to the Brunhes/Matuyama polarity reversal that was dated at 0.78 million years (Schneider *et al*. 1992; Lee and Wei, 2000).

Geological age of the fossil in the sandpits was suggested to be about Miocene to Holocene (Sato, 2002). Nakaya *et al*. (2003) divided the fossils into three assemblages. Firstly, the Middle Miocene Mammalian fauna consists of an amebelodontid gomphothere and *Prodeinotherium.* Secondly, the Late Miocene to Early Pliocene fauna contains *Hipparion*, *Stegolophodon*, and *Merycopotamus* and lastly, the early Pleistocene fauna is represented by advanced *Stegodon*. The conditions of erosion on the surface of these fossils were suggested that they were not transported for long distances and this was the Tertiary deposits in Khorat Plateau at more than 20 meters depth (Thasod and Ratanasthien, 2005).

1.5.2 Stratigraphy of the Sandpit

Nakchiya (2002) studied the sand pit at Ban Nong Bua Ri, Changwat Nakhorn Ratchasima. He concluded that the high gravel bed at Ban Nong Bua Ri is subdivided into stratigraphy of five units. The upper most unit was interpreted as a fluviatile deposites of the Pleistocene age. The unit 2nd and 3rd were interpreted as a alluvial fan deposits of the Pliocene age. The unit 4th and the lowest unit were interpreted as a alluvial fan deposits of the Miocene.

Sato (2002) reported about the stratigraphic of the sand pit at Ban Non Man Thet. Columnar section is shown in figure 1.3. It is subdivided into five horizons from top to bottom as shown in Table 1.1.

Table 1.1 Showing the description of lithostratigraphy from the sand pit at Ban Non Man Thet (Sato, 2002).

Horizon	Description	Fossil	Age
1	Sands and granule to pebble beds	*Elephas maximus* Linnaeus, Polished stone tools and fragments of ceramic	Historical age
2	Laminated fine sands with scars of roots and alternation of sand and clay		Holocene
3	Cross bedded coarse grain sandstone and granule pebble conglomerate	Tektite yielding horizon	Early Pleistocene
4	Granule to pebble conglomerate, Lenticular beds of clay with granule conglomeratic sandstone and laminated pebble conglomerate and cross laminated conglomeratic coarse grained sandstone	*Rhinoceros* sp. *Stegodon* sp. *S.(Eostegodon)* sp. *Bubalus* sp. *Cervus* sp. *Equus* sp.	Pliocene
5	Alternations of clay and laminated fine sandstone with fragments of plant and wood	*Mastodon* sp.? *Stegolophodon* sp.	Miocene (Early to Middle)?

From the characteristics of sedimentary structures, ill-sorted sediments and predominance of conglomerate, almost of the sediments belong to the fluvial deposits. In special, on the fourth horizon, lenticular structures are peculiar to the crescent lake deposits in the waste-filled valley deposits (Sato, 2002).

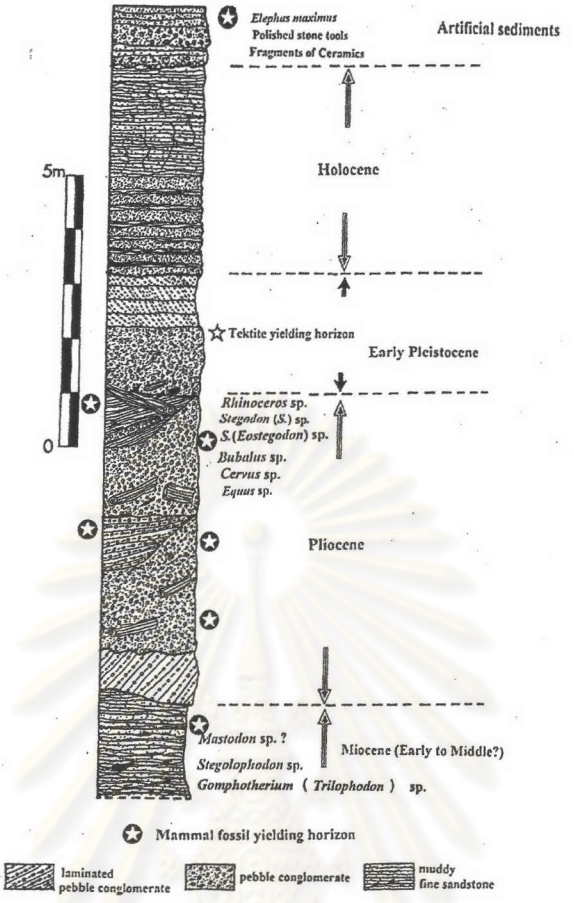

Figure 1.3 Columnar section of the sandpit, in Ban Non Man Thet (Sato, 2002)

Raksaskulvong *et al*. (2003) reported about the observation of Quaternary sediment in Changwat Nakhon Ratchasima. Almost of these area were covered by unconsolidated Quaternary sediment. The outcrop of the sandpit, core drilling, and hand auger drilling were used to observe and classified into three unit as terrace deposit unit (Qt), saprolite unit (Qr), and alluvial deposit unit (Qa). (see. Figure 1.4)

Hunta *et al*. (2005) reported about the stratigraphic sequences of the Tha Chang sandpit number 8, which yielded a *Merycopotamus* and a number of other mammalian fossils. They are made up of alternated layers of fine sand, coarse sand and silt with occasional gravel layer. Among the sediments, tree trunks, and animal fossil remains are associated in the silt, sand, and gravel layers.

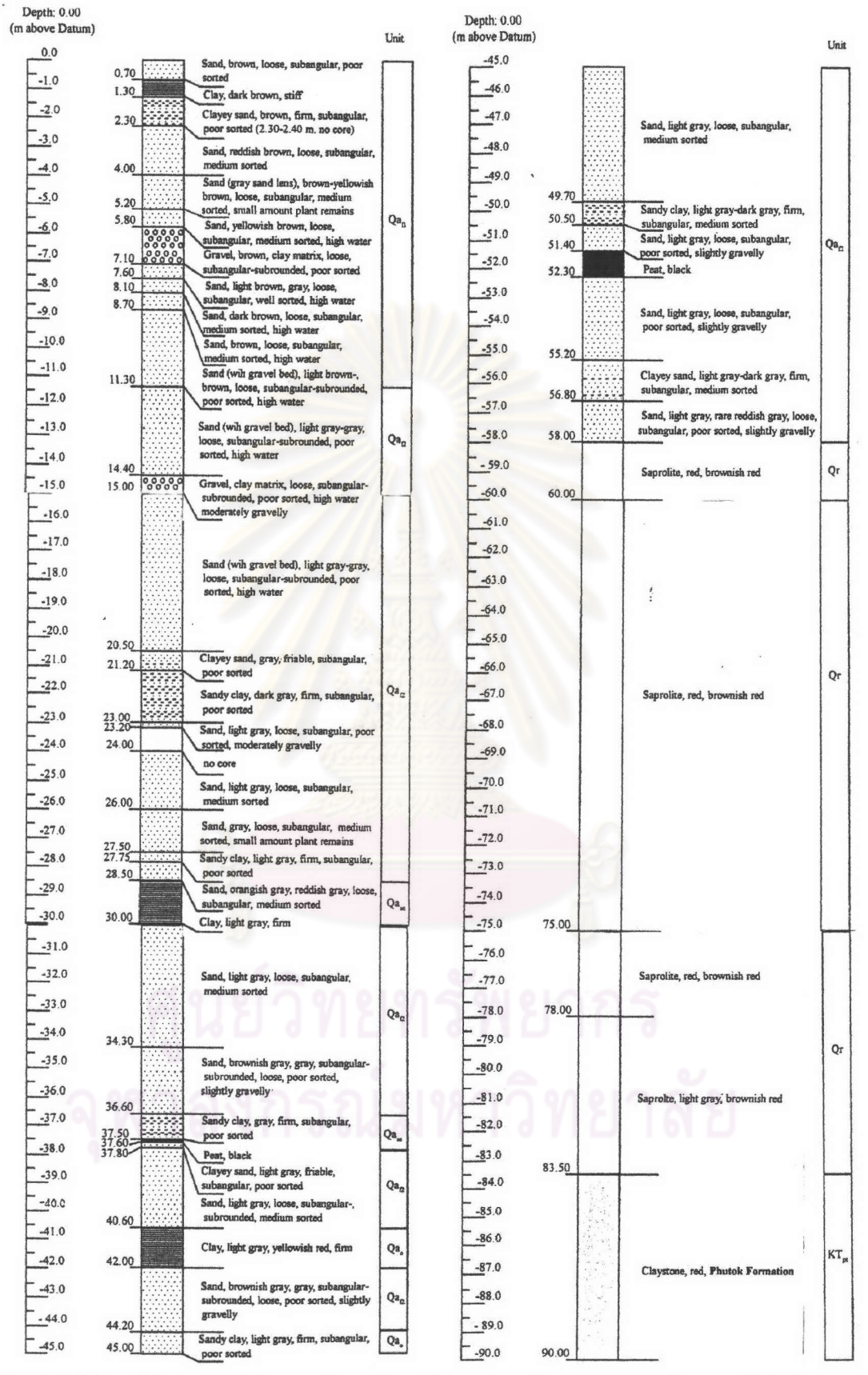

Figure 1.4 Lithostratigraphic columnar section of SW of Siam sand pit from core drilling (Raksaskulvong *et al.*, 2003).

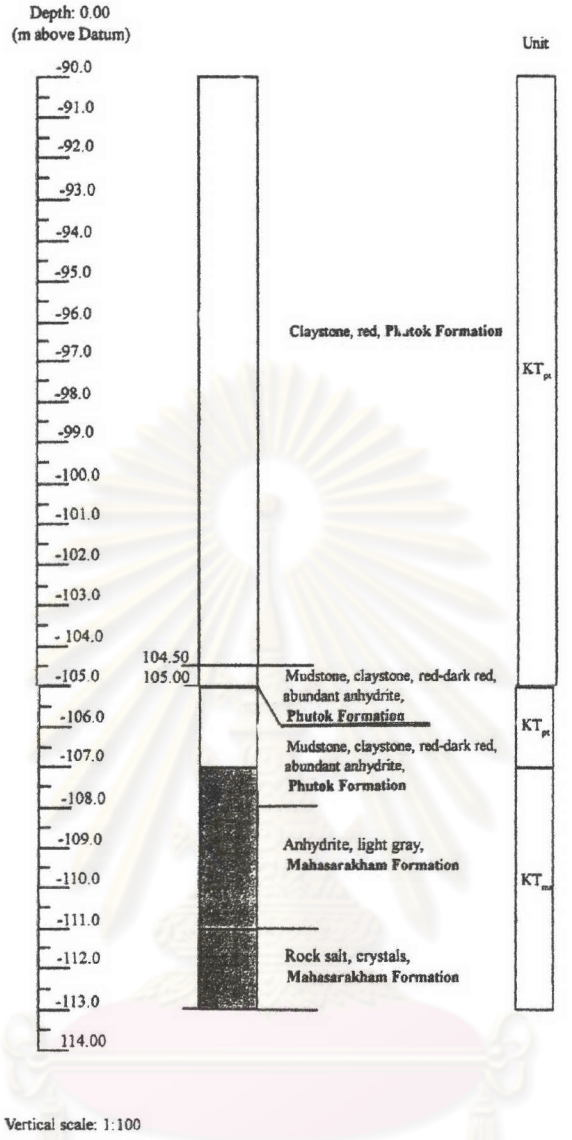

Figure 1.4 (continued) Lithostratigraphic columnar section of SW of Siam sandpit 200 meters from core drilling (Raksaskulvong *et al.*, 2003).

1.5.3 Paleo-environments

Nutalaya *et al.* (1988) reviewed the landform development of the Khorat Plateau as follow;

McGowan International Team (1982) attempt to systematically analyze the palaeoenvironment of the Khorat Plateau during the Quaternary Period. They recognized that at least two major periods of erosion and incision. The Tertiary period was characterized by deep weathering of the bedrock and gently undulating landscape, the remnants of which are preserved beneath the shallow alluvial sediments of the northern Tung Kula Ronghai plain. Low, flattop plateau remnants with deep weathering profiles (high terrace) along the margin of the Mun and Chi

River basin may also be remnants of this period. During the early the Quaternary period a lowering of base level caused this landscape to be dissected and the main valleys were deepened up to about 150 m below their present levels. This was followed by a major period of sedimentation in the basins leading to filling up of the valleys and the formation of the extensive plains.

Superimposed onto these events were climatic changes which were associated with the world wide cooling and warming during the Pleistocene. This cooling was associated with drier conditions probably resulting from the greatly extended land area during the glacial low sea level stage. These drier environments resulted in reducing vegetative cover in the catchment areas and increasing supply of sandy sediments into the rivers causing braided floodplain conditions. This led to the widespread accumulation of sand in the lower lying, low energy basins. Eolian activity was also associated with these processes and sandy material was blown out of the braided stream beds and deposited as sand sheets and sand mantles in the vicinity of the stream beds (Loeffler *et al.*, 1983).

The following event is stratigraphically well defined by the presence of organic material throughout the sequence. Three dated wood samples were given and approximate radiometric control of this period which lasted until about 34,000-20,000 years B.P. The presence of organic material throughout this layer indicates that deposition occurred in a relatively humid environment probably consisting of alluvial plains with central meander belts and wide marginal backplains that supported alluvial and swamp forests. Water logging caused reducing depositional and early burial environments and guaranteed the preservation of the organic matter. This phase was interpreted as a humid prior period to the last glacial maximum. (Loeffler *et al.*, 1983)