

CHAPTER IV
GEOMORPHOLOGY AND GEOLOGY
OF SAND DEPOSITS

4.1 Introduction

This chapter the geology and geomorphology of the study area will be discussed. The geomorphology and geology of sand deposits are based on airphoto interpretation, topographic maps, together with well log and drill hole data and field investigation.

The geomorphology and geology will be treated in separate parts.

4.2 Morphology and Landform of Sand Deposits

Tanaosri range is the source of materials (gravel, sand, silt and clay) that is transported by the Kvae Noi and Kvae Yai. These two rivers join together to form Mae Klong River at Kanchanaburi.

Base on magnetic anomaly Natalaya and Rau (1981) found that the faults are structural controlled of the Mae Klong. These faults were in NW-SE direction (Figure 1.7).

The study area is composed of Mae Klong Alluvial Fan (Takaya and Thiramongkol, 1983) or Kanchanaburi Alluvial Fan (Selvakumar, 1977) and tidal flat of brackish clays (Thiramongkol, 1984). The Mae Klong

Alluvial Fan covers most part of the study area and the tidal flat of brackish clay occurs in the east and south of the area.

4.2.1 Slope Conditions

Selvakumar (1977) and Supajanya (1983) made detailed study on topography and slope conditions of the study area. The Mae Klong Alluvial Fan and tidal flat of brackish clay have the elevation 28 to 2 meters above mean sea level. Supajanya (1980) classified the Lower Chao Phraya plain into 3 levels : 3.5-4 meters, 6-8 meters and 15-18 meters higher than the present sea level (Figure 1.6). Figure 4.1 shows cross-sections scale 1:50,000 every distance of 5 kilometers in East-West direction and the levels are the same as those of Supajanya (1983). But the detailed study from topographic maps scale 1:10,000 and 1:4,000, it is found that the approximate slopes 2-3 meters, 5-8 meters, 11 to 14 meters and 16 to 23 meters is 0.25 meters/kilometer (Figure 4.2) and 3-5 meters, 8-11 meters and 14-16 meters is 0.75 meter/kilometer. However Selvakumar (1977) made the mean slope of Kanchanaburi Alluvial Fan at approximately 0.5 meter/kilometer. It can be concluded that the slopes of the fan range from approximately 0.7 meter/kilometer at the top of the fan to approximately 0.3 meter /kilometer at the lower part.

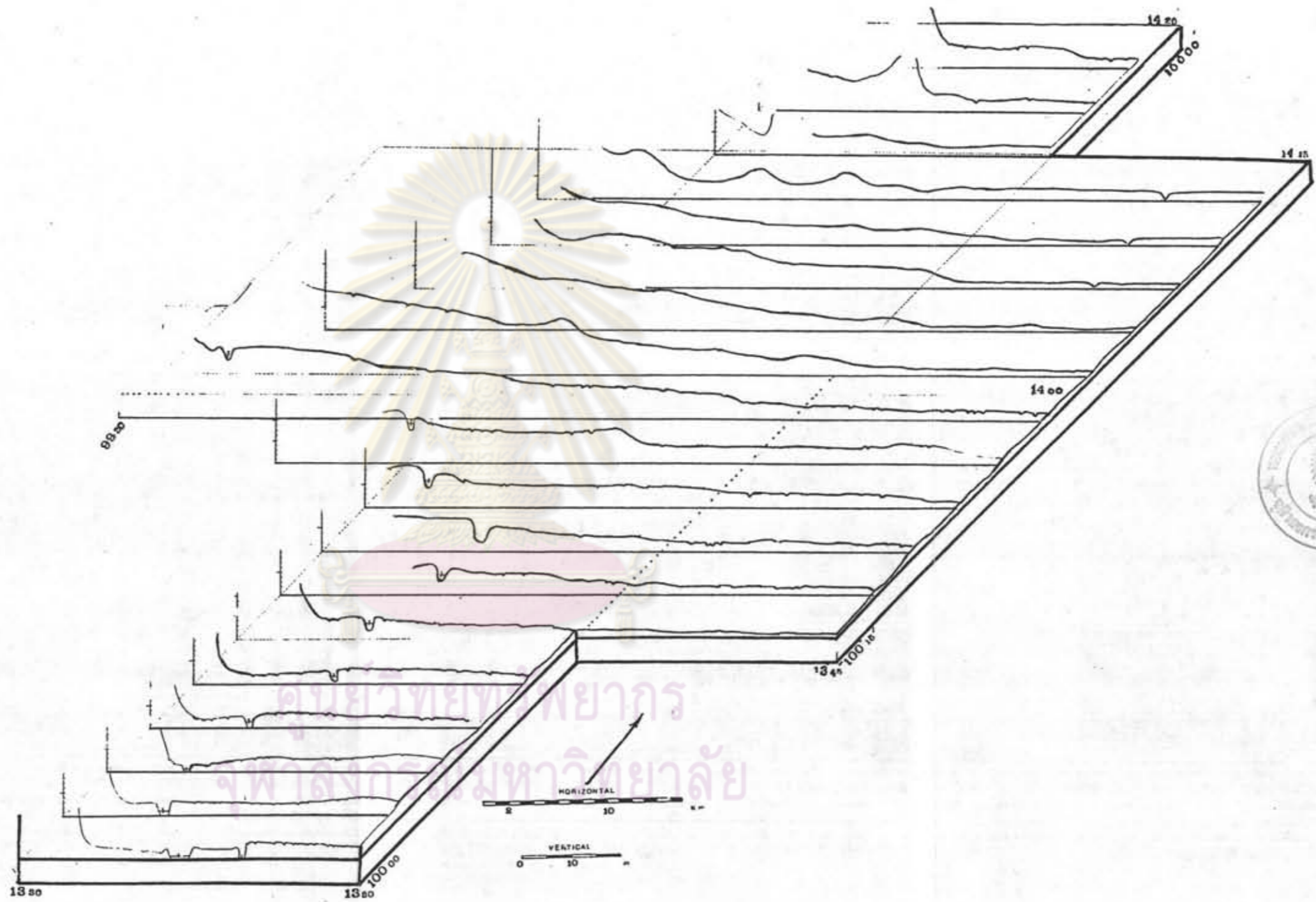


Figure 4.1 East - West cross sections show different topography every 5 kilometers
(modified from topographic map scale 1:50,000)

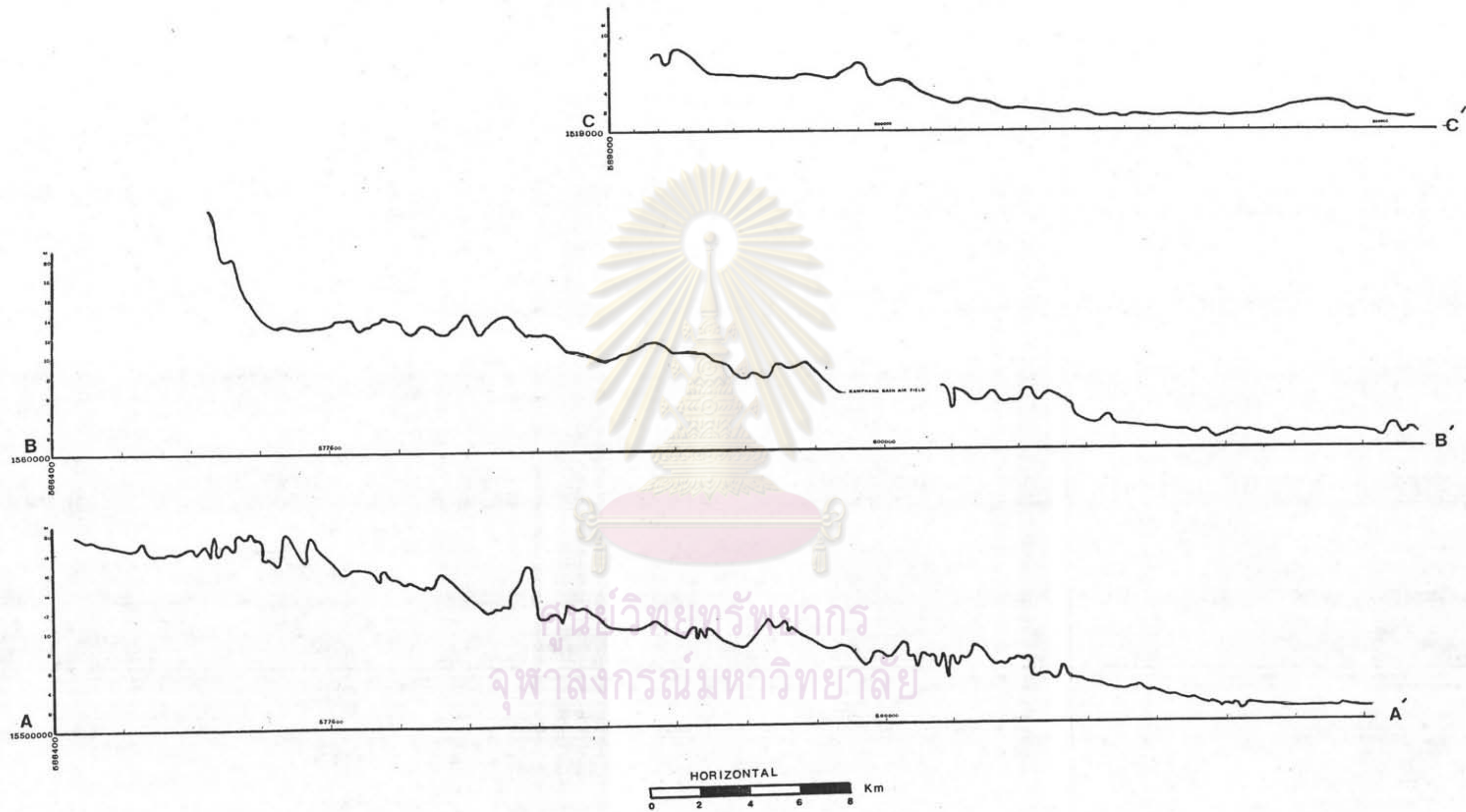


Figure 4.2 East - West cross sections of the study area (see Figure 4.16) kilometers showing profiles along AA' , BB' and CC'.

4.2.2 Drainage Patterns

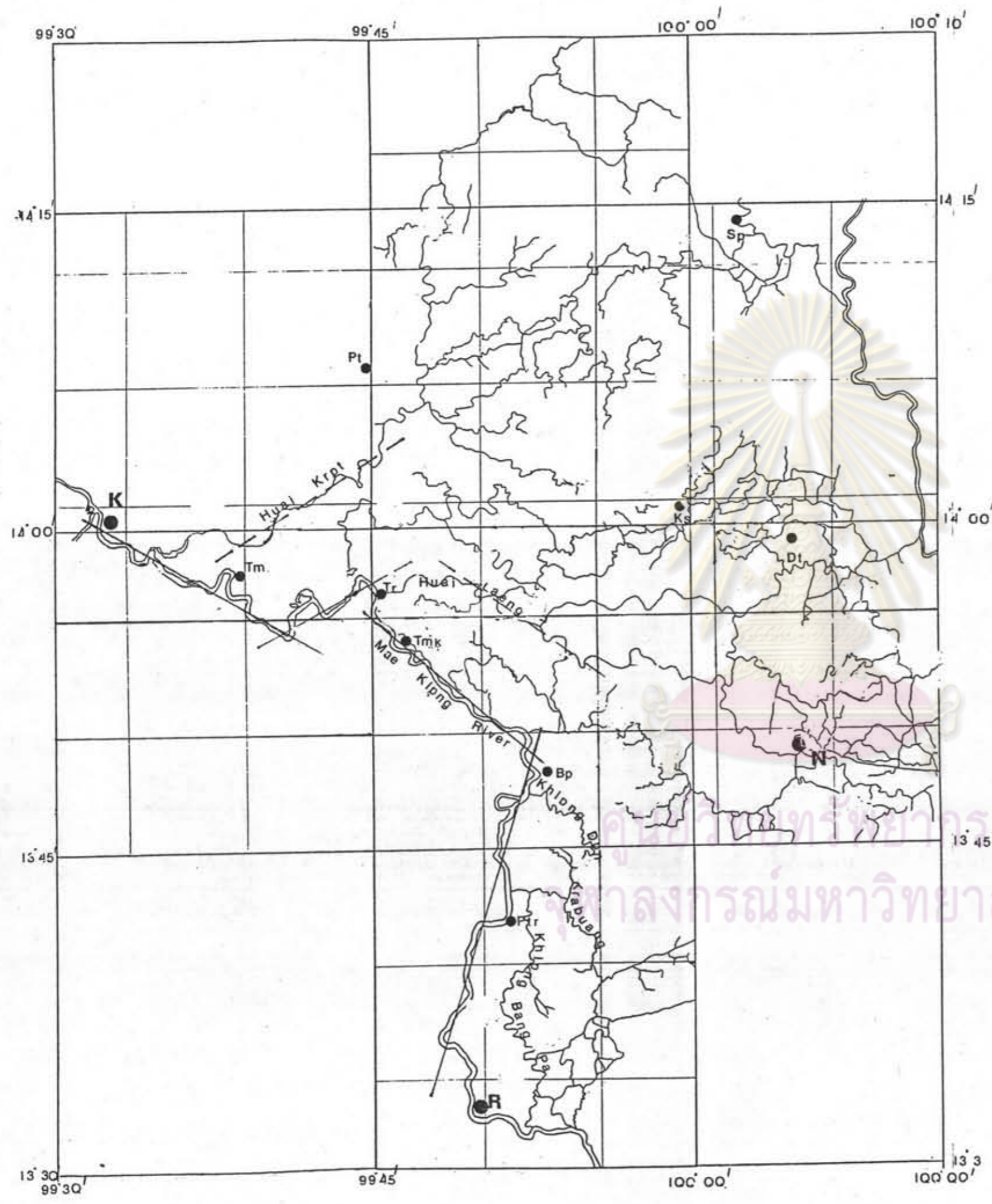
The drainages in the study area distribute from Mae Klong River at different points. The Mae Klong is controlled by a fault zone (Natalaya and Rau, 1981)(see Figure 1.7). Figure 4.3 shows Huai Krot, Huai Laeng and others distribute from the Mae Klong in NE-SW direction which might be another fault system.

There are four main distributaries of the Mae Klong. These four distributaries are :

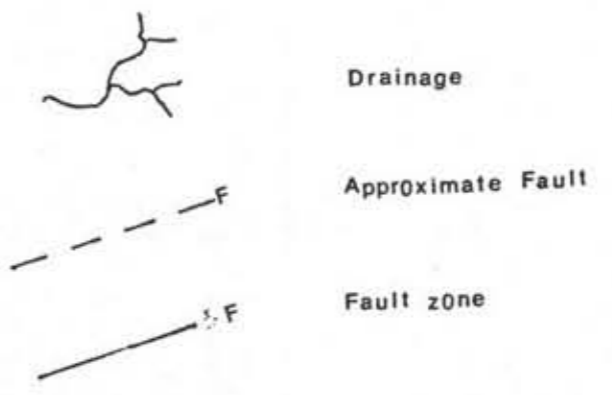
1. Huai Krot distributes from the Mae Klong at Ban Tha Lo, Amphoe Muang, Changwat Kanchanaburi (Figure 4.4).
2. Huai Laeng distributes from the Mae Klong at Amphoe Tha Rau, Changwat Kanchanaburi (Figure 4.5).
3. Khlong Don Krabuang distributes from the Mae Klong at Amphoe Ban Pong, Changwat Ratchaburi(Figure 4.6).
4. Khlong Bang Pa distributes from the Mae Klong at Amphoe Photharam, Changwat Ratchaburi (Figure 4.7).

4.2.3 Sand Deposits along Mae Klong Flood Plain

This area is in the western part of the study area. Sand deposits occur along the Mae Klong. The area. Sand deposits occur along the Mae klong. The size of sand deposit is related to the size of meander belt. The



EXPLANATION



- Changwat
- | | | | |
|---|--------------|---|---------------|
| K | Kanchanaburi | N | Nakhon Pathom |
| | | R | Ratchaburi |
- Amphoe
- | | | | |
|-----|---------------|-----|----------------|
| Sp | Song Phi Nong | Pt | Phanom Thuan |
| Tm | Tha Muang | Tr | Tha Rau |
| Tmk | Tha Maka | Ks | Kamphaeng Saen |
| Dt | Don Tum | Ptr | Photharam |
| | | Bp | Ban Pong |

Scale 1:400,000

Figure 4.3 Map showing drainage patterns and faults

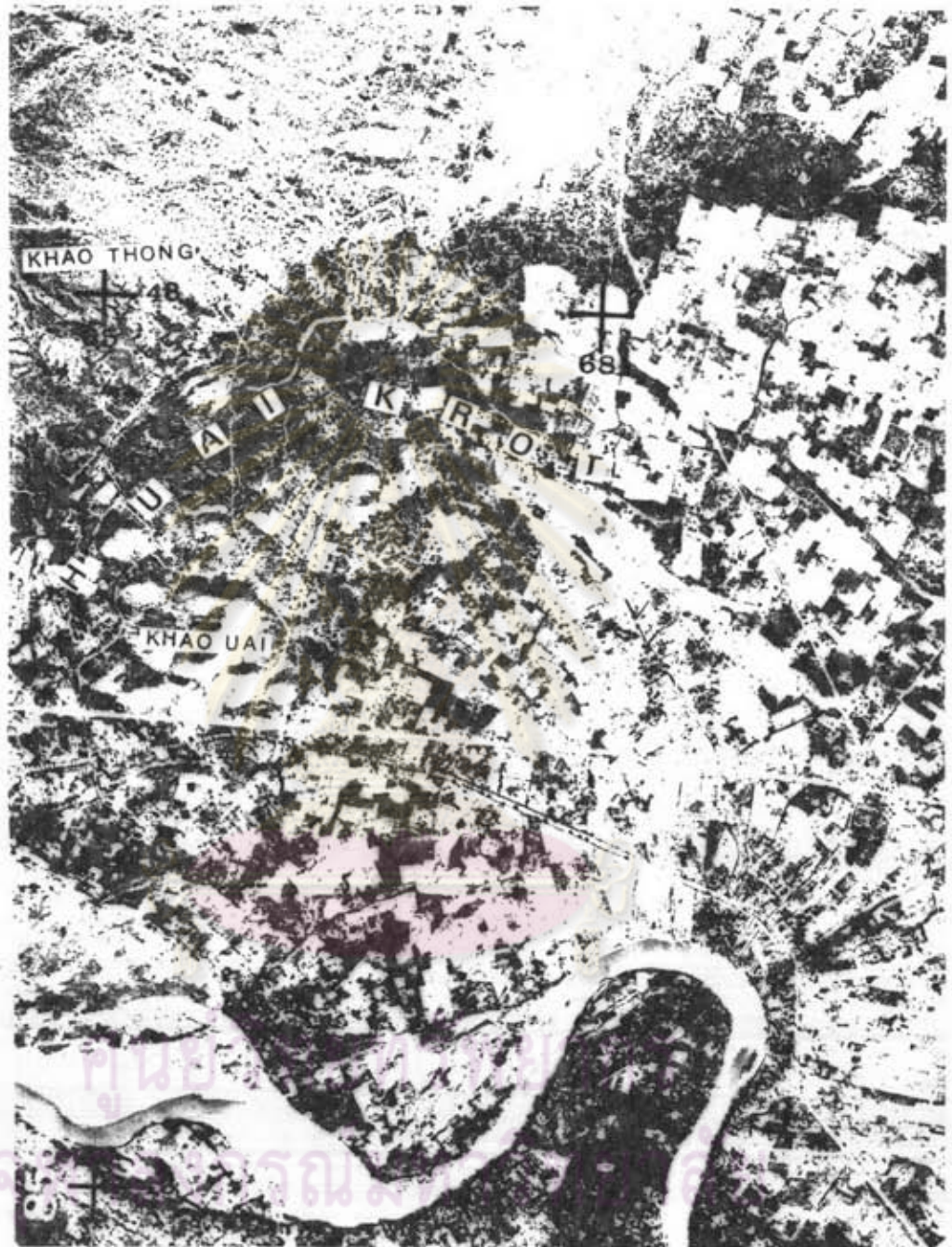


Figure 4.4 Showing Huai Krot distributes from Mae klong River at Ban Tha Lo. These two rivers have large meander belts and big areas of sand deposit at elevation 27 to 18 meters (Photo scale 1:40,000)



Figure 4.5 Showing distributes from Mae Klong River at Tha Rua. Huai Laeng shows oxbow lake (at the top of picture) at elevation 18 meters above MSL. (Photo scale 1:40,000)

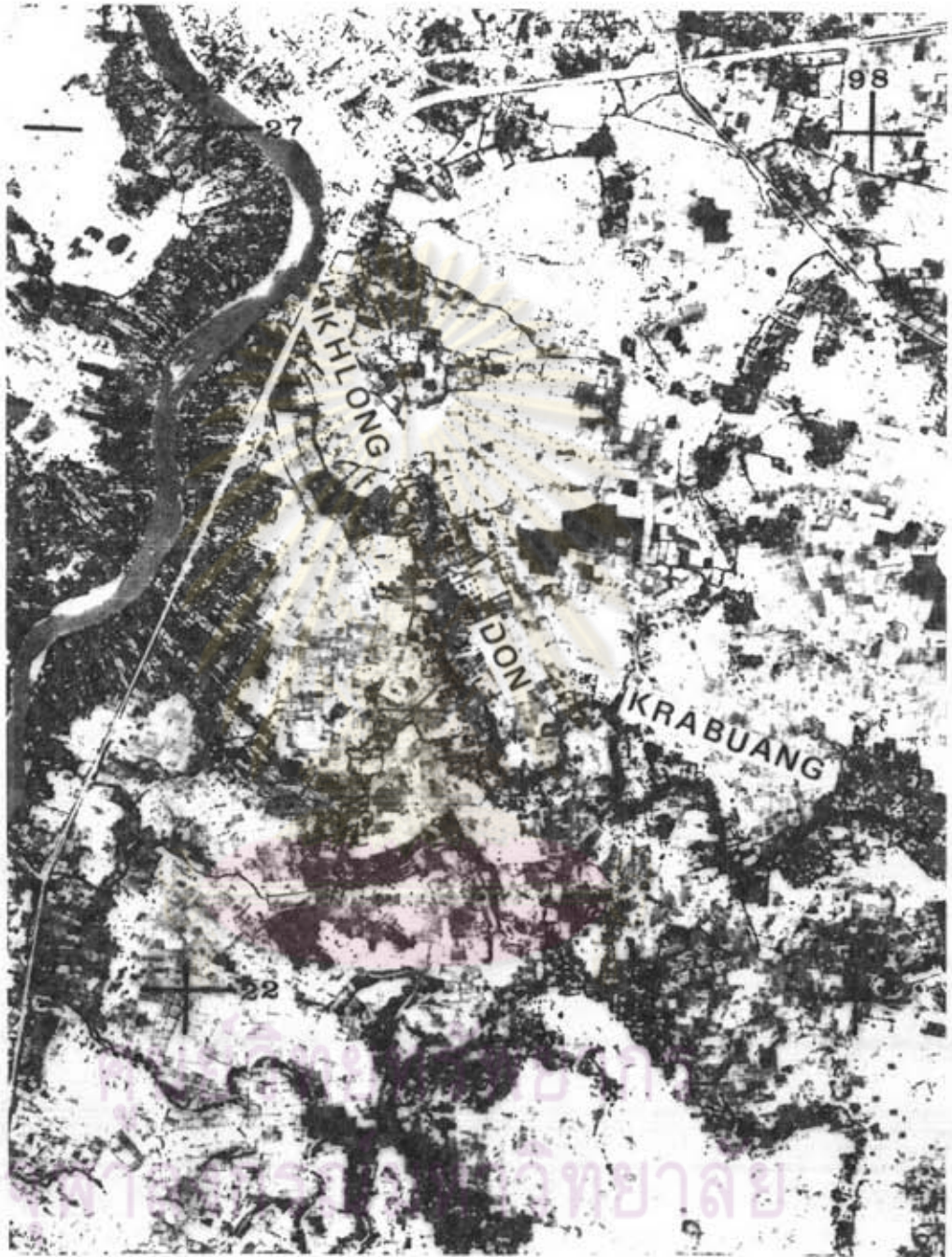


Figure 4.6 Showing Khlong Don Krabuang distributaries from Mae Klong River at Ban Pong at elevation 8 meters above MSL (Photo scale 1:40,000)

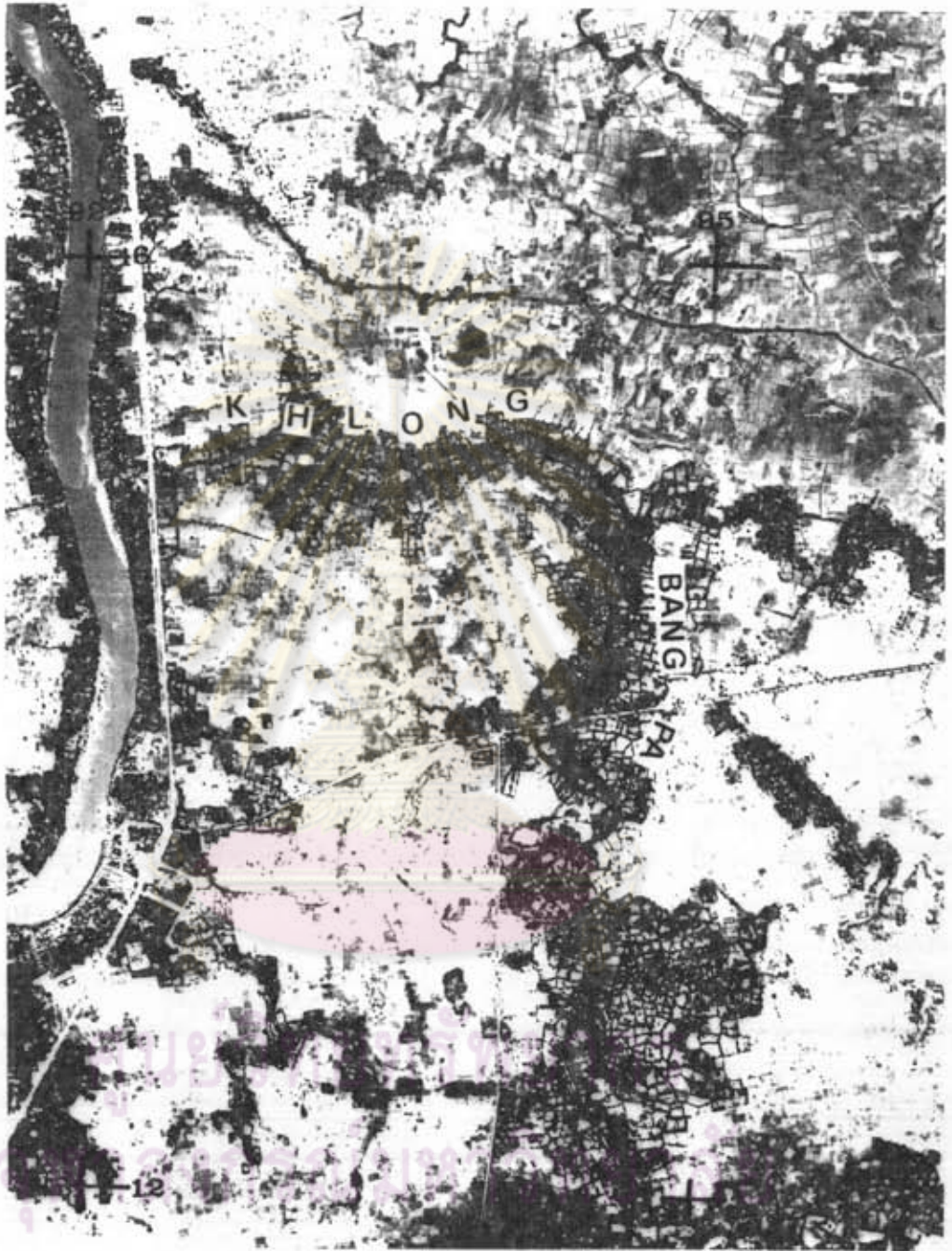


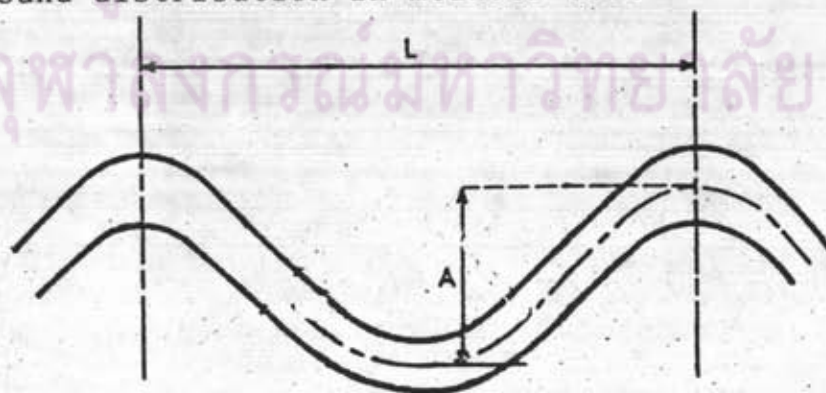
Figure 4.7 Showing Khlong Bang Pa distributes from Mae Klong River at Photharam, at elevation 8 meters above MSL. (Photo scale 1:40,000)

size of meander belt at elevation 27 to 18 meters between Amphoe Muang Kanchanaburi to Amphoe Tha Rau, at 18 to 8 meters between Amphoe Thu Rau to Amphoe Ban Pong, and at 8 to 5 meters between Amphoe Ban Pong to Amphoe Muang Changwat Ratchaburi are ranging from the large, medium and small respectively.

The ratio amplitude and length of meander can indicate the difference in size of sand deposits (Sobrinho, 1984) and so as the difference in elevation. The size of sand deposits in this study area are according to these concepts

Foot note

The ratio of amplitude per length of meander (A/L) determines the area of meander bar. The sand deposit of the meander bar located on the inside of , and extended into the curve of , a meander; more amplitude increase , more sand distribution in meander bar.



L - LENGTH OF THE MEANDER

A - AMPLITUDE OF THE MEANDER

4.2.3.1 Sand Deposits along Meander Belt of the Mae Klong at Elevation 27 to 18 meters

Flood plain of the Mae Klong at elevation 27 to 18 meters above mean sea level is between Amphoe Muang to Amphoe Tha Rua, Changwat Kanchanaburi. The meander belt is reprimanded by mountaneous area. Sand deposits occur in channel as sand bars and point bars. The ratio of amplitude per length of meandering is ranging from 1/3 to 1/1, width of amplitude is ranging from 1,000 to 2,000 metres, and length of meandering is ranging from 2,000 to 5,000 meters. From aerial photographs, the sand deposit is medium gray tone . Sand bar found along the channel and the length may be more than 1,000 meters, and it is light tone (Figure 4.4).

4.2.3.2 Sand Deposits along Meander Belt of the Mae Klong at elevation 18 to 8 meters

Flood plain at elevation 18 to 8 meters above mean sea level is between Amphoe Tha Rua to Amphoe Ban Pong. Sand deposits occur at meandering or at the vicinity of oxbow lakes in the west of the river. There are small number of sand bars in the area than the area at eleavation 18 to 27 meters above mean sea level. Sand deposits are bigger in the upper area. In the upper

part of this area the size of the meandering has ratio of amplitude per length of meandering (A/L) is ranging from 1/2 to 1/3, width of amplitude is from about 800 to 1,000 meters, and length of meander is from about 800 to 2,500 meters. In the lower part of the area the ratio of A/L is ranging from 1/4 to 1/8, width of amplitude is ranging from 2,000 to 4,000 meters; (Figure 4.5).

4.2.3.3 Sand Deposits along Meander Belt of the Mae Klong at Elevation of 8 to 5 meters

This area is the lower part of the flood plain of the Mae Klong and lies between 8 to 5 meters above mean sea level and is between Amphoe Ban Pong to Amphoe Muang, Changwat Ratchaburi. The size of meander of the Mae Klong in this area is the smallest. Sand deposits occur along point bars and natural levee. Ratio of amplitude per length of meander is ranging from 1/8 to 1/4, width of amplitude ranging from 200 to 600 meters and length of meander ranging from 1,000 to 3,000 meters, (Figure 4.7).

4.2.4 Sand deposits on the Mae Klong Alluvial Fan

The Mae Klong Alluvial Fan (Thiramongkol, 1983) or Kanchanaburi Alluvial Fan (Selvakumar, 1977) is situated in the northwest of the study area. In fact this alluvial fan is covering

Kanchanaburi, Suphanburi and Nakhon Prathom provinces. The apex of the fan is located approximately 10 kilometers in the east of Kanchanaburi and extends to the east direction to Kamphang Saen.

The approximate area of the Mae Klong Alluvial Fan is 2,000 square kilometers. Fan receives sediments from the Tanaosri Range. The elevation of the fan ranges from 27 to 5 meters above mean sea level. This alluvial fan can be divided into 3 zones, between 27 to 16 meters is upper fan, between 16 to 11 meters is mid fan and 11 to 5 meters is lower fan (Reineck and Singh, 1980).

Huai Krot and Huai Laeng are drainages on the Mae Klong Alluvial Fan. Sand deposits occur at point bars, oxbow lakes and old channels of Huai Krot and Huai Laeng.

From aerial photographs the areas of sand deposit along old channels are dark gray to dark tone and point bars are light to light gray.

4.2.4.1 Sand Deposits in Huai Krot

Huai Krot distributes from Mae Klong River at Ban Tha Lo, with elevation approximately at 23 meters above mean sea level, and flow to the northeast, and near Khao Luang Ta the channel bifurcates into 2 streams. At 18 meters above mean sea level (Figure 4.8) one stream flows to the northeast to Amphoe U-Thong and Song Phi Nong, and the other flows to the east to Amphoe

Kamphaeng Saen.

Sand deposits occur at point bar and along old channel. There are 23 sand pits near Kamphang Saen Air Field that are conducted on point bars and along channel of Huai Krot. The elevation difference of sand deposits is shown in Figure 4.9.

The ratio of amplitude per length of meandering is $1/5$ to $1/3$, width of amplitude ranges from 800 to 2,600 meters and length of meander ranges from 4,600 to 7,500 meters (Figure 4.8). These data indicate that sand deposits are generally large.

Huai Krot bifurcates into two streams. Figure 4.10 shows a stream flows to the northeast and Figure 4.11 shows another stream flows to the east direction. The ratio of amplitude per length of meander ranges from $1/2.5$ to $1/2$, width of amplitude ranges from 800 to 1,200 meters and length of meander ranges from 2,000 to 3,500 meters.

The U-form meander on Kamphang Saen sand pit the ratio of amplitude and length of the meander have equal values of $1/1$ and width of amplitude and length of meander have equal values of 1,500 to 2,000 meters.

At elevation between 8 to 5 meters of Huai Krot in the lower fan, the meanderings are smallest and not clearly seen. Thus the ratio of amplitude per length of

meander cannot be calculated.

4.2.4.2 Sand deposits along Huai Laeng

Huai Laeng distributes from the Mae Klong at Amphoe Tha Rua (Figure 4.5) at elevation of 18 meters above mean sea level. It flows to the east of Mae Klong Alluvial fan from elevation between 18 to 6 meters above mean sea level. The Huai Laeng bifurcates into 2 channels near Khao Saphai Raeng.

Sand deposits occur at the vicinity of oxbow lake, point bar and along old channel. From aerial photographs the old channel is dark gray to dark tone and point bar is light to light gray tone.

At elevation 18 to 13 meters above mean sea level it is found that near the distributary point at Ban Takram En, the old channel is oxbow lake (Figure 4.5). The ratio of amplitude per length of meandering ranges from $1/3$ to $1/1.8$, width of amplitude ranges from 700 to 1,700 meters and length of meander ranges from 1,900 to 3,000 meters.

In the southeast of Khao Saphai Raeng before Huai Laeng bifurcates into 2 channels the ratio of amplitude per length of meandering ranges from $1/4$ to $1/5$, width of amplitude ranges from 900 to 1,000 meters and length of meander ranges from 4,400 to 4,500 meters.

At elevation 13 to 6 meters above mean sea level, Huai Laeng bifurcates into 2 streams at the elevation 13

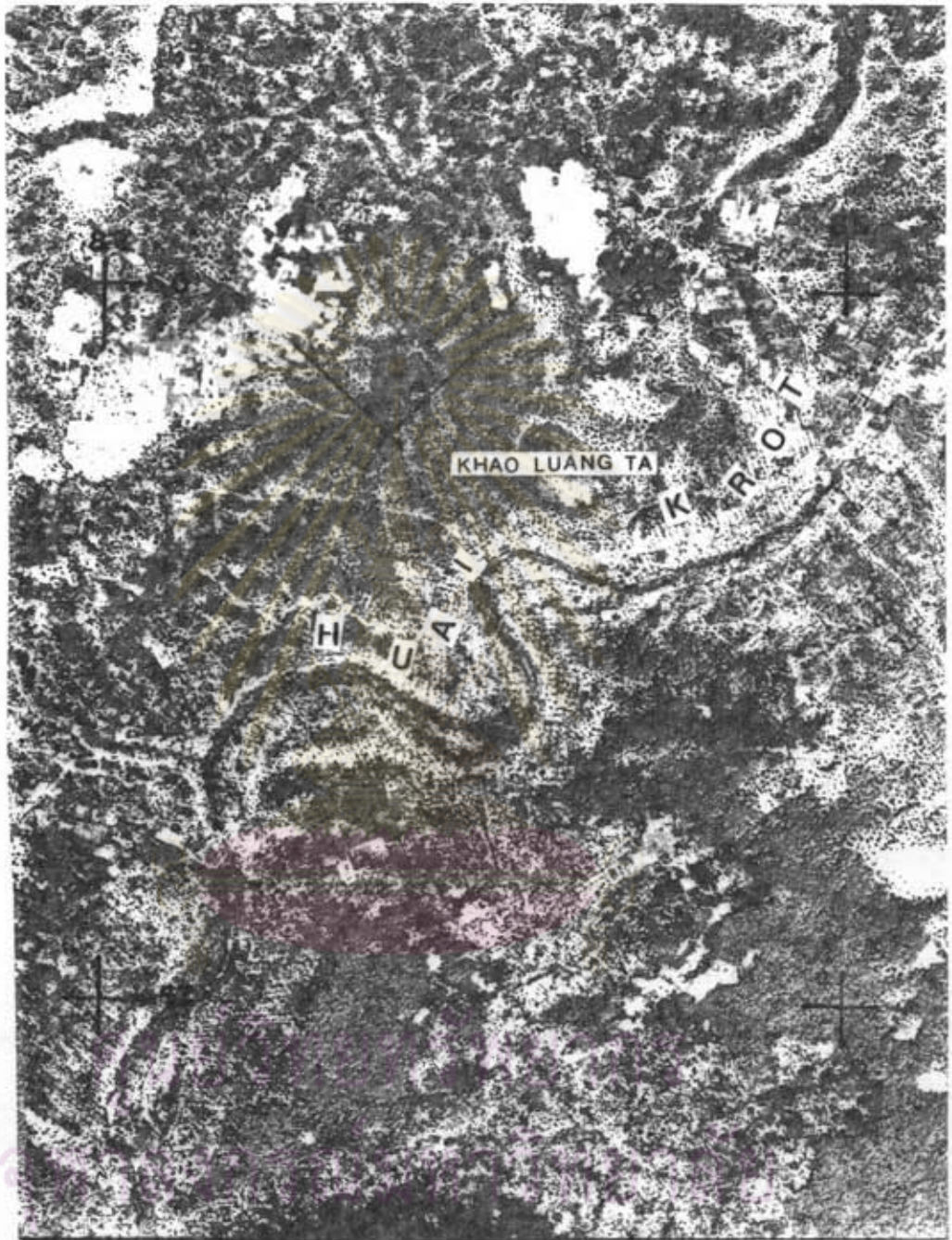


Figure 4.8 Showing Huai Krot bifurcate into two streams at Khao Luang Ta, one stream flows to the northeast and the other flows to the east direction. The size of sand deposits are large.(Photo scale 1:40,000)

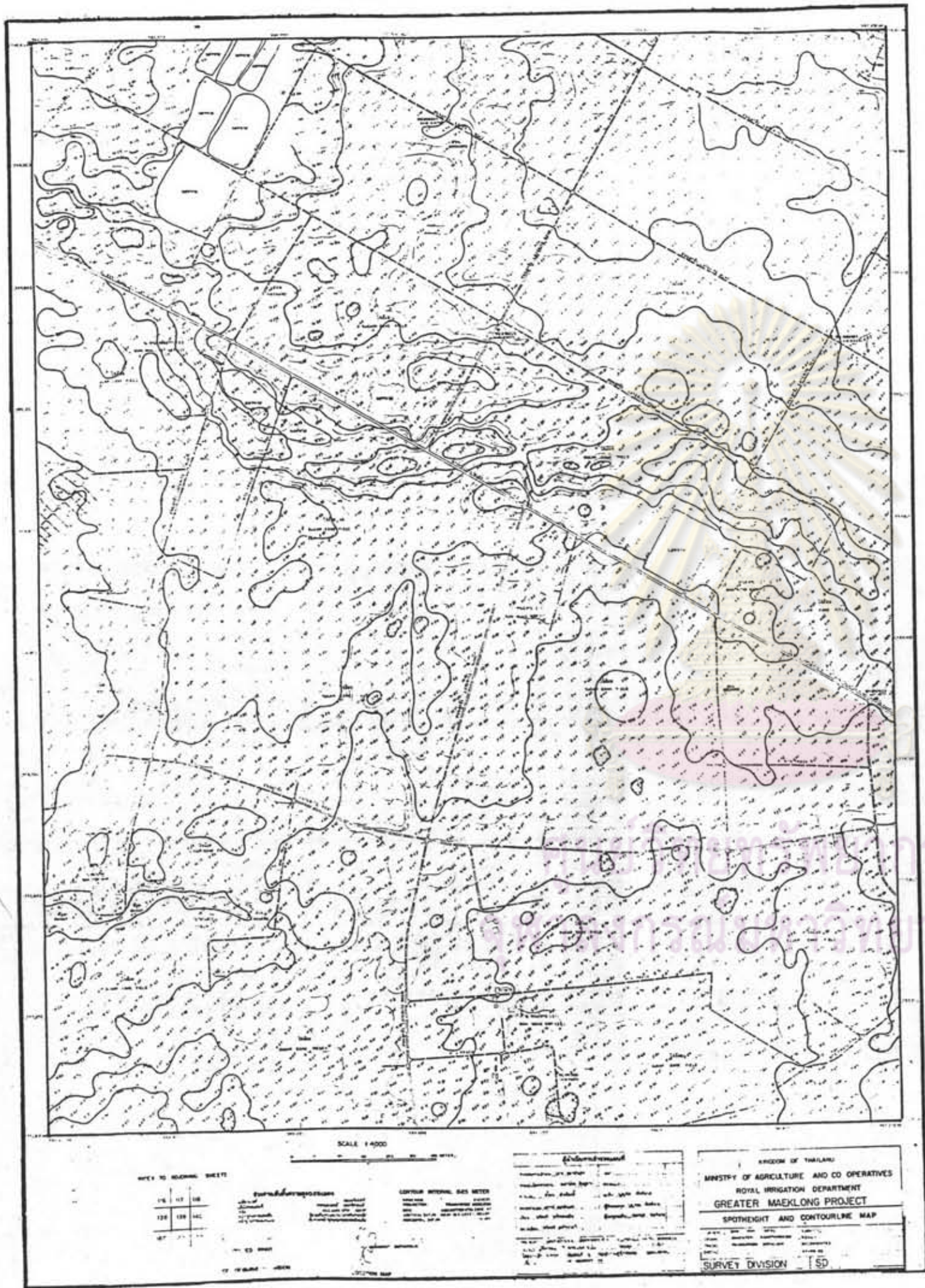


Figure 4.9 Show elevation defference of sand deposits at point bar and along the old channels (NW of photo scale 1:40,000) near Kamphaeng Saen Air Field.

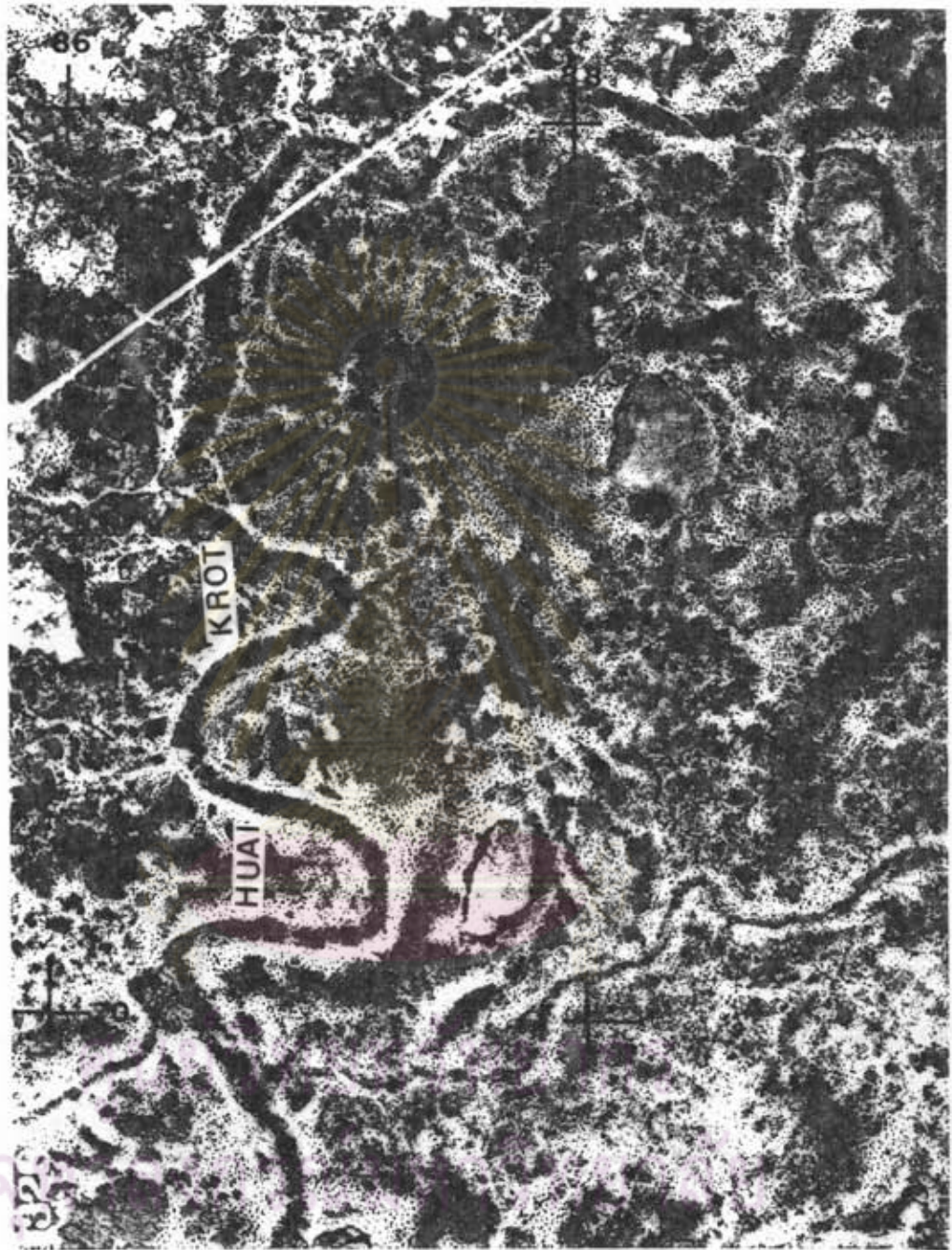


Figure 4.10 Showing a distributary of Huai Krot that flows to northeast direction. The stream is U-from meander. (Photo scale 1:40,000)

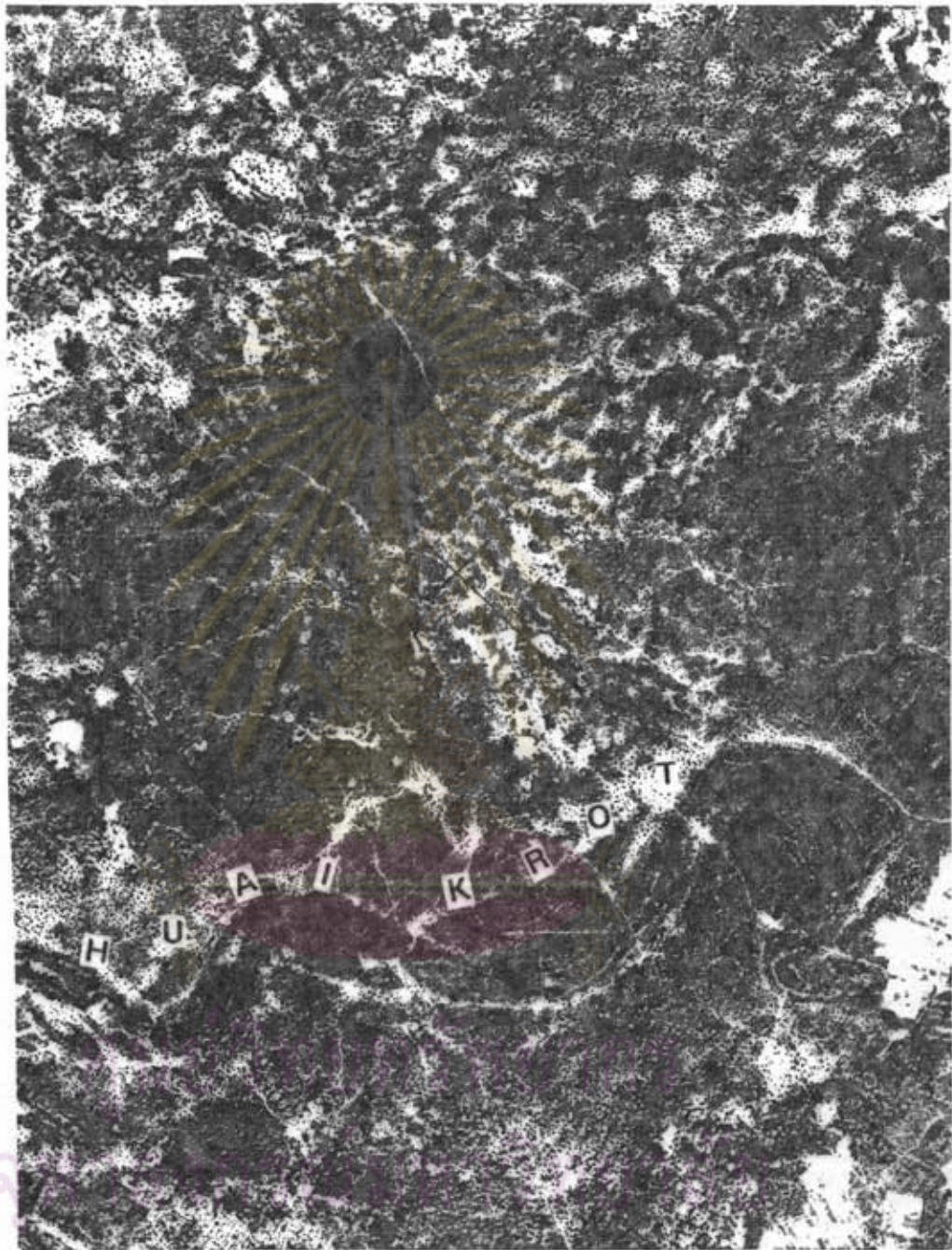


Figure 4.11 Showing Huai Krot flows to Kamphaeng Saen. Sand pit shows U-form shape. In the north of the picture there are many distributaries lie between 8 to 5 meters above MSL.

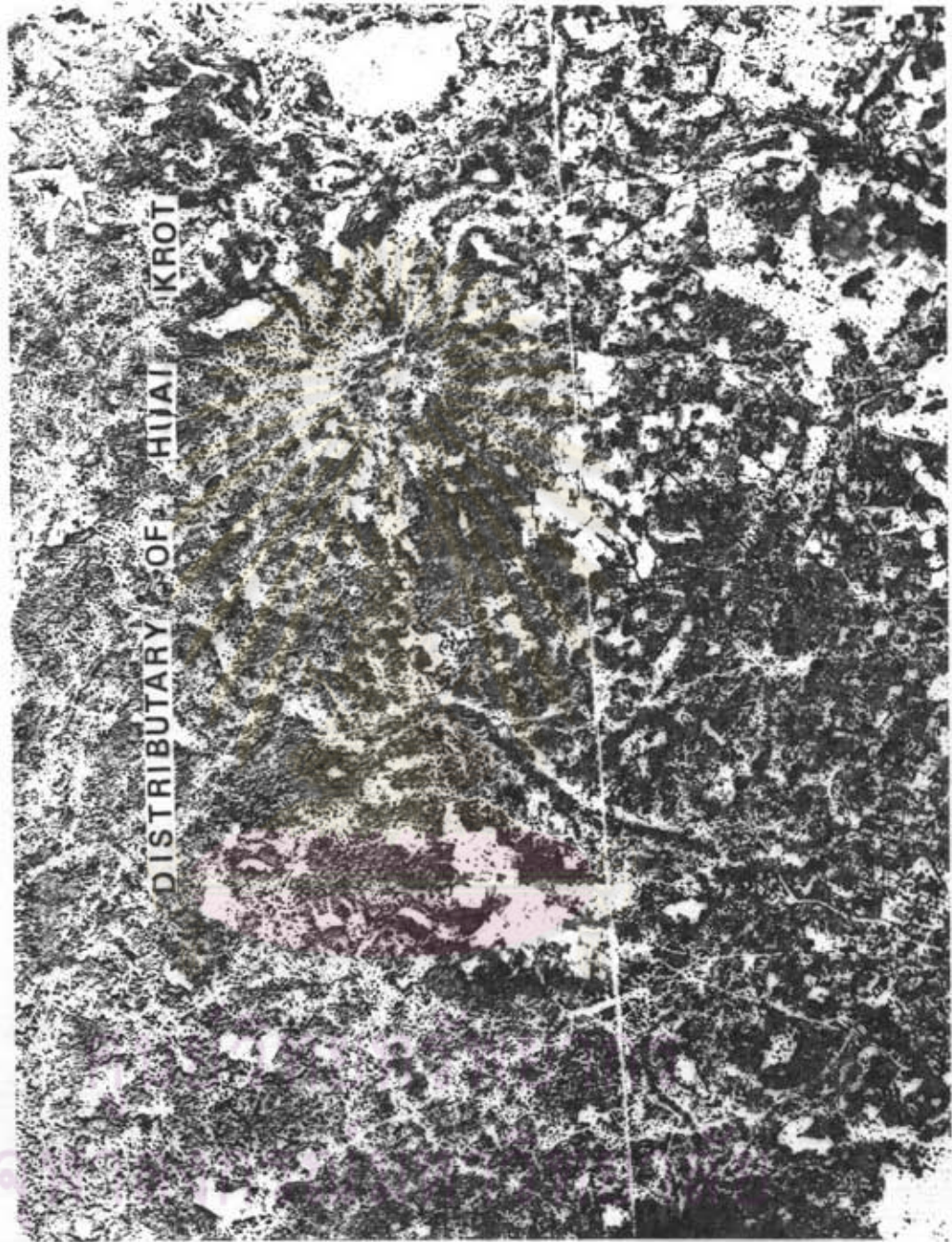


Figure 4.12 Showing numerous distributaries of Huai Krot at elevation between 8 to 5 meters. Sand deposits occur along channels

meters above mean sea level. A stream flows to the east (Figure 4.13) and the other stream flows to the southeast (Figure 4.14). The southeast stream again bifurcates into 2 streams and flow to southeast and south directions (Figure 4.15).

For the stream that flows to the east, the ratio of amplitude per length of meandering have equal value of $1/4.5$ to $1/2.5$, width of amplitude 600 to 1,400 meters, length of meandering 2,500 to 3,600 meters.

The stream that flows to the southeast, the ratio of amplitude per length of meandering ranges from $1/3.4$ to $1/2$, width of amplitude 500 to 1,600 meters, length of meandering 1,800 to 3,900 meters. Besides it is found that U-form meandering has ratio $1/1.25$, width of amplitude 1,200 to 2,000 meters.

The stream that flows to the south the ratio of amplitude per length of meandering ranges from $1/4$ to $1/2.5$, width of amplitude ranges from 400 to 1,000 meters and length of meander ranges from 1,800 to 2,000 meters.

4.2.5 Sand Deposit in Tidal Flat Area

According to Thiramongkol (1984) from the east to south of the study area is tidal flat of brackish clays (young brackish clay bed) that forms extensive low-land plain. The tidal flat of the study area covers about

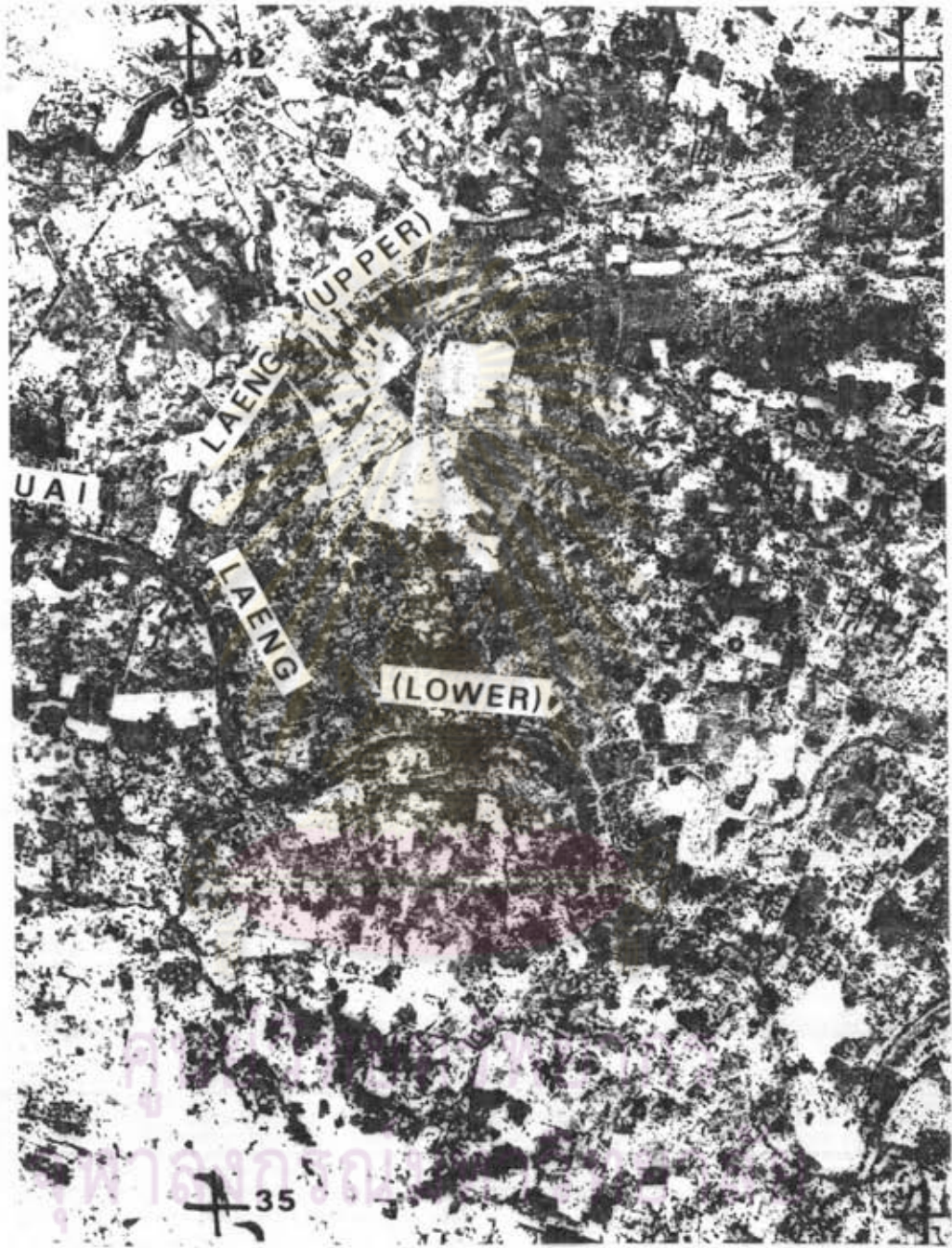


Figure 4.13 Showing Huai Laeng bifurcates into 2 streams the upper channel and the lower U-form channel (Photo scale 1:40,000)

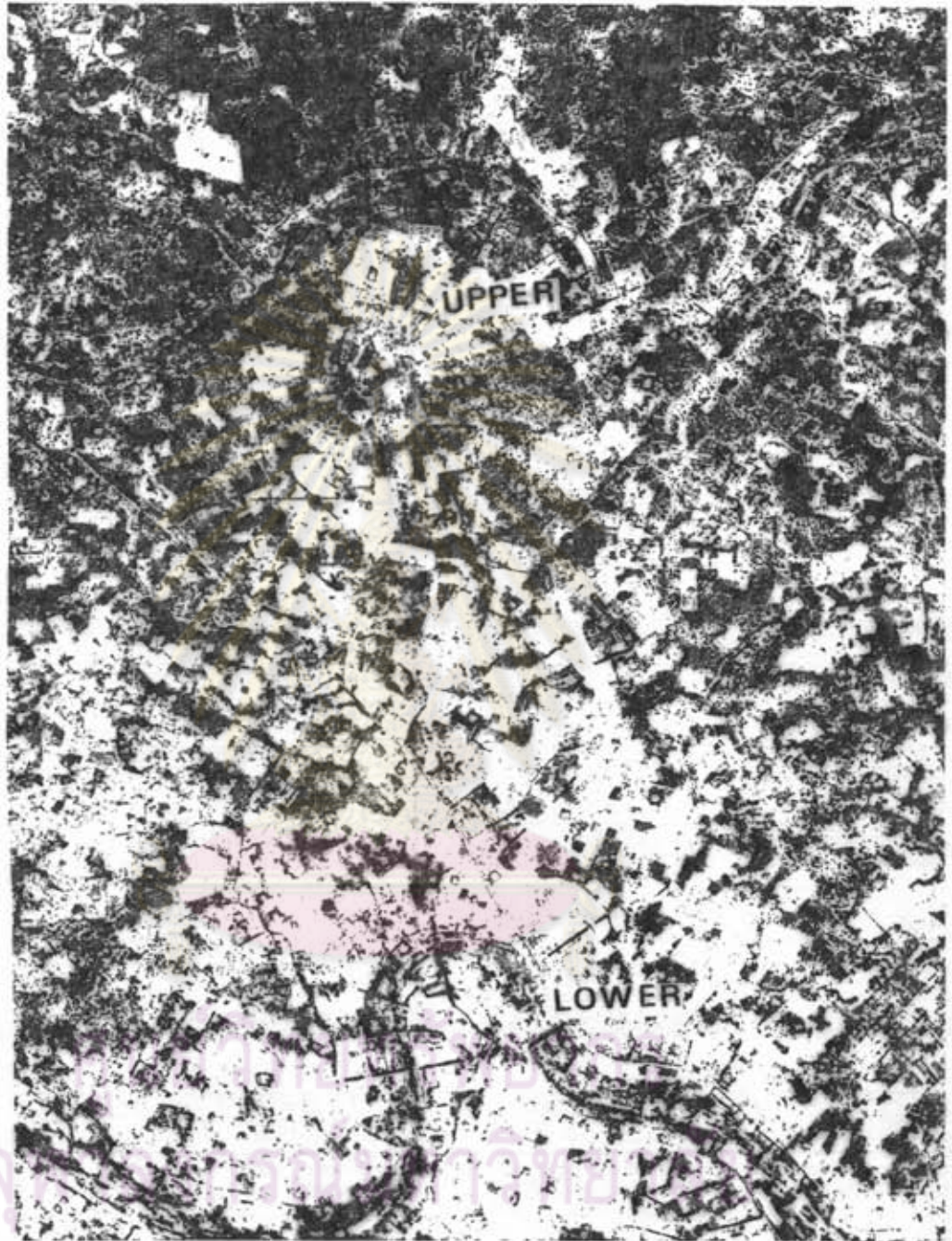


Figure 4.14 The upper channel of Huai Laeng, near Nakorn Phatom-Kamphaeng Saen Road, shows large meandering and U-form shapes.

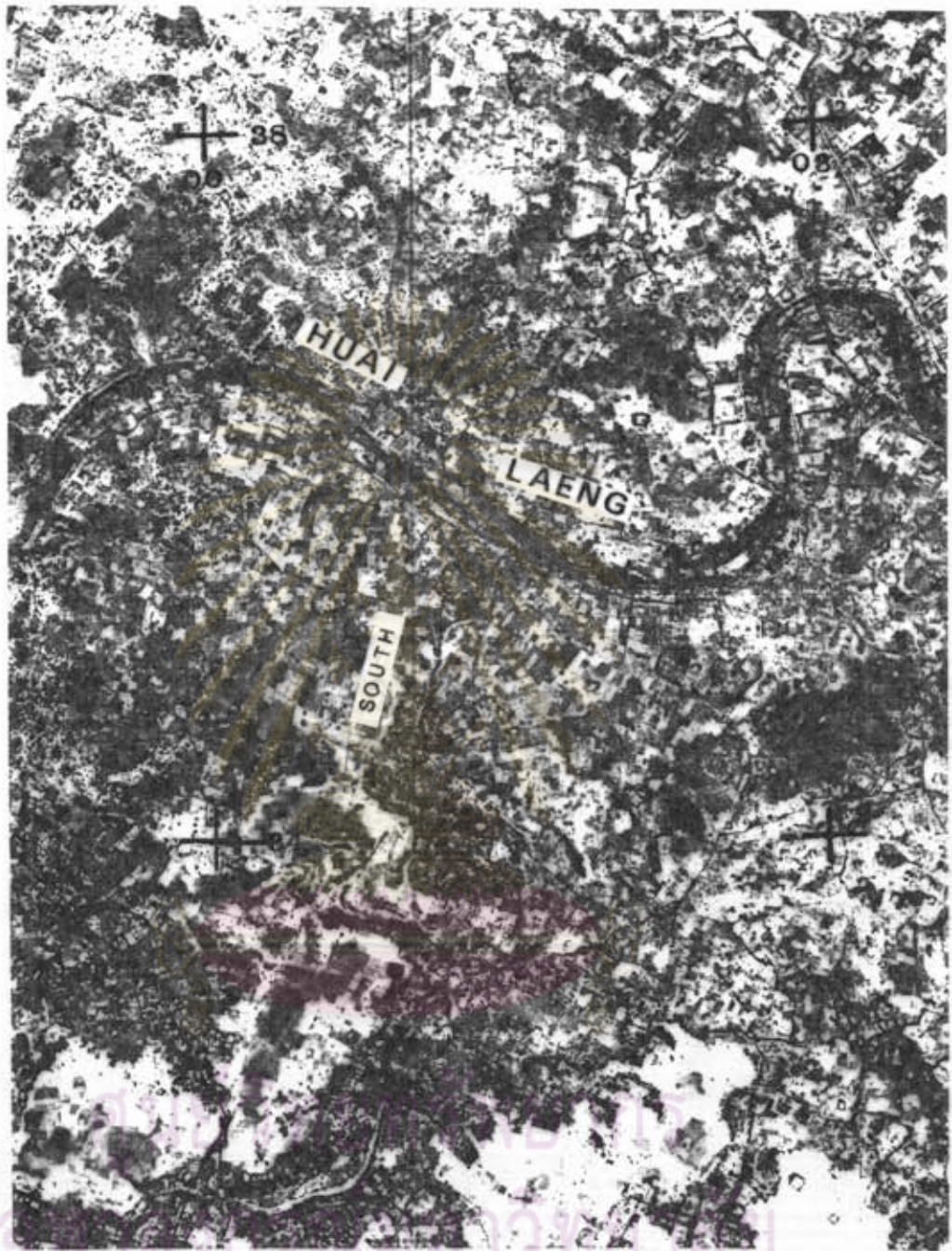


Figure 4.15 Shows lower channel of Huai Laeng, large and U-form meander, bifucates to the south. (Photo scale 1:40,000)

1,000 square kilometers.

The tidal flat of brackish clay occupies a relatively low-lying portion of the plain between 8 to 2 meters above mean sea level. The plain can be divided into 2 levels, 8 to 5 meters and 3 to 2 meters levels with the slope of 0.25 meter/kilometer. At 5 to 3 meters level slope is generally 0.75 meter per kilometer.

Sand deposits in the U-form shape of meandering and width or ratio of amplitude per length of meandering is nearly to 1 and the sand is likely to be a big deposit.

At elevation between 6 to 3 meters of Huai Krot and Huai Laeng the ratio of amplitude and length of meandering range from $1/7$ to $1/2$, but at some areas with a U-form shape the value is $1/1.25$, width of amplitude ranges from 100 to 500 meters and length of meander ranges from 600 to 1,500 meters.

Between elevation 3 to 2 meters above mean sea level sand deposits occur only along stream channel and natural levee.

Between elevation 8 to 4 meters above mean sea level, sand deposits of Khlong Don Krabuang occur at meandering with the ratio of amplitude per length of meandering at elevation 8 to 6 meters is ranging from $1/5$ to $1/2$, width of amplitude ranges from 300 to 500 meters and length of meandering ranges from 400 to 1,200 meters.

The Khlong Bang Pa distributes from the Mae Klong at Amphoe Photharam and flows south parallel to the lower parts of the Mae Klong. At elevation between 8 to 6 meters above mean sea level of Khlong Bang Pa the ratio of amplitude per length of meandering ranges from 1/1 to 1/5, width amplitude 200 to 1,000 meters and length of meandering 300 to 1,500 meters.

4.3 Regional Geology

To the west and north of the study area, it is bounded by mountainous area. In the study area there are monadnocks standing above alluvial plain. The alluvial plain consists of gravel, sand, silt and clay of Quaternary age. Based on Geologic map scale 1:500,000 of the Department of Mineral Resources (1985) (Figure 4.16). The following regional geology of the study area is briefly described as follow:

Pre-cambrian high grade metamorphic rocks consist of gneiss, schist and calc-silicate rocks which occur at Khao Phanom Yo and Khao Soi Dao to the north of Kanchanaburi. These rocks strike north or northwest and dip approximately 30 - 40 west.

Cambrian rocks consist of quartzite, schist and marble. These rocks occur in the north of the area.

		EXPLANATION	
		SEDIMENTARY AND METAMORPHIC ROCKS	
CENOZOIC	QUATERNARY	Qa Alluvial deposits: river gravel, sand, silt and clay Qt Terrace deposits: gravel, sand, silt and clay	
	TERTIARY		
	CRETACEOUS		
MESOZOIC	JURASSIC		
	TRIASSIC		
	PERMIAN	P Grey to dark grey, massive to bedded, partly reef, limestone; and white sandstone	
PALAEOZOIC	CARBONIFEROUS	Upper Middle Lower	
	DEVONIAN	D Light grey, recrystalline limestone with argillaceous bands	DC Brown to dark brown phyllite and quartzite
	SILURIAN		SD Black shale and thin bedded quartzite
	ORDOVICIAN	O Dark grey limestone with argillaceous bands	
	CAMBRIAN	C Quartzite, schist and marble	CO Thin to thick bedded quartzite, and phyllite
	PRE CAMBRIAN	PE Gneiss, calc-alicates rocks and schist	
			C Shale and fine-grained sandstone

IGNEOUS ROCKS

CENOZOIC	TERTIARY	
MESOZOIC	CRETACEOUS	
	JURASSIC	
	TRIASSIC	Tg Medium to fine-grained hornblende-biotite and biotite granite

- International boundary (must not be necessarily authoritative)
 Roads
 Railroad
 Contour 500 meter
 River
 Dam and reservoir
 Amphoe (District)
 Changwat (Province)

SYMBOLS

- Geological boundary
 Fault (undifferentiated)
 Thrust fault
 Anticline
 Syncline

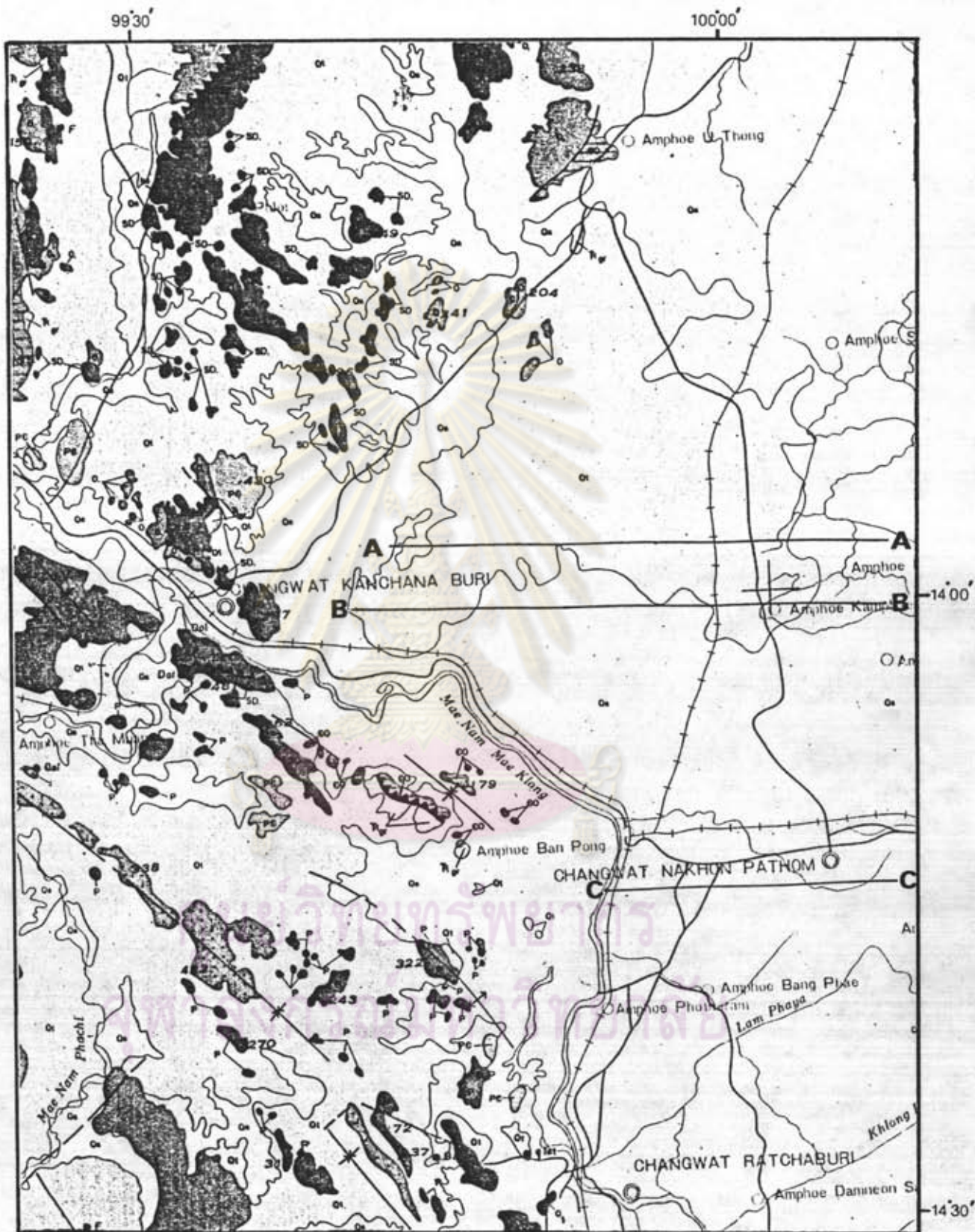


Figure 4.16 Geological map of the western part of the Lower Central Plain and adjacent area. (Modified after Chonglakmani et.al., 1980)

The Cambrian-Ordovician strata are scatterly occurred in the north and in the middle part of the mapped area. They are thin to thick-bedded quartzite and phyllite.

Ordovician limestone is gray and black limestone with argillaceous bands intercalated. The strike of the Ordovician limestone strata is mostly in north-south or northeast direction and approximate dip 70-80 west. The ordovician rock occurs at Khao Hua Lan, Khao Phu Lan, Khao Khok, Khao Khaew and Khao Malaeng Mum.

Metasediments of Silurian - Devonian age consist of brown, red-yellow and white quartzite and black-gray slate, shale and sandstone. At Khao Yai the rock strata strike in northwest direction and dip 30 NE. These rocks can be found at Khao Luang Ta, Khao Meng, Khao Phra Thaen Dong Rang and Khao Saphai Raeng.

The Carboniferous rocks are composed of the Lower Carboniferous and the Permo-Carboniferous shale and fine-grained sandstone. The Permo-Carboniferous strata consist of pebbly shale and mudstone, sandstone and shale. The Carboniferous rocks occur in the south and southeast of the area.

Permian Limestone consists of grey to dark grey and massive to bedded limestones with white sandstone interbedded. The Permian Limestone is partly reef limestone. These rocks occur in the west and in the middle



part of the area.

The Mesozoic rock consists of Triassic Granite. The Triassic Granite is composed mainly of medium to fine-grained hornblend-biotite and biotite granite. These rocks occur in the north and in the middle part of the area.

Quaternary deposits consist of terrace and alluvial sediments. The deposits are composed mainly of alternated layers of gravel, sand silt and clay.

However according to Thiramongkol(1984) Quaternary deposits in the study area are composed of fluvial and marine deposits. The details of the deposits are as follows:

In the study area, sand deposits occur in the Mae Klong flood plain, Mae Klong alluvial fan and Tidal flat of brackish clay (Thiramongkol,1984). The Mae Klong fan or the young fan consists of gravel beds alternating with sandy, silty and clay layers. The thickness of Mae Klong Fan deposits is more than 80 m. (Nanthaphisarn,1976). The upper most part of the deposits consists of silt, sand and clay with some pisoliths of iron oxide in the sandy upper layer and stiff clay in the lower layer. The age of the deposits is most probably Middle to Late Pliocene. The tidal flat of brackish clay is predominantly composed of dark to black coloured clays, without iron or manganese concretions. The basic ferric sulphate (Jarosite) and

gypsum needles are the most common characteristics of this clay bed. Moreover, the gray to black soft clay often yield shells and crab claws of brackish water genera. These facts give adequate evidence of brackish water origin of the clay (Takaya,1971). The flood plain consists of natural levees and backswamps. Natural levees form narrow strips along the river and consist of sandy and silty layers. They are commonly 2 to 3 m. higher than the backswamps. Backswamps are mainly composed of sediments about 1 m. thick.

4.4 Geology of Sand Deposits.

Sand deposits in the study area occur along the Mae Klong flood plain, Mae Klong Alluvial fan, and tidal flat of brackish clay.

From well log data in different locations (Figure 4.17) the thickness of top soil on sand bodies are varied from 0.5 to 8 meters. However, the top soil on sand bodies of the Mae Klong and the main streams on the Mae Klong Fan are 0.5 to 4 meters thick at point bar and sand bar and 0.5 to 8 meters along stream channels.

Sand deposits are varied in thickness, in some places they are a few meters thick whereas the other deposits are ranging from 7 meters and up to 25 meters.

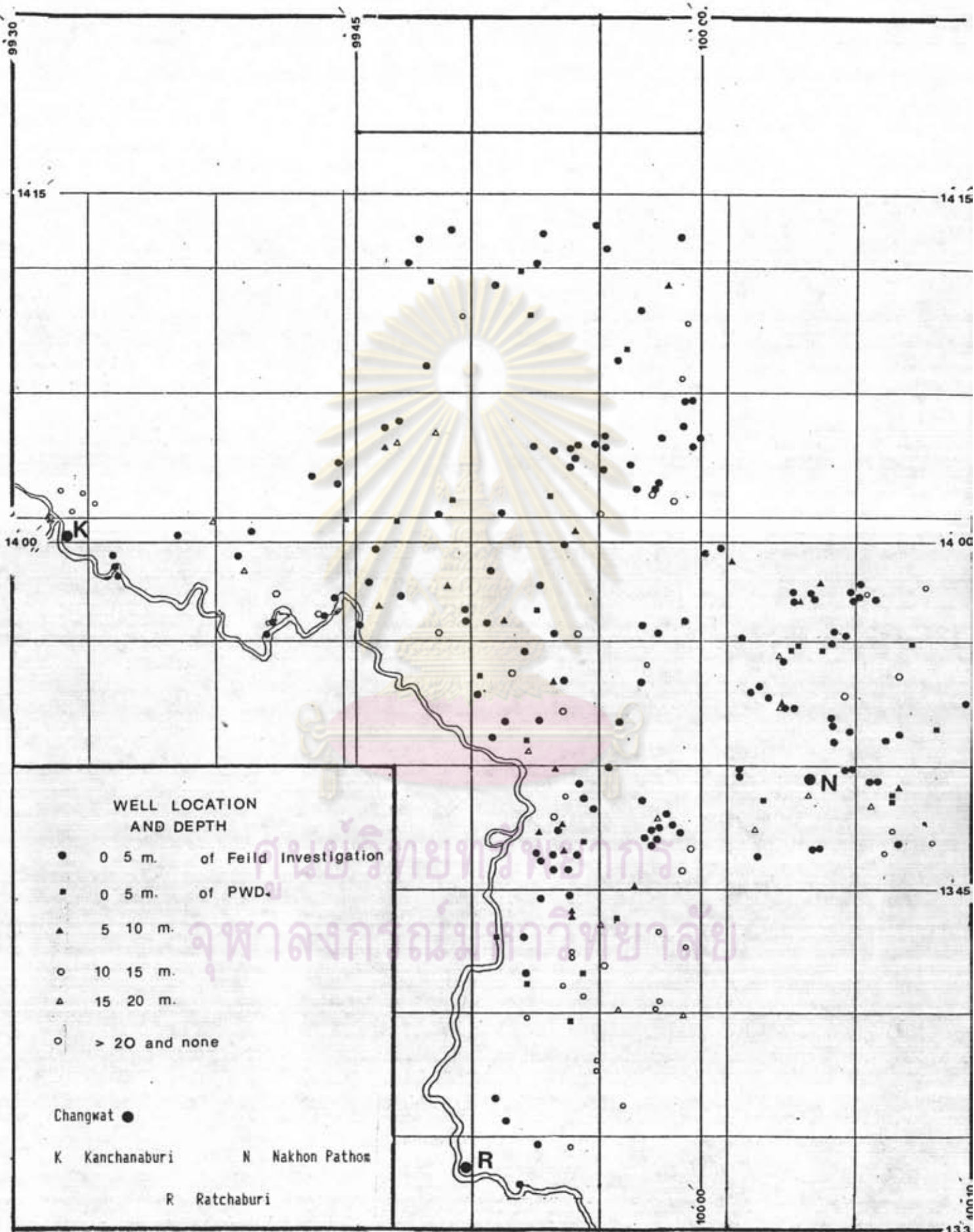


Figure 4.17 The location of Bore hole.

The thickness of sand deposits and the top soils are varied. The deposits and the top soils can be separately discussed in details between elevation 23 to 8 meters above MSL. and 8 to 3 meters above MSL.

4.4.1 Sand Deposits in the area between 23 to 8 meters above MSL.

The area between 23 to 8 meters consists of two geomorphic units. They are Mae Klong flood plain and Mae Klong alluvial fan. Sand body is normally overlain by top soil. At the highest part of point bar of sand body the top soil is generally thin and varied from 0.5 to 4 meters thick and it is silty sand. However, the thickness of top soil on sand bodies along old channels is varied from 2 to 8 meters, and the top soil is clayey silt to sandy clay.

In addition, sand bodies are varied in thickness, lithology, and in lateral extents. The sediments tends to be graded upward sequence which clay is rather rare in the sand unit, and clay content is increasing in the top soil or silty sand unit (see Figure 4.18)

Groundwater tables are normally below 3 to 6 meters from ground surface, and the appearance of the groundwater table is seriously an obstacle for the accomplishment of the stratigraphic sequence of sand unit, possibly the underlying unit.

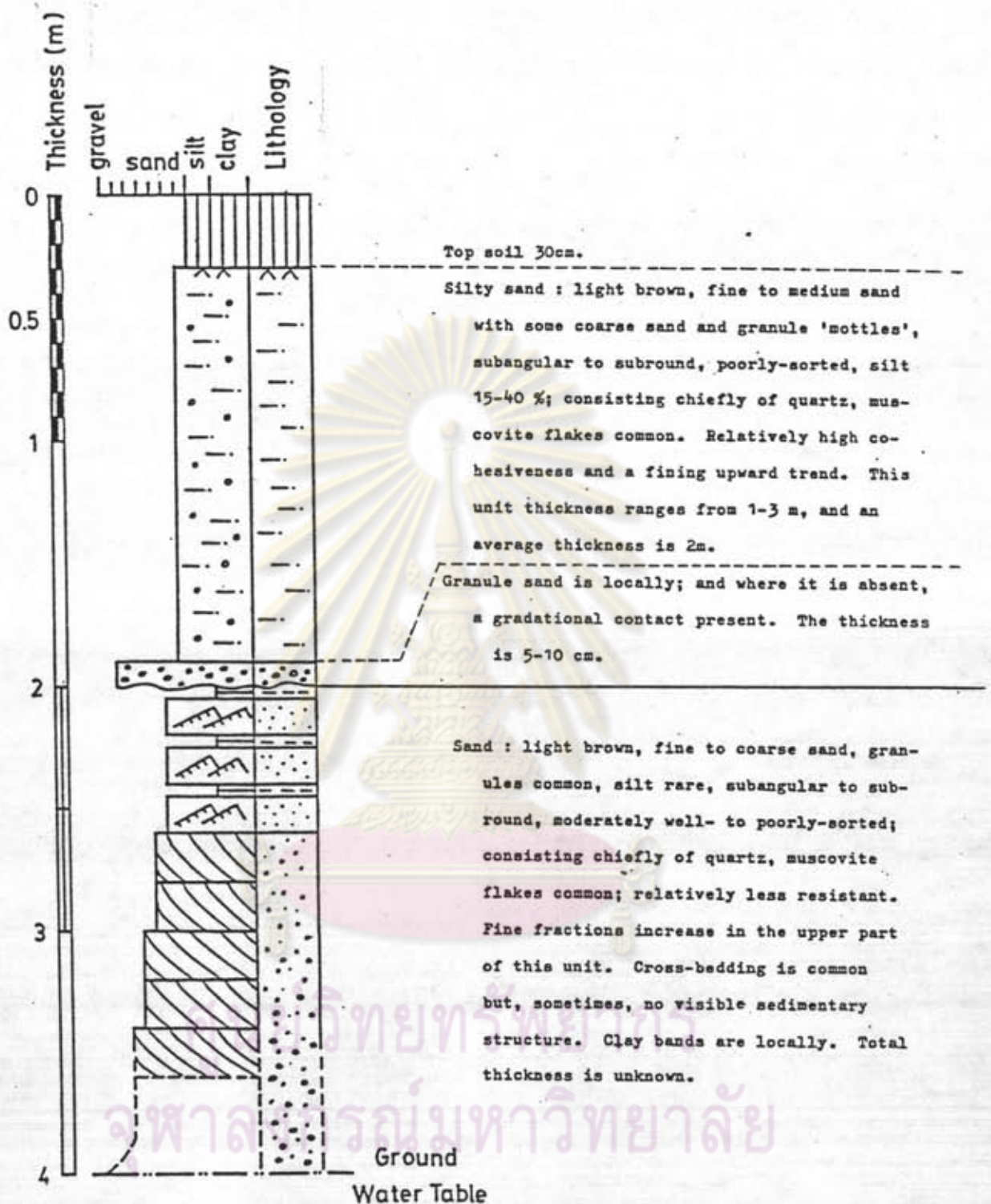


Figure 4.18 Generalized stratigraphic sequences elevation between 23 to 18 meters above MSL. (Weerapasong, 1985)

4.4.2 Sand Deposits in the area between 8 to 3 meters above MSL.

The area between 8 to 3 meters consists of two geomorphic units, the lower part of the Mae Klong Alluvial fan and the tidal flat of brackish clay. The top soil in this area is silty clay unit and sand body is sand unit. The top soil on point bar of sand body is varied from 1.20 to 2.50 meters thick and it is silty clay to clayey sand. However, the thickness of top soil on sand bodies along channels is varied from 0.5 to 2.0 meters. It is silty clay to sandy clay. However, the thickness of sand bodies are varied from 3 to 20 meters (PWD,1976).

Groundwater table is 1.80 to 4 meters below ground surface. The two sedimentary units are described as follows.

Silty clay unit (Top soil) : light brown, slightly to moderately plastic, undurated and compact.,

Sand unit (sand deposit or sand body): Sand ; light, gray, medium to fine sand, subangular, well sorted: composed of quartz, feldspar, dark minerals, chert and micas.