CHAPTER III

LITHOSTRATIGRAPHY

It is a known fact that the genesis of lithostratigraphic units and their various component is useful in the interpretation of ancient sedimentary environments because there is an obvious relationships between the characteristics of a given sedimentary environment and the materials that accumulate there. Adjacent environments show some contrasting conditions and sediments. Therefore, sedimentary rocks produced by such environments will be markedly different, and these differences are designated as lithostratigraphic units. Hence, adjacent lithostratigraphic units represent adjacent depositional environments.

In order to fully understand the depositional environment, it is an essential step to firstly define the nature and characteristics of the sedimentary deposits in terms of suitable lithostratigraphic units. At present, the lithostratigraphic unit of the diatomite deposits and associated sediments in the southeastern part of Lampang Basin is poorly defined. It is therefore necessary to focus the study on the classification and nomenclature of lithostratigraphic units concerned of these deposits.

A lithostratigraphic unit is "a body of rock strata which is unified by consisting dominantly of a certain lithologic type, or combination of lithologic types, or by possessing other impressive and unifying lithologic features. It may consist of sedimentary, or igneous, or metamorphic rocks, or in some cases of intricate interbedding of two or more of these. It is a three-dimensional body and its concept must be based on its character as a unit through its full extent, both vertically and laterally" (Friedman and Sanders, 1978). The features used to define lithostratigraphic units can be as varied as the strata themselves. Boundaries separating lithostratigraphic units may be placed at sharp contacts or at arbitary levels with respect to a zone of gradation.

Besides, the purpose of selecting such units is to carry out some geological objective, such as geological mapping, a sedimentological study, assessment of a mineral resources, study of the distribution of fossils, collection of specimens for some laboratory measurements (such as paleomagnetism, for example), and so forth.

In this study, an attempt had been made to informally classify the lithostratigraphy of Mae Tha Sub-basin into two hierarchies units, notably, group and formation. In addition, the nomenclature used in this study are tentative ones only for the purpose of reference.

3.1 Sub-surface Geological Data

Due to the fact that almost all of the diatomite deposits and associated sediments under the present investigation are not exposed in the study area, therefore the sub-surface geology of the area has to be assessed mainly by drilling exploration. Within the study area of approximately 340 km^2., data and information obtained from 56 drill-holes with some geophysical logs, and 6 exploratory shafts are employed in the synthesis of sub-surface geology. Out of these, there are 42 drill-holes with cutting samples ranging in depth from approximately 6 to 97 m., 11 drill-holes with core samples ranging in depth from approximately 30 to 500 m., 3 deep drill-holes for petroleum exploration ranging in depth from approximately 733 to 1,320 m. in neighbouring area, and 6 exploratory shafts ranging in depth from approximately 12 to 43 m.

All of the geological data and information previously mentioned are rearranged into the suitable and consistent form particularly regarding the drill-holes data. The standard geological drill charts are prepared for each drill-hole including some geophysical logs and oil content data. After that, 4 geological sections are prepared. Among these, 2 sections are in the N/S direction and the other 2 sections are in the E/W direction. These geological sections are used as a basis for lithostratigraphic analysis, notably, classification and description of various lithostratigraphic units. Besides, other graphic representations including isopach maps, structural contours maps, and fence diagram are prepared to illustrate the three-dimensional characteristics of each

lithostratigraphic units. Finally diagram representing the lithostratigraphy of sub-surface sedimentary sequences of the study area are prepared (Figs. 3.1.1,3.1.2).

3.2 Classification and Description of Lithostratigraphic Units

3.2.1 "Top Soil" formation

Evidences from sub-surface geology with in the 340 km^2. areas of Mae Tha Sub-basin indicate that the uppermost lithostratigraphic unit is the "Top Soil" formation. This formation is characterized by pale yellowish orange to dark yellowish orange, light brown to moderate reddish brown, and medium grey to dark grey (10YR8/6 to 10YR6/6, 5YR6/4 to 10YR4/6, N5 to N3), mixtures of lateritic, sandy, some quartz pebbly, limestone pebbly, clayey materials of 1-5 m. thick. The "Top Soil" formation covers extensively throughout the study area. The sediments are unconsolidated in nature deposited during Holocene age. (Fig. 3.2.1)

3.2.2 Mae Taeng formation

Below the "Top Soil" formation in the central belt extending approximately in the N/S direction of the study area, there is another unconsolidated clastic unit of up to 170 m. thick. This lithostratigraphic unit is characterized by the association of unconsolidated, sand, clay, and coarse-grained clastics of granule to pebble size. The sequence of sand and clay strata are predominant with the ratio of sand/clay approximately equal to 1:1. Layers of coarse-grained clastic sediments of mainly quartz,quartzite fragments, limestone fragments and crystals of secondary selenite gypsum are present in the sequences of sand and clay as various depths in some area. This lithostratigraphic unit is equivalent to Mae Taeng Group (Piyasin, 1972) and Mae Fang Formation (Piyasin, et al., 1977). The generalized lithostratigraphy of this formation is presented in Fig. 3.2.2.

3.2.3 Ko Kha formation

The lithology of this lithostratigraphic unit is characterized by the interbedding of diatomite and diatomaceous clay strata. The color of the sequence varies from white (N9), pale brown, pale yellowish orange

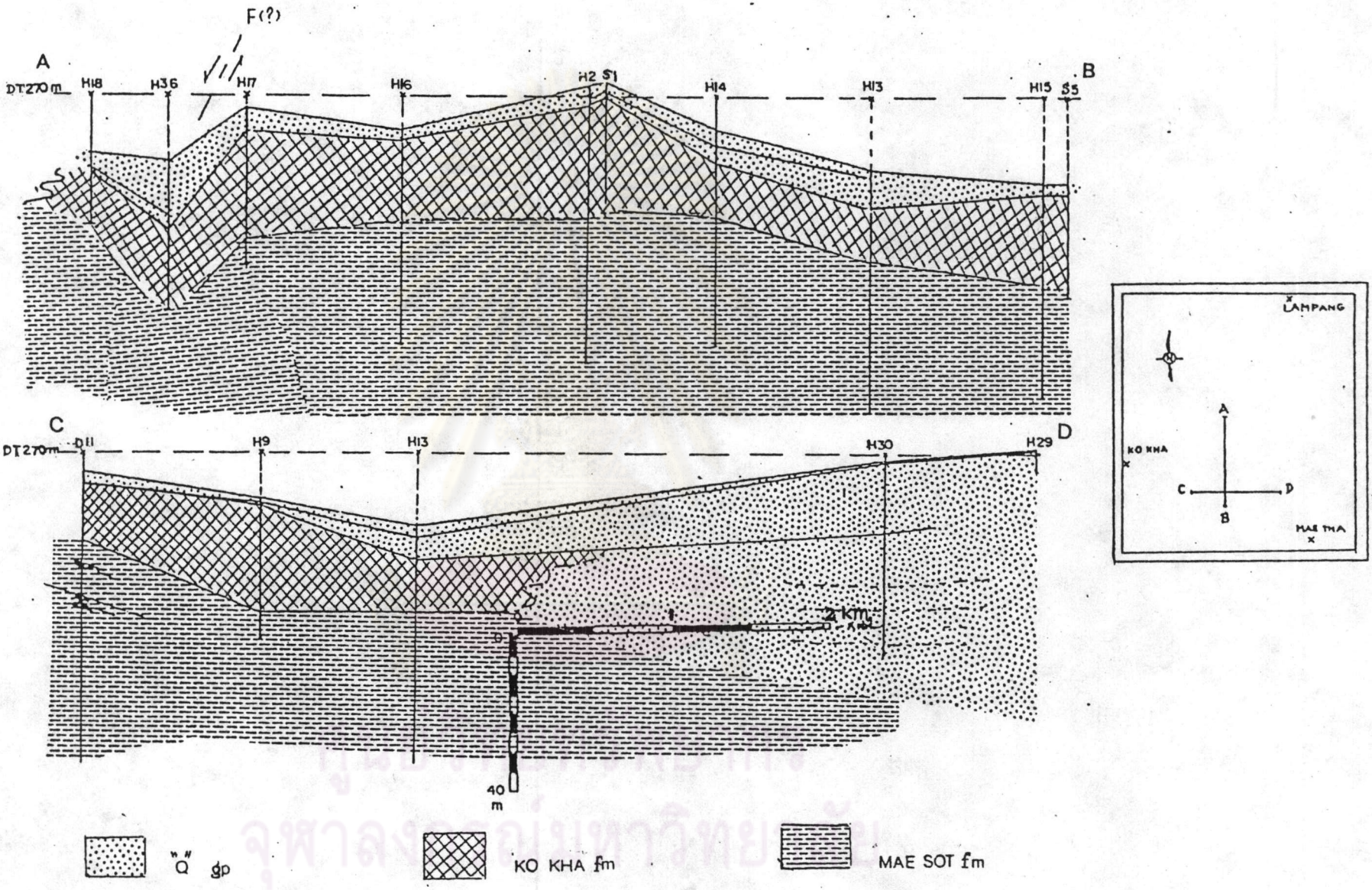


Fig 3.1.1 Showing geological section in the N/S, E/W direction along lines A–B, C–D respectively

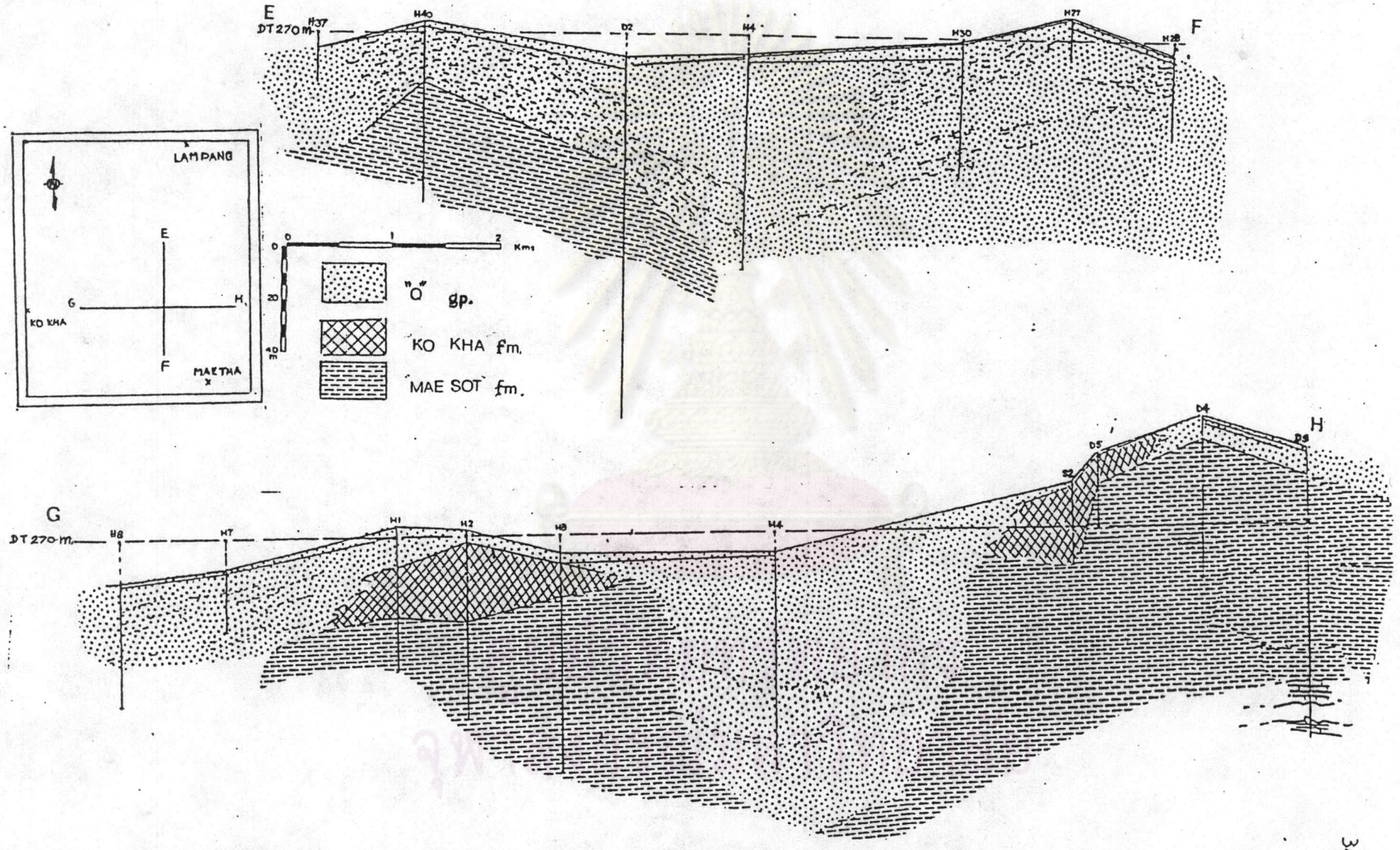
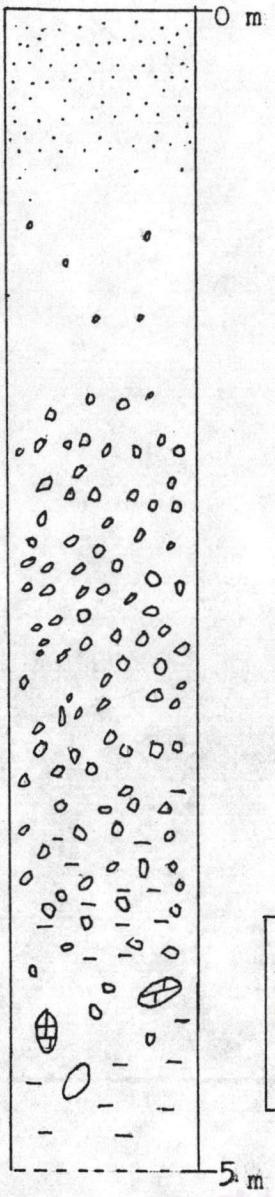


Fig 3.1.2 Showing geological section in the N/S, E/W direction along lines E–F, G–H respectively



Top soil, laterite, quartz grains, Fe oxide grains

size: coarse sand to gravel
shape: angular to subangular

and clay with limestone frangments in some area

colour varied from moderate yellowish brown(10YR5/4)
pale orange(10YR8/2)
to dark yellowish orange(10YR6/6)

Fig 3.2.1 General lithostratigraphic section of the 'Top Soil' formation of Mae Tha Sub-basin, Lampang Basin

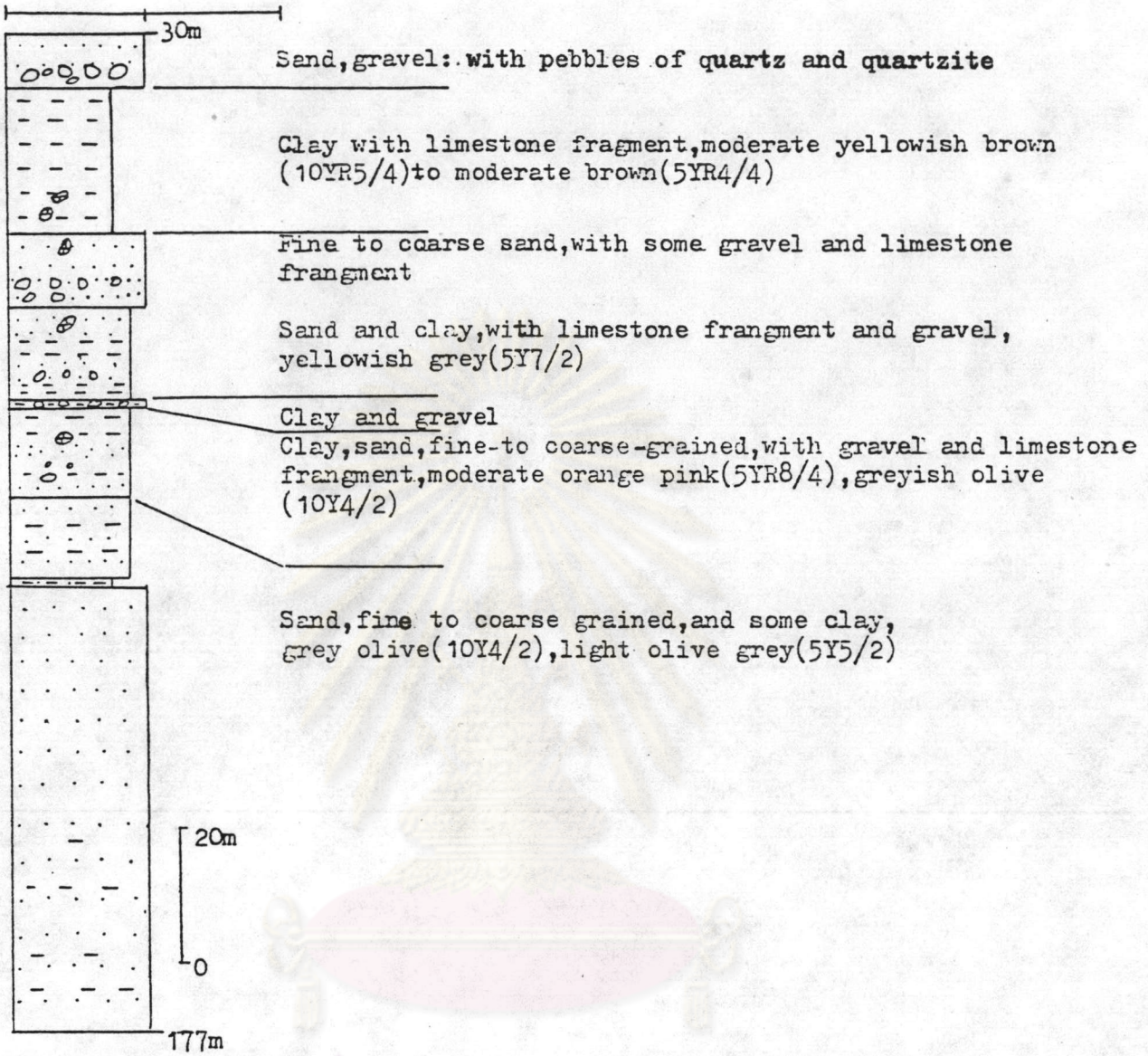


Fig 3.2.2 General lithostratigraphic section of the Mae Taeng formation of Mae Tha Sub-basin, Lampang Basin

(10YR8/6), very light grey (N8), and the maximum thickness of the whole unit is approximately 35 m. It is noted that the lithological boundary between diatomite and diatomaceous clay is in almost all cases transitional or gradational.

The diatomite deposits covered in this study are found in 3 separate zones. The biggest one is located in the western part of study area covering approximately 25 km^2. and extending from south of Ban Huai Lo in the north to Ban Nam Bo Cho in the south and Ban Muang in the east to east of Ban Ton Mun and Ban Mon Hin Kaeo in the west. The deposit is elongated approximately in the N/S direction with 3.5 km. wide and 8 km. long. The second deposit is located in the vicinity of Ban Phae (I) covering an area of approximately 4 km^2. The size of the deposit is 2.5 x2 km^2. and elongated in the N/S direction. The smallest deposit is located in the neighbourhood of Ban Uan, Tambon Na Krua Amphoe Mae Tha covering an area of approximately 1.5 km^2. The size of deposit is 1.25x 1.25 km^2. in sub-circular shape. The second and the third deposits are in the eastern part of the study area, whereas the first one is in the western part.

The diatomite and diatomaceous clay sequences are all covered by the top soil and 3-5 m. thick of Mae Taeng formation characterized by clay and gravel. All of the three diatomite deposits are distinctively separated from each other by relatively thick sequence of unconsolidated clastic sediments of Mae Taeng formation. The relationships between Mae Taeng formation and Ko Kha formation is believed to be paraconformable. The geometry of each diatomite deposit is generally lentiform. It is interesting to note that the bases of diatomite deposits in the eastern part and western part are present at different elevation in the order of a few tens of meters.

With regards to the paleontological aspect of diatomite in the study area, it is mainly composed of diatom frustules, and is entirely composed of frustules of *Melosira granulata* (EHR.)RALFS, and rarely *Navicula spp.* and *Fragilaria spp.* (Akutsu, 1972.). The abundance of *Melosira granulata spp.* indicates the age of these three deposits

ranging from Miocene to Holocene.

The diatomite deposits of these three localities overlie conformably the fine-grained clastic sequence of "Mae Sot" formation.

The clayey fraction of diatomite deposits of Ko Kha Formation is essentially kaolinite with some illite and/or montmorillonite. The chemical composition of 11 major elements, namely SiO_2, Al_2O_3, Fe_2O_3, MnO, TiO_2, CaO, Na_2O, K_2O, MgO, H_2O^+, H_2O^- for every 1 ft.-interval of diatomite deposits at the Shaft no. I have been intensively analysed. Only some chemical composition, namely, SiO_2, Al_2O_3, and Fe_2O_3 for the Shaft no. II and, namely, SiO_2, Al_2O_3, Fe_2O_3, and CaO for the Shaft no. III have been determined for every 1 ft.-interval of the deposits. The analytical results are presented in Appendix 1, and summarized in Table 3.2.3a. Besides, the determination of density, specific gravity, oil absorption, and refractive index of some diatomite samples obtained from the Shaft no. I, II, and III, have been carried out. The results are presented in Appendix 1, and summarized in Table 3.2.3b.

Generalized lithostratigraphy of the Ko Kha formation is summarized and presented in Fig. 3.2.3.

3.2.4 Mae Sot formation

The lithology of this formation is characterized by light olive grey (5Y6/1) mudstone, claystone, shale, oil shale, coal, with abundant fossil content. Among these, claystone is the most dominant. In Lampang Basin, this formation is equivalent to Mae Sot Formation of Fang Basin (Buravas, 1973), but they are different in thickness. In Fang Basin this formation is about 610 m. thick whereas in Lampang Basin the thickness of this formation is about 152 m. to more than 430 m.

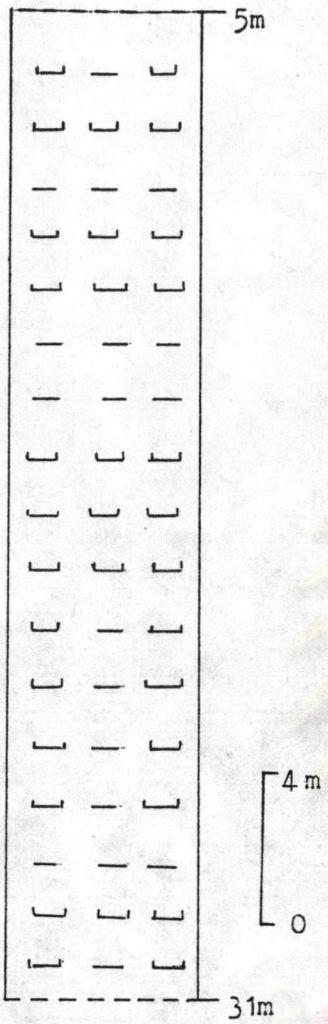
Mae Sot formation has been found underlying Ko Kha formation and Mae Taeng formation throughout the study area in Mae Tha Sub-basin. The thickness of these formations exceeds 430 m. in the study area. The relationships between "Mae Sot" formation and Ko Kha formation is conformable, whereas the relationships between Mae Sot formation and Mae Taeng formation is unconformable with erosional surface (Fig. 3.2.4). It is

Table 3.2.3a Chemical analysis of diatomaceous clay in Mae Tha Sub-basin, Lampang Basin.

Chemical composition	Shaft no.I		Shaft no.II		Shaft no.III	
	range %	average %	range %	average %	range %	average %
SiO_2	38.90-76.53	63.95	18.40-89.27	62.09	41.88-84.66	69.501
Al_2O_3	10.34-22.10	15.68	2.72-17.46	11.88	8.22-16.67	12.09
Fe_2O_3	0.04-36.30	9.15	0.78-55.04	6.866	1.27-17.16	3.56
MnO	0.02- 1.30	0.07	-	-	-	-
TiO_2	0.18- 0.49	0.425	-	-	-	-
CaO	0.05- 0.60	0.20	-	-	0.18- 8.64	0.89
Na_2O	0.06- 0.30	0.15	-	-	-	-
K_2O	0.49- 2.34	1.375	-	-	-	-
MgO	0.13- 0.46	0.369	-	-	-	-
H_2O^+	5.08- 9.54	6.556	-	-	-	-
H_2O^-	0 - 3.70	1.56	-	-	-	-

Table 3.2.3b Physical properties of diatomaceous clay in Mae Tha Sub-basin, Lampang Basin.

Shaft no.	Density gm./c.c. (105°C)				Specific gravity		Wt % oil absorption		Refractive index	
	bulk		loosed-140 mesh.							
	range %	average %	range %	average %	range %	average %	range %	average %	range %	average %
I	0.49- 0.90	0.69	0.16- 0.31	0.25	2.16- 2.58	2.30	125-233	174	1.45- 1.47	1.46
II	0.17- 0.96	0.78	0.23- 0.42	0.34	-	-	144-164	153.5	1.45- 1.47	1.46
III	0.41- 0.61	0.52	0.14- 0.23	0.17	2.20- 2.6	2.32	200-276	235.2	1.451-1.478	1.46



Diatomite, diatomaceous clay and Fe oxide solution

semi to consolidated rock

massive to laminated, dip 0–5°

colour varied from moderate yellowish brown(10YR5/4)
very pale orange (10YR8/2)
pinkinsh grey (5YR8/1)
dark yellowish orange(10YR6/6)
greyish orange (10YR7/4)
to greyish orange pink(5YR7/2)

Fig 3.2.3 General lithostratigraphic section of the Ko Kha formation of Mae Tha Sub - basin, Lampang Basin

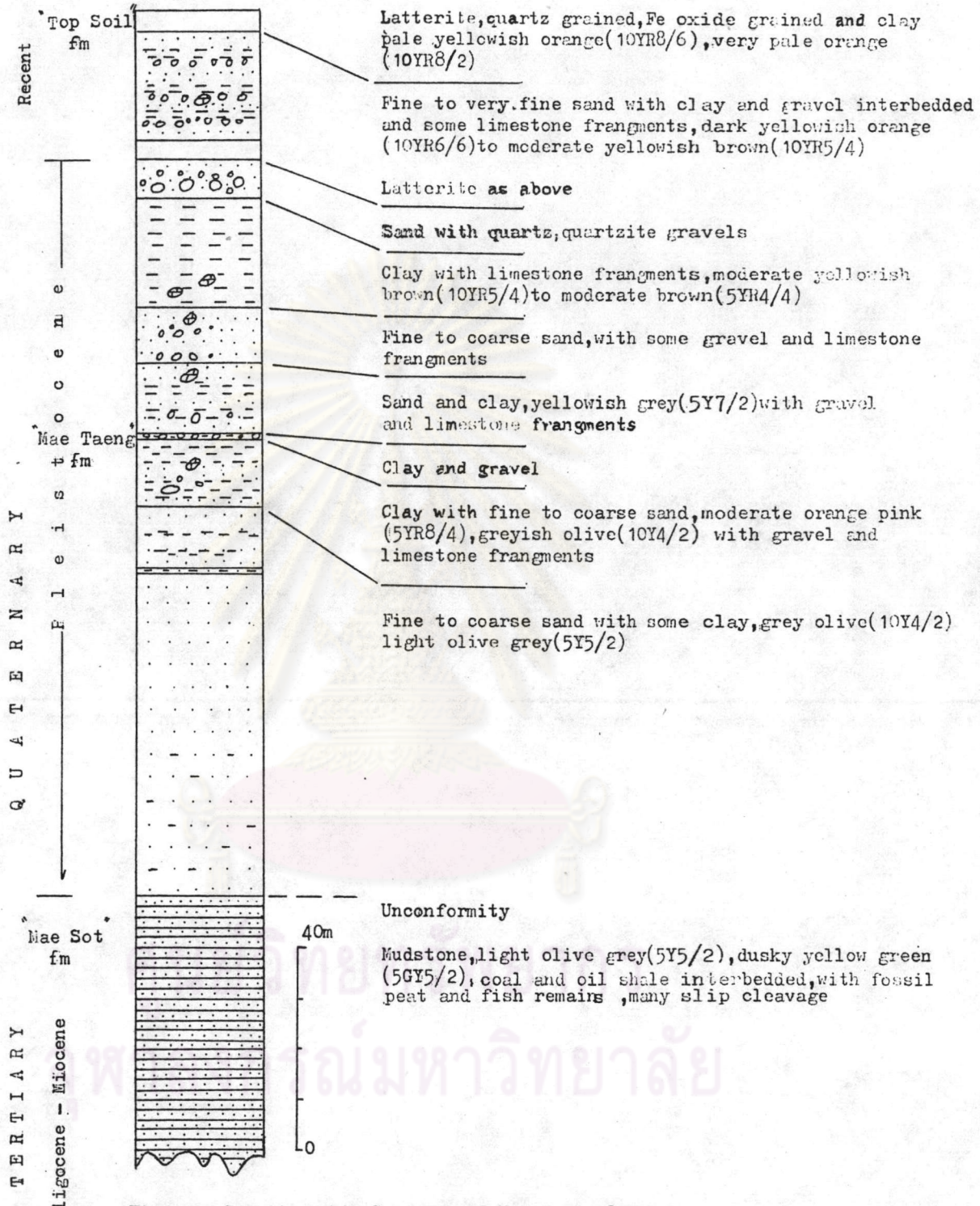


Fig 3.2.4 Stratigraphic Sequence of Mae Taeng formation

believed that there is an unconformity between Mae Sot formation and the underlying Lampang Group.

The age of this formation ranges from Oligocene to Miocene (Piyasin, 1978). Besides, fossil of fish remains have been found in this formation from drill-hole No.D1 at the depth level of 162.5 m. They are identified as Cyrinids and Nematoganthi (Cypriniforms and Siluriforms) of fresh water nature in Neogene (Miocene probably), (Ingavat, 1981, personal communication)

Analyses of cutting and core samples of some drill-holes particularly at oil shale and coal layers every 1 ft.-interval for shale oil content in oil shale; and moisture, ash, volatile matter, fixed carbon, sulphur, calorific value and specific gravity, in coal seams. Besides, oil shale extraction has been carried for samples obtained from drill-hole No. D1. The analytical results are summarized and presented in the Appendix 2. Generalized lithostratigraphy of Mae Sot formation is presented in Fig. 3.2.5.

3.3 Lithostratigraphy of Mae Tha Sub-basin

3.3.1 Basement Configuration

Evidences of the Bougeur gravity survey by the Department of Mineral Resources for Defence Energy Department in 1978 reveal that the basement configuration of Mae Tha sub-basin is the folded pre-Tertiary rocks. The major synclinal axis is oriented in the NE/SW to NNE/SSW direction (Fig. 2.2.1). Besides, evidences from the geological map, photolinearment and folding map (Fig. 2.1.1, 3.3.1), as well as the prospecting Shaft no. II (Fig. 3.3.2) indicate that there might be a major fault oriented in the NE/SW direction on the eastern margin of Mae Tha Sub-basin. Similarly, Mae Nam Wang in the western margin of the sub-basin is believed to be a fault-controlled river. Therefore, the basement configuration of Mae Tha Sub-basin is probably a fault-bounded depression (graben) with major synclinal structure on the graben floor.

3.3.2 Lithology of the Basement Rocks

The lithology of pre-Tertiary basement rocks, as concluded

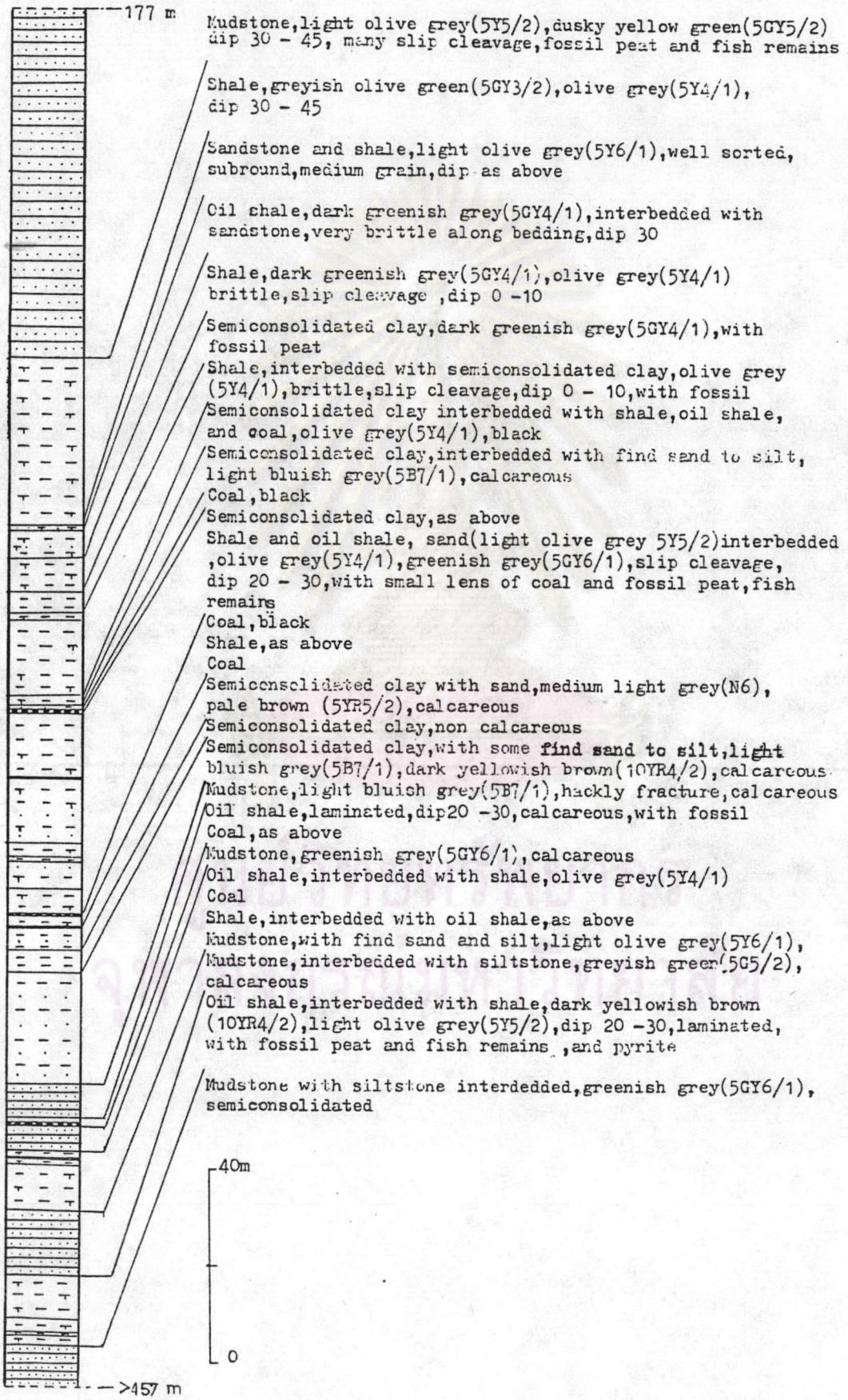
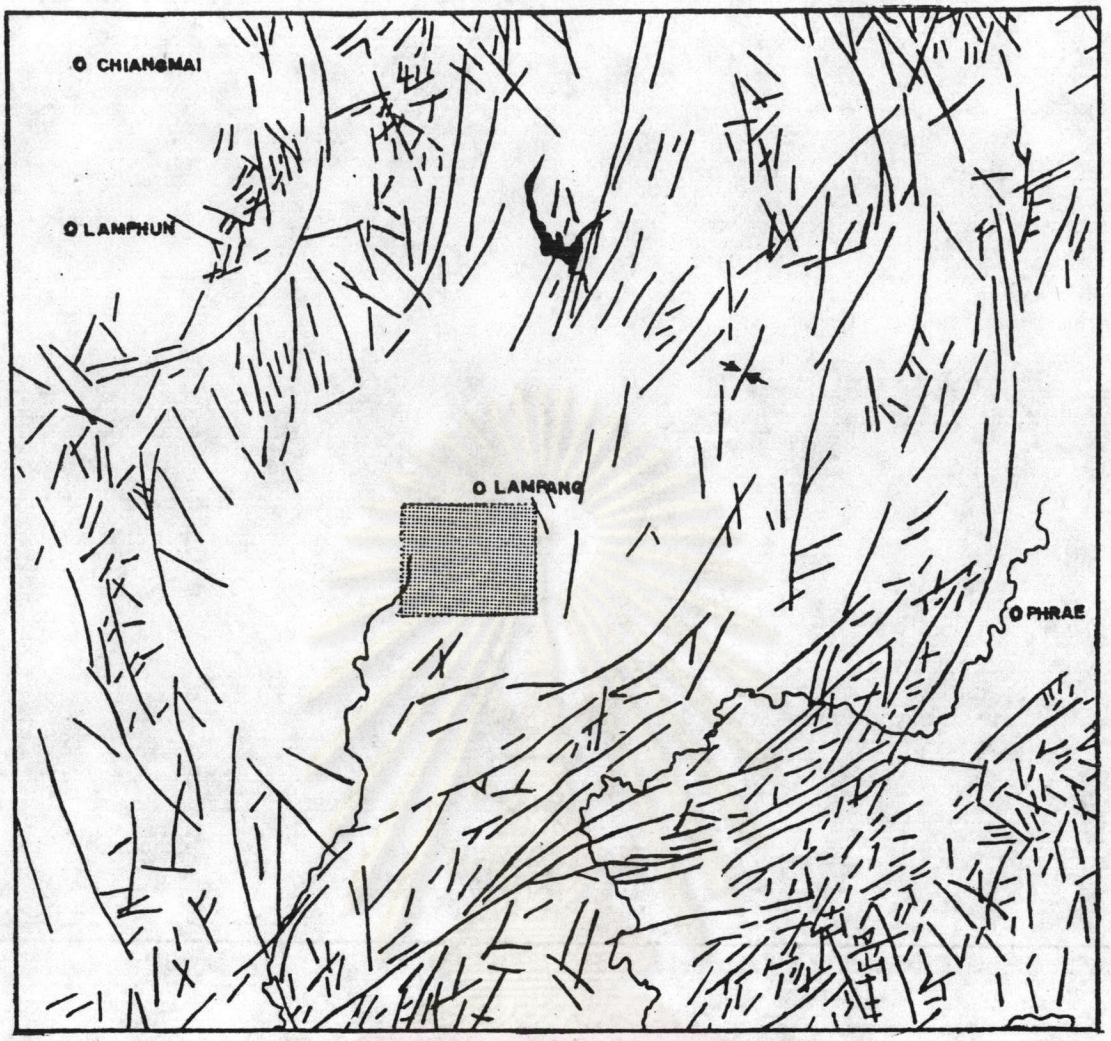


Fig 3.2.5 General lithostratigraphic section of the Mae Sot formation of Mae Tha Sub - basin, Lampang Basin



(FROM B, Aramprayoon 1981)

Study area

Photolineament (faults & fractures)

1:1,000,000

FIG 3.3.1 Photolineament and Folding Map of Thailand

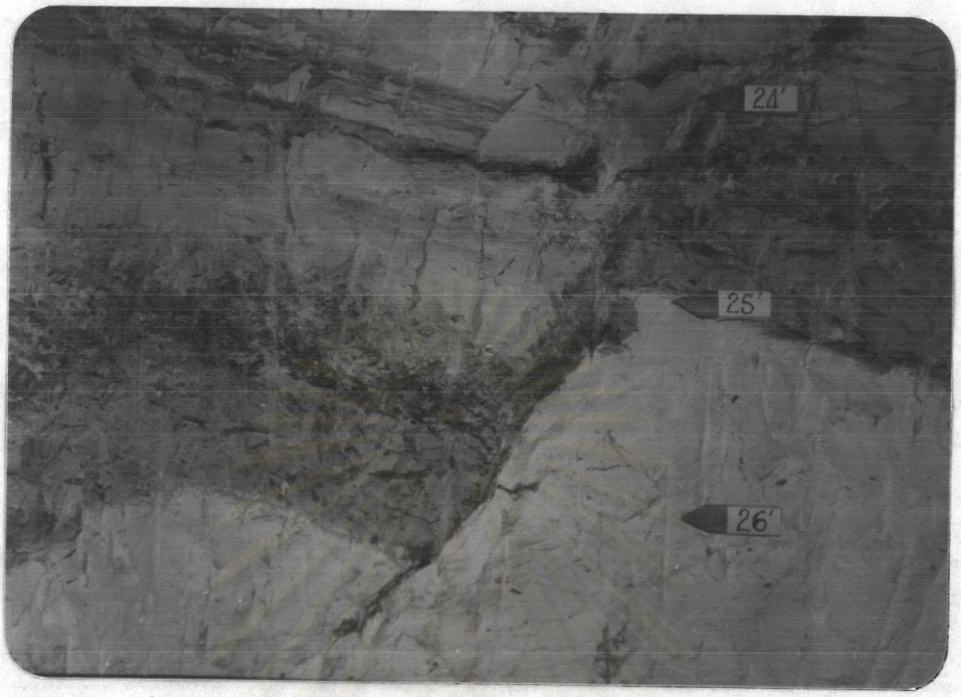


Fig. 3.3.2 Showing fault structure of Ko Kha formation in prospecting shaft no 2(S.2)

from the geological setting of neighbouring area, are believed to be fine-grained clastic/carbonate rocks of Lampang Group and volcanic rocks of Permo-Triassic age. The lithology of Lampang Group generally grey to dark grey, pinkish grey, massive to well bedded, fossiliferous limestone; greenish grey, dark to olive grey, laminated, fossiliferous, calcareous shale; grey to greenish grey, greenish brown to reddish brown, well stratified, fossiliferous, calcareous sandstone; limestone conglomerate; tuffaceous, agglomerate tuff; basal conglomerate and mudstone. For Permo-Triassic volcanic rocks, there are generally rhyolite, tuff, agglomerate, andesite agglomerate.

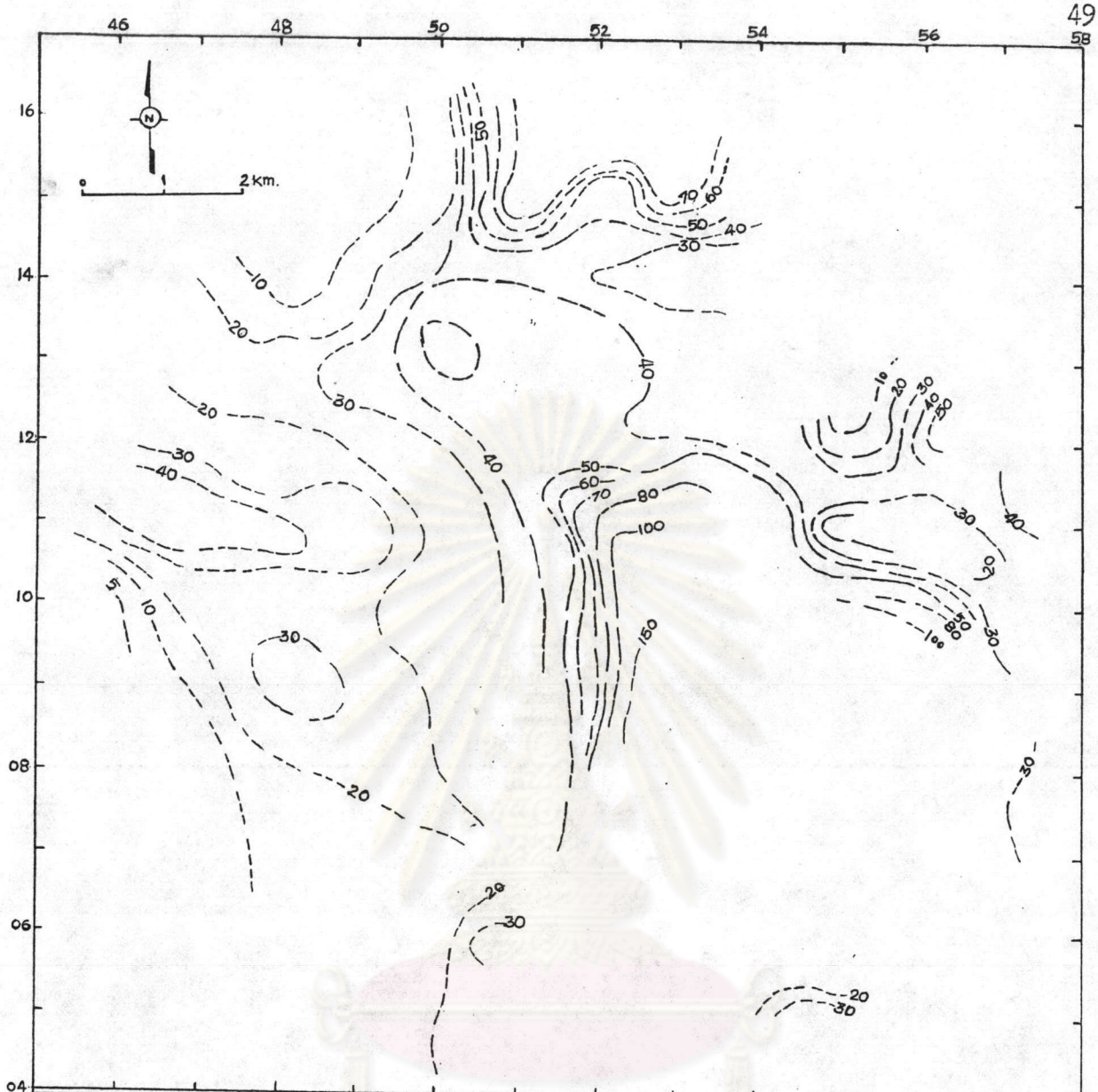
3.3.3 Lithostratigraphy

The Cenozoic strata in the Mae Tha sub-basin of Lampang Basin have been tentatively assigned to the informal "Q"-group and Mae Moh group (Piyasin, 1972) in descending order. The upper sedimentary succession of varying thickness from 4-175 m. is the "Q"-group which can be further subdivided into two informal formations, namely, "Top Soil" formation and Mae Taeng formation, in descending order. The lower sedimentary succession with thickness exceeding 460 m. is the Mae Moh group where the upper strata can be subdivided into two formations , namely, Ko Kha Formation and Mae Sot formation.

The "Top Soil" formation is characterized by pale yellowish orange to dark yellowish orange, light brown to moderate reddish brown, and medium grey to dark grey mixture of laterite, sandy, some quartz pebbly, limestone pebbly, clayey materials of 1-5 m. thick. The "Top Soil" formation covers extensively throughout the study area.

The Mae Taeng formation is characterized by the association of unconsolodated, sand, clay, and coarse-grained clastics of granule to pebble size. The maximum thickness of the formation is approximately 170 m. The distribution pattern of this formation is generally wide-spread throughout the study area with the thickest zone oriented as the belt extending approximately in the N/S direction at the central part of of the study area (Figs. 3.3.3a and 3.3.3b)

FIG.	ISOPACH MAP OF UNCONSOLIDATED SEDIMENTS (QUATERNARY)	
3.3.3a	Lithostratigraphy and Depositional Environment of Diatomite Deposits in the Southeastern Part of Lampang Basin, Changwat Lampang	PONGSAK SRIPONGPHUN GEOLOGY DEPARTMENT CHULALONGKORN UNIVERSITY 1980



STRUCTURAL CONTOUR MAP ON UPPER BED OF LIGHT GREENISH GREY CLAYSTONE	PONGSAK SRIPONGPHUN GEOLOGY DEPARTMENT GRADUATE SCHOOL CHULALONGKORN UNIVERSITY 1985
Lithostratigraphy and Depositional Environment of Diatomite Deposits in the Southeastern Part of Lampang Basin, Changwat Lampang	FIG. 3.3.3b

The Ko Kha formation is characterized by diatomite and diatomaceous clay with maximum thickness of approximately 35 m. The diatoms are identified to be frustules of *Melosira granulata* (EHR.) RALFS, with rarely *Navicula spp.* and *Fragilaria spp.* . The diatomite deposits are distributed in 3 separate areas covering approximately 25, 3.5, and 1.5 km^2. (Figs. 3.3.3c and 3.3.3d).

The "Mae Sot" formation is characterized by light olive grey mudstone, claystone, shale, oil shale, coal with abundant fossil content. Among these, claystone is the most dominant. The thickness of this formation exceeds 430 m. in the study area. The fish fossil, Cypriniformes and Siluriformes found in this formation. This unit is also widely distributed throughout the study area.

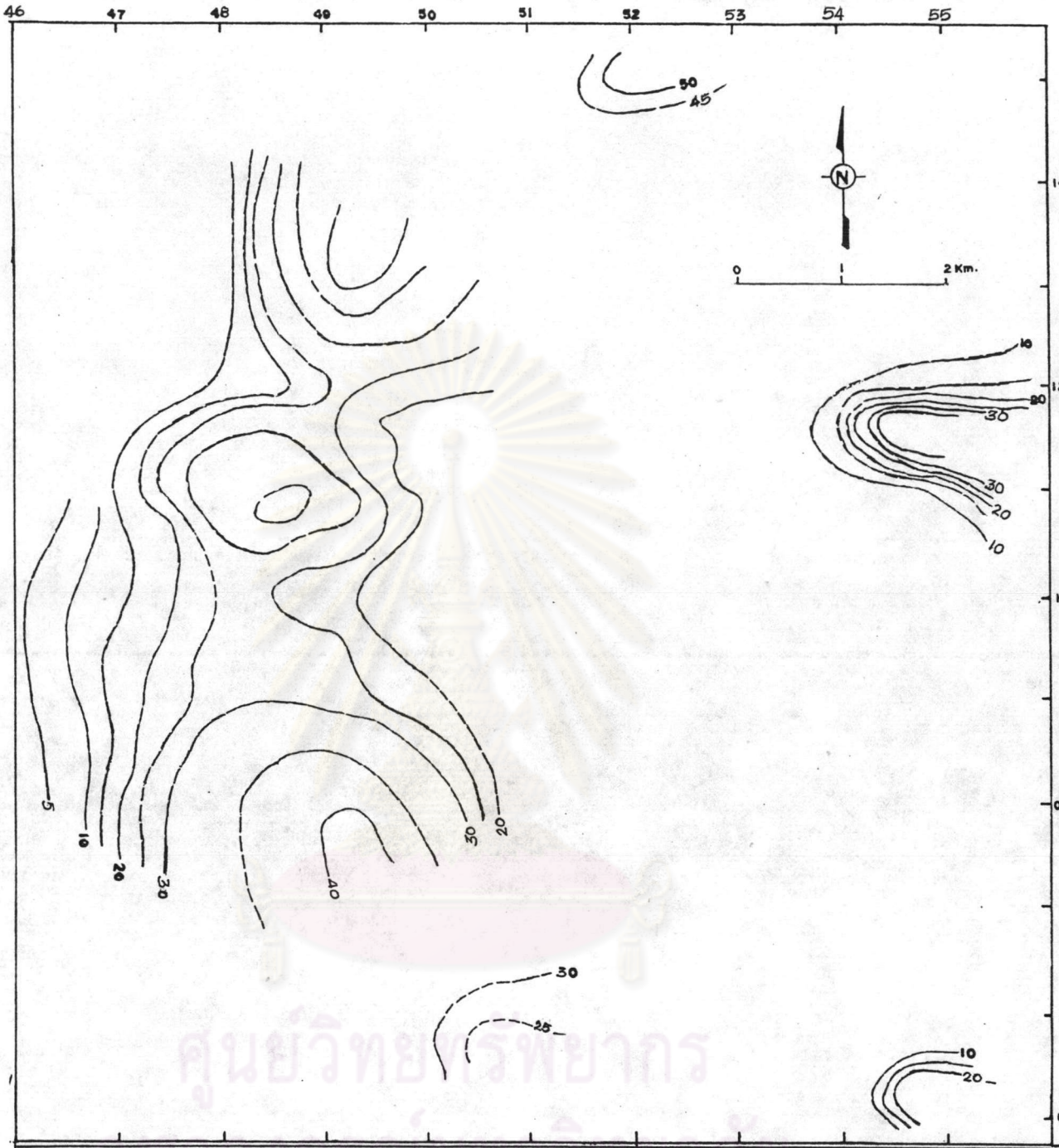
Generalized lithostratigraphy of sedimentary sequence within Mae Tha Sub-basin is summarized and presented in Fig. 3.3.3e. Besides, The distribution pattern of various lithostratigraphic units concerned is presented in Fig. 3.3.3f.

ISOPACH MAP OF DIATOMACEOUS CLAY

PONGSAK SRIPONGPHUN GEOLOGY DEPARTMENT
GRADUATE SCHOOL CHULALONGKORN UNIVERSITY 1985

Lithostratigraphy and Depositional Environment of Diatomite Deposits in the Southeastern Part of Lampang Basin, Changwat Lampang

FIG. 3.3.3c



STRUCTURAL CONTOUR MAP ON BOTTOM OF DIATOMACEOUS CLAY

PONGSAK SRIPONGPHUN GEOLOGY DEPARTMENT
GRADUATE SCHOOL CHULALONGKORN UNIVERSITY 1985

Lithostratigraphy and Depositional Environment of Diatomite Deposits in the Southeastern Part of Lampang Basin, Changwat Lampang

FIG. 3.3.3d

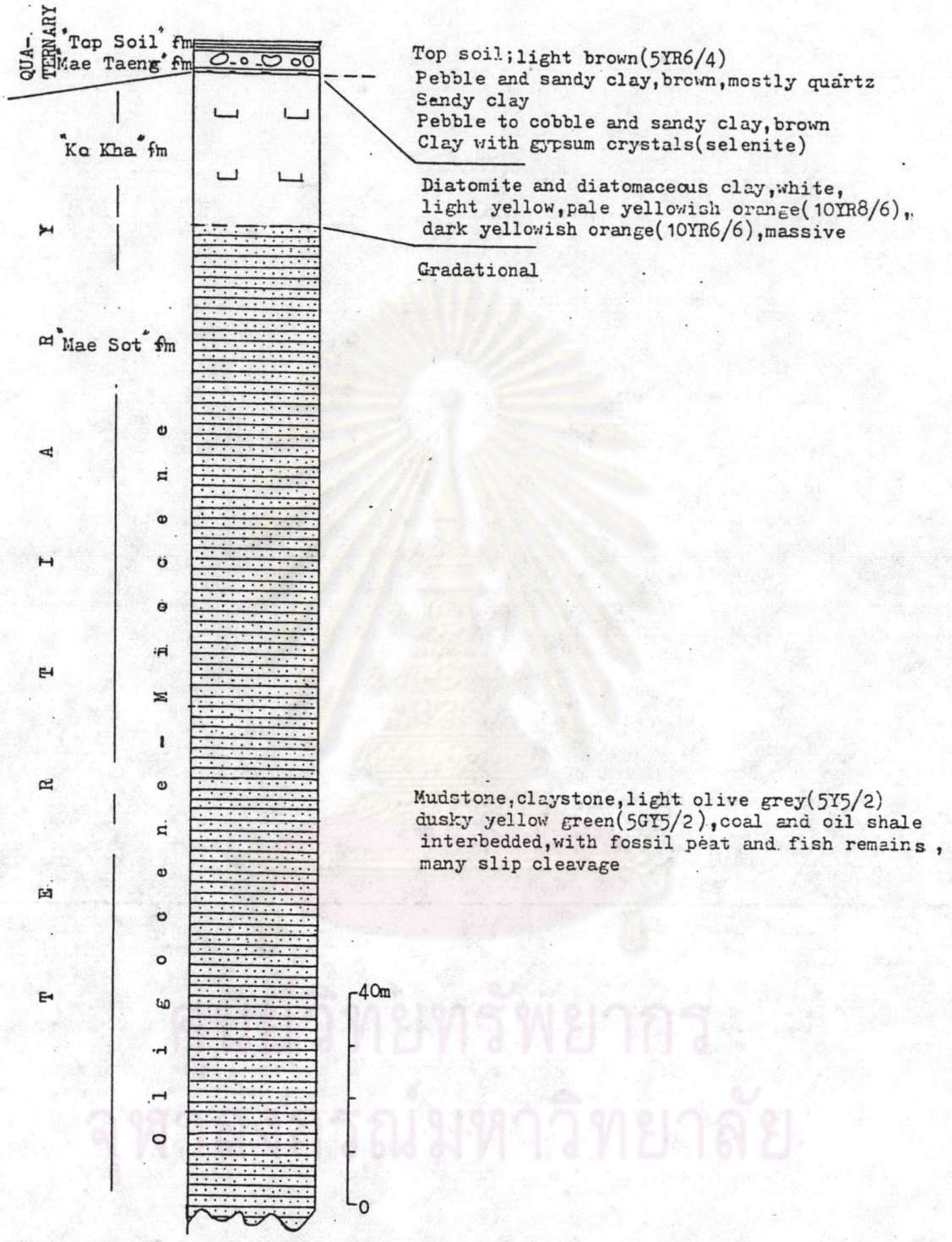


Fig.3.3.3e Stratigraphic Sequence in Mae Tha Sub-basin

EXPLANATION

Unconsolidate sediments. sand, silt, clay and gravel — QUATERNARY

Diatomaceous clay, white to yellowish brown — TERTIARY

Claystone, mudstone, shale, light greenish grey with some lignite, oilshale and limestone bed

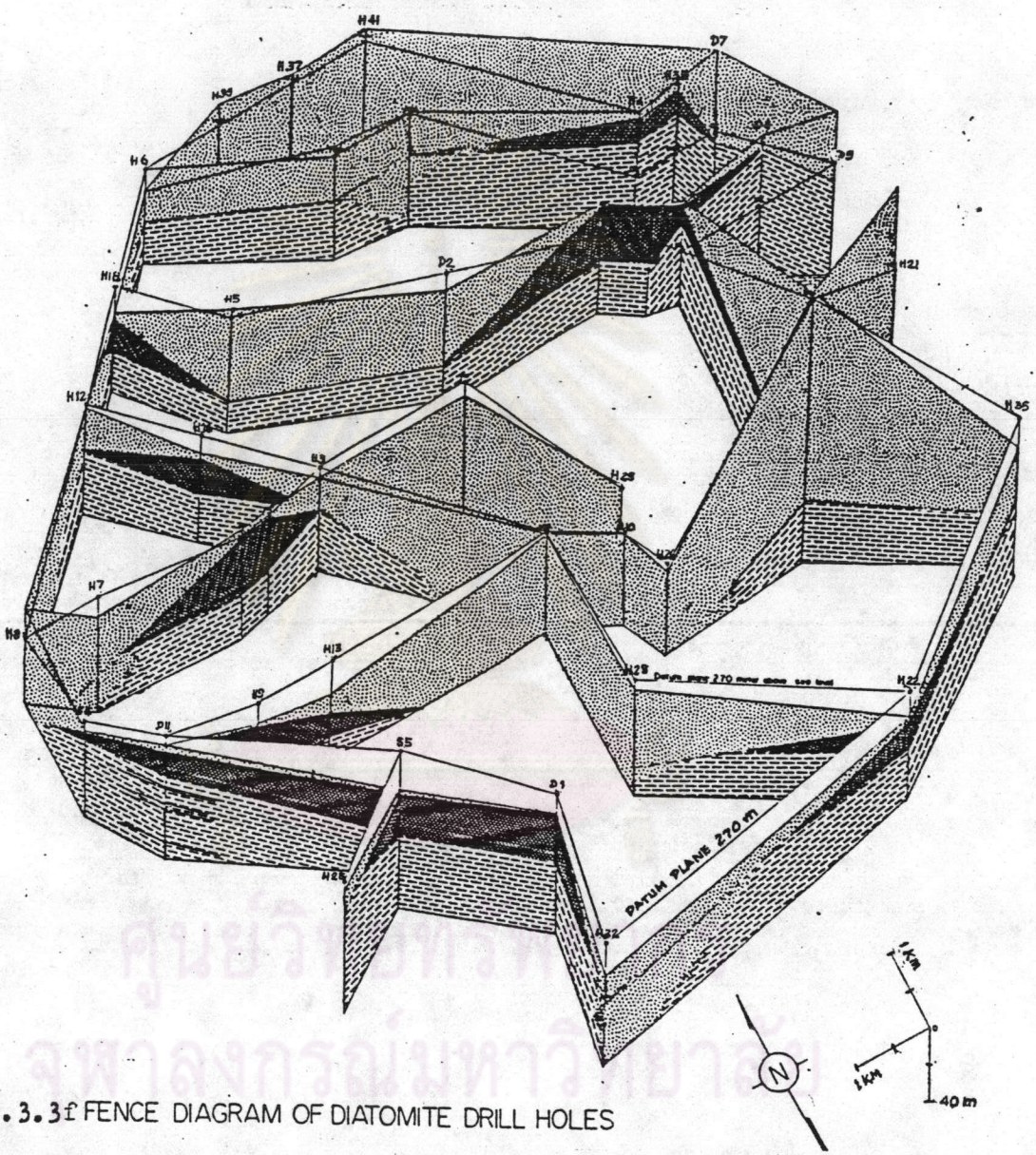


Fig.3.3.3f FENCE DIAGRAM OF DIATOMITE DRILL HOLES