CHAPTER I

INTRODUCTION

1.1 General

Diatomite is a sedimentary rock composed mainly of the siliceous remains of diatoms. The chemical composition is principally of amorphous opaline silica ($SiO_2 \cdot nH_2O$) and numerous other elements, such as alumina, iron oxide, titanium oxide, phosphate, lime, magnesia, sodium, and potassium. Diatomite, also known as diatomaceous earth, diatomaceous silica, kieselguhr or infusorial earth, occurs as a lightweight, porous and permeable sedimentary rock composed of diatom frustules. Diatoms depend upon a form of photosynthesis; consequently they flourish only in sunlit waters. They develop frustules, or shells of amorphous opaline silica that commonly are complexly perforated and bear ribs, spines, and bristles, the combined area of holes in the frustules generally ranges from 10-30 % of the total area (Lewin and Guillard, 1963, p. 378). Many valuable properties of the rock depend upon the aggregate effect of the microscopically complex and chemically inert diatom frustules.

The deposits formed in either marine or fresh water and the most important ones are of Tertiary and Quaternary ages. Many of the large deposits are associated with volcanic formation and the suggestion has been made that the source of the silica that was extracted from water by the diatoms was volcanic activity. Diatoms are one of the chief agents by which silica is removed from solution in marine and fresh water, their role as consumers of dissolved silica and the concentration of biogenous silica in their accumulated remains are major factor in the silica balance of most water bodies. Diatoms live in nearly all aquatic environment, but they form thick pure deposits only where they flourish for a considerable time away from contaminating sediment sources. Other major environmental requirements essential for the growth of bottom dwelling diatoms are, namely, large shallow basin (less than 35 m. in depth) that will serve as depositories in which photosynthesis can take place, abundant supplies of nutrients and soluble silica, and an absence of toxic or growth-inhibiting substances in the water

Diatoms are microscopic, unicellular of colonial ALGAE constituting the Class Bacillariophyceae of the Phylum CHRYSOPHYTA. This phylum, which comprises also the CHRYSOPHYCEAE and the XANTHOPHYCEAE, is characterized by:

a) the carotinoid pigments β-carotene and fucoxanthin, in addition to chlorophyll a and c,

b) leucosin (a glucose polymer) and oil as storage products, and the absence of starch

c) a tendency to deposit silica in the cell walls.

In the diatoms, the cell protoplast is typically enclosed in perforated siliceous wall (frustule) made up of two separate parts (thecae); hence the name "dia-tom" (= across + cut, Gr.)

Two subclass are usually recognized: (a) the Pennales (oblong, feather- or boat-shaped diatoms), in which the valve exhibits two planes of symmetry, and (b) the Centrales (usually cylindrical or disc-shaped diatoms) in which the valve is radially symmetrical. There are exceptions to both of these generalizations: a few genera of pennate diatoms (e.g. Gomphonema) may exhibit only one plane of symmetry, and some centric diatoms (e.g. Triceratium) may be triangular or bilaterally symmetrical.

Diatomites have long been used for various purpose, and their use as abrasives goes back to antiquity. They are also extensively use for filtering in modern industry, and for insulation of safes. In 1867, Nobel first discovered that nitroglycerine (glyceryl trinitrate) could be made safer by absorption in a porous material such as Kieselguhr, which is chemically inert. It is the wealth resulting from this discovery, i.e., dynamite, which is now used to fund the Nobel Prize. Diatomites are sometimes used in building construction, and one such classic use in the marvelous 30-m. diameter dome of the Church of Saint Sophia in Istanbul Turkey.

At present, diatomite has hundreds of specific uses in 10 principal categories: (1) filters, (2) fillers, (3) insulating materials, (4) mild abrasives, (5) absorbents, (6) catalyst carriers, (7) reactive -silica sources, (8) structural material, (9) additive or pozzolan for concrete,and(10) conditioner or anticaking agent. Therefore, diatomite is an abundant and extremely valuable mineral resource in industrialized societies. The consequences of shortages of diatomite would be manifold. The hundreds of current and future uses should afford ample incentive for the seeking of new deposits nearer the larger markets.

Economic diatomite deposits are of three main types: (a) marine rocks that accumulated near continental margins (b) non marine rocks that formed in lakes or marshes, and (c) sediments in modern lakes, marshes, and bogs. Modern marine sediments are a potential fourth source of diatoms. However, diatomite resources are difficult to describe because diatomaceous rocks underlie large areas and include strata of various qualities. Reserves are estimated to be adequate beyond the year 2000. Presently known deposits are stretching beyond forecasted depletion through the efforts of research and development in finding methods to process lower grade crude. Other deposits that are currently considered marginal by virtue of quality, minability, or accessibility will undoubtedly take on new importance should the present reserves begin to dwindle.

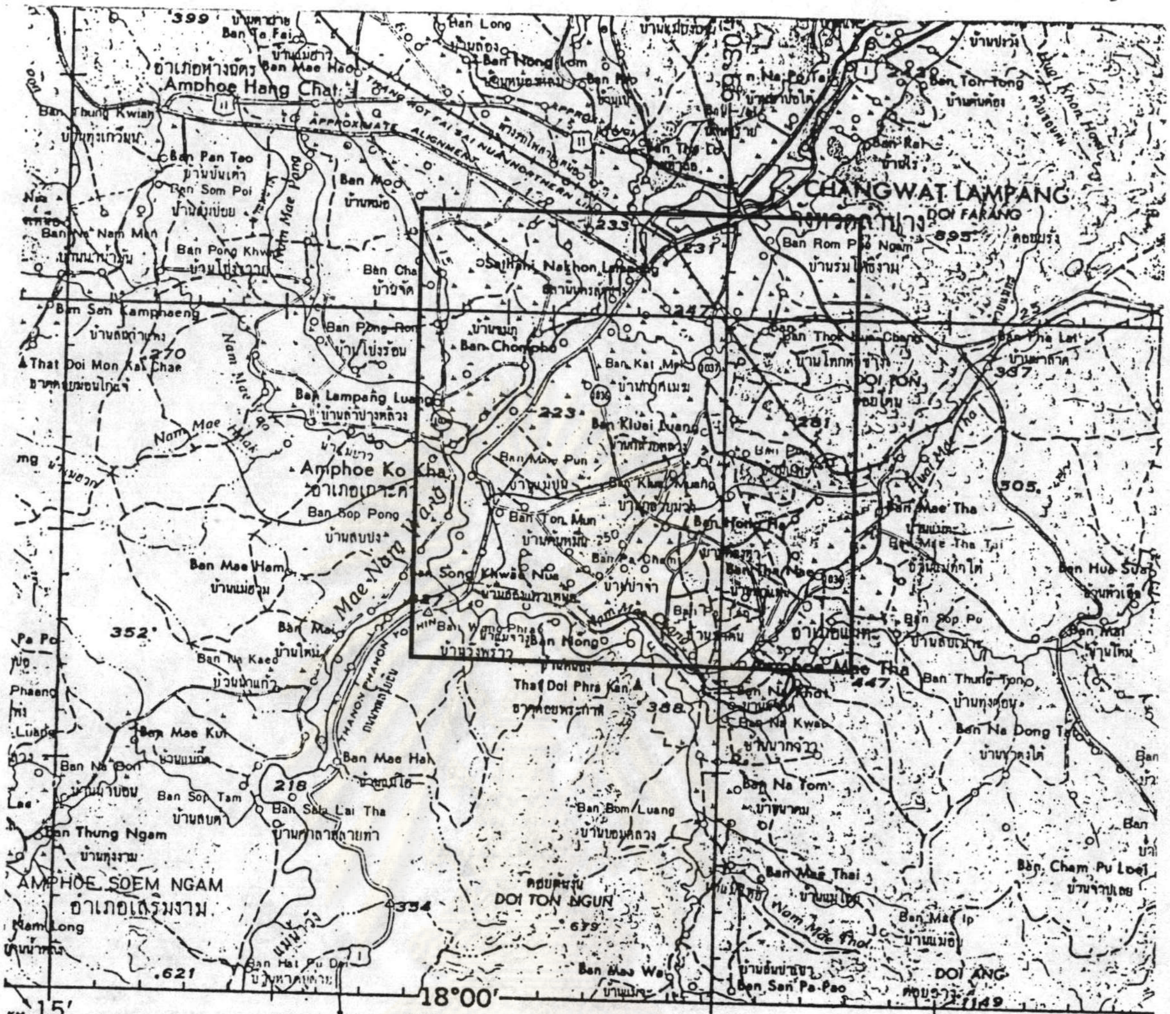
Considering the physical properties of diatomite, it ranges from various shades of white to light gray or buff in color, it can also be yellowish, light to dark brown, pink, and green. Its chemical composition is approximately that of opaline silica ($SiO_2 . nH_2O$), and it is resistant to the action of most chemicals. Impurities in diatomite deposits include volcanic ash, clay, shale, chert, sandy layers, pebbles, iron concretions, carbonates, carbonaceous material, and other fossils. Petroleum is found in some diatomite deposits, which naturally often is of commerical interest. The specific gravity of dry unconsolidated diatomite ranges from 0.12 to.0.25. Because of its high porosity (75 % -80 %), its natural moisture content is high. Its thermal conductivity is low. Its absorption power is such that it may carry 25 to 45 percent of water. It is insoluble in acid but soluble in alkalies. The important commercial properties of diatomite are its porosity, fineness of pores, absorptive power, light weight and low heat conductivity.

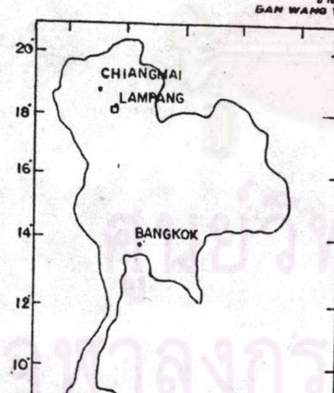
With regards to diatomite deposits in Thailand, there are several deposits in the Lampang Basin, notably, Ko Kha deposits, Kluai Phae deposits, Mae Tha deposits, Pichai deposits and Kuai Nam Kam deposits. In the present study, attention is focused upon the Kluai Phae deposits.

1.2 Location of the Study Area

Lampang Basin is the second largest Tertiary intermontane basin in northern Thailand covering an area of approximately 1,000 km^2 of Amphoe Muang, Amphoe Ko Kha, Amphoe Mae Tha, Changwat Lampang. The basin is oriented in the NNE/SSW parallel to the regional geological structure of the area. The shape of the basin is more or less triangular tapering to the north with maximum width of approximately 35 km. in the vicinity of Amphoe Ko Kha and approximately 50 km. in length. The average elevation of the ground surface in the basin is about 250 m. above the mean sea level (Fig. 1.2.1)

The study area is located in the southeastern part of Lampang basin covering an area about 340 km^2. of parts of Amphoe Muang and Amphoe Mae Tha, Changwat Lampang (Fig. 1.2.2). The area lies between longitude 99° 22.9' to 99° 33' and latitude 18° 7.5' to 18° 17.3'. The shape of the study area is almost square, 18x19 km^2. The reference topographic maps (1:50,000 scale) of the area are Amphoe Ko Kha sheet (4845II) and Amphoe Mae Tha sheet (4945III).





Study area

SHOWING THE LOCATION OF THE STUDY AREA.

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FIG. 1.2.1	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	

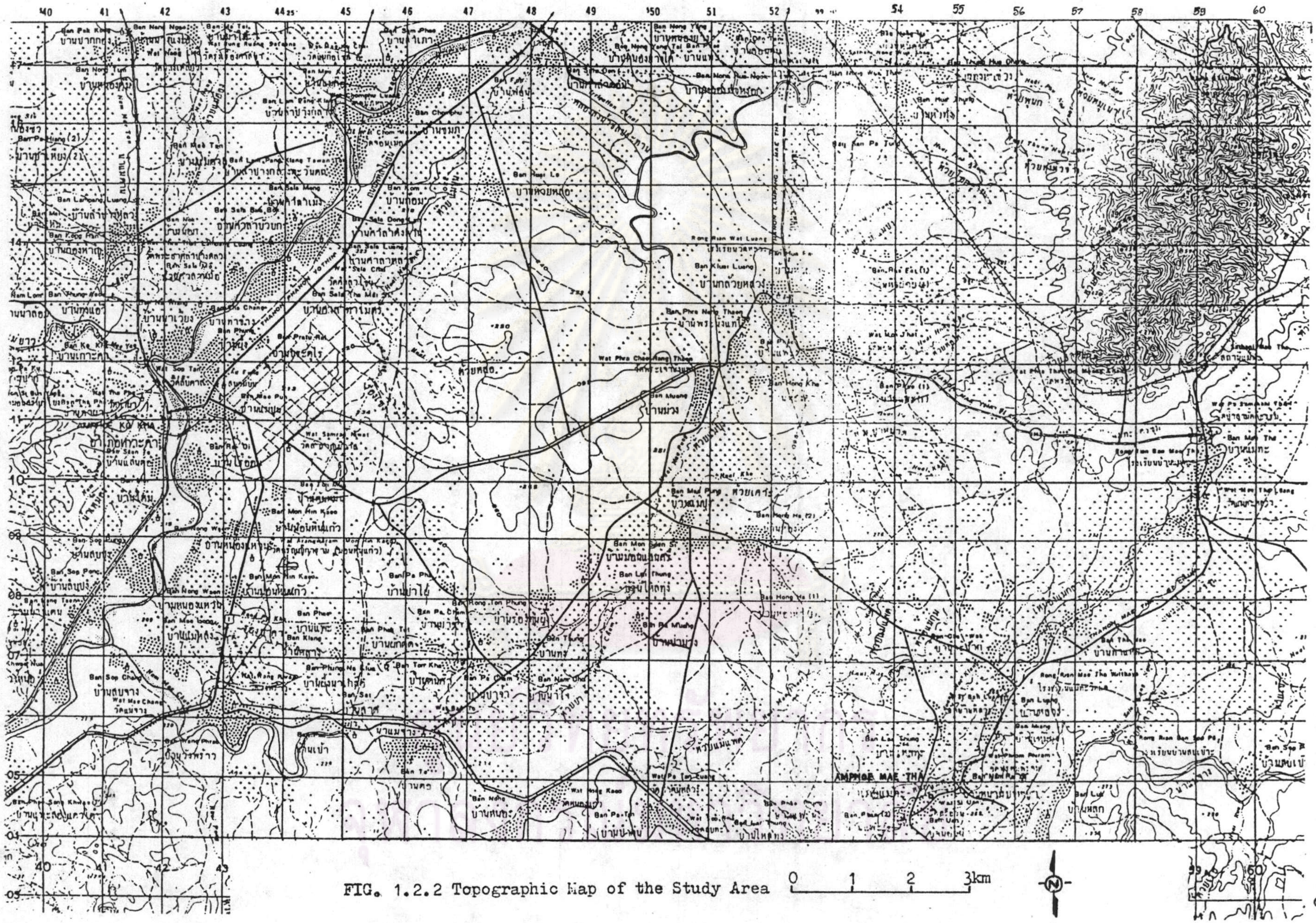


FIG. 1.2.2 Topographic Map of the Study Area

1.3 Objective of the Study

The present investigation primarily aims at defining the subsurface lithostratigraphy of the diatomite-bearing sedimentary sequences for the reconstruction of depositional environment of diatomite deposits and associated sediments. Additional attempt will be made to determine the geological history of the deposits concerned as well as to appraise economic potential of diatomite deposits.

1.4 Methodology

Originally, the existing geological information and data of the study area as well as adjacent area are compiled and analysed. Additional field mapping has been conducted in order to obtain the complete geological setting of the areas.

Another input data and sampling materials under the present investigation are obtained from the co-operation of the Industrial Mineral Development Project of the Department of Mineral Resources (D.M.R.). These include data and rock samples from 42 rotary drill holes, 13 diamond drill holes, and 6 prospecting shafts. Besides, 37 bore-holes geophysical logs of γ-ray, density, resistivity, and spontaneous potantial (SP) are obtained under this project (Table 1.4.1, 1.4.2)

The subsurface information on geological and geophysical aspects of the area (Fig. 1.4.1) are then compiled and analysed in order to obtain the lithostratigraphic sequences and geological condition from the ground surface down to the depth of approximately 450 m. These analyses are represented in the forms of geological cross-sections, fence diagram, isopach maps, and structural contour maps.

Rock samples from the bore holes have been intensively studied in the laboratory using various techniques for additional details. For diatomite and diatomaceous clay samples, various analytical techniques have been employed to detailing importance chemical composition of the whole sample quantitatively. This can be summarized as follows (Table 1.4.3)

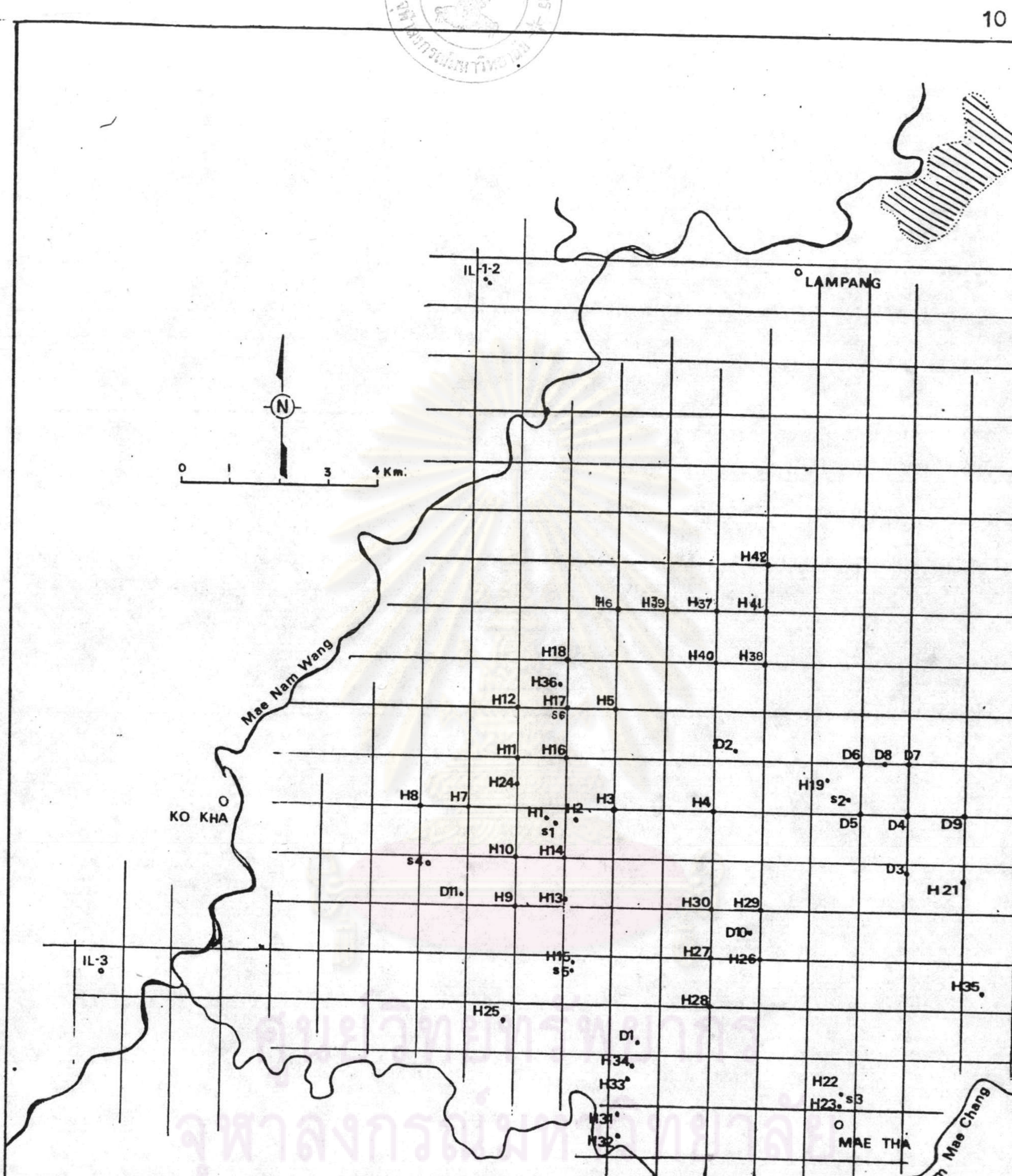
Selected rock samples have been studied for their mineralogical

Table 1.4.1 Summary of the dilling exploration data of the study area

Hole / Shaft no.	Location	Gd. elv (m)	Depth (ft)	Geophysic logs D	γ	R	SP	Thickness (ft) Top soil/Lat	Cl/ Sd/ Grv	DiatomaceousCl	Clst/Mdst
H_{1}	486108	274.69	183	-	-	-	-	13	41	60	> 69
H_{2}	491108	272.89	232	-	-	-	-	12	4	94	>122
H_{3}	500110	263.82	266	-	-	-	-	15	-	40	>211
H_{4}	520110	262.19	260	✓	✓	-	-	3	>257		
H_{5}	500130	274.67	292.83	✓	✓	-	-	1	163	-	>128.83
H_{6}	500150	258.27	245	✓	✓	-	-	10	49	-	>186
H_{7}	470110	258.20	79		-	-	-	4	> 79		
H_{8}	460110	253.94	150	✓	✓	-	-	6	>144		
H_{9}	480090	258.12	120	✓	✓	-	-	3	3	91	> 23
H_{10}	480100	274.69	110	✓	✓	-	-	9	1	75	> 25
H_{11}	480120	253.16	80	✓	✓	-	-	3	1	46	> 30
H_{12}	480130	268.20	183	✓	✓	-	-	5	91	-	> 87.83
H_{13}	490092	250.97	204	✓	✓	-	-	5	27	58	>130
H_{14}	409100	261.51	183	✓	✓	-	-	13	13	49	>108
H_{15}	491079	248.01	183	-	-	-	-	8	-	124	> 51
H_{16}	490120	260.82	183	-	-	-	-	9	-	65	>109
H_{17}	490130	266.75	173	✓	✓	-	-	18	-	106	> 49
H_{18}	490140	255.19	60	✓	✓	-	-	12	-	> 48	
H_{19}	544117	287.56	150	✓	✓	-	-	5	1	117	> 27
H_{20}	654325	-	153	✓	✓	-	-	3	5	34	>111
H_{21}	570097	314.40	76	✓	-	✓	✓	2	> 74		
H_{22}	547053	256.60	115	✓	-	-	-	2	16	45	> 52
H_{23}	drilling incomplete			-	-	-	-				
H_{24}	480115	264.31	154	✓	✓	✓	✓	9	-	86	> 59
H_{25}	478067	264.94	30	-	-	-	-	6	> 24		
H_{26}	530080	266.10	150	-	-	-	-	8	>142		
H_{27}	520080	278.93	50	✓	✓	-	-	4	> 46		
H_{28}	520070	265.07	156.	✓	✓	✓	✓	4	>151		
H_{29}	530090	271.58	18	-	-	-	-	4	> 14		
H_{30}	520090	268.50	162	-	-	-	-	2	>160		
H_{31}	501049	255.72	18	-	-	-	-	4	> 14		
H_{32}	502045	252.41	34	-	-	-	-	4	> 30		
H_{33}	503056	253.61	167	✓	✓	✓	✓	3	>164		
H_{34}	504058	254.40	154	✓	✓	✓	✓	3	51	50	> 50
H_{35}	574073	253.20	116	✓	✓	✓	✓	8	>108		
H_{36}	489134	252.75	104	✓	✓	✓	✓	10	46	>67	
H_{37}	520150	263.91	224	-	-	-	-	2	148	-	> 74
H_{38}	530140	271.33	70	-	-	-	-	2	> 68		
H_{39}	510150	258.30	252	✓	✓	✓	✓	2	>230		
H_{40}	520140	274.34	272	✓	✓	-	-	2	72	-	>173
H_{41}	530150	277.51	232	✓	✓	✓	✓	4	>228		
H_{42}	530160	277.16	130	✓	✓	✓	✓	2	>128		
D 1	506062	259.73	1250	✓	✓	-	-	2	-	84.5	>1165.5
D 2	523122	261.00	500	-	-	-	-	15	122	-	> 378
D 3	556087	273.50	600	✓	-	✓	✓	5	342	-	> 253
D 4	560110	310.98	200	-	-	✓	-	2	25	-	> 173
D 5	550110	297.92	90	✓	-	✓	✓	2	25	34.5	> 51
D 6	550120	305.70	200	✓	-	✓	✓	2	8	44	> 146
D 7	560120	315.30	350	✓	-	✓	✓	-	169	-	> 181
D 8	555120	310.16	350	✓	-	✓	-	1	18	40	> 291
D 9	570110	298.87	350	✓	-	-	✓	7	30	-	256(293'-350'Lst)
D 10	529087	269.32	1500	-	-	-	-	14	566	-	> 920
D 11	465102	264.50	1400	✓	-	✓	-	12	-	42	>1346
S 1	488107	274.70	100	-	-	-	-	8.33	6.33	> 85	
S 2	547113	287.56	104	-	-	-	-	2	-	>102	
S 3	546051	265.97	62	-	-	-	-	2	-	> 43.5	
S 4	461099	264.50	37	-	-	-	-	.4.5	-	13.5	> 19
S 5	491078	248.01	96	-	-	-	-	8	-	25	> 29
S 6	490130	266.75	131.42	-	-	-	-	7	12	88	> 24.42

Table 1.4.1b Summary of the drilling exploration data of the study area

depth range (feet)	nos of well	well nos
0 - 100	15	H_7 H_{11} H_{18} H_{21} H_{25} H_{27} H_{29} H_{31} H_{32} H_{38} D_5 S_1 S_3 S_4 S_5
0 - 200	25	H_1 H_8 H_9 H_{10} H_{12} H_{14} H_{15} H_{16} H_{17} H_{19} H_{20} H_{22} H_{24} H_{26} H_{28} H_{30} H_{33} H_{34} H_{35} H_{36} H_{42} S_2 S_6 D_4 D_6
0 - 300	10	H_2 H_3 H_4 H_5 H_6 H_{13} H_{37} H_{39} H_{40} H_{41}
0 - 400	3	D_7 D_8 D_9
0 - 500	1	D_2
0 - 600	1	D_3
0 - 700	-	-
0 - 1000	-	-
0 - 2000	3	D_1 D_{10} D_{11}
0 - 3000	1	IL-3(15)
0 - 4500	2	IL-1(13), IL-2(14)
	61	



DRILL HOLES LOCATION MAP	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. 1.4.1

Table.1.4.2 Analytical techniques employed in the quantitative determination of some bulk rock sample composition.

Composition	Analytical techniques used
SiO_2	Gravimetry
Al_2O_3	Gravimetry
Fe_2O_3	Volumetry
TiO_2	Colorimetry
MnO	Atomic absorption spectroscopy
CaO	Gravimetry
Na_2O	Atomic absorption spectroscopy
K_2O	Atomic absorption spectroscopy
MgO	Gravimetry
H_2O^+	Gravimetry
H_2O^-	Gravimetry

composition particulary the clay mineralogy using the X-ray diffractometry technique (The Philips X-ray generator model PW 1730/10 and the goniometer model PW 1050/70). Wherever there is a layer of oil shale present in the drill holes, oil shale samples are always taken for the determination of oil content using the colorimetry method.

Textural and mineralogical composition have been studied using the standard thin-sections petrography. For friable sample, impregnation have been carried out prior to the preparation of the thin-sections.

Identification of diatoms have been carried out under the high-power microscope as well as the scanning electron microscope. For other macrofossils, the standard identification technique is being used.

Besides, other important physical properties, namely, specific gravity, bulk density, oil absorption, and cohesion force as well as interfraction angle have been randomly examined.

The subsurface geological and geophysical interpretation supplemented by laboratory data and information are used to define and subdivide lithostratigraphic units of the sedimentary sequences of the study area. The lithostratigraphy is then served as base-line information to establish the sedimentary faceis for further step in the reconstruction of depositional environment. As a result, the depositional model is synthesised using Selley (1978, 1982), Blalt et al. (1980), Reading (1978).

Finally, additional attempt is made to appraise the economic potential of the diatomite deposits in this area for further development.

The study procedures employed in this study can be summarized and presented in Figure 1.4.2.

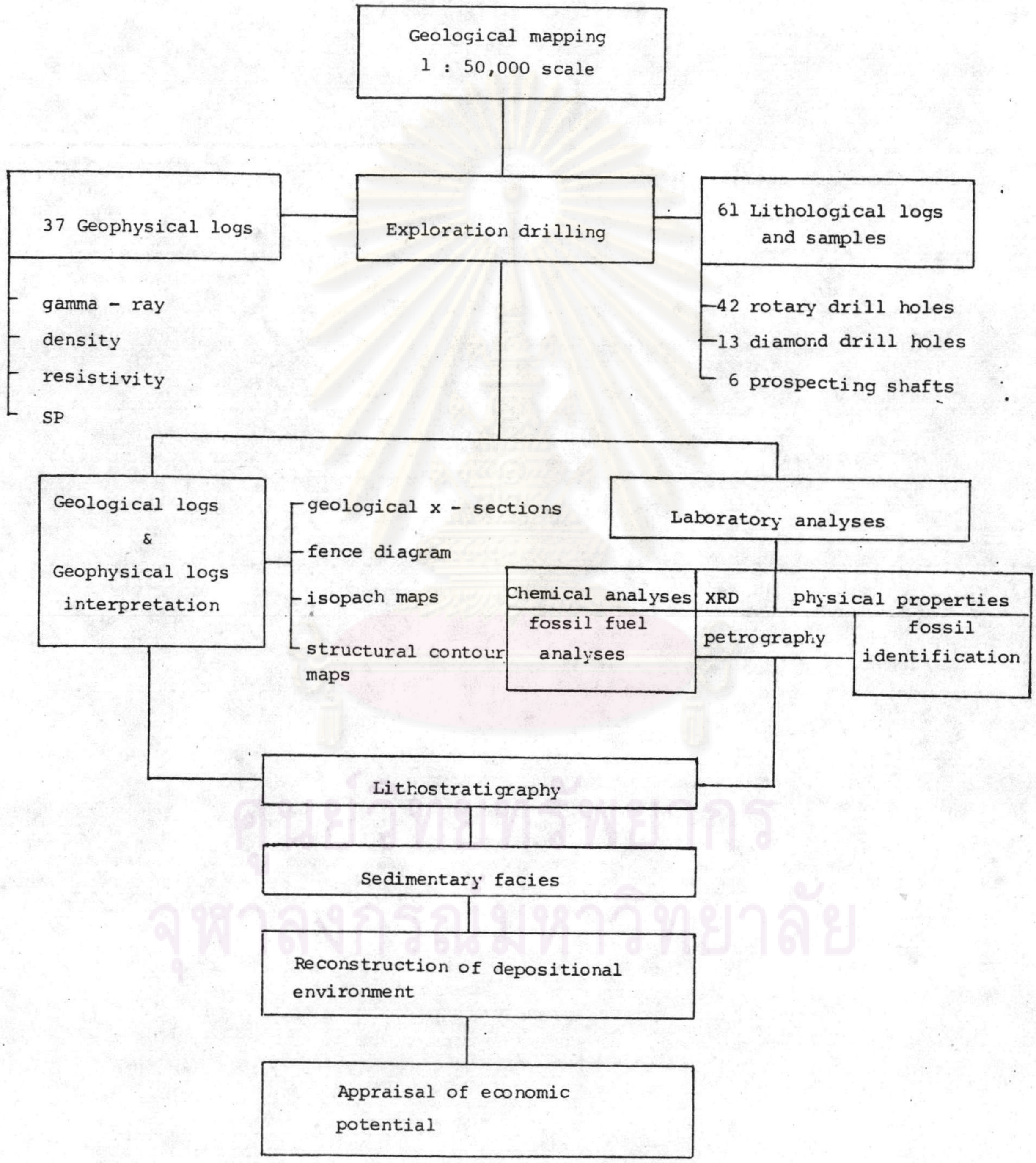


FIG. 1.4.2 Flow chart illustrating the methodology

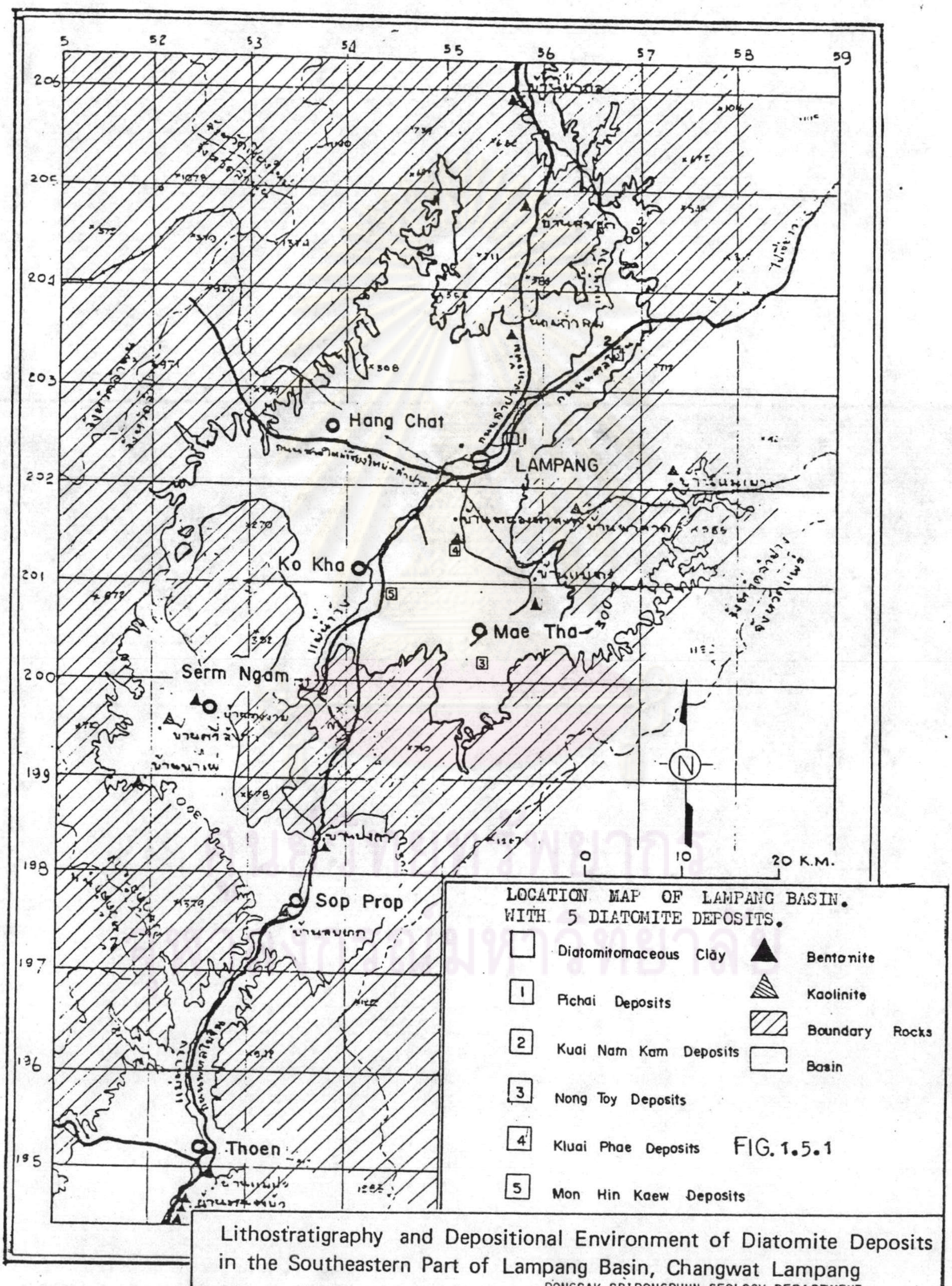
1.5 Previous works

The first geological investigation of the diatomite deposits in Lampang was reported by Sresthaputra in 1953 (Brown, et al.,1953). The deposit is located in the basin of Mae Nam Wang which occupies the Mae Nam Wang valley between Amphoe Hang Chat and Amphoe Mae Tha about 18 km. south of Mae Tha railway station. The exposure of 10 by 20 m. crops out on the southern bank of Mae Chang, a tributary of Mae Wang, dipping westwardly to the center of the basin. Chemical analysis of the diatomite had also been reported.

In 1951, Charaljavanaphet (Brown, et al., 1951) had examined the diatomite microscopically for varieties of diatoms including the grain size estimation and concluded the deposits is of fresh-water origin.

Brown et al. (1951) had considered the diatomite deposits in Lampang area to be parts of the time stratigraphic unit of Mae Sot Series of Tertiary Period. The rocks of Mae Sot Series are consisting mainly of semiconsolidated fluviatile and lacustrine deposits of clay, gravel, marl, oil shale, lignite, gypsum, and fresh-water limestone

In 1962, Pariwatawan had conducted a semi-systematic study on diatomite deposits in Lampang area. Altogether five deposits had been reported, namely, Pi Chai deposit and Huai Nam Khem deposit of Amphoe Muang, Nong Toi deposit and Kluai Phae deposit of Amphoe Mae Tha, and Mon Hin Kaew deposit of Amphoe Ko Kha (Fig. 1.5.1). Besides, the geological condition, properties, reserves, and fossil identification of each deposits had been described. It is concluded that the diatomite are of fresh-water species ranging in age from Pliocene to Recent.



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

PONGSAK SRIPONGPHUN GEOLOGY DEPARTMENT
GRADUATE SCHOOL CHULALONGKORN UNIVERSITY 1985

In 1967, Gardner described the Pliestocene (?) rocks of Lampang valley west of Mae Moh valley which contain a thick, widespread deposit of white diatomite. The diatomite is in massive beds separated by a few thin layers of ochre-colored diatomaceous clay.

In 1969, Charaljavanaphet had reclassified the lithostratigraphy of Thailand, and further subdivided the Krabi Group into two formation. The lower formation is called Li Formation, and the upper formation is called Mae Moh Formation. The diatomite deposits in Lampang area is therefore included in the Mae Moh Formation.

Later on 1971, Piyasin investigated and described the lithostratigraphy of Mae Moh group in Lampang Basin. The rocks are characterized by the exposure of diatomite and greyish brown shale in the neighbourhood of Ban Pi Chai. It is also noted that there is no lignite outcrop in this basin and the lower part of Mae Moh group was not defined.

In 1972, Akutsu had collected and identified the fossil diatoms from Mon Wang Ith, Lampang. The diatomite is found to be mainly composed of diatoms valves and is entirely composed of valves of *Melosira granulata* (EHR.) RALFS, and rarely *Navicula spp.* and *Fragilaria spp.* It is inferred that the deposit was accumulated under the particular condition favorable for *Melosira granulata* (EHR.) RALFS. From the abundant occurrences of *Melosira granulata*, it seems that the sedimentary environments of the deposit was freshwater, eutrophic, stagnant lake deposit. Concerning the geological ages, this species ranges from Miocene to Recent, it is difficult to define the geological age only by the evidence of diatom fossils.

In 1977, Piyasin, et al., had conducted the petroleum exploration drilling program for the Defense Energy Department in Lampang basin. The diatomite had been found associated with grey claystone, mudstone with plant remains between the depth range of 140-170 ft. at well number IF 1(16) and at the depth range of 110-120 ft. at well number IL-2(14). The diatomite deposits are categorized in the Ko Ka Formation.

Recently in 1979, Kumanchan had reported the present of bentonite interbedded with diatomite in an area of northern part of Amphoe Mae Tha. The bentonite is believed to be the alteration products of volcanic tuff in Lampang basin.