CHAPTER III

LITHOSTRATIGRAPHY

3.1 General

The basic geological utilizations of subsurface information are to prepare maps of subsurface structure at various depths and of stratigraphic feature. However, the ultimate degree to which one can recognize and describe difference strata within a given succession may appear to be practically and unlimited. Strata can be subdivided on the basis of their physical characteristics, on the basis of their fossil contents, and by their time relationship. Accordingly, three kinds of units have been established, namely, lithostratigraphic units, biostratigraphic units, and chronostratigraphic units. In this study, sequences of strata have been subdivided on the basis of their physical characteristics which are the products of many depositional processes in various depositional environments.

A lithostratigraphic unit is a body of rock strata which is unified by consisting dominantly of a certain lithological type, or combination of lithological types, or by possessing other impressive and unifying lithological 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-dimentional body and its concept must be based on its characteristics as a unit through its full extent, both vertically and laterally. The features used to define lithostratigraphic units can be as varied as the strata themselves. Boundaries separating lithostratigraphic units may be placed

at sharp contact or at arbitrary levels with respect to a zone of gradational. Besides, the subdivision of lithostratigraphic units is depending upon the purpose of selecting such units for particular geological objective, such as geological mapping, a sedimentological studies, assessment of mineral resources, the study of the distribution of fossil, collection of specimen for some laboratory measurement (i.e. paleomagnetism), etc. In this study, the classification of lithostratigraphic units is primarily carried out for the purpose of reconstruction of depositional environments. Consequently, the lithostratigraphic units are therefore interrelated with sedimentary facies. An attempt has been made in this investigation to classify and describe the lithostratigraphic units of the sedimentary sequence within Mae Moh basin into the following levels: group, formation, member, and bed. Besides, arbitrary nomenclature of various lithostratigraphic units has been proposed as informal name to serve the discussion.

The formation is the primary formal unit of lithostratigraphic classification; it is a body of rock strata of intermediate rank in the hierarchy of lithostratigraphic units. Formation is the only formal lithostratigraphic units into which the stratigraphic column everywhere should be divide completely on the basis of lithology. A member is the formal lithostratigraphic unit next in rank below a formation and is always a part of formation. It is recognized as a named entity within the formation because it possesses lithological characters distinguishing it from adjacent parts of the formation. A bed is the smallest formal unit in the hierarchy of lithostratigraphic units. It is a unit layer in a stratified sequence of rocks which is lithologically distinguishable from other layers above and below (Hedberg, 1976).

Descriptions of a stratigraphic unit should include : 1) its name; 2) rank of unit (i.e. group, formation, etc); 3) historical background (original references, priorities, assurances against unnecessary duplication of already existing units); 4) geological and geographical identification (maps, columnar sections, structural sections, photographs, and diagnostic taxons).

Prior to the detailed discussion on the basin lithostratigraphy, it is necessary to well understand about the terminology used in the present study. Due to the fact that there are many classifications dealing with fine-grained clastic sedimentary rocks (Table 3.1a and Figure 3.1a). In this study the classification of fine-grained sedimentary rocks of Picard (1971) has been used. The classification based on the proportions of clay, silt and sand, and are useful in defining four major groups of sedimentary rocks, namely, claystone (clay), siltstone (silt), mudstone (mud) and sandstone (sand). Claystone, siltstone and sandstone are rocks containing more than 50 percent of clay, silt and sand, respectively. Silty and sandy are used as modifiers of claystone when clay-sized material is less than 75 percent but more than 50 percent. Clayey and Sandy are used to modify siltstone when silt-sized material is less than 75 percent but more than 50 percent. Mudstone is composed of a mixture of clay-, silt-and sand-sized particles, none of which equals 50 percent of the rock. (Figure 3.1a).

The following discussion will be focusing upon the proposed classification, tentative nomenclature, and description of various lithostratigraphic units of sedimentary sequence of Mae Moh basin.

Table 3.1 a Criteria used to define fine-grained sedimentary rocks. (after Lewan, 1981).

Reference	Grain size	Composition	Splitting	Bedding
		Shale		
Pettijohn (1975, p. 261)	Clay and silt	N.S.	Fissile	Laminated
Blatt and others (1972, p. 374)	Clay and/or silt	Substantial amounts of clay minerals	Fissile	N.S.
Jackson (1970, p. 377)	Clay and silt	N.S.	Fissile	Laminated
Moorhouse (1959, p. 361)	Very fine grained	Argillaceous	Fissile	N.S.
		Mudstone		
Pettijohn (1975, p. 261)	Clay and/or silt	N.S.	Nonfissile	Nonlaminated
Blatt and others (1972, p. 375)	Clay = 67%-33%, silt = 33%-67%	N.S.	Nonfissile	N.S.
Jackson (1970, p. 377)	Fine-grained	N.S.	Nonfissile	N.S.
Dunham (1962, p. 118)	Mud with less than 10% grains	Carbonate	N.S.	N.S.
		Claystone		
Pettijohn (1975, p. 261)	Clay	N.S.	Nonfissile	N.S.
Blatt and others (1972, p. 375)	Clay = 100%-67%, silt = 33%-0%	N.S.	Nonfissile	N.S.
Moorhouse (1959, p. 366)	Fine-grained	Argillaceous	Nonfissile	Nonlaminated
Picard (1971, p. 185)	Clay = 100%-50%	N.S.	N.S.	N.S.
		Marlstone (marl)		
Pettijohn (1975, p. 285)	Clay = 65%-35%	Carbonate = 35%-65%	N.S.	N.S.
Jackson (1970, p. 384)	N.S.	Subequal amounts of clay and carbonate	N.S.	N.S.
Moorhouse (1959, p. 378)	N.S.	Equal amounts of clay and carbonate	N.S.	N.S.

Note: N.S. = Not specified.

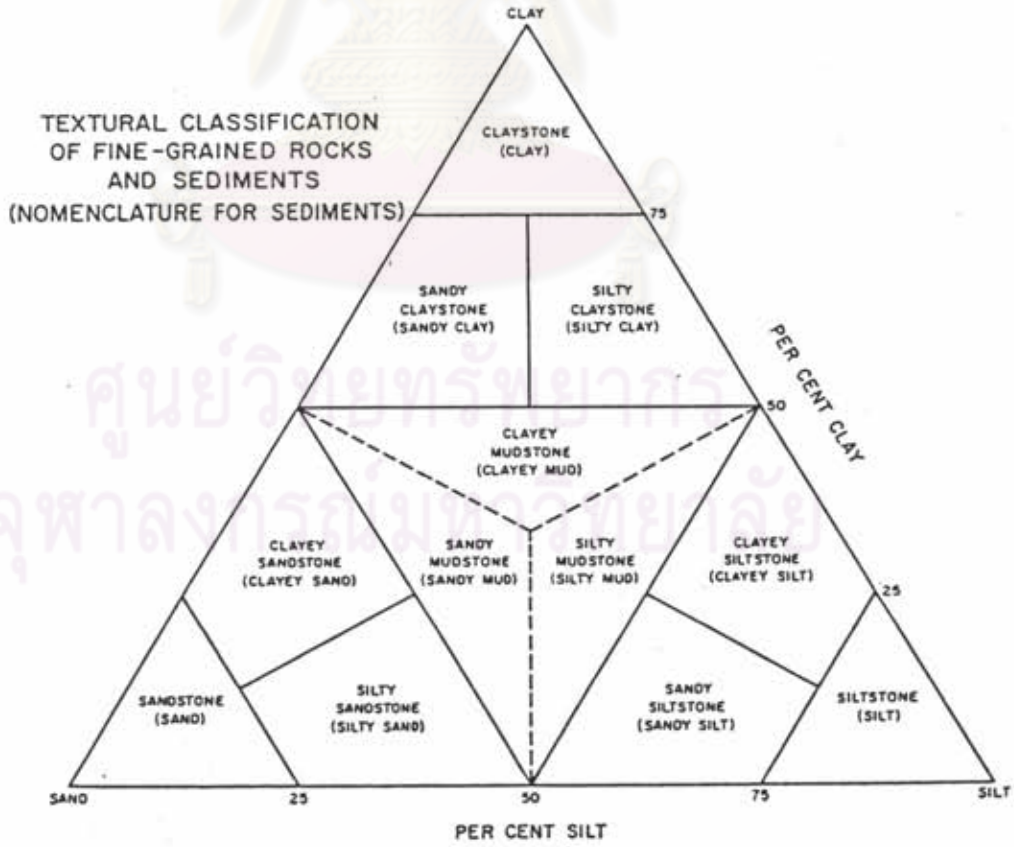


Fig. 3.1 a Textural classification of fine-grained clastic rocks, unconsolidated sediments, and soil.(after Picard, 1971)

3.2 A-Formation

The lowermost lithostratigraphic unit of the Mae Moh Group is referred to as "A-Formation" which further subdivided based on lithology and grain-size distribution, into 2 members: the upper A-2 Member, and the lower A-1 Member. Due to the unexposed nature of the formation, the classification of A-Formation depends entirely on subsurface data. The A-Formation overlies unconformably on the highly folded pre-Tertiary rocks, such as, Hong Hoi Formation, Doi Long Formation, etc., and underlies conformably the B-Formation of fine-grained clastic associations. From the previous borehole record the rocks of this formation has been found in boreholes LM 1800, LM 1885, LM 1913 and LM 2189. Most of them are located at the edge of the study area. However, they were described equivalent to the Lampang Group. During the period of the present investigation, a few boreholes, so-called "stratigraphic hole" were drilled, some of them reached the basinal basement rocks of Lampang Group. Consequently, the stratigraphy of the Mae Moh basin has been modified. Generally, A-Formation is characterized by the fining upward sequence, the A-1 Member shows a relatively coarser grain-size than the A-2 Member. The A-Formation is weakly consolidated as compared with the overlying strata the B-Formation, and the unit thickness varies even in short spacing distance of boreholes. The variation of unit thickness is probably the result of the paleogeography of the Mae Moh depositional basin.

3.2.1 A-1 Member

The A-1 Member is the lowermost lithostratigraphic unit in the Mae Moh basin. It overlies unconformably on the folded pre-Tertiary strata of Lampang Group (Figure 3.2.1a) and underlies conformably the

A-2 Member. According to the drilling data obtained from EGAT., a few boreholes reached this member, namely, LM 1800, LM 2813 S LM 2963 S, LM 3382 S, and LM 3450 S (Appendices 1 and 2). Generally, the A-1 Member comprises of coarse-grained clastic association with fining upward sequence. Over ten cycles of fining upward sequence are observed from borehole LM 2813 S with both erosional surface and abrupt changed in grain-size at the base of each cycle. The overall picture of the member is decreasing in grain-size upwardly.

The lithostratigraphy of the member can be separated into 2 parts, the upper and the lower parts. In the lower part of the member each cycle begins with lag deposit of fine-grained conglomerate to conglomeratic sandstone at the base (Figure 3.2.1a), and grading upward to sandstone at the top of the cycle. The thickness of each cycle varies considerably to over 3 metres. However, the sequence of these coarser-grained of high energy sediments has limited extension which is found only in boreholes LM 2813 S and LM 3450 S, and thickness varies from 18 metres in LM 2813 S to 9 metres in LM 3450 S. In the upper part of A-1 Member, grain-size is considered finer than the lower part and the fining upward sequence normally begins with coarse grained sandstone or conglomeratic sandstone at the base and grades upward to clayey siltstone at the top. The A-1 Member is weakly consolidated, highly weathered, the coloration varies in shades of gray, green, brown, purple, red and yellow. The color mottling of red, yellow and brown is common.

Lithologically, fine-grained conglomerate and conglomeratic sandstone are closed work structure, gray to green color and often overlie

on the erosional surface. Clasts are subangular to rounded, low to medium sphericity, normally granule-to pebble size with some cobble-size of quartz, chert and sandstone with some mudrocks and volcanic rocks. Sandstone is green, gray and purple with red and yellow mottles, weakly consolidated, fine-to very coarse-grained, subangular to rounded, and medium to high sphericity. Siltstone and clayey siltstone are gray and red colors, highly weathered, common color mottle of yellowish brown and red, and in part with calcrete (Figure 3.2.1b). Besides, red to yellow clayey siltstone or siltstone is common with some gray claystone fragments and occasionally intercalated with thin lamination of gray claystone. According to the borehole LM 3450 S, this member contains Viviparus sp. bed and fragments which is found in sequence of calcareous sandstone a few metres above the basement of probably Doi Chang Formation of Lampang Group.

Thin-section study of sandstone samples collected from LM 2963S, at depth 693.24-693.45 metres and 699.00-699.16 metres below the ground level indicate that all samples are lithicarenite (Pettijohn et al.,1973). Lithicarenite is coarse-to fine-grained, poorly sorted, angular to subrounded, and comprising of quartz, rock fragments and some feldspars. Rock fragments are chert, quartzite, limestone, phyllite, etc.

The total thickness of A-1 Member varied from 52 metres in LM 2813 S (N1 W 29) to 9 metres in LM 3450 S (S 24.85 W 9.95). The A-1 Member has a tendency to be thickening in the western part of the study area rather than in the eastern part and distributed in a narrow zone.

Fig. 3.2.1a Photograph of core-samples showing succession at the base of the A-1 Member (arrow), and the underlying intensively folded Hong Hoi Formation.
(from LM 2813S, at depth 460.00-467.50 metres)

Fig. 3.2.1b Photograph of core-samples showing gray clayey siltstone, red clayey siltstone, weathered red sandstone, calcrete (white) and color mottling.
(from LM 2813 S, at depth 410.00-420.00 metres)

Generalized succession of the A-1 Member is shown in Figure 3.2.1c.

3.2.2 A-2 Member

The A-2 Member is the uppermost lithostratigraphic unit of the A-Formation. The basal limit of the member is placed at the bottom of fining upward cycle represented by discernible claystone or silty claystone, and the top limit is marked by the coal band. Generally, the lithology is characterized by fine-grained clastic rocks alternating with some fining upward sequences.

At the lower part of the A-2 Member, the top of fining upward sequence is indicated by silty claystone or claystone. For the fine-grained clastic rocks, it consists of interbedded red silty claystone, gray claystone and gray silty claystone with graded bed base type. The color varies in shade of gray, green, red, yellow and brown. Red silty claystone is stiff with common gray rock fragments and calcrete. However, some of red, yellow and brown colors are caused by weathering processes. Gray silty claystone and claystone are stiff with common mottled of yellow, brown and red color, in part calcrete. In borehole LM 2813 S, gray claystone contains abundant plant remains and shows colored wavy lamination. The fining upward sequences are generally begin with coarse - grained sandstone or fine-grained conglomerate and topmost with gray, greenish gray and greenish brown claystone or silty claystone. The cycles commonly show erosional surface at the base with common color mottle and calcrete. The rocks are semi-consolidated, in part calcrete, red and yellowish brown mottles. Organic matter contents of plant origin is increasing upward to clayey

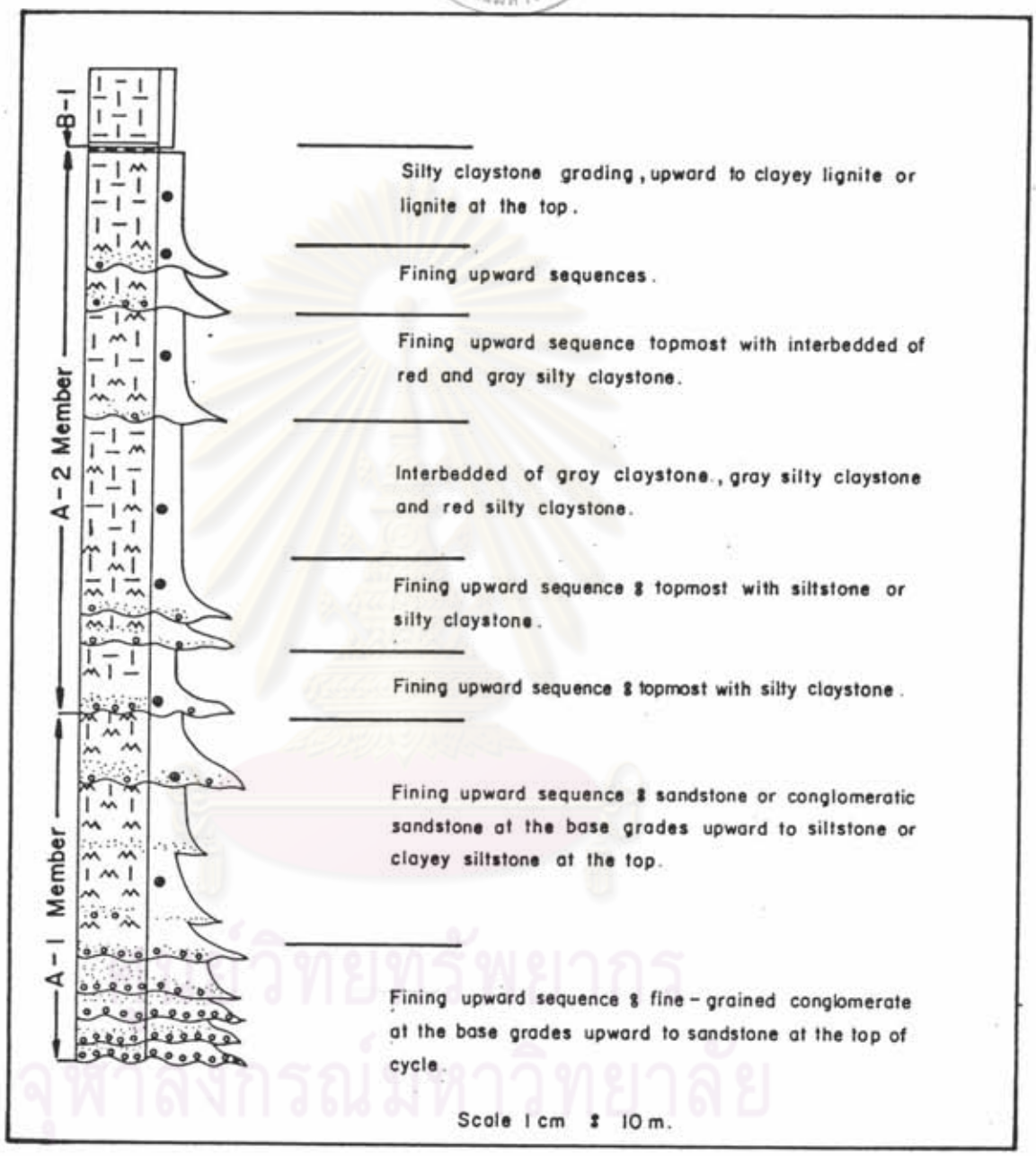


Fig. 3.2.1c Generalized succession of A-1 Member and A-2 Member

lignite and lignite. This minor coal seam is called "S Zone" by Krichkrivan et al.(1984), and ADAB. Project. This minor coal seam comprises of alternating of thin band of low quality lignite and parting of calcareous silty claystone (Figure 3.2.2 a). Gastropod, intraformational conglomerate and lignite flakes are common in these calcareous partings. The thickness of the coal seam varies from a few centimetres upto about 2 metres and the coal seam is widely distributed in the study area indicated by borehole LM 1913, LM 2813 S, LM 2963 S, LM 3382 S, and LM 3450 S. Data from borehole LM 3382 S indicates that the A-2 Member overlies unconformably on probably Doi Long Formation.

Petrographic study of sandstone in the lower and middle parts of A-2 Member from borehole LM 2963 S indicates that all of samples are lithicarenite (Pettijohn et al.,1973). Lithicarenite comprises of angular to subrounded quartz; rock fragments of quartzite, chert, shale, siltstone, schist and volcanic rocks, some feldspar, poorly sorted with siliceous cement.

The A-2 Member is relatively more extensive than the A-1 Member. The A-2 thickness in each borehole is greater than the A-1 Member. The maximum thickness from LM 2813 S is about 88 metres.

Generalized lithostratigraphic succession of A-2 Member is shown in Figure 3.2.1c.

3.3 B-Formation

This formation is predominantly characterized by fine-grained clastic association containing two major coal seams and two minor coal seams, some thin-bedded micrite, low-grade oil shale, as

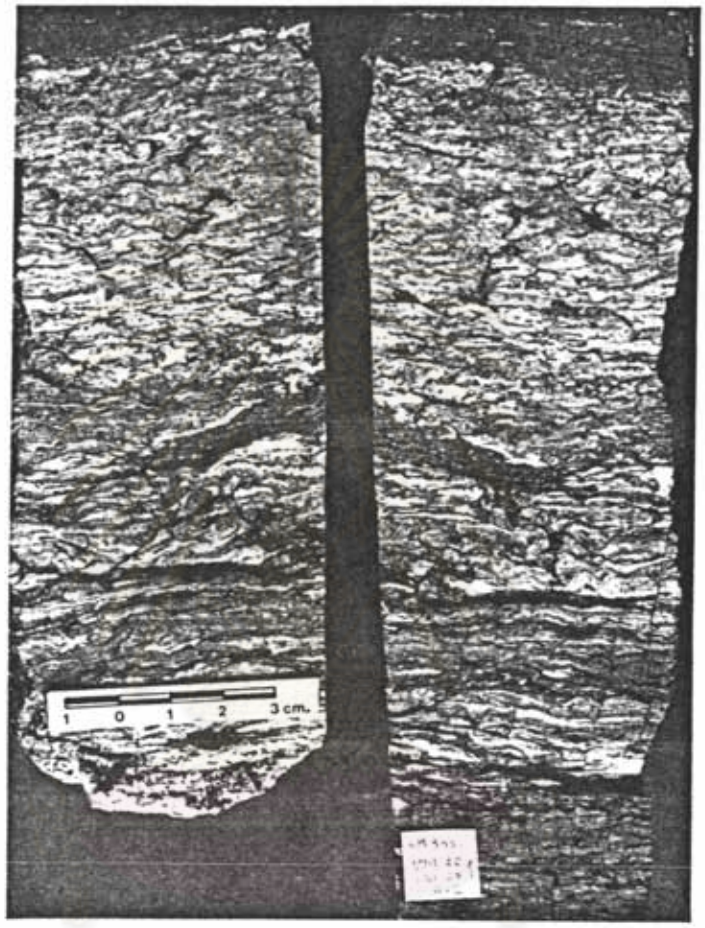


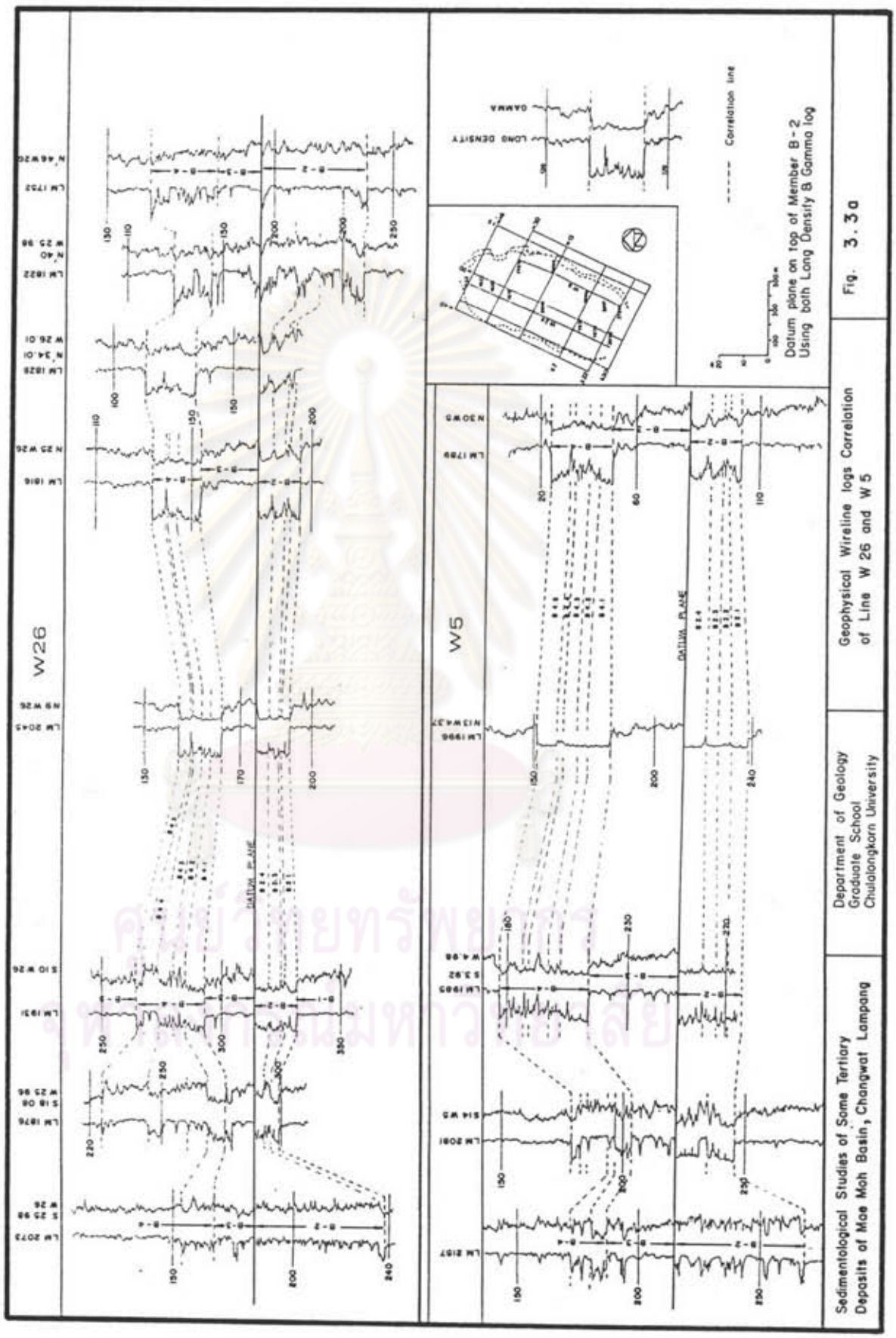
Fig. 3.2.2a Photograph of core-slabs from the uppermost part of A-2 Member showing deformed lineation, lignite flake (black), highly calcareous layer (white) and intraclasts.

well as some medium-grained clastic association, such as siltstone and sandstone. The B-Formation overlies conformably on A-Formation and underlies partly conformably and partly unconformably the C-Formation. The nature of the rock is relatively very stiff, hard and more compacted as compared with the overlying and underlying formations. All of coal seams within the formation are believed to be lignite in rank, two of which have been mined by EGAT., namely, B-2 and B-4 Members. Due to the objectives of EGAT. which mainly concentrates on the exploitation of lignite and limited number of deep exploratory borehole in the past, almost all of the previous detailed studies are emphasized only on this formation. The previous lithostratigraphic classifications are shown in Table 2.2.1a. In this study, the B-Formation consists of 6 members in desending order as : B-6, B-5,B-4,B-3,B-2, and B-1 Members.

The marker beds used for stratigraphic correlation are coal seams, fossil bed and the so-called"siliceous hard band". Besides, the signature of geophysical logs of each member is rather unique in characteristics. The geophysical logs used in stratigraphic correlation is shown in Figure 1.6 a, and geophysical logs correlation using both density and neutron logs of the B-2, B-3 and B-4 Members is shown in Figure 3.3 a.

3.3.1 B-1 Member

The B-1 Member is the lowermost lithostratigraphic unit of B-Formation. It lies conformably on the A-2 Member with gradational contact, and underlies conformably the major coal seam, the B-2 Member, with gradational contact. According to borehole data obtained from


W26
W5
B-1
B-2
B-3
B-4
DATUM PLANE
GAMMA
LONG DENSITY
Correlation line
Datum plane on top of Member B-2
Using both Long Densify & Gamma log
Sedimentological Studies of Some Tertiary
Deposits of Moe Moh Basin, Changwat Lampang
Department of Geology
Graduate School
Chulalongkorn University
Geophysical Wireline logs Correlation
of Line W 26 and W 5
Fig. 3.3a

EGAT., most of them penetrated only a few metres into the upper part of this member. However, a few boreholes reach the base of the member, namely, LM 1800, LM 1835, LM 2813 S, LM 2963 S, LM 3382 S and LM 3450 S. The lithology of the member is very consistent throughout the study area, some medium-grained clastics are present in northern part of the study area. The marker beds used in stratigraphic correlation of this member are minor coal seam, and gastropod beds. Besides, the lithological sequence of the member differs from the overlying strata. The minor coal seam marker bed in the upper of middle part of the member is called "L lignite" by Gloe (1955), "L lignite bed" by Gardner (1967), "R Zone" by Krichkrivarn et al. (1984) and ADAB Project. One gastropod marker bed is present in the uppermost part of the member whereas the other is found in upper part of the minor coal seam. However, gastropod marker beds are useful locally.

The B-1 Member usually begins with silty claystone, gray to greenish gray, highly calcareous, in part highly carbonaceous, laminated to thin-bedded, with common lignite flakes and fish fragments, and abundant gastropods. Some scour-and-filled and load structure are recorded. Intraformational conglomerate and light-color calcareous claystone lentil are also common. It is interesting to note that the shape of the lentil is parallel to the bedding plane. The above sequence is a few metres thick and is overlain by thick sequence of claystone with some silty claystone and siltstone. Claystone is characterized by gray, greenish-gray and light gray colors, highly calcareous, thin to medium bed of planar type (Figure 3.3.1 a), common fish fragments, and rare gastropod, bioturbation, calcareous claystone lentil and plant remains. The complete dicotyledon leaves

have been found at the depth 288.60 metres below the ground surface of LM 2813 S (Appendix 4, Photo A-4.10). It is noted that claystone with light color contains more silt content than the dark color one. Disregarding the minor coal seam and the overlying strata, these lower strata are thickening in the central part of the study area with over 100 metres thick.

The upper middle part of B-1 Member is characterized by lignite deposits (Figures 3.3.1 b and 3.3.1 c). The lignite or minor coal seam extends widespreadly covering most of the study area especially in the central part of the area. The thickness of lignite band is about 1-2 metres. The lithology a few metres above and below the lignite band are characterized by claystone and silty claystone. The rocks are gray, greenish gray and yellowish gray, highly calcareous, thin bedded to laminated, common to abundant gastropods of Viviparus sp. and Melanoides sp., in part ostracods, rootlet, fish fragments, and strongly bioturbated by organic boring and burrowing. Intraformational conglomerate and calcareous claystone lentil are present in part (Figure 3.3.1 d). This sequence is upto 15 metres thick. The overlying strata are sequence of claystone greenish gray to light gray, thin bedded to laminated, common fish fragments, framboidal pyrite, with rare gastropods and bioturbation. The topmost strata are characterized by claystone gray to dark gray, thin bedded to laminated, highly calcareous, abundant Viviparus sp. beds (Figure 3.3.1 e), common fish fragments,bioturbation and intraformational conglomerate.Carbonaceous content increases upwardly. However, the upper sequence of this member in the northern part is influenced by some medium-grained clastics as clearly shown in geophysical logs of boreholes LM 1767,LM 1850,LM 2217 etc.

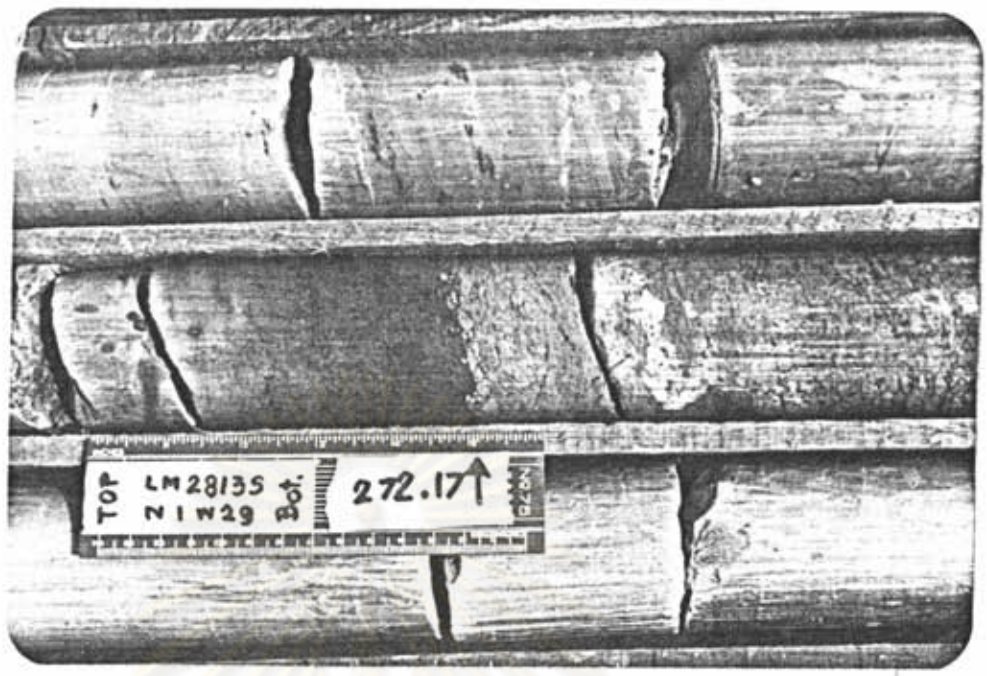


Fig. 3.3.1a Photograph of core-samples of B-1 Member showing thin to medium bedded claystone. Note bioturbation and intraclasts (arrow).

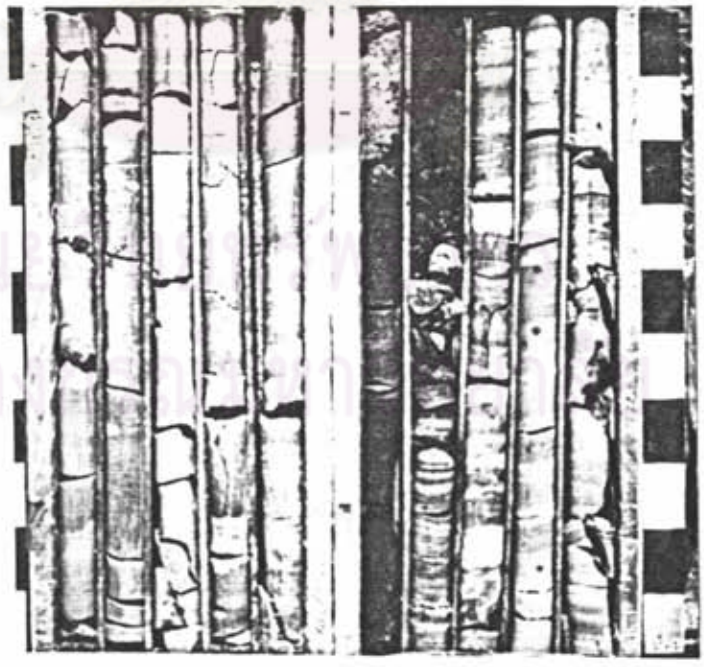


Fig. 3.3.1b Photograph of core-samples of B-1 Member showing minor coal seam, laminated to thin bedded silty claystone with bioturbation. Top is upper left and bottom is lower right, each column is a metre long.

Fig. 3.3.1c Photograph of core-sample of B-1 Member showing the organic boring filled with gastropod shell fragments. (the arrow indicates depth from ground level)

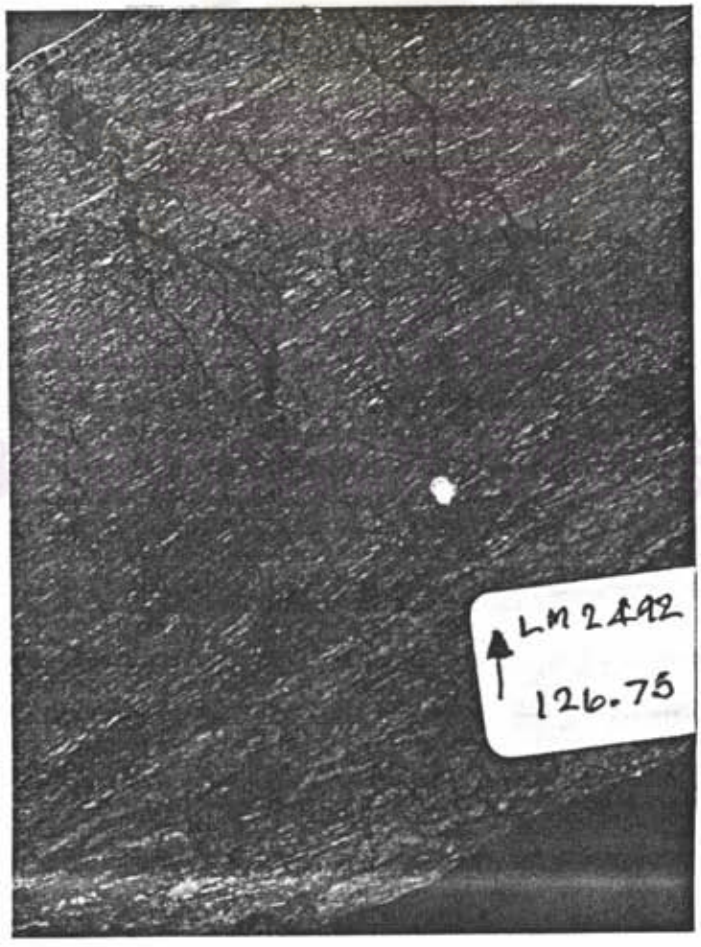


Fig. 3.3.1d Photograph of core-slab of B-1 Member showing the light color of highly calcareous claystone lentil parallel to the bedding plane (from LM 2492 C, at depth 126.75 metres right position)

In thin section, sample of calcareous lentil structure collected from LM 2492 C, at the depth of 126.60 metres is composed mainly of tiny crystals or grains of calcite with lense-formed. The calcareous lentil is enclosed by micaceous mineral (clay mineral ?),carbonaceous matter and some Fe-oxides. Rare silt-sized quartz is recorded. The lentil structure and micaceous mineral are oriented subparallel to the bedding plane (Figure 3.3.1 f).

The total thickness of B-1 Member from LM 2963 S is about 217 metres. However, the thickness in general is varied and thinning toward the edge or margin of the study area (Appendices 1 and 3).

Generalized lithostratigraphic succession of the B-1 Member is shown in Figure 3.3.1g.

3.3.2 B-2 Member

The "B-2 Member" is the lower major coal seam. This member or coal seam is one of the two coal seams which has been mined by the EGAT. It is called "M lignite bed" by Gardner (1967)."Q seam" by Longworth CMPS Engineers, and "Q Zone" by the ADAB. and currently report of EGAT. (Table 2.2.1a).

The B-2 Member is used as marker bed for lithostratigraphic correlation. It is well recognized on geophysical logs especially density and neutron parameters (Figure 3.3a). The upper and lower limits of the member are marked by the extent of coal or lignite band. Due to the vertical variation in lithological characteristics of the succession, the B-2 Member in this study can be separated into 4 beds, namely, B 2.1, B 2.2, B 2.3, and B 2.4 Beds in ascending order. Inaddition,

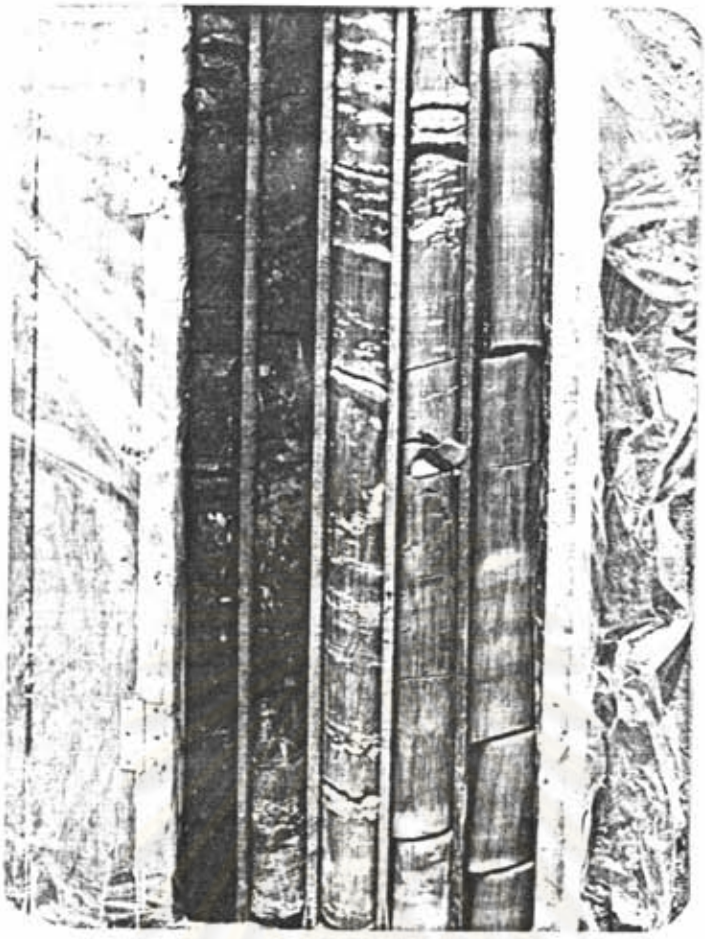


Fig. 3.3.1e Photograph of core-samples showing succession at the top of B-1 Member and the overlying lignite band of B-2 Member; note gastropod beds (white), laminated to thin bedded, lignite flake. (from LM 2813 S, top is upper left and bottom is lower right).

Fig. 3.3.1f Photomicrograph of highly calcareous claystone lentil (Figure 3.3.1d) showing oriented micaceous mineral and microcrystalline calcite (lenses).
(plane-polarized light, field of view is 1mm across).

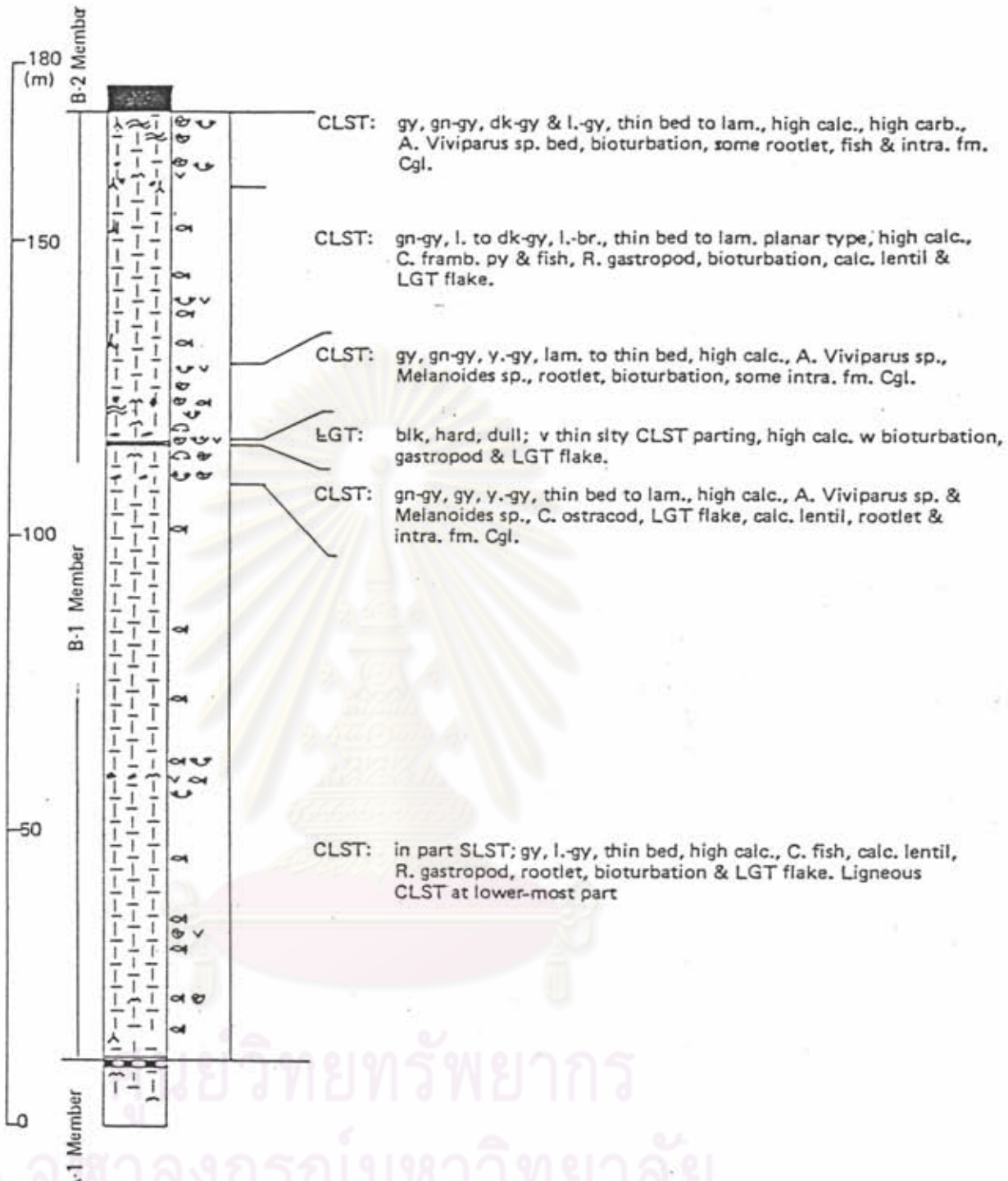
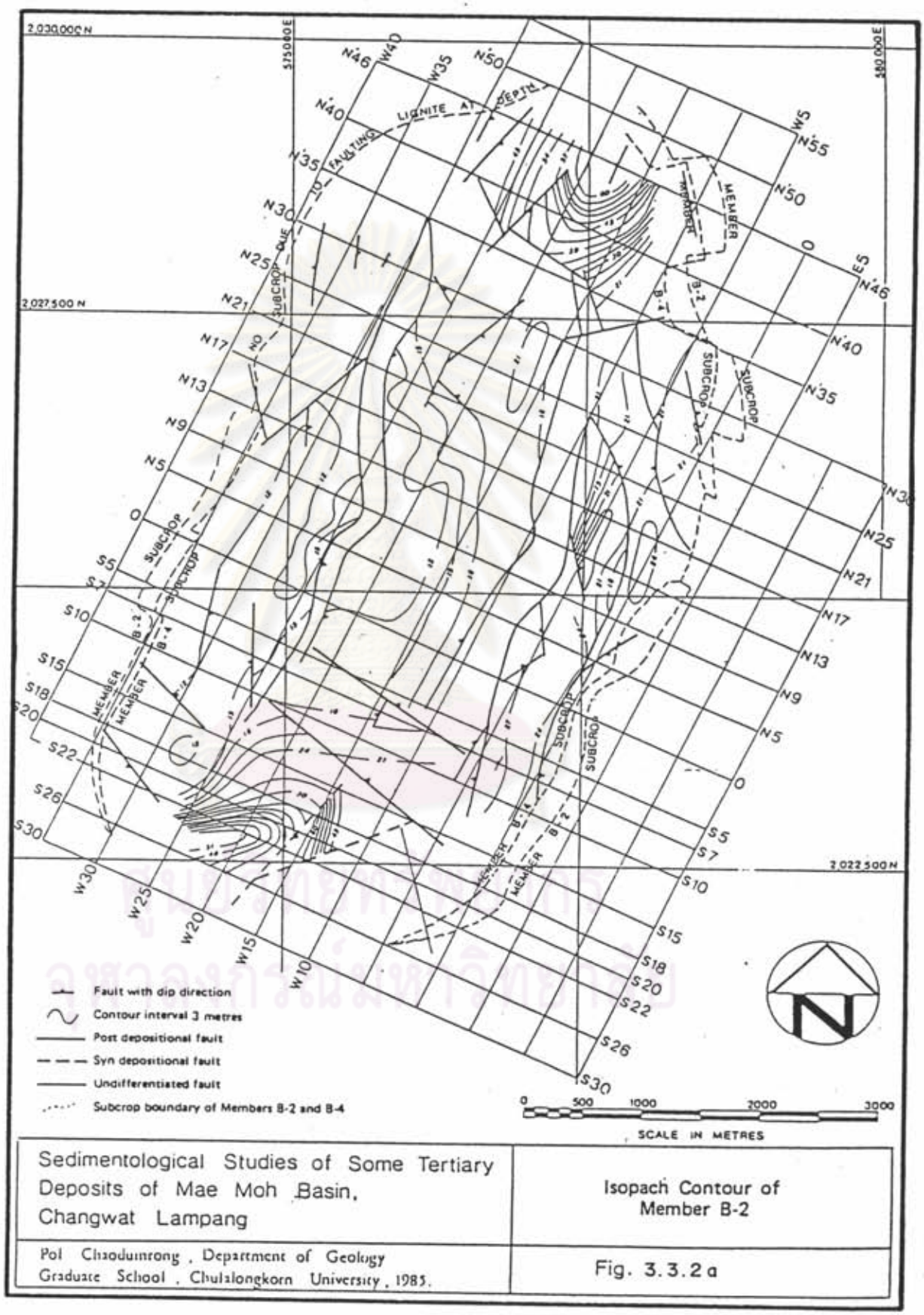


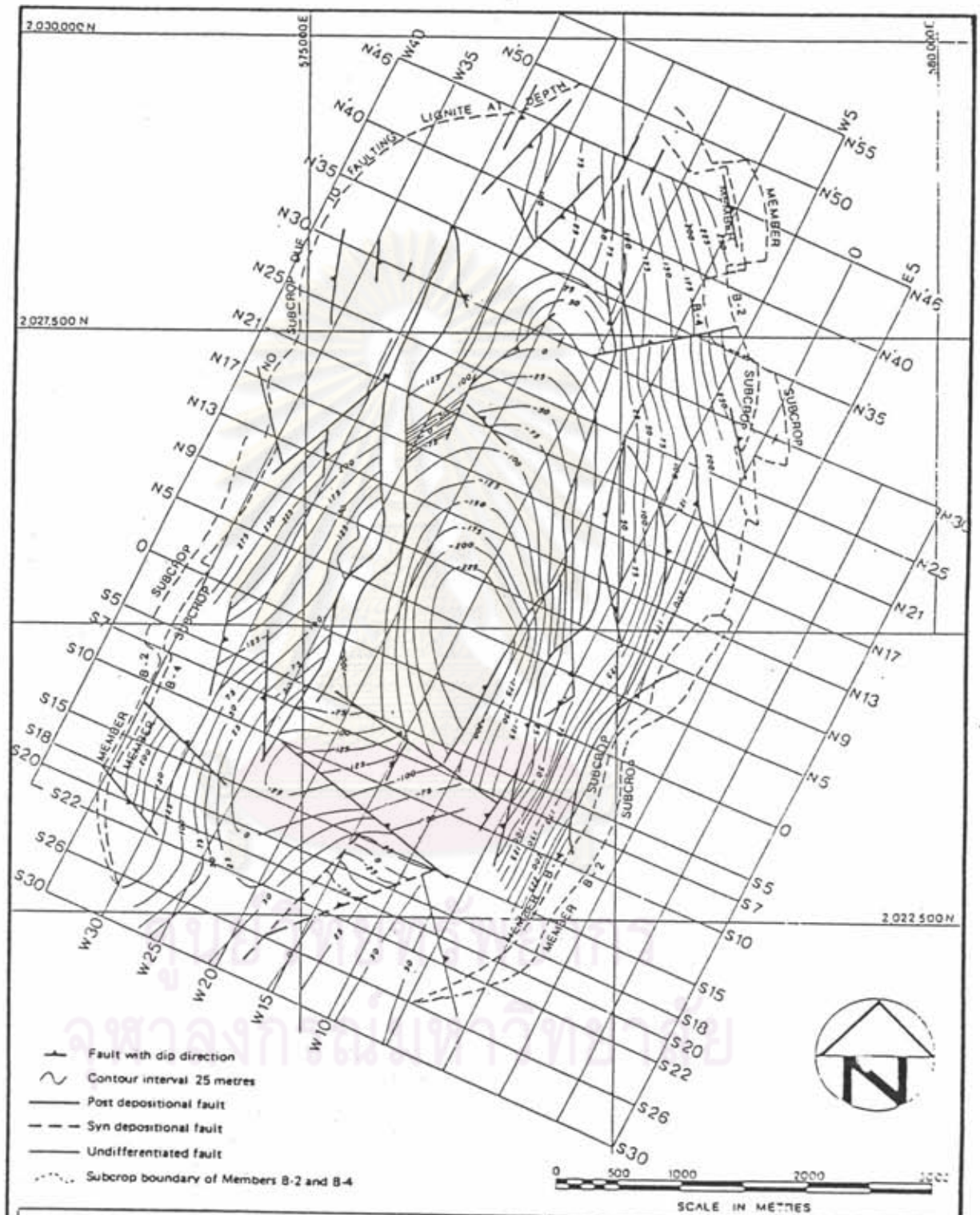
Fig. 3.3.1 g Generalized lithostratigraphic succession of B-1 Member in the study area.

the elevation at the base of each member with respect to the mean sea level, and the thickness of the member and beds have been measured and calculated as shown in Appendices 2 and 3, respectively.

In the middle part of the study area between mine grids S7 and N'34, the lignite quality and the number of partings present are fairly consistent, but beyond those limits the lignite rapidly deteriorates in quality and the number of partings increases rapidly. The member with good quality lignite and a few partings varies from 10 to less than 30 metres thick, and is thickest on the southeastern and eastern parts of the area. It is gradually thinning towards the central and western parts of the area with thickness less than 20 and 15 metres, respectively. In the central parts of the southern and the northern areas, the total thickness of the member increases with increasing in thickness of parting, over 60 metres thick is recorded (Figure 3.3.2a). Generally partings are fine-grained clastic rocks except in the far southern and northern areas around N'41 to N'46 and S 18 to S 30 where the sequence contains some beds of siltstone and sandstone. In those far northern and southern areas only thin band of lignite is present on top and bottom of the member. The depth to the floor of the member increases rapidly toward the central of the study area with elevation varies from over 250 metres above the mean sea level at the margin to over 240 metres below the mean sea level at the central part of the study area. The deepest zone is confined within two major fault zones which are oriented in the NNE-SSW direction (Figure 3.3.2b). It is necessary tonote that the shapes of the isopach contour and the structural contour on floor of the member are not conformable. Additional attempt to classify the type of some



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Member B-2
Pol Chaodumrong, Department of Geology Graduate School, Chulalongkorn University, 1985.	Fig. 3.3.2 a



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Floor of Member B-2 Structural Contour
Pol Chaodumrong, Department of Geology Graduate School, Chulalongkorn University, 1985.	Fig. 3.3.2b

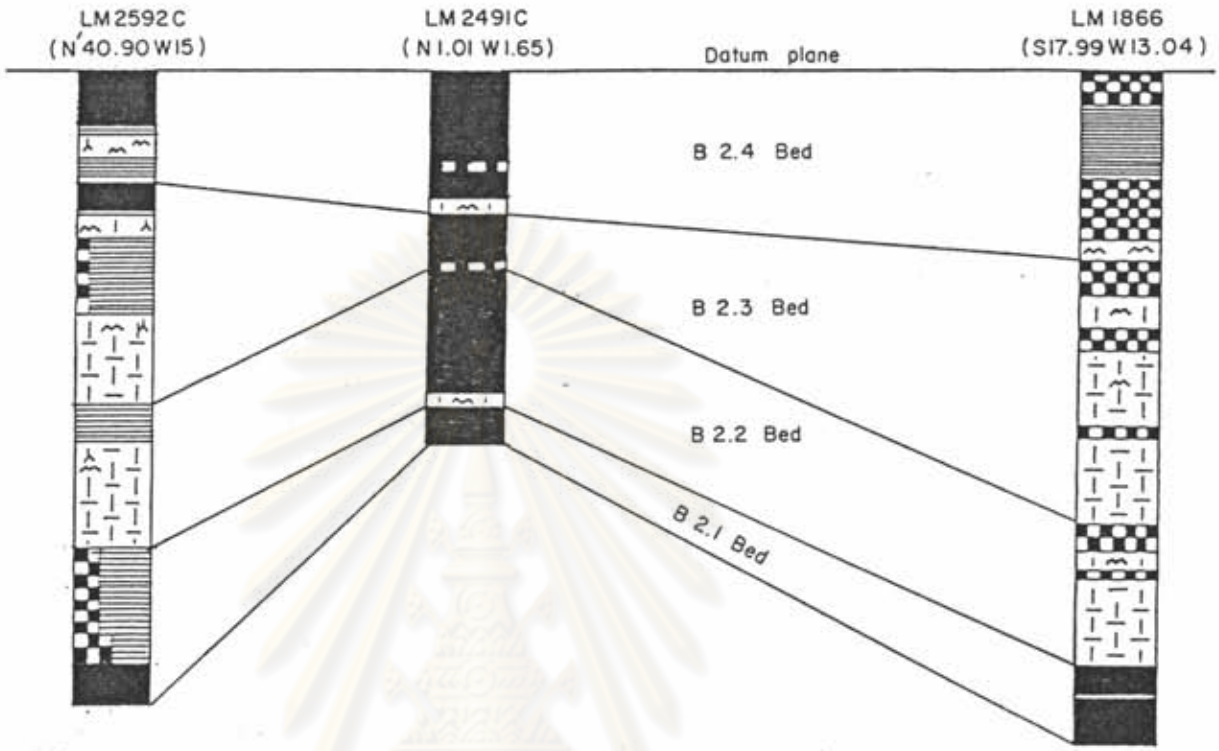
faults within this member in the study area has been made. The results show that most type of the faults are post-depositional faults with only a few syn-depositional ones (Figure 3.3.2a).

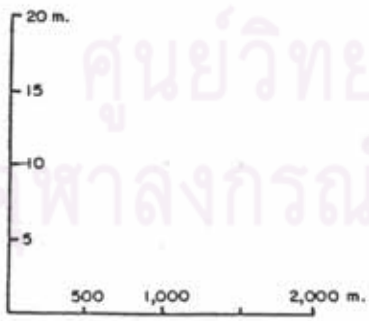
The generalized lithostratigraphic correlation of B-2 Member in the study area is shown in Figure 3.3.2c. The detail lithology of each bed is as follow:

a) B 2.1 Bed

The "B 2.1 Bed" is the lowermost bed of B-2 Member. The bed is characterized by thick lignite bands in the lower part of the member. The lower boundary of the bed is gradational and marked at lignite limit, and the upper limit is marked at the base of the parting. However, the bed also contains some minor parting. All of partings are well recognized and easily distinguished from lignite by density log. Besides, the signature from density log of the bed is rather unique in characteristics. Therefore, the upper limit of the bed can be clearly determined (Figure 3.3a).

The B 2.1 Bed widely distributes throughout the study area, but the thickness and lignite quality are varied. In the area between the mine grids S 7 and N 25, the thickness of lignite including some parting is fairly consistent and subparallel to the longitudinal boundary of the basin. It is thickest on the southeastern and eastern margins with thickness upto 9 metres thick, and like lignite of the other beds, thinning toward the western margin. Outside those area, in the zone up to the mine grids S 18 and N'40 the lignite in the upper part of the bed is gradually deteriorated. Farther beyond those two areas, the lignite is drastically deteriorated and only a few metres thick is





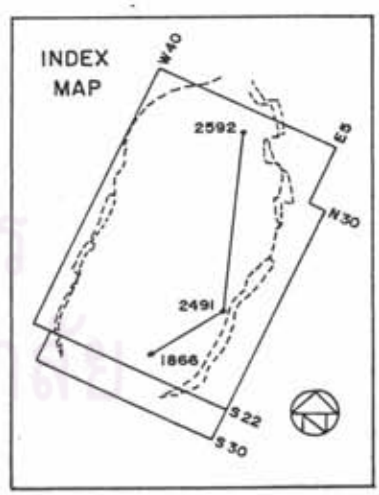


Fig. 3.3.2c Proposed correlation of the generalized lithostratigraphic succession of the B-2 Member of Mae Moh basin.

recorded (Figure 3.3.2.1a).

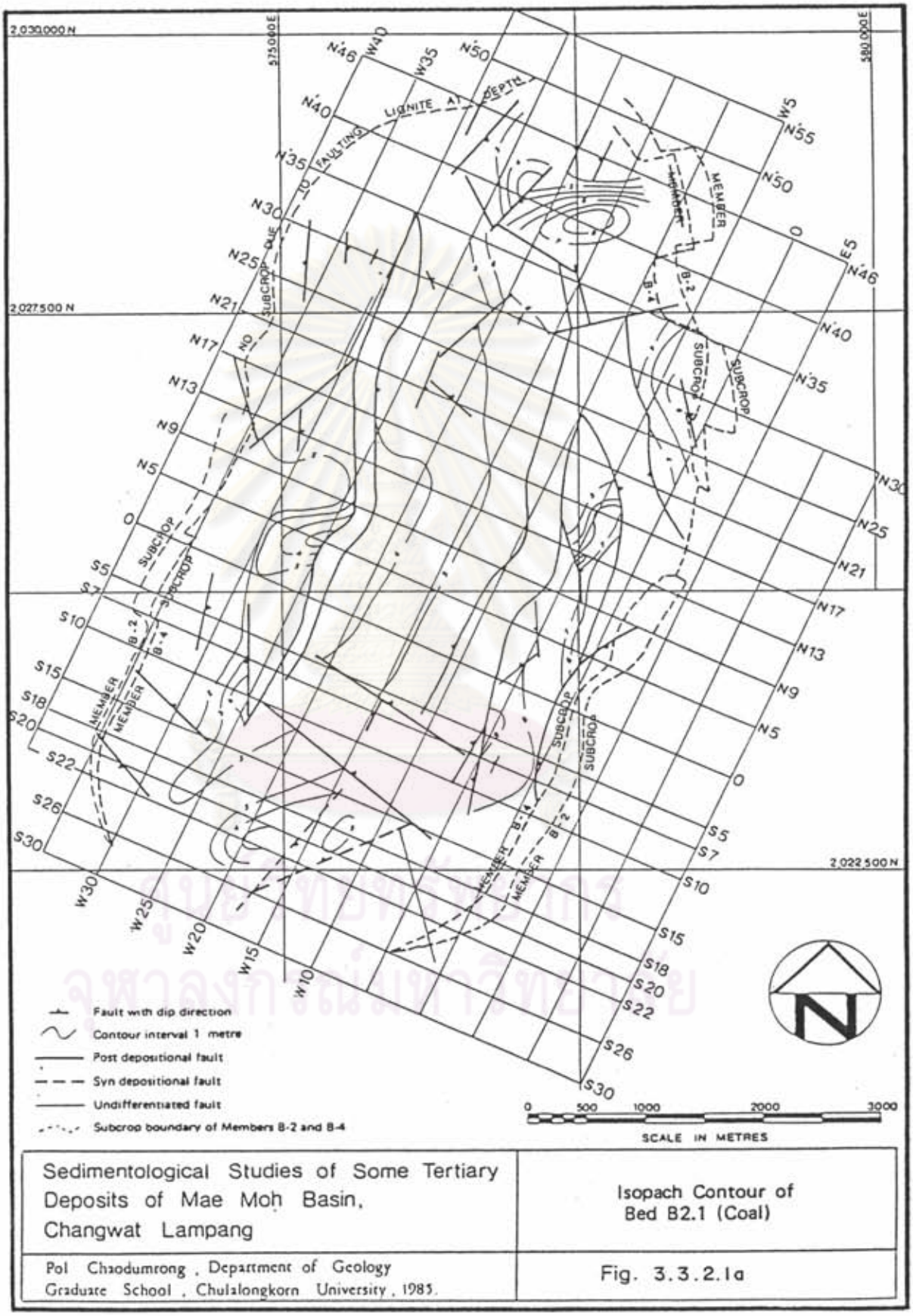
In the southeastern part of the active mine pit where the lignite of B-2 Member has been exploited, the B 2.1 Bed begins with lignite of black to brownish black color, hard and brittle, moderately dull with some previtrain and gastropods of Planorbis sp. Partings are thin bedded and lens of highly calcareous claystone and some silty claystone of light brown color (Figure 3.3.2.1b). Patings also contains Planorbis sp., Viviparus sp., intraclasts and oriented lentil of highly calcareous silty claystone. One prominent parting in the middle part of the bed is recorded outside the area between mine grids S 7 and N 25 (Figure 3.3.2c).

Generalized lithostratigraphic correlation of the B 2.1 Bed is shown in Figure 3.3.2c.

b) B 2.2 Bed

The B 2.2 Bed consists of two distinct parts, parting in the lower part, and lignite in the upper part. The thickness of lignite in this bed is relatively thinner than the other beds. In the area between the mine grids S 7 and N'34, lignite is thickening on the eastern margin with thickness upto 5 metres, and gradually thinning toward the western margin with less than a metre thick. The parting of this area is mainly claystone of highly calcareous, with common lignite flakes and highly calcareous intraclasts. The claystone parting is only a few centimetres thick or absent on the eastern margin and less than a metre thick on the western margin.

In the areas south of S 7 and north of N'34, the quality of



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Bed B2.1 (Coal)
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.2.1a

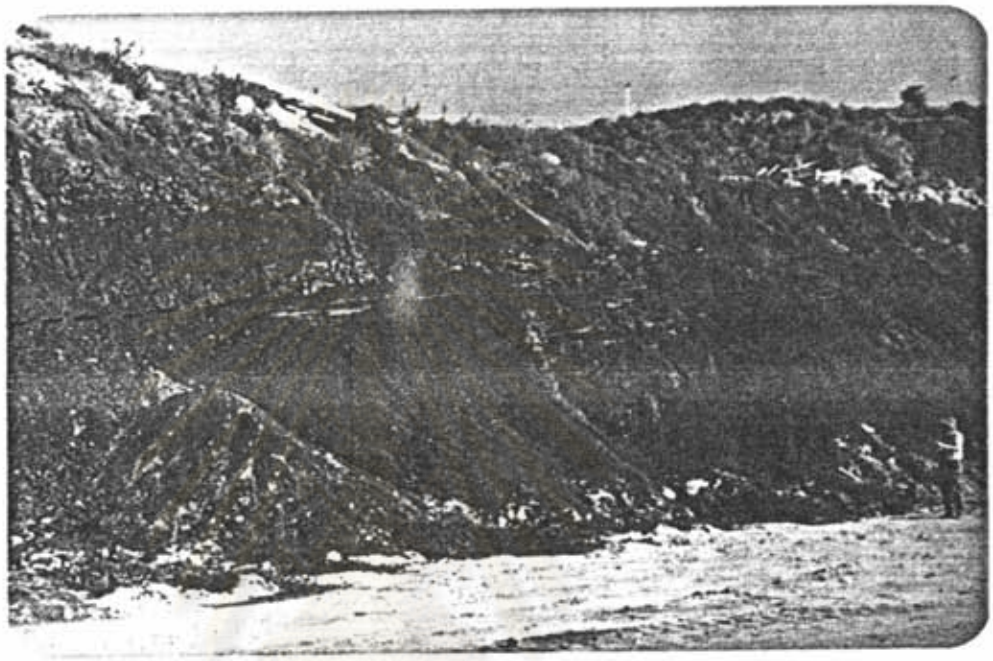


Fig. 3.3.2.1b Photograph of the mine face showing the lithostratigraphic sequences of the B 2.1 and B 2.2 Beds.

lignite is declining and the number of parting increases with some beds of medium-grained clastic rocks. Besides, the thickness of lignite decreases while the parting increases in thickness rapidly. The total thickness of B 2.2 Bed in the northern and southern areas are upto 30 metres (see Appendix 3). Parting in this area is slightly different from the area between the mine-grids S 7 and N'34, it consists of highly calcareous silty claystone and some bed of siltstone. Siltstone is light color, slightly to non-calcareous, poorly sorted, with common rootlet, siderite concretion and load cast structure. Thin section study of samples collected from the northern area of LM 2592 C, at the depth of 160.00 metres, it is silty claystone with pyrite and calcite as accessorial minerals.

In the southern part of the active mine-pit area, the B 2.2 Bed is characterized mainly by the lignite of black, hard and brittle with spheroidal fracture. The lignite, however, is alternating with thinly bedded or lense of light color and highly calcareous silty material.

The photography at the mine-face of the B 2.2 Bed is shown in Figure 3.3.2.1b. The generalized lithostratigraphic correlation of the B 2.2 Bed is shown in Figure 3.3.2c.

c) B 2.3 Bed

The B 2.3 Bed, like the B 2.2 Bed, is characterized by parting in the lower part, and lignite in the upper part. In the area between mine-grids S 7 and N'34, lignite in the bed is of high quality and thickest on the eastern margin in the range of 4 to 7 metres, and thinning towards the western margin in the range of 2 to 5 metres. The

thickness of parting is negligible in the area between N 0 and N 13. Beyond this area, the parting gradually increases in number. In the area north of N'34 and south of S7, the lignite decreases in both quality and thickness, while the thickness of parting increases rapidly upto 18 metres and 34 metres, in the far northern and southern areas, respectively (Appendix 3). From geophysical logs, parting in the northern area of LM 2217, LM 2136, LM 1974, and LM 1753 are claystone with some beds of medium-grained clastic rock, such as siltstone. Parting of the primary borehole in LM 2592C consists of white claystone and light brown siltstone of non -to slightly calcareous, with siderite concretion, rootlet and color mottling (Appendix 1, Figure A-1.10).

In the southern part of the active mine pit area, the B 2.3 Bed consists mainly of lignite. However, in the lower part of the bed, alternating of thinly beds or lens of light color and highly calcareous claystone (Figure 3.3.2.3a) and common with bioturbation, gastropods of Planorbis sp. and Physa sp., fish and amphibian fragments.

In thin section, the sample of calcareous claystone collected from the active mine pit consists mainly of tiny micaceous mineral and Fe-oxides. Some microcrystalline calcite appears as lump (silt-to fine sand-sized). The another sample collected from parting of LM 2592C, at the depth of 151.00-151.15 metres (see Appendix 1, Figure A-1.10) is silty claystone (Picard, 1971). The main constituent is tiny micaceous clay minerals with scatterred very fine sand-to silt-sized quartz. The other accessorial minerals are calcite, siderite ?, and carbonaceous matter. Cement is of both types siliceous and calcareous.

Generalized lithostratigraphic correlation of the B 2.3 Bed

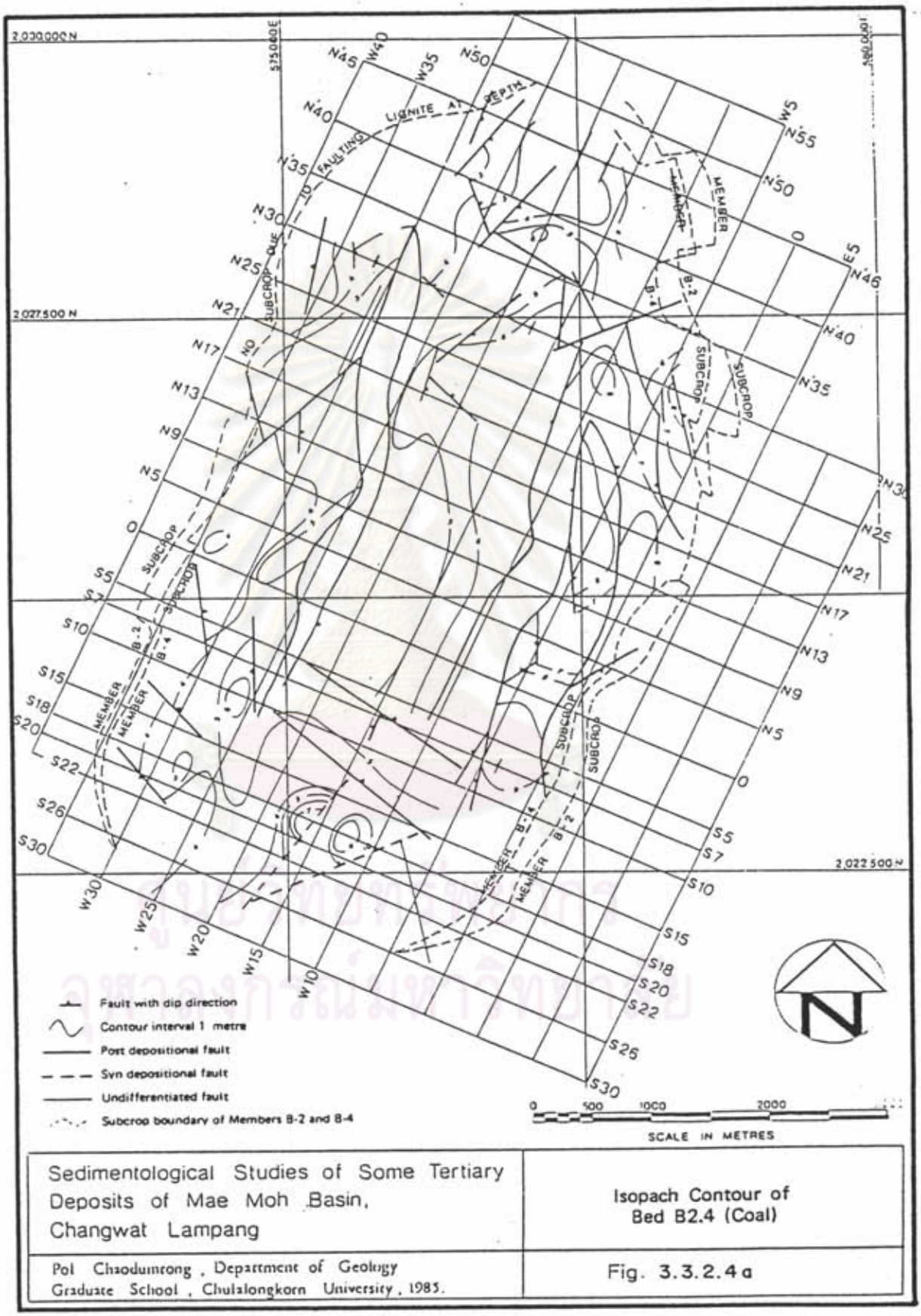
Fig. 3.3.2.3a Photograph of the mine face showing lithostratigraphic sequences of B 2.2, B 2.3 and B 2.4 Beds.

within Mae Moh basin is summarized in Figure 3.3.2c.

d) B 2.4 Bed

The B 2.4 Bed is the topmost bed of B-2 Member. It overlies conformably the B 2.3 Bed, and underlies conformably the B-3 Member with abrupt contact. In this study, the lithological sequence of the B 2.4 Bed can be separated into 2 parts, parting in the lower part, and lignite bands in the upper part. The lignite of this bed, like the lignite of B 2.1 Bed, is widely distributed throughout the study area. In the area between the mine-grids S10 and N'34, the bed is rather consistent and characterized by lignite with less parting. The thickening is also present in the southeastern and eastern parts of the area and gradually thinning towards the western margin. The bed thickness in the southeastern and eastern parts are about 8 metres, whereas thickness in the western margin is about 5 metres (Figure 3.3.2.4a, and Appendix 3). In the area north of N'34 and south of S10, the lignite splits and the quality is declining. Eventually, only thin band of lignite in the topmost is recorded, while parting increases rapidly upto over 10 metres and over 20 metres thick in the northern and southern part of the areas, respectively (see Appendix 3). The far north and south areas, the parting is silty claystone with some beds of medium-grained clastic rock but in the north there is relatively more meidum-grained clastic influence than in the south.

In the southeastern part of the active mine pit area, lignite is predominant and interbedded with light color and highly calcareous thinly bedded or lense of silty claystone, with common gastropods, bioturbation and white calcareous spot. It is interesting to note



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Bed B2.4 (Coal)
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.2.4 a

that the number of parting of each sedimentary cycle decreases upwardly (Figure 3.3.2.4 b).

In thin section, the sample collected from parting of LM 2592 C, at the depth of 136.95 metres is silty claystone. The rock shows matrix-supported fabric and the main constituent is tiny micaceous mineral and scattered angular to rounded and poorly sorted of fine sand-to silt-sized quartz. The other accessorial minerals are pyrite, calcite, siderite?, and hematite.

Generalized lithostratigraphic correlation of the B 2.4 Bed is shown in Figure 3.3.2c.

3.3.3 B-3 Member

The B-3 Member is characterized by fine-grained clastic sediments postulated to be within the two major coal seam of B-2 and B-4 Member. The B-3 Member is called "N shale" by Gloe (1955), "N claystone bed" by Gardner (1967), "Interburden" by Longworth CMPS Engineers (1981), and "The third sub-unit" by Krichkrivan et al. (1984) as well as currently ADAB Project. The limit of the member is easily distinguished because of its position between two marker coal seams. Besides, the lithostratigraphic sequence and signature from geophysical logs are rather unique (Figure 3.3a, and Appendix 1).

The lithology of the member is fairly consistent throughout the study area. Generally, the lithostratigraphic sequence of B-3 Member begins with abrupt changed contact with the underlying lignite band of B 2.4 Bed. Ten of centimetres above the lower contact is the sequence of light brown to brown claystone, highly calcareous with common bioturbation, rootlet, gastropod fossil, fish fragment and

Fig. 3.3.2.4b Photograph of the mine face showing lithostratigraphic sequence of B 2.4 Bed and B-3 Member. Note the number of parting of each cycle increases upwardly.

lignite flake. The overlying sequence is characterized by alternating pale green to olive claystone and gray, grayish brown claystone of laminated to thin bedded. Both rock types are highly calcareous, with common to abundant ostracods, common fish fragments, gastropods, and intraclasts. However, the pale-green claystone often shows swelled characteristics. The sequence passes upwardly to thick succession of laminated to thinly bedded, light brown claystone to silty claystone, highly carbonaceous claystone, with common bioturbation, intraclasts, lignite flake, calcareous lentil, and fish fragments; rare ostracods and gastropod. The upper part of this succession contains thin to thick band of lignite. This lignite is found a few metres below the upper boundary and is widely distributed in the northern and southern parts of the area whereas in the eastern and western parts it appears as trace or only a few centimetres thick. The upper boundary of the member is gradational with carbonaceous contents increases upwardly (Figure 3.3.3a). An attempt to define lithostratigraphic succession of the member has been made as shown in Appendix 1.

The thickness of B-3 Member varies in the range 15-38 metres with thickening towards the southeastern and eastern parts of the area. The thickness of this unit is rather conformable with the overlying and underlying units. The B-3 Member gradually thinning towards the western, northern, and southern parts (Figure 3.3.3b). The present deepest part of the member is confined between the two major fault zones oriented in NNE-SSW direction with elevation varies from over 200 metres below the mean sea level at the central part of the area, to over 280 metres above the mean sea level at the margin of the area (Figure 3.3.3c). Additional attempt to classify some of faults within

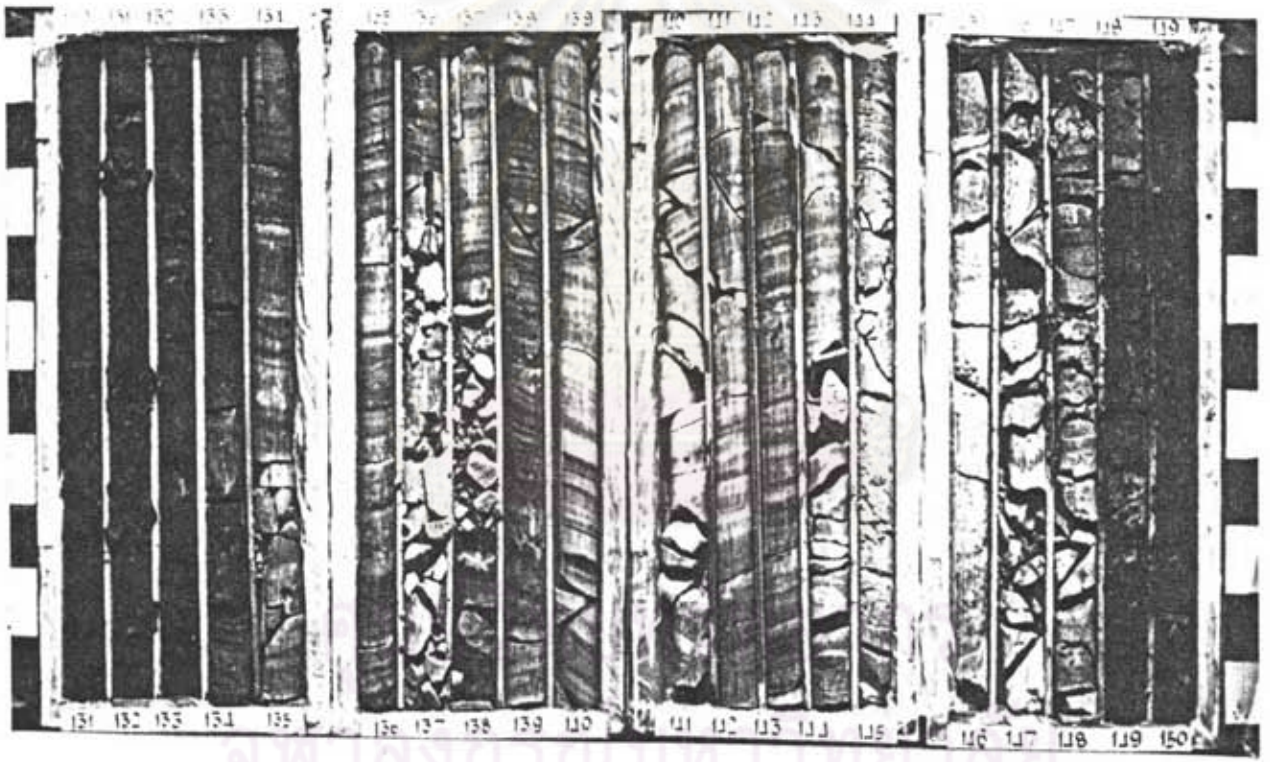
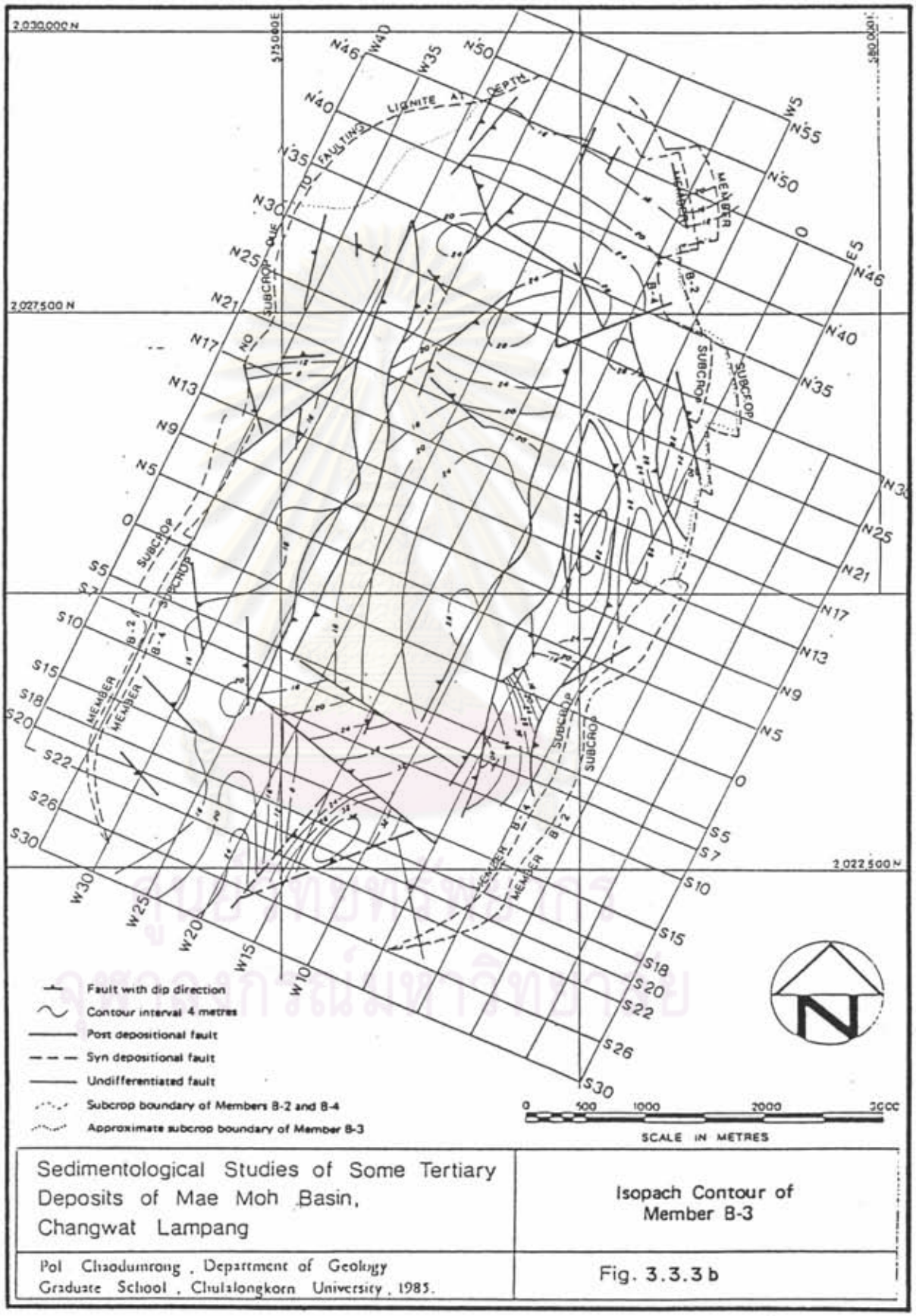
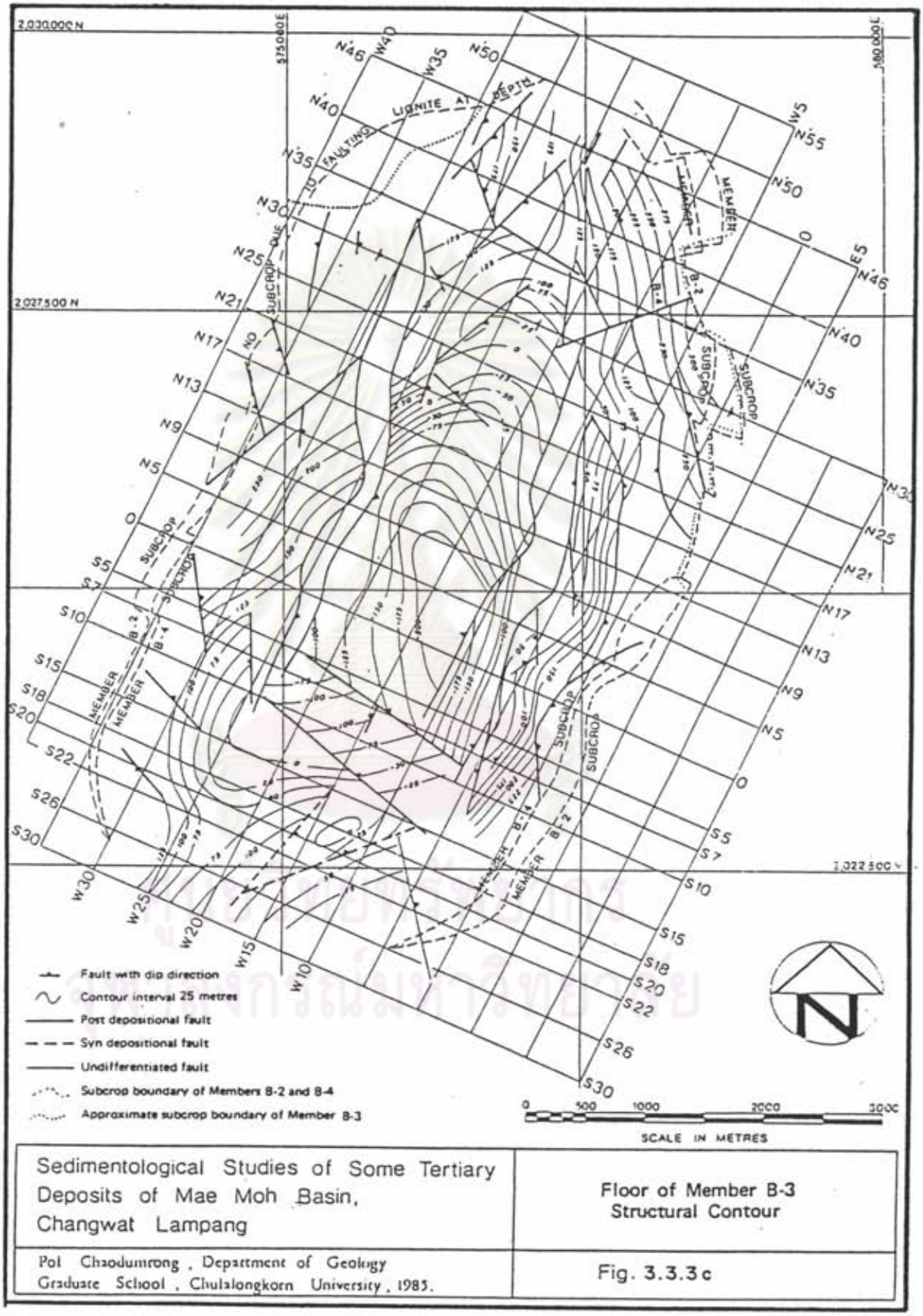


Fig. 3.3.3a Photograph of core-samples from LM 2813S illustrating the lithostratigraphic succession of the B-3 Member. Note the abrupt contact at the lower limit and gradational contact at the upper limit.



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Member B-3
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.3 b



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Floor of Member B-3 Structural Contour
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.3c

the area based on unit thickness, elevation and lithostratigraphic sequence has been made. Most of the faults within this member are post-depositional faults. However, some syn-depositional faults are also identified (Figure 3.3.3b or 3.3.3c).

In thin section, samples collected from LM 2148, at the depth of 37.60 metres and 56.30 metres show that they are calcareous claystone. The main constituents are tiny micaceous clay mineral and micritic calcite. Micaceous mineral appears as patches subparallel to the bedding plane. The others are some angular silt-sized quartz, pyrite, carbonaceous matter and iron-oxide.

Generalized lithostratigraphic correlation of the B-3 Member of the Mae Moh basin is shown in Figure 3.3.3d.

3.3.4 B-4 Member

The B-4 Member is the upper major coal seam. This coal seam is one of the two seams which has been currently mined by the EGAT. It is called "N lignite" by Gloe (1955), "K seam" by Longworth CMPS Engineers (1981), and "K Zone" by ADAB Project, Jitapunkul (1984), and Krichkrivan et al. (1984). The comparative stratigraphic classification from previous works is shown in Table 2.2.1a. This member is well recognized and rather different from the B-2 Member or lower major coal seam, because it is marked by the so-called siliceous hard band in the lower part, and two distinct calcareous partings in the upper part. Besides, the lithological sequence, signature of geophysical logs especially density and gamma logs (Figure 3.3a), and the lithology of sediments above and below each major coal seam are rather unique in characteristics. The B-4 Member overlies conformably the B-3 Member

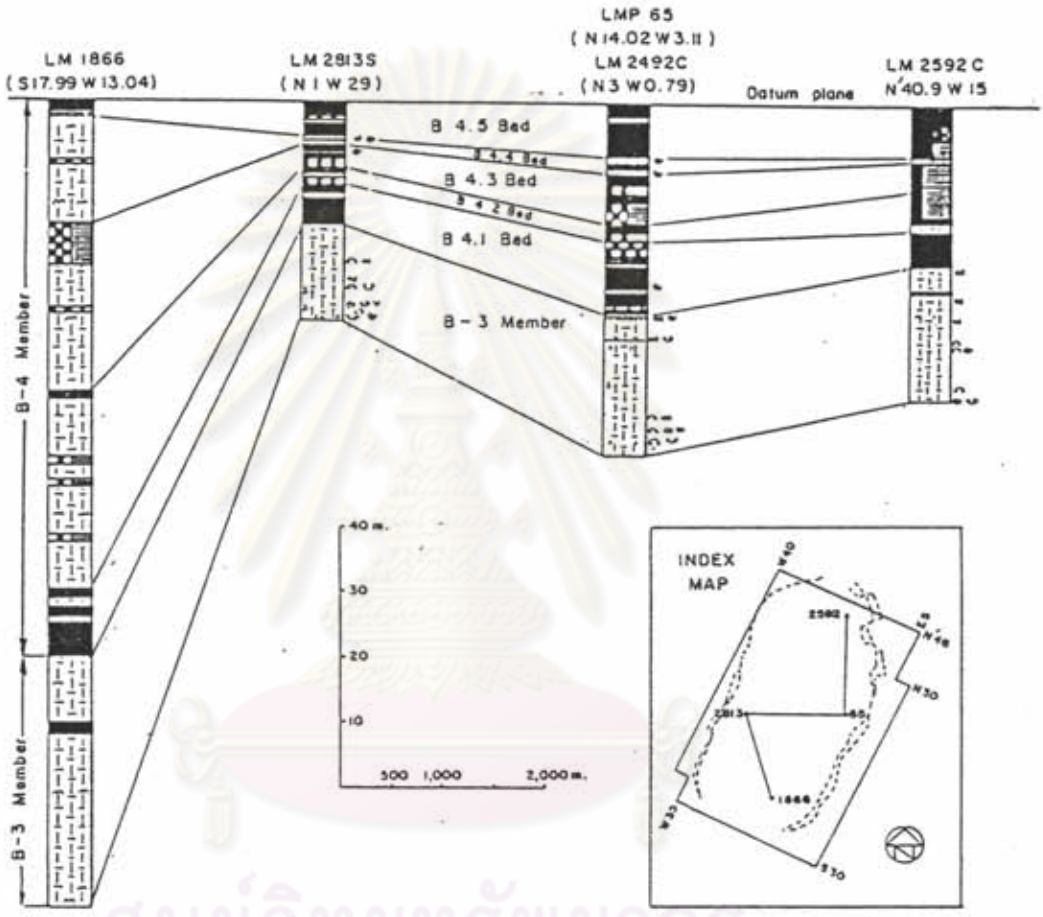


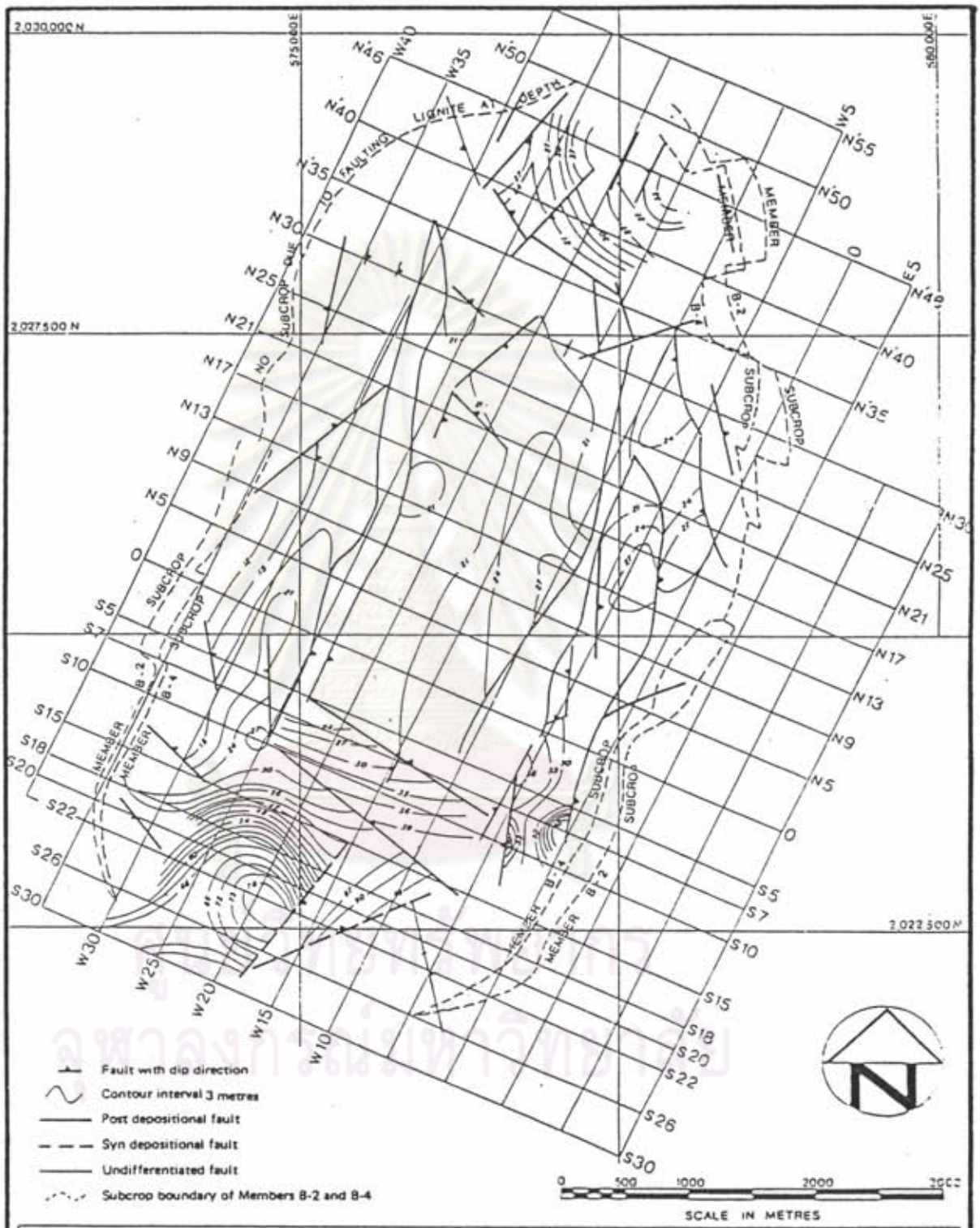
Fig. 3.3.3d Proposed correlation of the generalized lithostratigraphic succession of the B - 3 and B - 4 Members of the Mae Moh Group, Mae Moh basin.

with gradational contact and underlies conformably the B-5 Member with abrupt change in lithology from lignite to silty claystone. Due to the vertical variation in lithological characteristics of the succession and the characteristics of lignite band, the B-4 Mamber in this study can be subdivided into 5 beds, in ascending order as; B 4.1, B 4.2, B 4.3, B 4.4, and B 4.5 Beds.

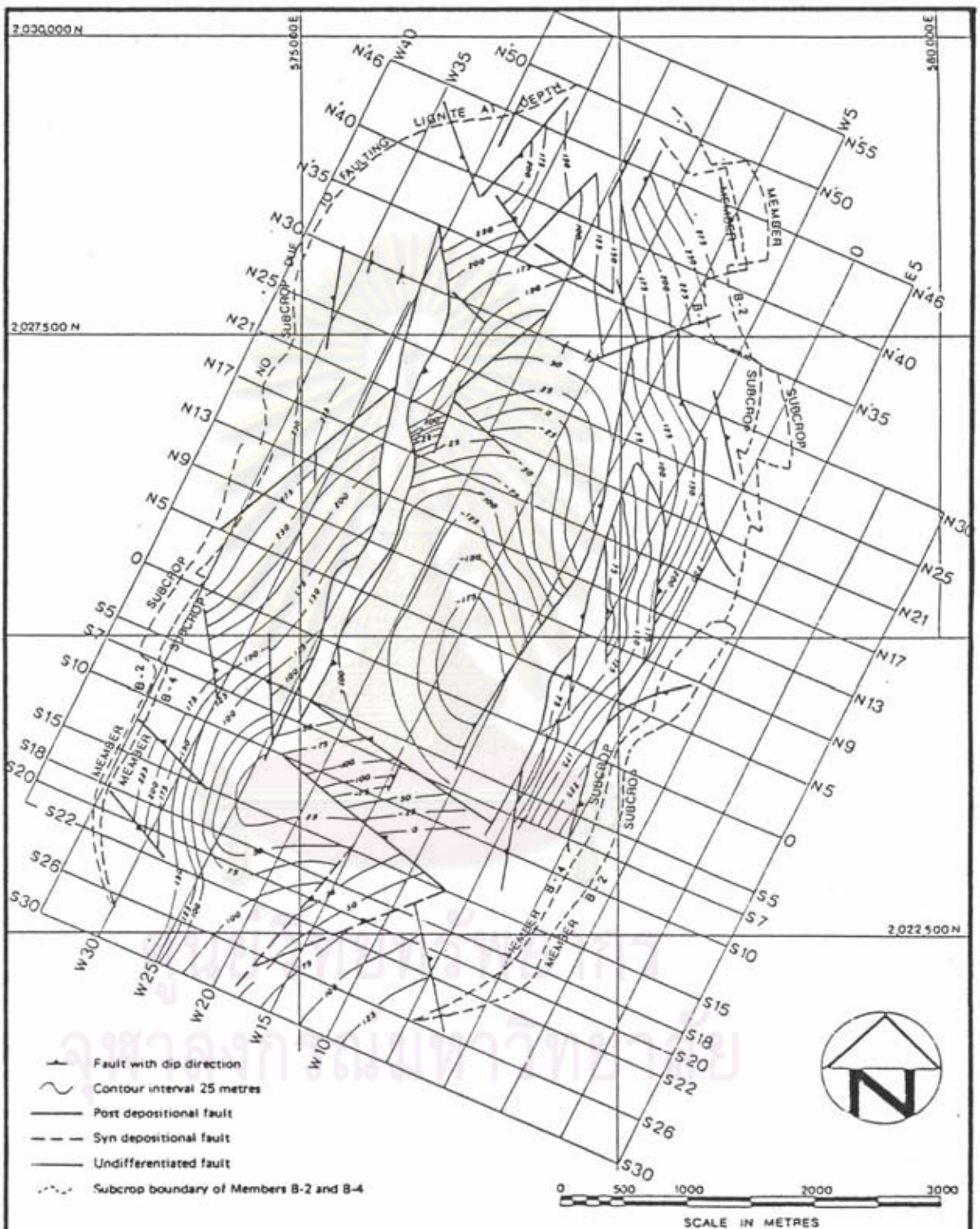
Generally, the lignite within the B-4 Member is thicker than the B-2 Member, varying from 30 metres in the eastern margin to about 15 metres in the western margin particularly within the area between S7 and N'34. Beyond this, each bed of lignite decreases in quality and thickness, while the parting increases in number. The total thickness of the member in the northern and southern parts increases rapidly to 40 metres and 80 metres, respectively (Figure 3.3.4a). These partings consist mainly of claystone interbedded with some siltstone, highly calcareous, and containing some lignite flakes. In places, it is heavily pyritized with abundant fossils, bioturbation and occasionally with intraclasts. The lignite within the B-4 Mamber is relatively widely distributed than the B-2 Mamber. In the north, trace of poor quality lignite of B 4.5 and B 4.1 Beds persist northwardly to N'46 and continue a short distance into the northern sub-basin. In the south, it can be traced as far south as S30, while lignite of B-2 Member generally grades out completely at S26.

The deepest part to the base of the member, like the underlying member, is confined within the two major fault zones or in the central part of the study area with elevation over 175 metres above the mean sea level. In the marginal area the elevation of the base of the member appears at 300 metres above the mean sea level (Figure 3.3.4b).

Generalized lithostratigraphic correlation of the bed within



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Member B-4
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.4a



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Floor of Member B-4 Structural Contour
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.4b

the B-4 Member is shown in Figure 3.3.3d. The lithology in detailed of each bed within the B-4 Member from bottom to top are as follows:

a) B 4.1 Bed

The B 4.1 Bed is characterized as lignite in the lower part of the B-4 Member. This bed is widely distributed in the study area. The lower limit is gradational contact with increasing upwardly of carbonaceous matter from the underlying member. Lignite is black to brownish black, hard and brittle, almost attrital coal type, containing with some previtrain, and subconcoidal fracture. It also contains Planorbis sp., fish fragments and some partings. In the central and eastern parts of the area between the mine grids N5 and N30, there is a siliceous hard band or carbonaceous siltstone at a few centimetres above the lower limit of the bed. This siliceous hard band is about 30 centimetres thick (Figure 3.3.4.1a), and can be well recognized from geophysical logs (Figure 3.3.4.1b). It is black, hard, very compacted, and consists of highly carbonaceous matter, silt-sized quartz, and quartz veinlet.

The B 4.1 Bed within area between mine grids S7 and N'34 shows lignite of good quality with some partings in the middle part of the bed. In this area, the bed thickening in the southeastern part upto 11 metres, and thinning towards the western margin with 5 metres thick (Figure 3.3.4.1c). Beyond this area, the quality of lignite is declining with increasing number of parting. The parting is gray claystone and silty claystone.

Petrographic study of siliceous hard band or carbonaceous siltstone indicates that it consists mainly of carbonaceous matter and

Fig. 3.3.4.1a Photograph illustrating the siliceous hard band or carbonaceous siltstone of the B 4.1 Bed

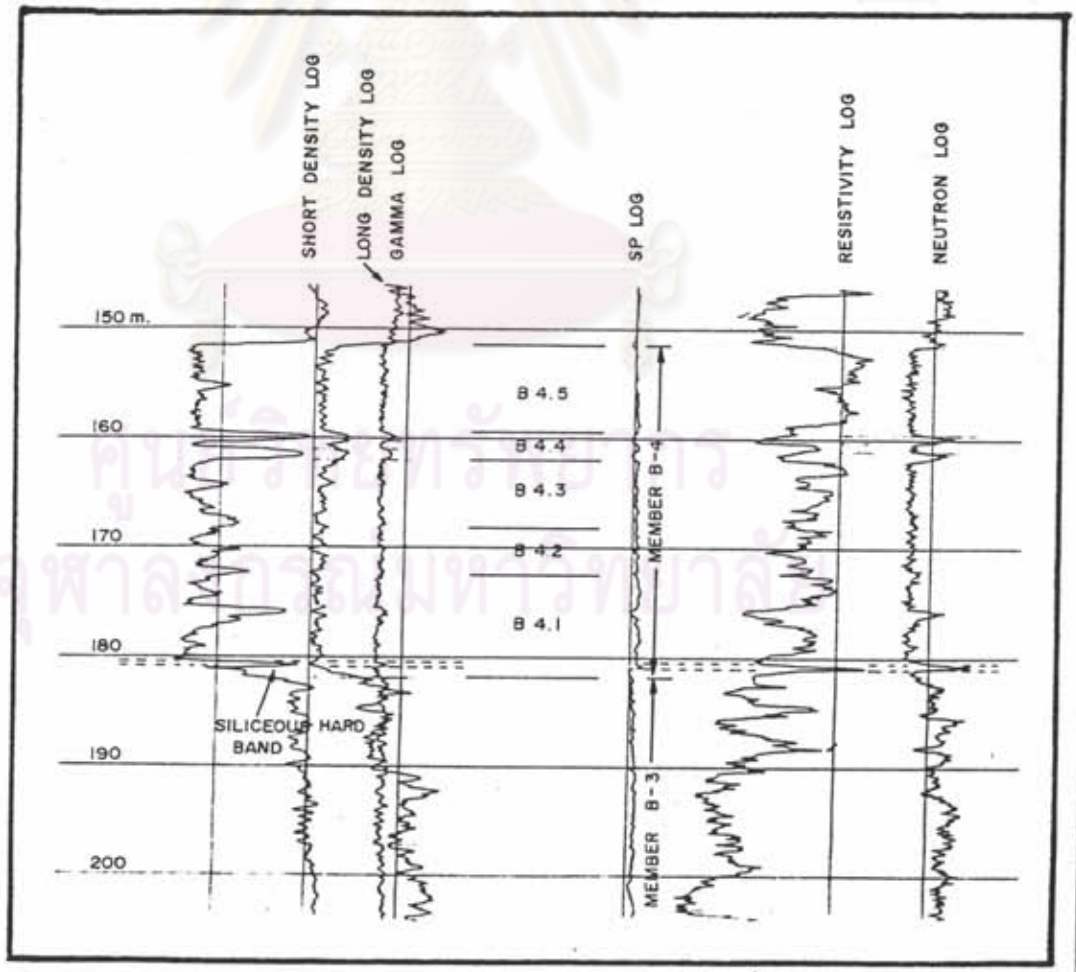
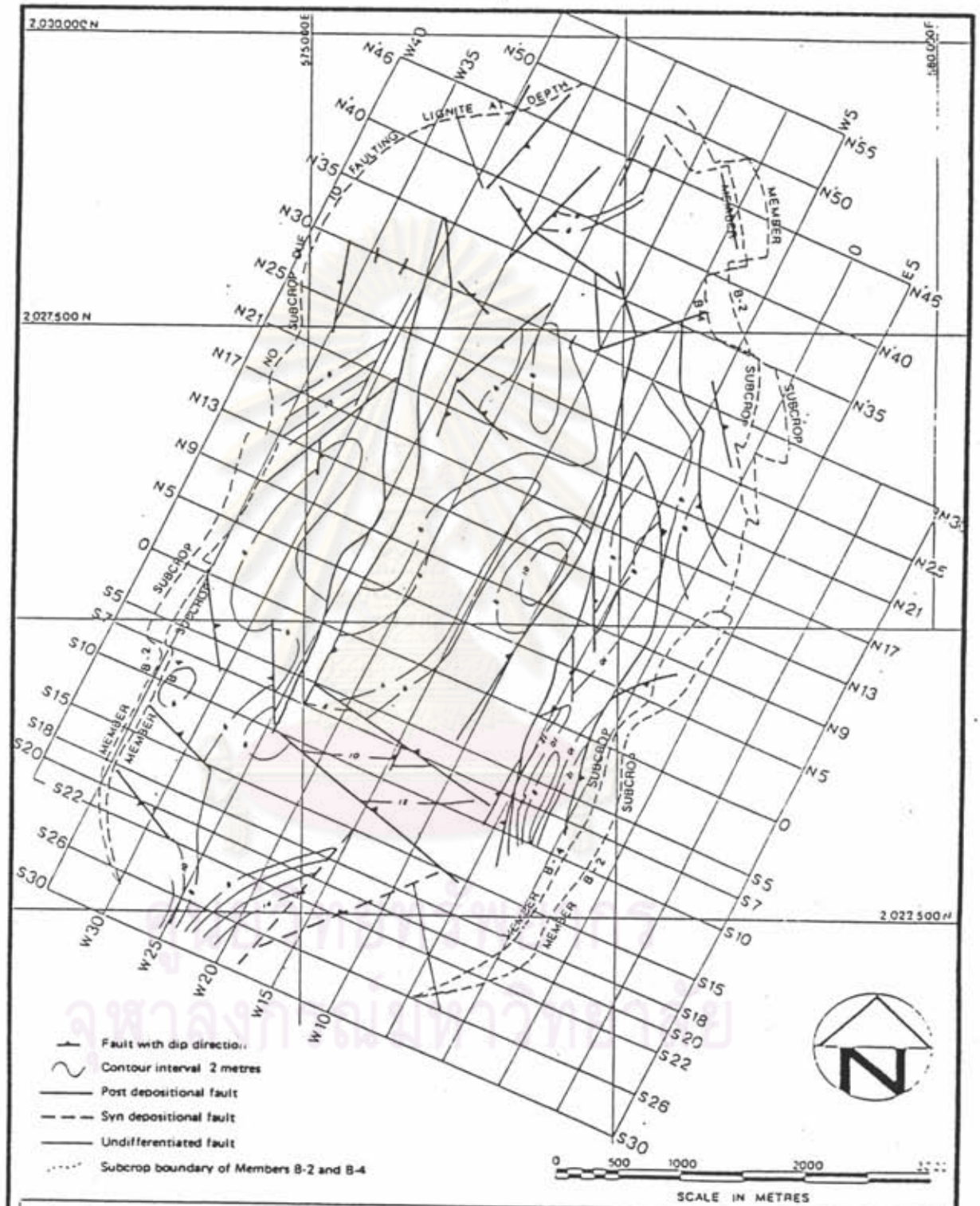


Fig. 3.3.4.1b Typical geophysical logs of the B-4 Member illustrating the signature of each bed and of siliceous hard band.



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Bed B4.1 (Coal)
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.4.1c

silt-sized quartz. Cement is of siliceous origin with some quartz veinlet. Clay minerals are also present (Figures 3.3.4.1d and 3.3.4.1e).

Generalized lithostratigraphic correlation of the B 4.1 Bed is shown in Figure 3.3.3d.

b) B 4.2 Bed

The B 4.2 Bed can be subdivided into 2 parts, the parting in the lower part, and the lignite in the upper part. The thickness of lignite and parting in each borehole has been measured and presented in Table 1 of Appendix 3. In the area between mine grids S7 and N 34, the lignite is dominant with a few parting, and the thickness of lignite varies in range of 5 to 2 metres, while parting is either absent or present with 1 metre thick. Beyond this area, the lignite decreases in both thickness and quality, again the number of parting increases rapidly. Parting within the area between mine-grids S1 and N 17 is characterized by thinly bedded or lense-shaped, highly calcareous of light color claystone (Figure 3.3.4.2a). Farther north and south, the parting is predominant with total thickness of upto 9 metres in the north, and upto 30 metres in the south. The parting of these far north and south areas is claystone and ligneous claystone with some beds of siltstone especially in the areas north of N'46 and south of S18 (LM 1752, LM 1753, LM 2010, etc.).

c) B 4.3 Bed

This bed, like the B 4.2 Bed, can be subdivided into 2 parts, the parting in the lower part, and the lignite in the upper part. However, the lignite portion also contains thin to medium bedded parting

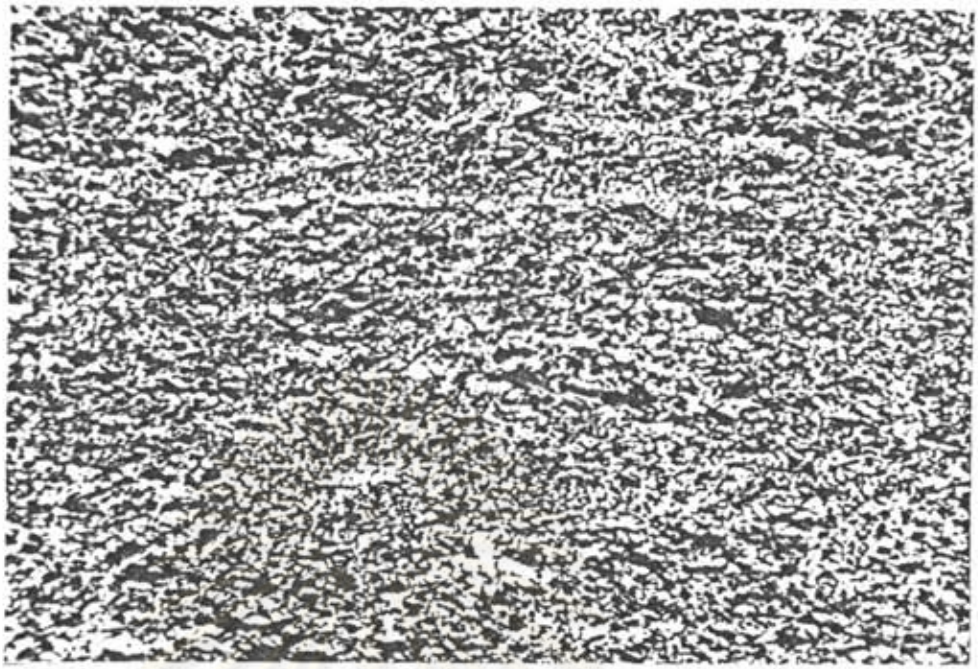


Fig. 3.3.4.1d Photomicrograph of siliceous hard band showing silt-sized quartz (white) enclosed by carbonaceous matter (black).
(plane-polarized light, field of view is 1 mm, ccross).

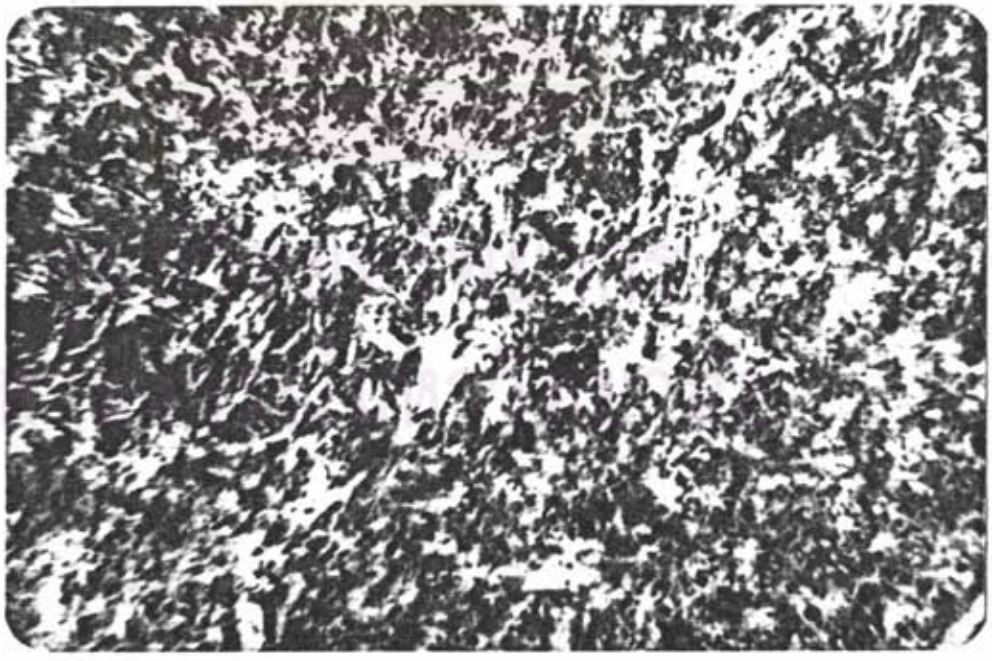


Fig. 3.3.4.1e Photomicrograph of siliceous hard band showing quartz veinlet, (crossed nicol field of view is 1 mm. across)

Fig. 3.3.4.2a Photograph of mine face showing the lithostratigraphic sequence of the beds of B-4 Member. Note normal faults forming horst and graben structure.

(Figure 3.3.4.2a). Generally, the parting of each sedimentary cycle decreases in number upwardly with increasing in thickness of lignite in the upper part. In the area between mine-grids N30 and S7, lignite is thickening on the eastern margin to over 5 metres and thinning towards the western margin with thickness less than 4 metres. Parting in this area of high calcareous, gray to light brown silty claystone and claystone, with common Planorbis sp., fish fragment, lignite flake, varies in thickness from 0.5 to 2 metres in the eastern margin to less than 1.50 metres in the western margin. Lignite is black to brownish black, dull luster, almost attrital coal with some previtrain, and contain some highly calcareous lentil of claystone. In the areas north of N30 and south of S7, the quality of lignite declining with the number of parting increases rapidly. Parting in the southern part of the study area is relatively thicker than in the northern one with upto over 25 metres thick in the south and upto 7 metres thick in the north.

Generalized lithostratigraphic correlation of the B 4.3 Bed is shown in Figure 3.3.3d.

d) B 4.4 Bed

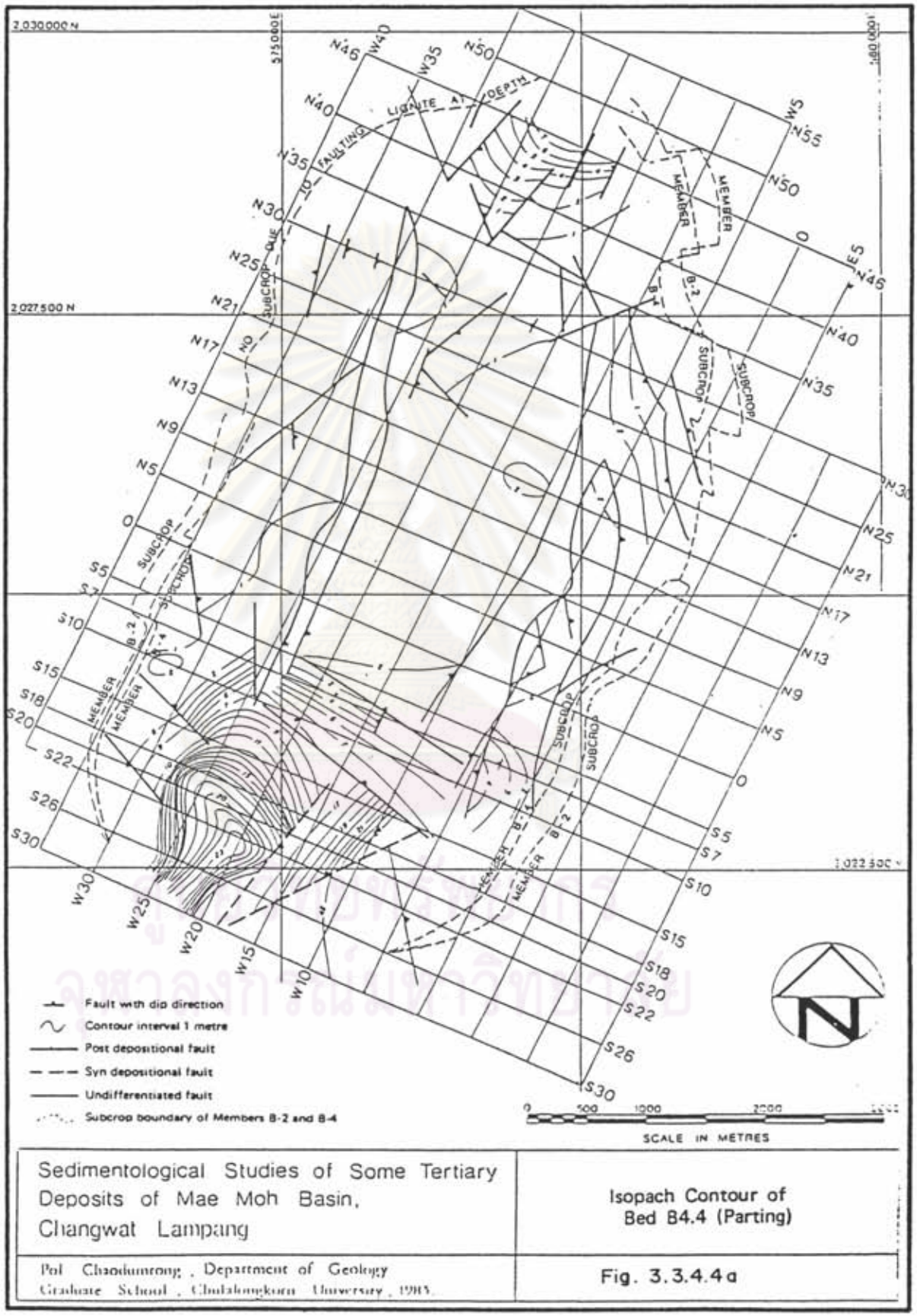
The B 4.4 Bed is one of the two marker bed of the B-4 Member and is characterized by two distinct partings with lignite in between. However, these two partings merge together in some places and only one parting is recorded. The boundary between lignite and parting shows sharp contact. Parting is mainly claystone except in the north and south where some medium-grained clastic sediments are present. It is light gray color, highly calcareous, with common lignite flake,

bioturbation, highly calcareous of intraclasts, white calcareous spot, and gastropod fossil especially Planorbis sp. According to Sithiprasasna (1959), the mastodon teeth, turtle rib have been found in this bed. In the north, the evidences from LM 2567C and LM 2582C show that this bed is mainly clastic rocks consisting of sandstone, siltstone and claystone of white to light gray, slightly to non-calcareous, with common plant fragments, rootlet, bioturbation, gastropod, siderite concretion, and load structure.

The thickness of this bed varies from about 2.50 metres in the eastern margin to 0.50 metres in the western margin. However, in the areas north of N'46 and south of S10, the total thickness increases rapidly to 7 metres and to over 20 metres, repectively (Figure 3.3.4.4a).

In thin section, sample of silty claystone collected from LM 2567C, at the depth of 93.75-93.90 metres is matrix-supported fabric, consisting of tiny micaceous clay mineral with some poorly sorted, angular to subrounded silt-sized quartz. The other samples collected from the active mine pit and LMP 65 at the depth of 61.50 metres. Macroscopically, the rock is highly calcareous claystone with abundant white calcareous spot, and lignite flake (Figure 3.3.4.4b). Microscopically, it is comprised of microcrystalline calcite and tiny micaceous mineral. Some tiny calcareous clusters structure are recorded. The others are hematite and carbonaceous matter (Figure 3.3.4.4c).

Generalized lithostratigraphic correlation of the B 4.4. Bed is shown in Figure 3.3.3d.



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Bed B4.4 (Parting)
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.4.4 a

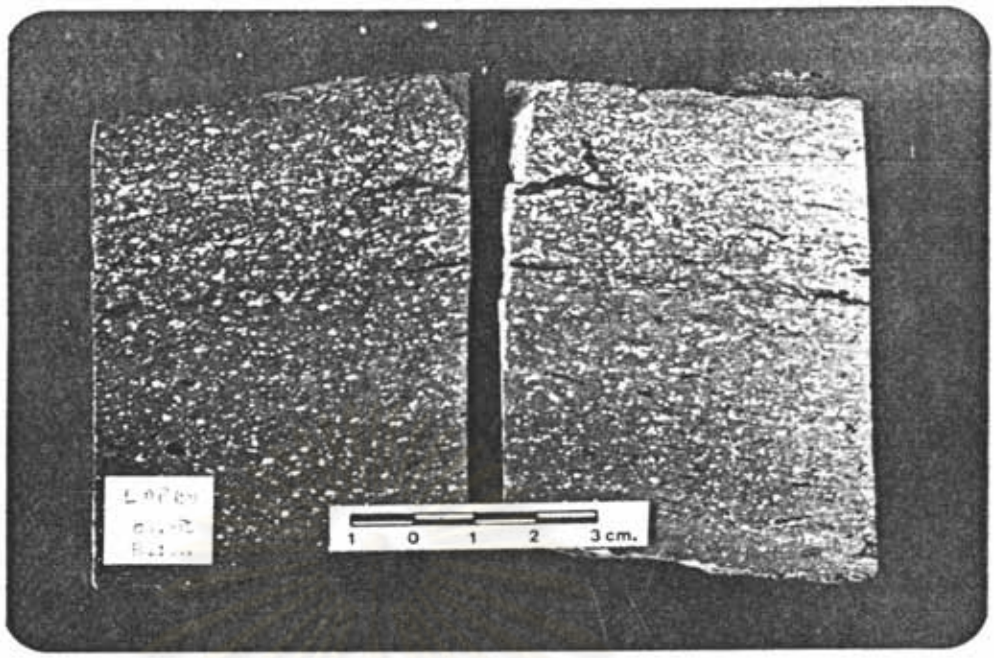


Fig. 3.3.4.4b. Photograph of core-slabs of B4.4 Bed showing white calcareous spot, lignite flake.
(from borehole LMP 65, at depth 61.50 metres)

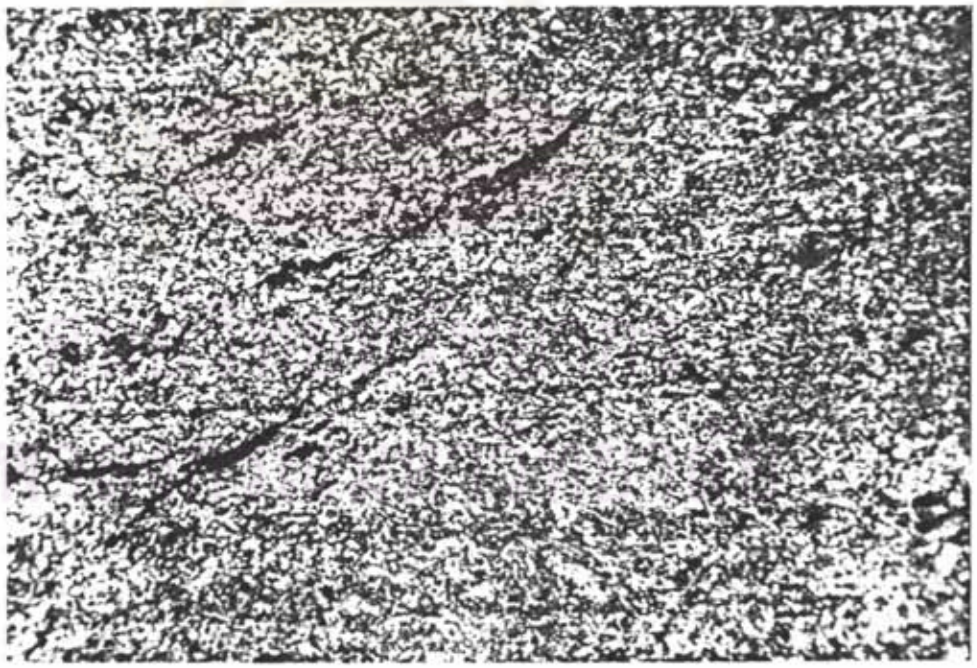
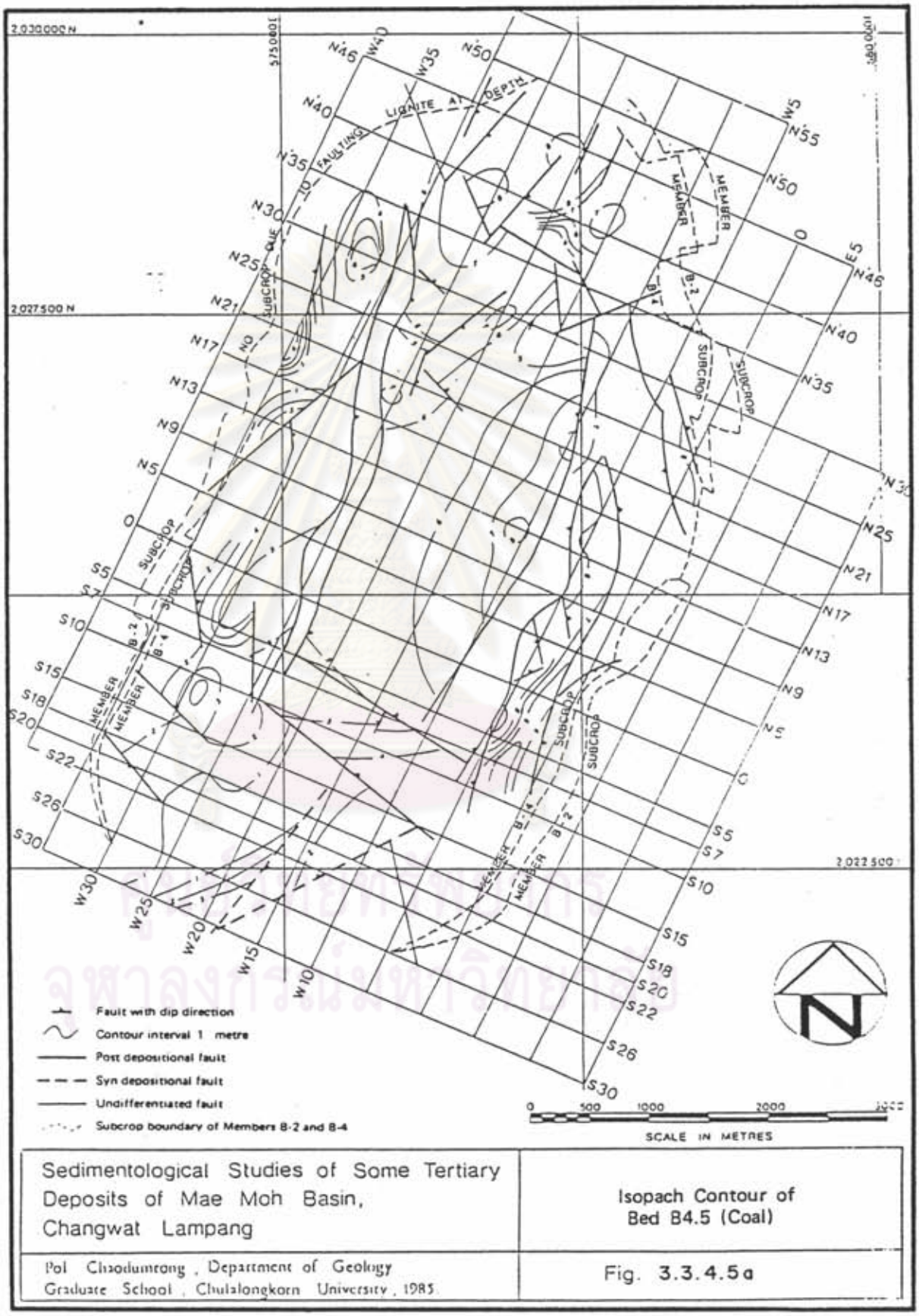


Fig. 3.3.4.4c. Photomicrograph of Figure 3.3.4.4b. Note the microcyrstalline calcite of lump shaped.
(crossnicol, field of view is 1 mm. across)

e) B 4.5 Bed

The B 4.5 Bed is the topmost bed of B-4 Member and is characterized by lignite sequence overlying conformably the parting of marker bed (B 4.4 Bed). Lignite is black to brownish black,hard and brittle, dull to moderately shiny luster with some previtrain, contain some Planorbis sp., gastropod fragments and white calcareous spot. It also contains some partings especially in the middle part of the sequence. The parting is silty claystone, light brown,highly calcareous, with common lignite flake, plant remains and calcareous lentil. According to Sithiprasasna (1959), one set of the mastodon teeth has been collected from this bed. The lignite of the B 4.5 Beds, like the B 4.1, Bed, is widely distributed throughout the study area. The area between mine-grids S7 and N'34, the lignite is thickening on the eastern and southeastern margins upto 9 metres thick (in the vicinity of the active mine pit) and gradually thinning towards the central and western margins to over 5 metres and over 2 metres thick, respectively. In the areas south of S7 and north of N'34, the lignite splits into thin bands with declining quality, and increasing in the thickness of parting. However, in the north, the lignite is more consistent than in the south. Poor quality lignite in the central part of northern area is upto 8 metres thick, while in the southern area only thin band or trace of lignite is present (Figure 3.3.4.5a).

The generalized lithostratigraphic correlation of the B 4.5 Bed of the Mae Moh basin is shown in Figure 3.3.3d.



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Bed B4.5 (Coal)
Pol Chaodumrong, Department of Geology Graduate School, Chulalongkorn University, 1985	Fig. 3.3.4.5a

3.3.5 B-5 Member

The B-5 Member is characterized by thick sequence of fine-grained clastic rocks. It overlies conformably the B-4 Member with abrupt contact and underlies conformably the B-6 Member with gradational contact. The B-5 Member is called "O shale" by Gloe (1955), "O shale bed" by Gardner (1967), Overburden or grey claystone by Longworth CMPS Engineers (1981).

Generally, the lithology can be separated into 3 parts, namely, the lower part, the middle part, and the upper part. The lithological sequence of the B-5 Member is uniform over almost all parts of the study area except in the far southern areas contains some beds of sandstone and conglomerate.

In the lower part, a few metres above the lower contact is characterized by sequence of claystone and silty claystone, dark gray to light brown highly calcareous and thin bedded to laminated. It also contains thin lignite band, gastropods of Planorbis sp., Viviparus sp. and Melanoides sp., some ostracods and fish fragments. The bioturbation, rootlet, highly calcareous silty claystone lentil, white spot of calcium carbonate, and intraclasts are also common (Figures 3.3.5a and 3.3.5b). The highly calcareous silty claystone lentil lies parallel to the bedding plane.

In the middle part, the lithology is graded from the lower part and characterized by thick sequence of claystone, gray, light gray and light colors, highly calcareous, thin bedded to laminated, with common fish fragments and framboidal pyrite. Gastropods, bioturbation, rootlet, lentil structure are occasionally found. It is noted that light color claystone contains more silt content than dark color

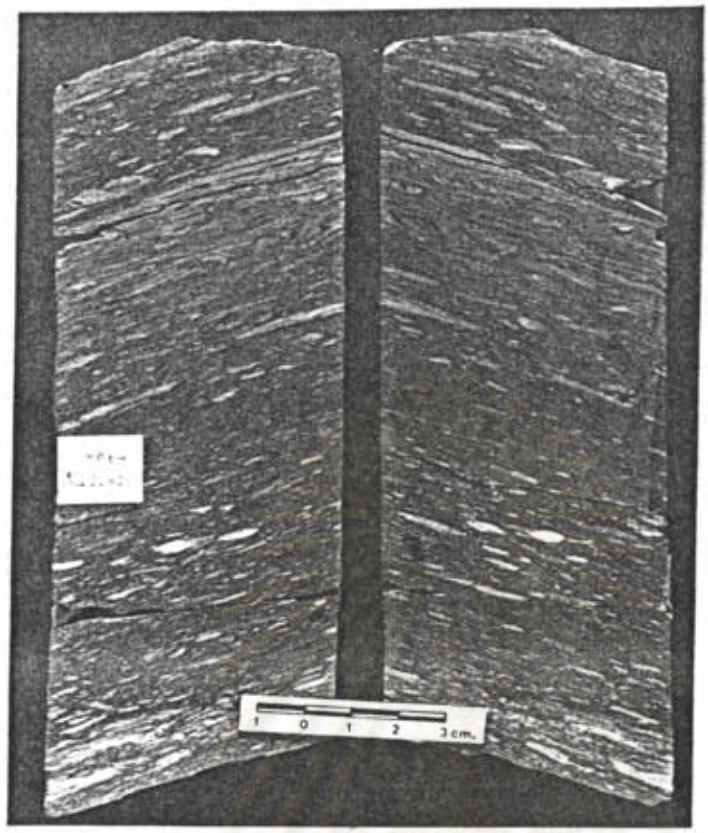


Fig.3.3.5a Photograph of core-slabs showing lentil structure of highly calcareous claystone oriented subparallel to bedding plane, pull-apart structure (beneath the upper crack) and some white calcareous spots. (from LMP 65, at depth 42.80 metres)

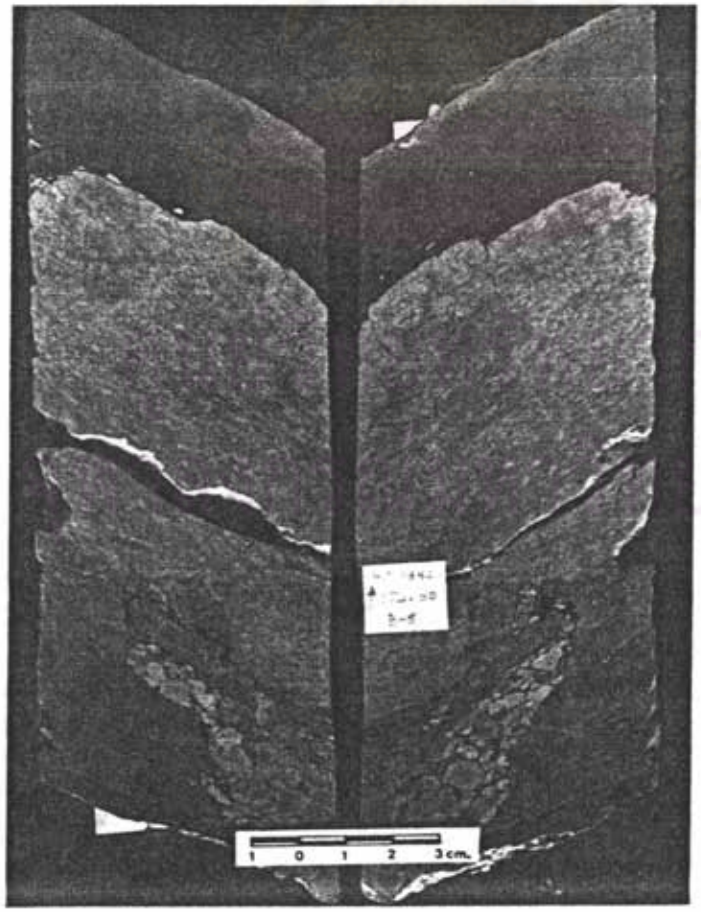


Fig. 3.3.5b Photograph of core-slabs showing bioturbation (boring), local erosional surface and silting-up structure. (from LM 3382S; at depth 174.50 metres)

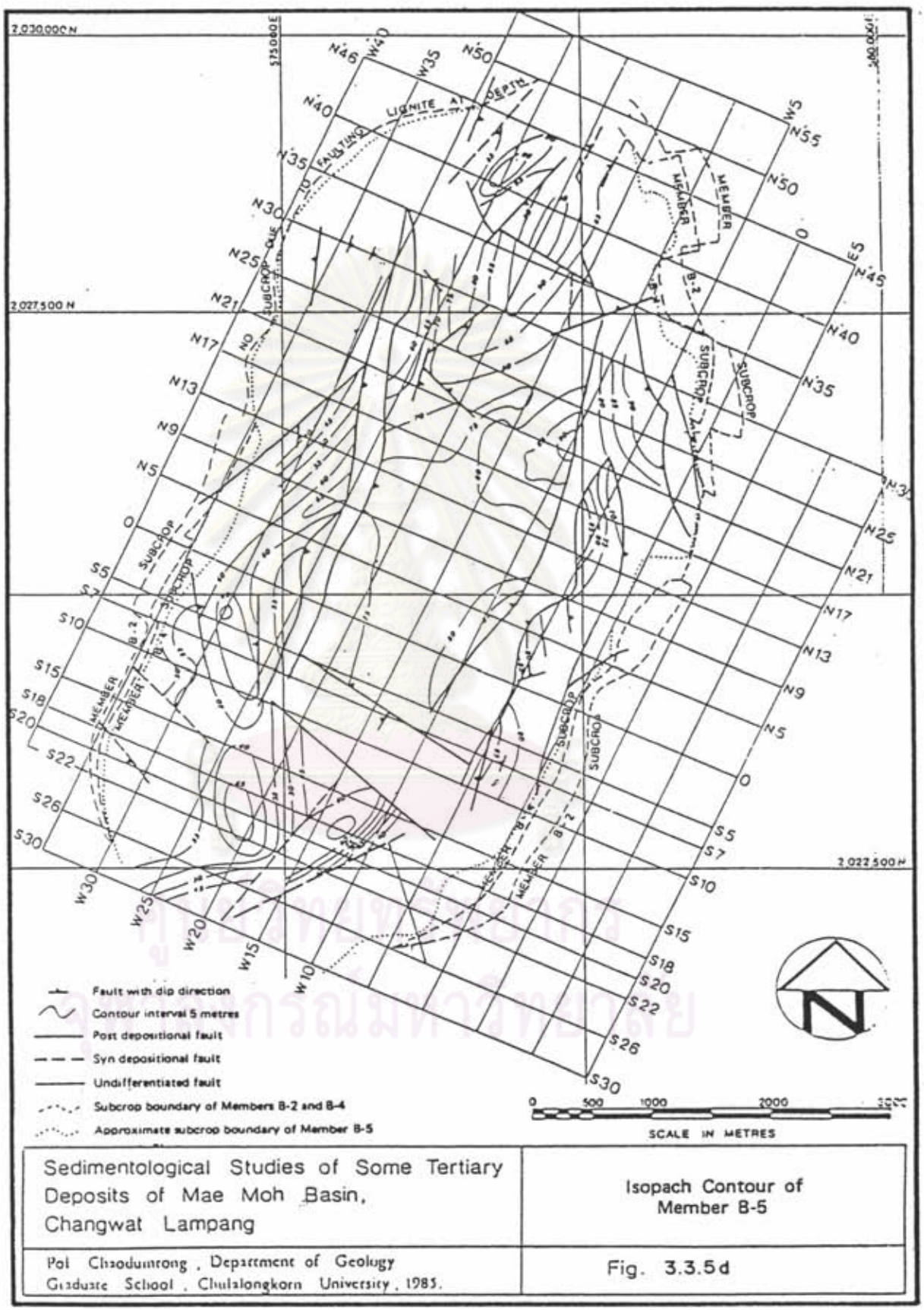
one. Figure 3.3.5c shows the sedimentary cycle, each cycle starts with sharp contact at the base of light color claystone and the lithology grades upward to dark gray claystone at the top. It is interesting to note that the lithological sequence of this middle part is quite different from the sequence in the lower and partly middle parts of the B-1 Member by its laminated to thin-bedded characteristics.

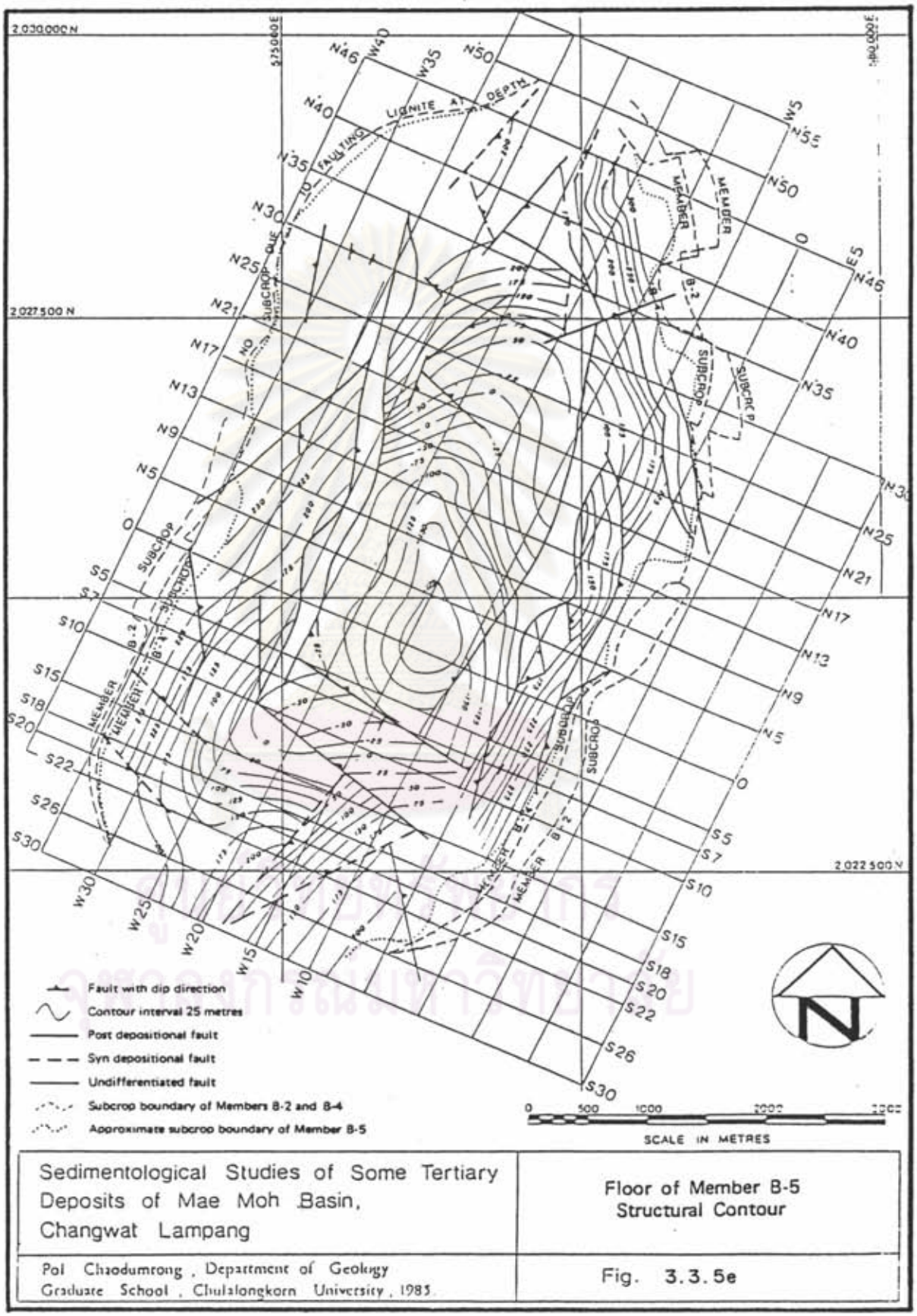
In the upper part, the lithology is characterized by claystone and silty claystone similar to the lower part, dark gray to light-brown color, laminated to thin bedded, and highly calcareous. The gastropods of Viviparus sp., Melanoides sp., ostracods, fish fragments, rootlet and lignite flake are common to abundant. Besides, bioturbation, load structure, calcrete, and intraclast or intraformational conglomerate are also common. Penecontemporaneous fault is recorded from LM 2813S. The upper boundary is gradational contact with an increasing upward of carbonaceous matter and the upper limit of the B-5 Member is marked at the base of lignite.

The thickness of the member varies within the range of 60-100 metres with thickening in the southeastern and northern parts of the study area and gradually thinning towards the western and southern margins (Figure 3.3.5d). The deepest part of the member, similar to others underlying units, is confined within the two major fault zones with over 170 metres below the mean sea level at the central part of the area and over 250 metres above the mean sea level at both eastern and western margins of the area (Figure 3.3.5e).

In thin section, the samples of calcareous claystone collected from the southern part of the active mine pit and from LM 2492C at

Fig. 3.3.5 c Photograph of core-samples showing the sedimentary cycle. Note each cycle starts with sharp contact at the base of light color claystone and the lithology grades upward to dark gray claystone at the top (from LM 2988G, at depth 44.57-44.76 metres)


2,030,000 N
2,027,500 N
2,022,500 N
175,000 E
200,000 E
LIGNITE
FAULTING
SUBCROP
MEMBER
B-2
B-4
Fault with dip direction
Contour interval 5 metres
Post depositional fault
Syn depositional fault
Undifferentiated fault
Subcrop boundary of Members B-2 and B-4
Approximate subcrop boundary of Member B-5
0 500 1000 2000
SCALE IN METRES
N
Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang
Isopach Contour of Member B-5
Pol Chaodumrong, Department of Geology Graduate School, Chulalongkorn University, 1985.
Fig. 3.3.5d



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Floor of Member B-5 Structural Contour
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.3.5e

the depth of 52.20 metres show that the main constituents are tiny micaceous clay minerals and microcrystalline calcite oriented subparallel to the bedding plane. The others are hematite, and rare silt-sized quartz.

The generalized lithostratigraphic correlation of the B-5 Member of the Mae Moh basin is shown in Figure 3.3.5f.

3.3.6 B-6 Member

The B-6 Member is the topmost member of the B-Formation. It is called "O lignite and P shale" by Gloe (1955), "O lignite and P claystone bed" by Gardner (1967), partly of "Red bed" by Longworth CMPS Engineers (1981), and J Zone by ADAB Project and currently EGAT works.

The B-6 Member overlies conformably the B-5 Member with gradational contact and underlie partly conformably and partly unconformably the C-1 Member. The upper limit is marked at the base of red-colored silty claystone or claystone and the lower limit is marked at the presence of lignite band.

Generally, the member is semiconsolidated except where calcareous matter is predominant where it becomes hard and dense. This member is characterized by alternation of semiconsolidated sequence of thin to thick bands of lignite, gray silty claystone, and claystone with some thin bedded micrites. However, in the area south of mine grid S26 the sequence contains some beds of sandstone and conglomerate. Lignite of the member is predominantly present only in the eastern and northern parts of the study area. In the southern area, lignite appears as trace while gray silty claystone and claystone are predominant.

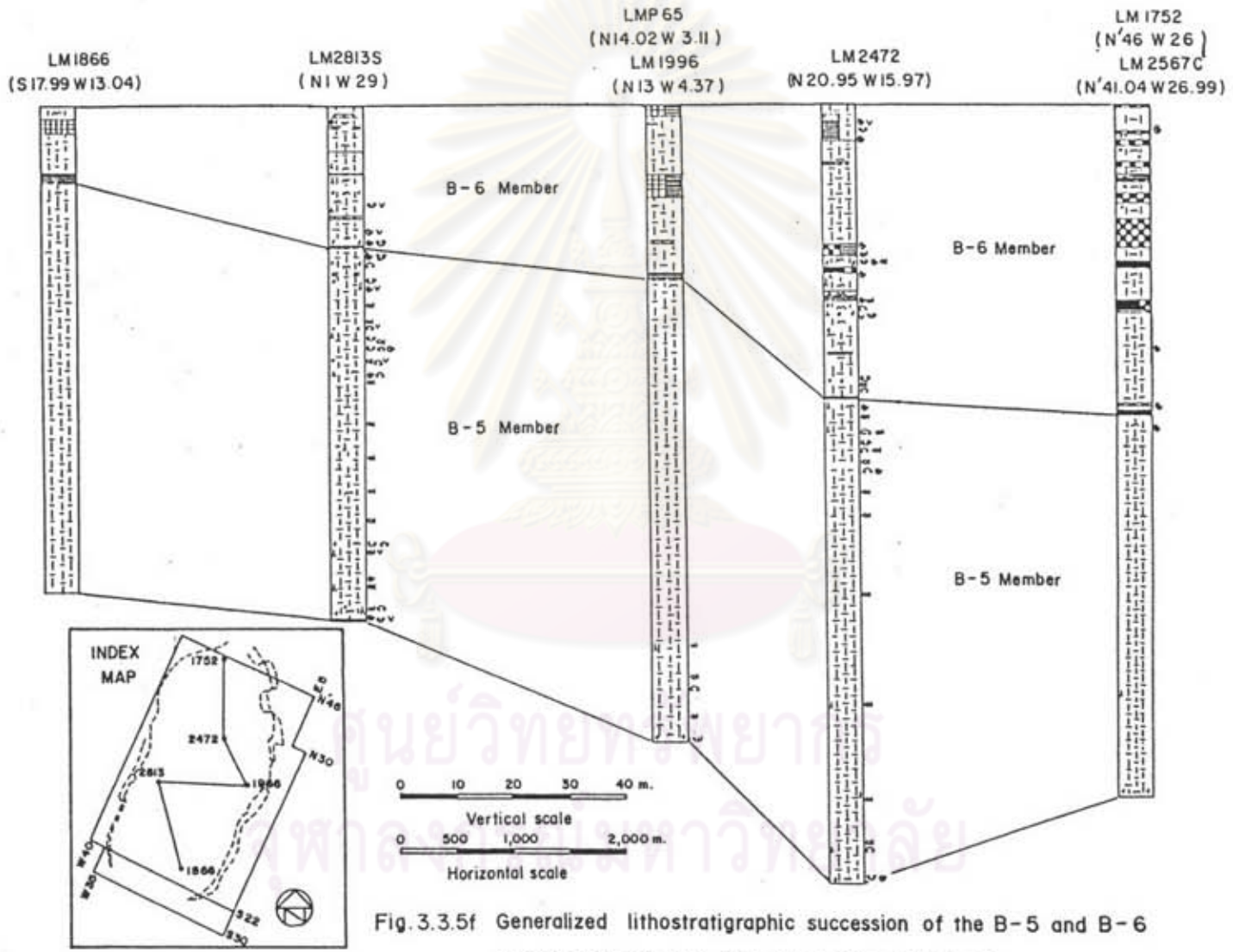
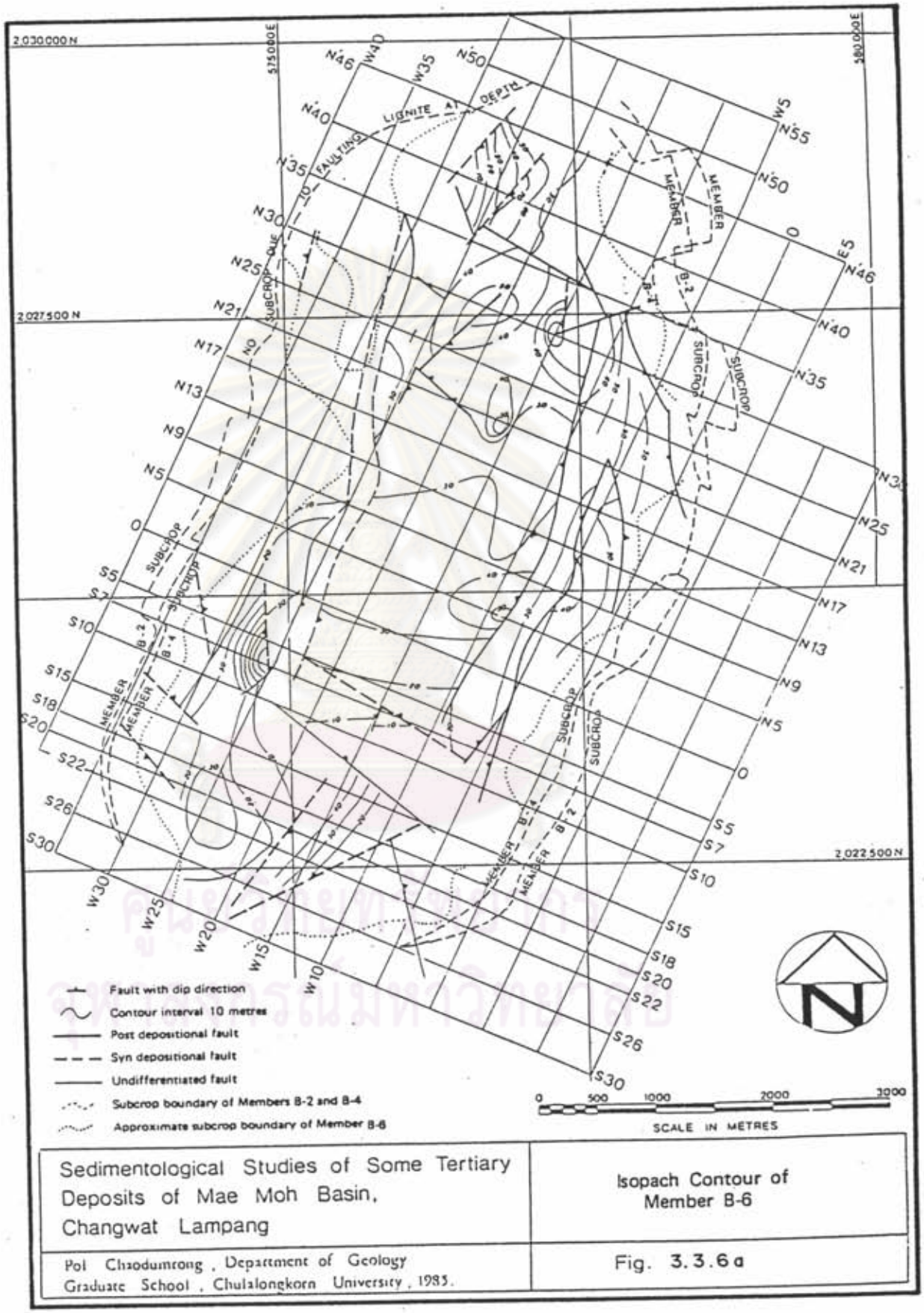


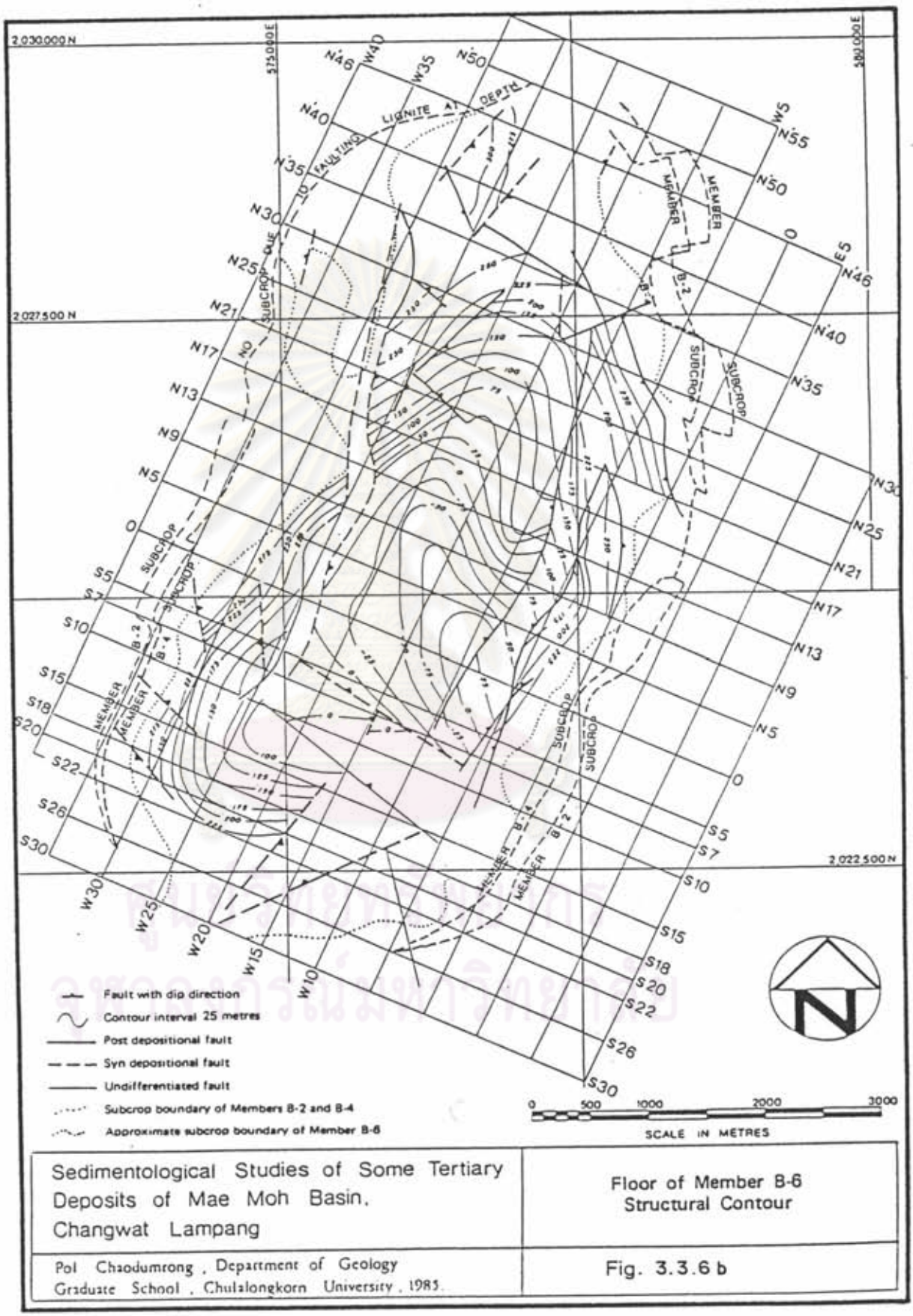
Fig. 3.3.5f Generalized lithostratigraphic succession of the B-5 and B-6 Members of the Mae Moh Group, Mae Moh basin.

The areal extent of this member is relatively lesser than the underlying lithostratigraphic units. The approximate boundary and the thickness of this member is shown in Figure 3.3.6a. This member, generally, is found in the central zone elongated parallel to the shape of the basin whereas in the far eastern and western margin areas it is completely absent in the stratigraphic sequence. The B-6 Member is thickening in the northern and eastern parts of the study area with thickness upto 70 and 40 metres, respectively. It is gradually thinning towards the western and the southern parts of the area (Figure 3.3.6a). The depth to the base of the member, generally, gradually increases towards the central part of the study area except in the eastern part, where evidence of post-depositional fault is apparent (Figure 3.3.6b). The study of some faults within this member indicates that almost all of the faults in the western area are syn-depositional faults whereas the faults in the eastern area are post - depositional faults.

In the active mine pit area, the member is characterized by alternation of thin to thick band of poor quality lignite, semiconsolidated gray silty claystone, and claystone with some bed of micrite. The micrite is present in the lower and upper parts of the sequence. Lignite is predominant in the middle part of the sequence while semiconsolidated silty claystone and claystone are predominant in the lower and upper parts of the sequence. Lignite is black, dull luster, hackly to earthy texture with some fissilities and most of them are attrital coal. Totally 13 thin to thick bands of poor quality lignite are present in the western flank of the active mine pit. However, some of them thin-out southwardly. The semiconsolidated silty claystone



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Member B-6
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1983.	Fig. 3.3.6 a



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Floor of Member B-6 Structural Contour
Pol Chaodumrong, Department of Geology Graduate School, Chulalongkorn University, 1985.	Fig. 3.3.6 b

and claystone are gray to dark gray, highly calcareous, laminated to thin-bedded, with common to abundant bioturbation in place, fossils of Melanoides sp., Viviparus sp., Ostracods, fish fragments, plant ramains and lignite flakes. Intraclasts of intraformational conglomerate is common throughout the sequence and in each sedimentary cycle and the grain size decreases upwardly. Load structure is also common and some of them appear as pull-apart structure.

In thin section, samples of micrite (Folk, 1962) from the active mine pit show that it consists mainly of sacharoidal texture of calcite with some dolomite crystals.

The generalized lithostratigraphic correlation of the B-6 Member of Mae Moh basin is shown in Figure 3.3.5f.

3.4 C-Formation

The C-Formation is the uppermost formation of the Mae Moh Group. It overlies partly conformably and partly unconformably the B-6 Member, and underlies unconformably the gravel deposit of Quaternary Period. This formation is called Red bed by Longworth CMPS Engineers (1981), Huai Luang Zone by currently ADAB Project (Table 2.2.1a).

Lithologically, it is characterized by semiconsolidated sequence of red silty claystone with some beds of gray claystone in the lower and the upper part of the sequence, and siltstone, sandstone and conglomerate in the middle part of the sequence. The calcrete, color mottling gypsum crystals are abundant in place. However, gastropod fragments are reported from the upper part of the sequence.

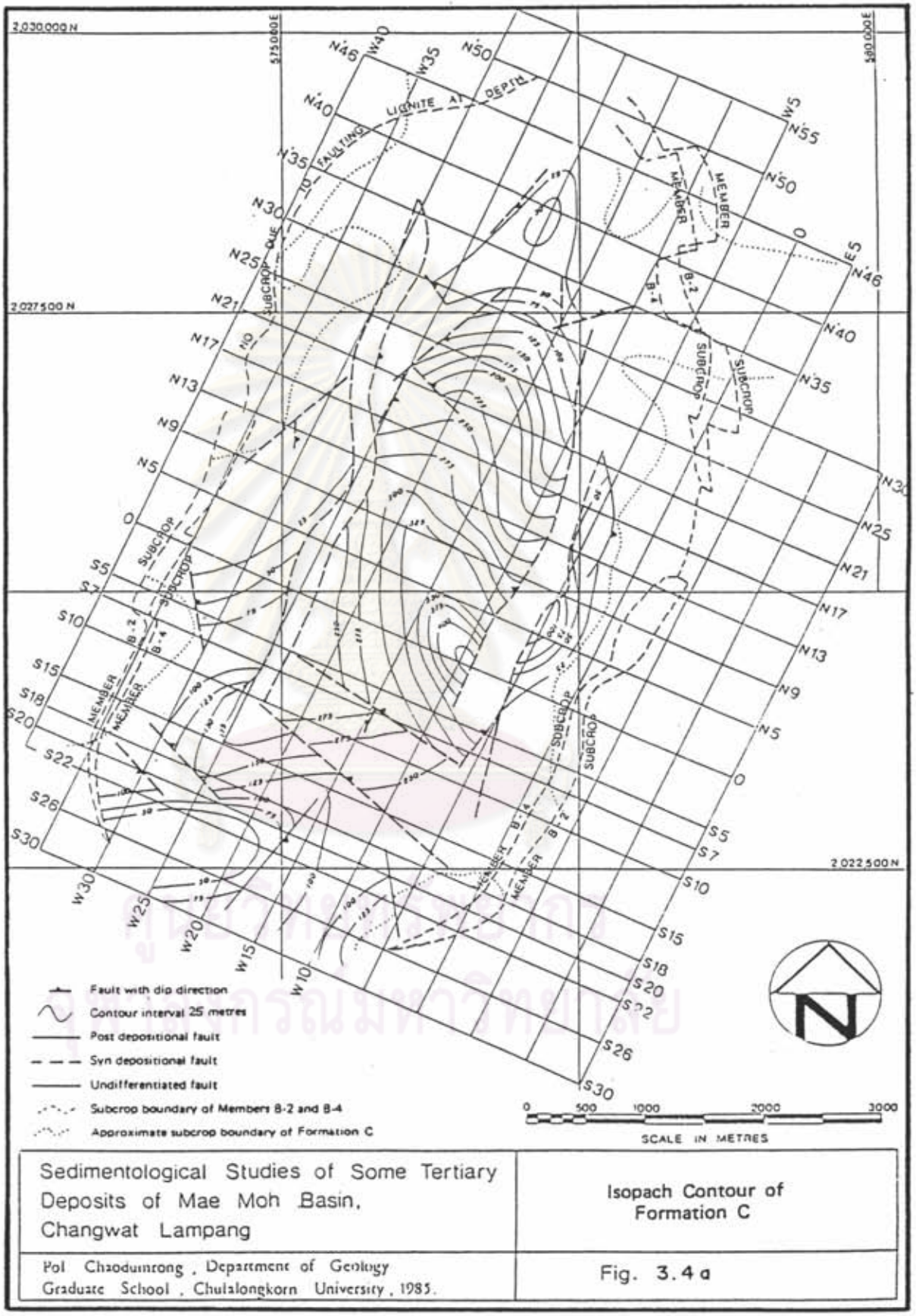
This formation is rather confined within the two major fault -

zones. It is thicknening in the central part of the study area with thickness over 400 metres (Figure 3.4a) and thinning very rapidly towards the eastern and western margins where it is either entirely absent from the stratigraphic sequence or present only a few metres thick. The study of some faults within this formation, based on stratigraphic sequence and thickness, shows that almost all of faults are syn-depositional type. However, some of them can not be classified and are grouped together as undifferentiated fault (Figure 3.4a).

In this study, the C-Formation has been subdivided into 3 members as, C-1, C-2, and C-3 Members in ascending order. The generalized lithostratigraphic correlation of these member is shown in Figure 3.4b.

3.4.1 C-1 Member

The C-1 Member, the lowermost member of C-Formation, is characterized as a semiconsolidated sequence of fine-grained clastic association with some beds of medium-grained clastic. The lower limit of the member is marked at red color claystone or silty claystone, and the upper limit is marked at the base of coarse-grained clastic rocks. The C-1 Member consists of claystone and silty claystone, red color with varying shades of brown, yellow and some gray color, medium to high plasticity. The member also contains patches and spot of calcrete, color mottling, and abundant small sized gypsum crystals (Firure 3.4.1a). However, it is noted that large selenite crystals are abundant on exposed surface. According to Brown et al. (1953), during the Second World War when gypsum could not



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Formation C
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.4 a

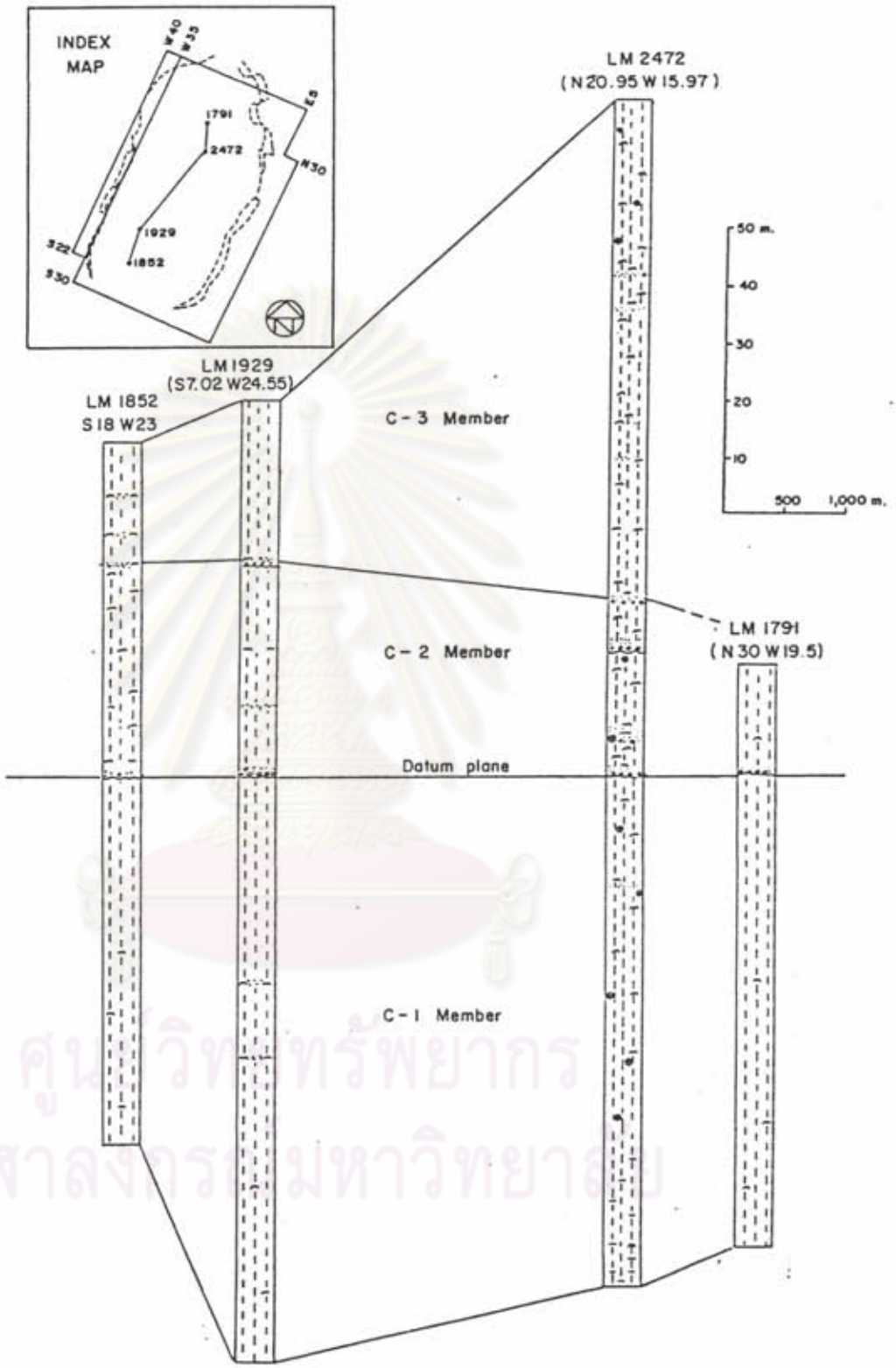


Fig. 3.4 b Proposed correlation of the generalized lithostratigraphic successions of the C-1, C-2 and C-3 Members of the Mae Moh Group.

be imported for use in cement manufacturing, approximate 1,000 tons of gypsum were mined from this area. Some of the semiconsolidated red silty claystone and claystone contain fragments of gray claystone and gray-colored veinlet (Figure 3.4.1b). One distinctive feature of this member is alternation of thin to thick bedded of red and gray claystone or silty claystone in the lower part of the sequences. Plant remains and rootlets are also common in the gray claystone. The upper part of this member is predominantly consisting of red colored semiconsolidated silty claystone and claystone.

This member is thickest in the central part of the study area and confined within two major fault-zones (Figure 3.4.1c). The thickness varies from over 200 metres in the central area to only a few metres thick at the margins. In the northern and southern parts, the member appears as slightly thinning whereas in the eastern and western parts, appear as rapidly thinning. The subcrop boundary of this member is slightly closed in the eastern, western and northern margin, but in the southern margin it is widely extent. The depth to the base of the member varies from over 100 metres below the mean sea level at the central area to over 300 metres above the mean sea level at the margin (Figure 3.4.1d). The shapes of the structural contoure and isopach contour of this member is rather conformable and conformable with the structural contoure of the others underlying members.

3.4.2 C-2 Member

The C-2 Member is bounded on top and bottom by medium to coarse-grained clastic rocks. Lithology of the member is characterized

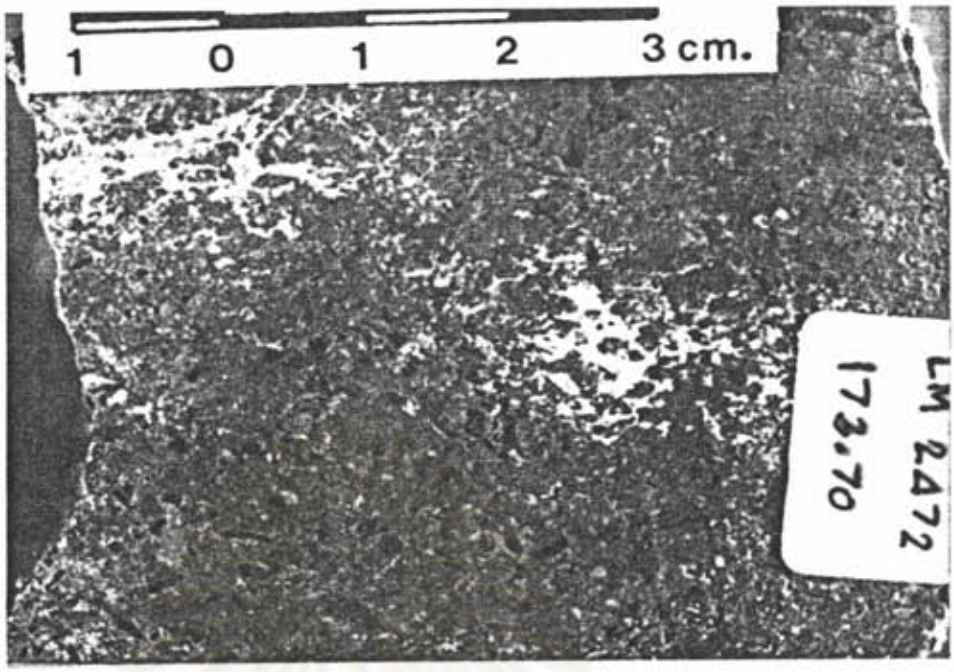


Fig. 3.4.1a Photograph of core-slab showing the gypsum crystal scattered in weakly consolidated red silty claystone. (from borehole LM 2472, at depth 173.70 metres)

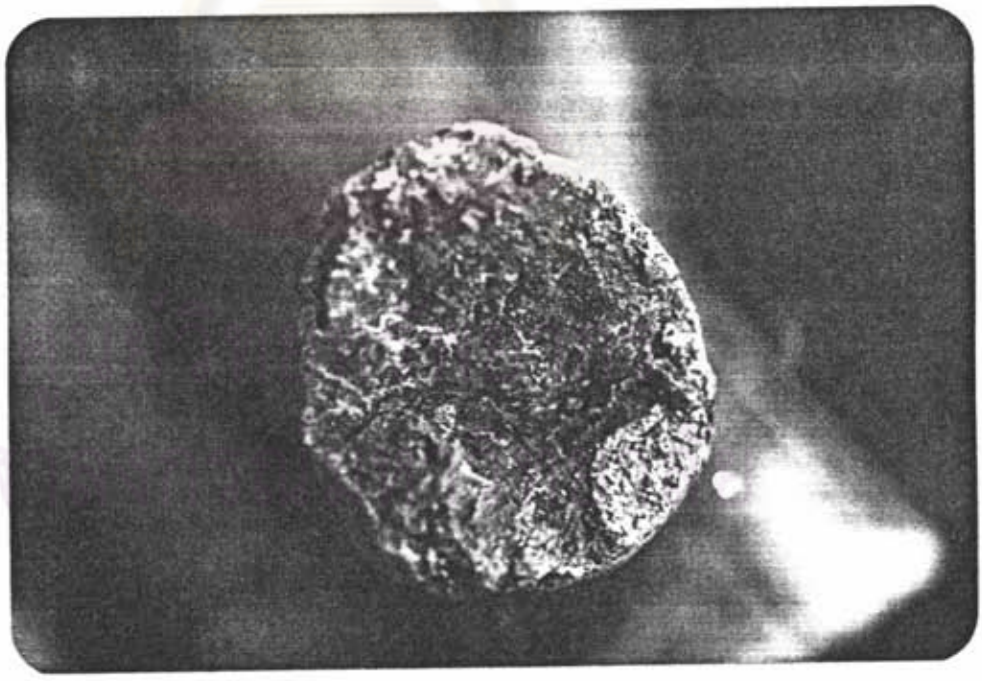
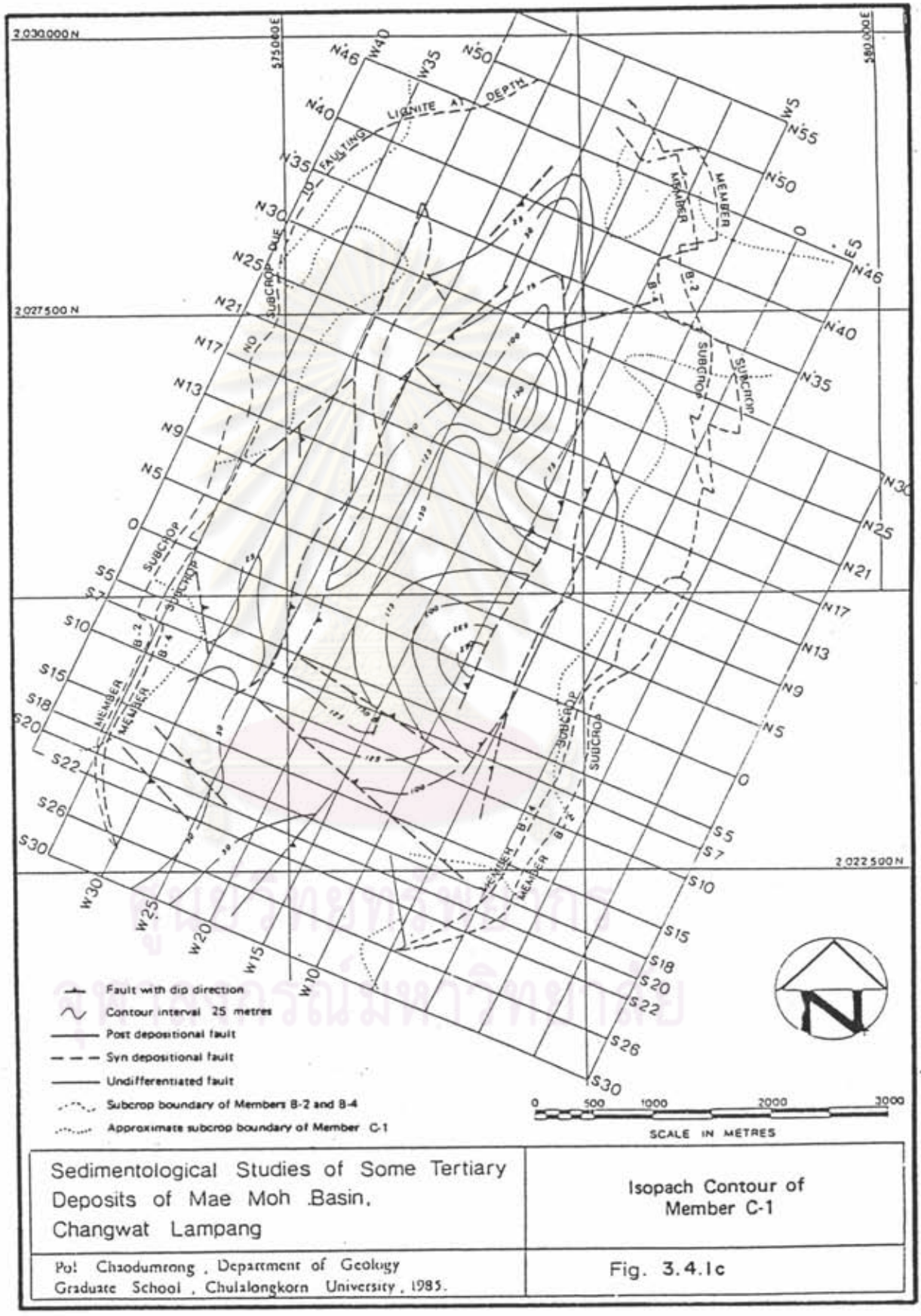
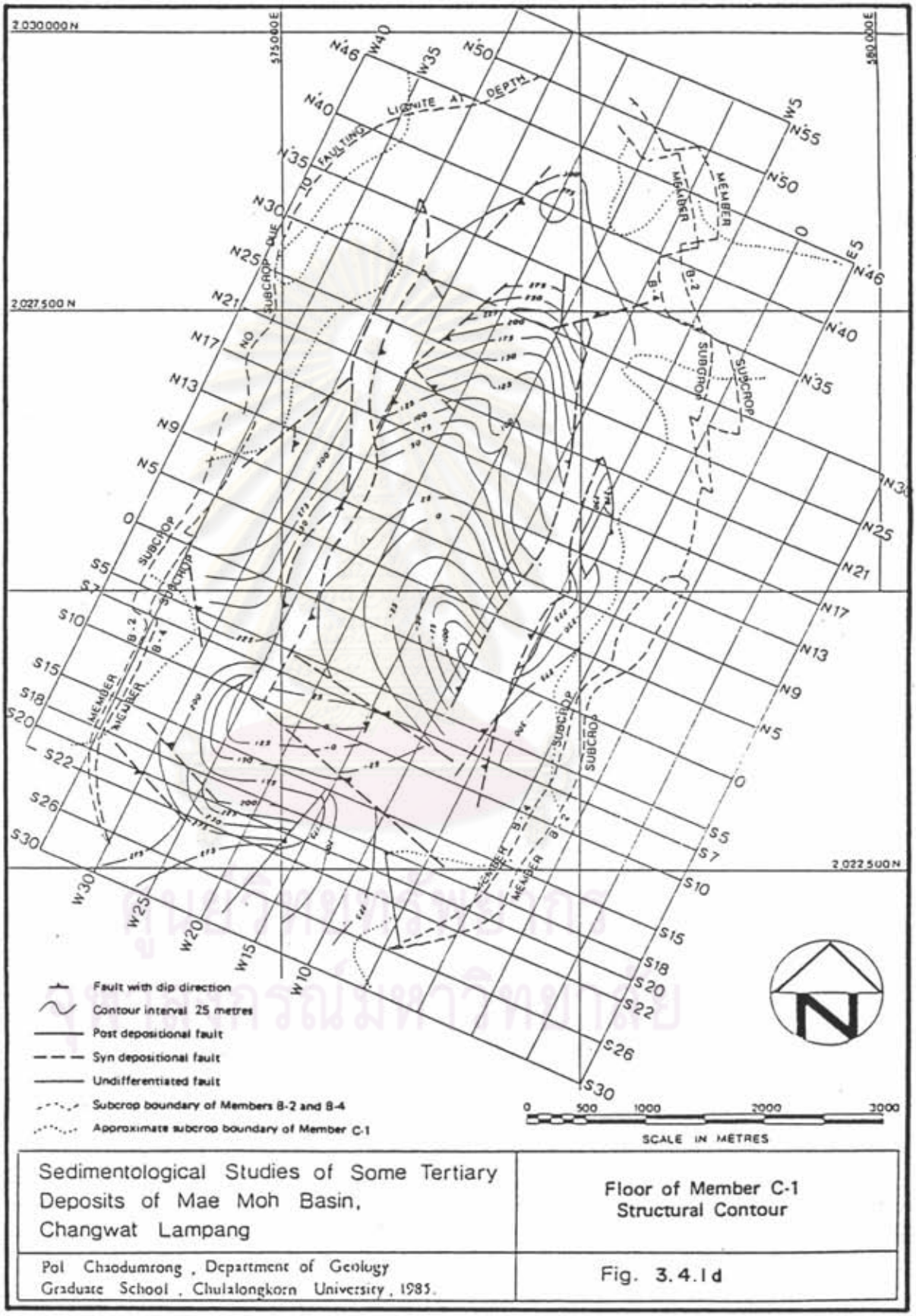


Fig. 3.4.1b Photograph of core-samples showing gray claystone fragments and gray color veinlets. (from borehole LM 2813S)



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Member C-1
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.4.1c



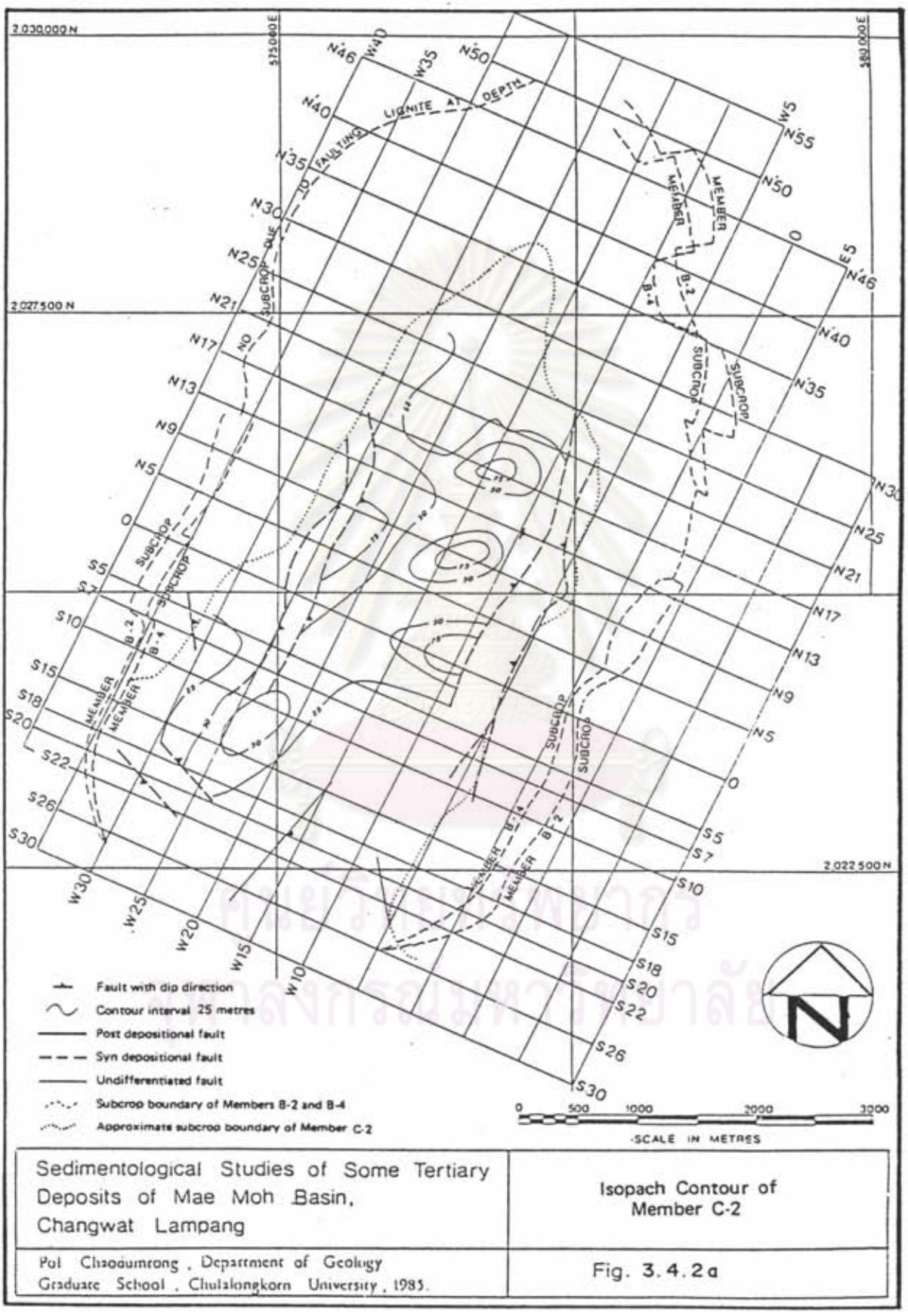
Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Floor of Member C-1 Structural Contour
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.4.1d

by semiconsolidated claystone, silty claystone, siltstone, sandstone and conglomerate, with fining upward nature. The middle part of this member is predominantly composed of fine-grained clastic rocks.

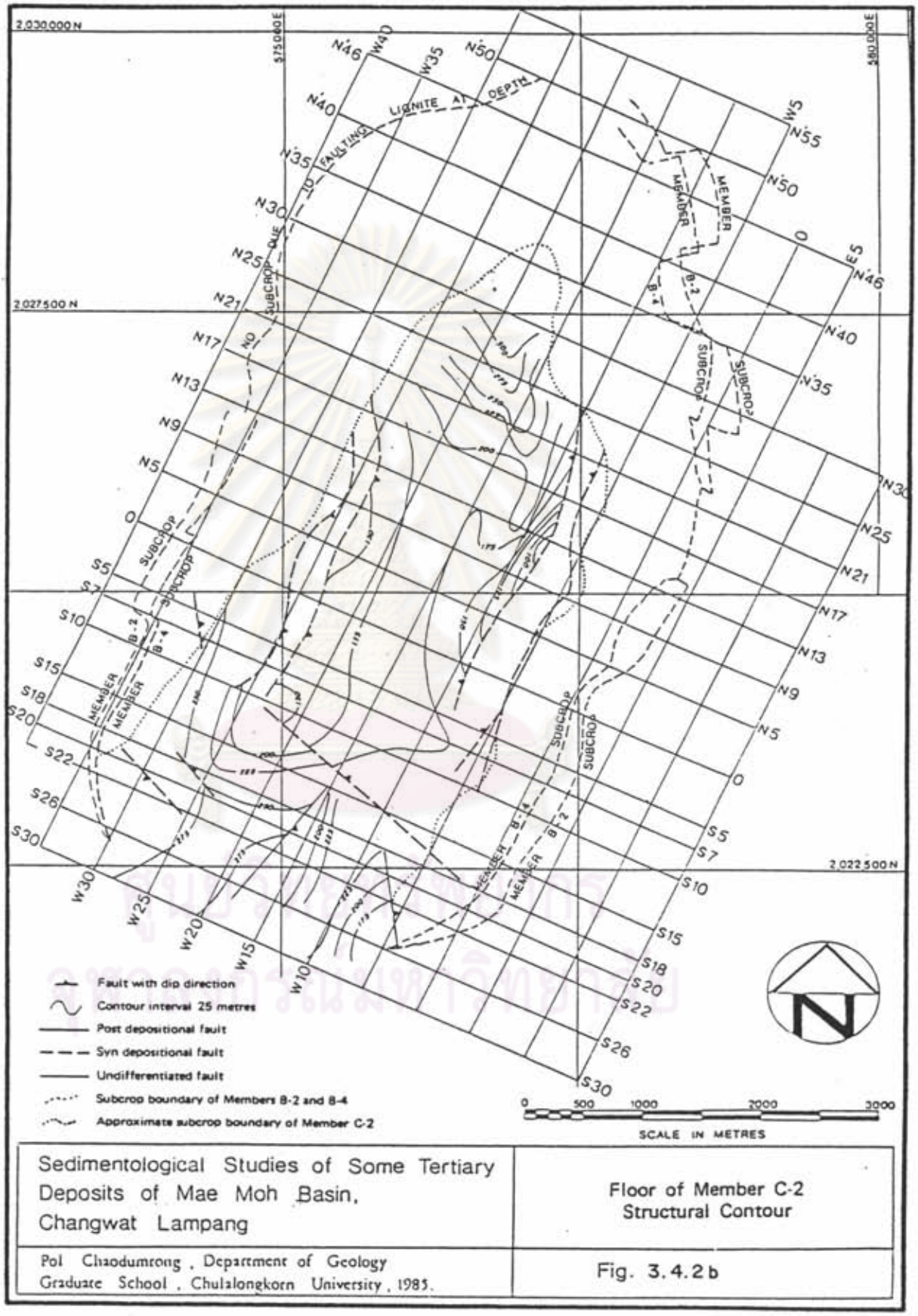
Semiconsolidated silty claystone and claystone, similar to those overlying and underlying members of this formation, are red, brown to dark brown colors with common yellow and purple mottles, medium to high plasticity, common calcrete, gypsum and plant remains, and gray claystone fragments. Semiconsolidated siltstone and sandstone are poor to moderately sorted, brown to reddish brown, and with some calcrete and siderite concretion in part. Semiconsolidated conglomerate is gray to dark brown, with the clast size varies from granule to pebble composing mainly of quartz, chert, sandstone, limestone and volcanic rocks, angular to subrounded, low to moderate sphericity, and poorly sorted.

This member is relatively less limited in areal extent than the C-1 Member but more extensive than that of the C-3 Member. Its subcrop boundary is closed except in the southern margin where it is open underneath the basalt trap. This member, like the others, is thickest in the central part of the study area with over 75 metres thick and thining rapidly towards the eastern and western margins whereas in the southern and northern areas are only slightly thinning (Figure 3.4.2a). The depth to the base of this member is increasing towards the central part of the study area (Figure 3.4.2b). The shapes of the isopach contour and sturctural contour on floor of this member are slightly conformable.

The generalized lithostratigraphic correlation of this member in the Mae Moh basin is shown in Figure 3.4b.



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Member C-2
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.4.2a



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Floor of Member C-2 Structural Contour
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.4.2 b

3.4.3 C-3 Member

The C-3 Member forms the uppermost member of the C-Formation. The upper limit of the member is placed at an unconformity with deposits of coarse-grained clastic sediments of Quaternary Period. This member is overlying conformable the C-2 Member with sub-horizontal bedding plane. Generally, the lithology can be separated into two parts, the lower and the upper parts. These two parts are different in characteristics. The lateral extension of the lower part is relatively wider than the upper part, and gross picture of this member is silting upwardly.

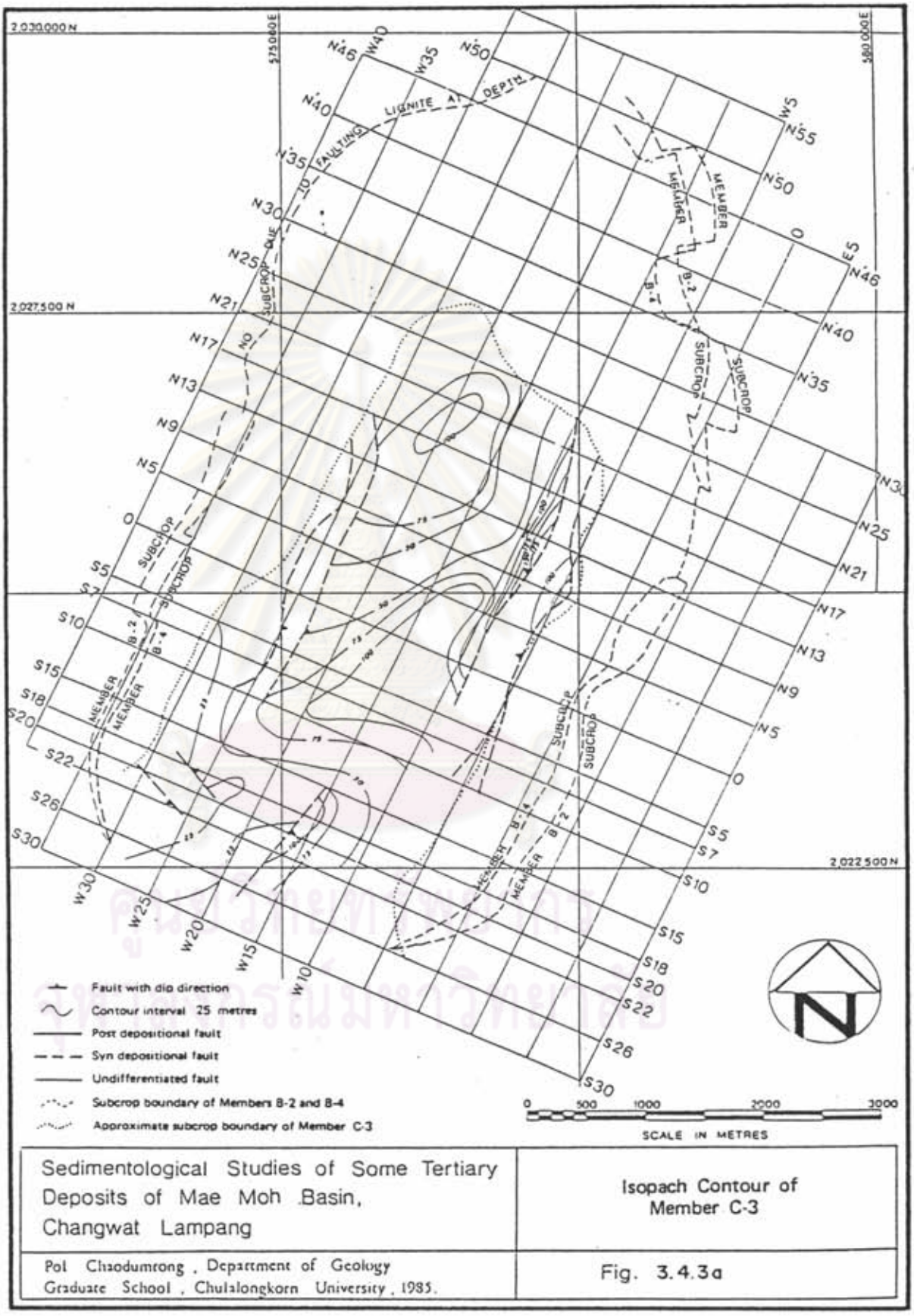
The lower part of this member comprises of semiconsolidated, medium to high plasticity claystone and silty claystone with minor bed of siltstone and sandstone. Red color is predominant but varies in the shades of yellow, purple and brown. The red color is both primary color and caused by oxidation process. Calcrete, and color motting of yellow and brown are common. Minor siltstone and sandstone are found in the lower portion of this part. It is also noted that the red-colored rocks contain some gray claystone fragments and/or gray veinlets.

The upper part of this member comprises of semiconsolidated, medium to high plasticity of gray claystone with minor siltstone and sandstone beds. The bottom part of this portion, there is high carbonaceous content in the form of lignite. Mottled feature, gypsum crystal of needle-shaped and calcrete are locally present. Rootlet is also common in this upper part. According to the lithological logs LM 1906 and LM 1924 by EGAT, this high carbonaceous zone contains

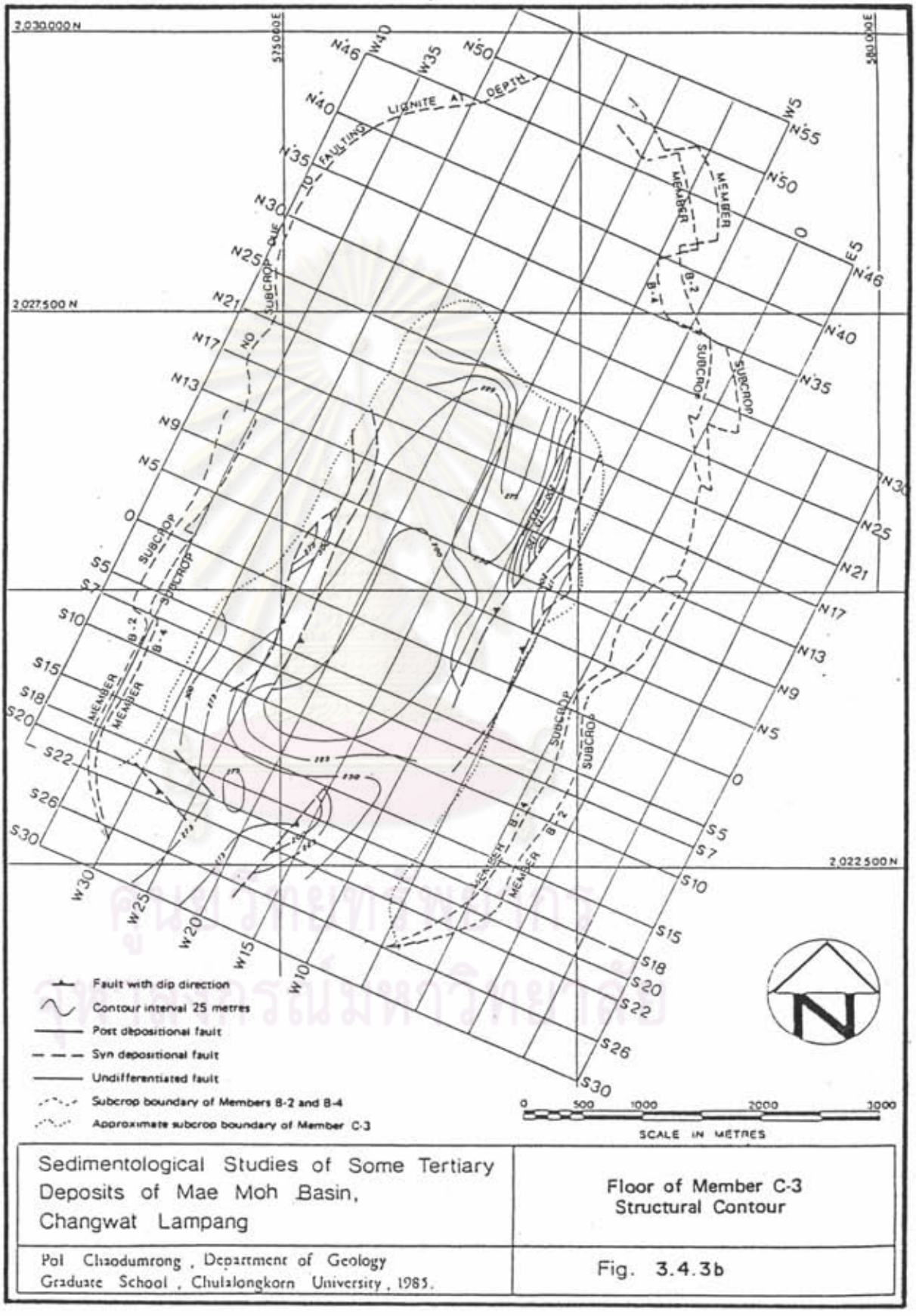
gastropod fragments.

The approximate subcrop boundary of this member has been prepared and the boundary is indicated to be closed except in the southern part where it is open underneath the basalt trap. Thickness varies in range of 8 to over 190 metres. This member is also thickest in the central part of the study area, and is confined within the two major fault zones similar to the other members (Figure 3.4.3a). The structural contour on the floor and the isopach contour of this member are rather conformable (Figures 3.4.3a and 3.4.3b).

The generalized lithostratigraphic correlation of this member in Mae Moh basin is shown in Figure 3.4b.



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Isopach Contour of Member C-3
Pol Chaodumrong, Department of Geology Graduate School, Chulalongkorn University, 1985.	Fig. 3.4.3a



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Floor of Member C-3 Structural Contour
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University , 1985.	Fig. 3.4.3b

3.5 Proposed lithostratigraphy of the Mae Moh basin

Lithostratigraphic succession within the Mae Moh basin comprises of 2 parts, the lower succession, and the upper succession. This study is focussing upon the lithostratigraphy of the lower succession which is characterized as Mae Moh Group.

3.5.1 Mae Moh Group

The Mae Moh Group overlies unconformably the highly folded pre-Tertiary rocks and underlies unconformably the unconsolidated upper succession. The lithostratigraphy of the Mae Moh basin is obtained from both lithostratigraphic succession in the active mine pit, and data as well as information from the boreholes. The proposed lithostratigraphy of the Mae Moh basin is characterized as Mae Moh Group which is further subdivided, based mainly on lithology and sedimentary structure with respect to sedimentary environment, into 3 formations, 11 members, and 9 beds. All lithostratigraphic units recieve their informal name at this stage (Table 3.5.1a).

Detailed description of each lithostratigraphic unit is given under the headings 3.2, 3.3, and 3.4 of Chapter III. However, a brief description will be presented in the foregoing passage.

The A-, and C-Formations are characterized by fine-to coarse-grained clastic associations while the B-Formation is made up predominantly of fine-grained clastic rocks and coal bands. The A-1 Member, about 9-52 metres thick, is made up of fining-upward sequence of conglomerate, sandstone to clayey siltstone. The A-2 Member of upto 88 metres thick consists predominantly of varicolored claystone, siltstone and some fining-upward sequence with coal bands in the upper

Table 3.5.1a Proposed lithostratigraphic classification of the Mae Moh Group (not to scale)

Lithostratigraphy							
Group	Formation	Member	Bed	Graphic	Thickness (m)	Sedimentary Structure	Description
Mae Moh Group	C-Formation	C-3			~190	mottle, calcrete, intraclasts, rootlet	semi-cons. rocks : rd silty CLST & CLST in lower part, gy col. w carb. matter & gastropods in upper part.
		C-2			2-93	fining upward, mottle, intraclasts, iron concretion	semi-cons. rocks : m.- to c.-g. clastic rocks in upper & lower parts, fine-g. in mid part, rd col., gyp. xal
		C-1			4-277	mottle, calcrete, intraclasts, rootlet, intb.	semi-cons. rocks : fine-g. clastic rocks rd col. in upper part, alternation of rd & gy col. in lower part, gyp. xal
	B-Formation	B-6			15-65	bioturbation, intraclasts, rootlet, lam. to thin, wavy bedded, load structure, local unconformity	semi-cons. rocks : alternation of highly calc. gy CLST & silty CLST, banded LGT, w some LST, intra. fm. cgl., SS & Cgl., A. gastropod, ostracod & fish frag.
		B-5			60-100	bioturbation, intraclasts, lam. to thin, local unconformity	gy silty CLST, highly calc. w intra. fm. cgl. gastropod, ostracod & fish in - upper & lower parts; gy CLST, highly calc. w fish frag. in mid part.
		B-4	B 4.5 B 4.4 B 4.3 B 4.2 B 4.1		20-35 -80	bioturbation, rootlet, thin to thick, banded, lentil, hard band, wh. calc. spot	LGT w partings of highly calc. gy CLST & silty CLST, siliceous hard band, foss. of Planorbis sp. Viviparus sp., Melanoides sp., fish frag., mastodon, turtle, amphibian. Partings are predominant in northern & southern parts.
		B-3			15-38	lam. to thin, bioturbation, load structure	gy CLST, highly calc. w LGT banded in upper part, C. fish frag & ostracod.
		B-2	B 2.4 B 2.3 B 2.2 B 2.1		10-30 -60	bioturbation, rootlet, thin to thick, banded, lentil, wh. calc. spot	LGT w partings of highly calc. gy CLST & silty CLST, Viviparus sp., fish. frag. Partings are predominant in northern & southern parts.
		B-1			38-217	lam. to thin, intraclasts, bioturbation, thin to m.	gy CLST, highly calc. w Viviparus sp. beds in upper part, LGT banded in mid part w gastropod, fish, intra. fm. cgl.; C. fish frag. & py.
	A-Formation	A-2			~88	mottle, calcrete, bioturbation, banded, intraclasts, fining upward, load structure	semi-cons. rocks : alternation of fine-to c.-g. clastic rocks, varicolored w. LGT or highly carb. at the top, gastropod.
		A-1			9-52	fining upward, lag deposit, closed work, mottle	semi-cons. rocks : m. to c.-g. clastic rocks, varicolored, gastropod.

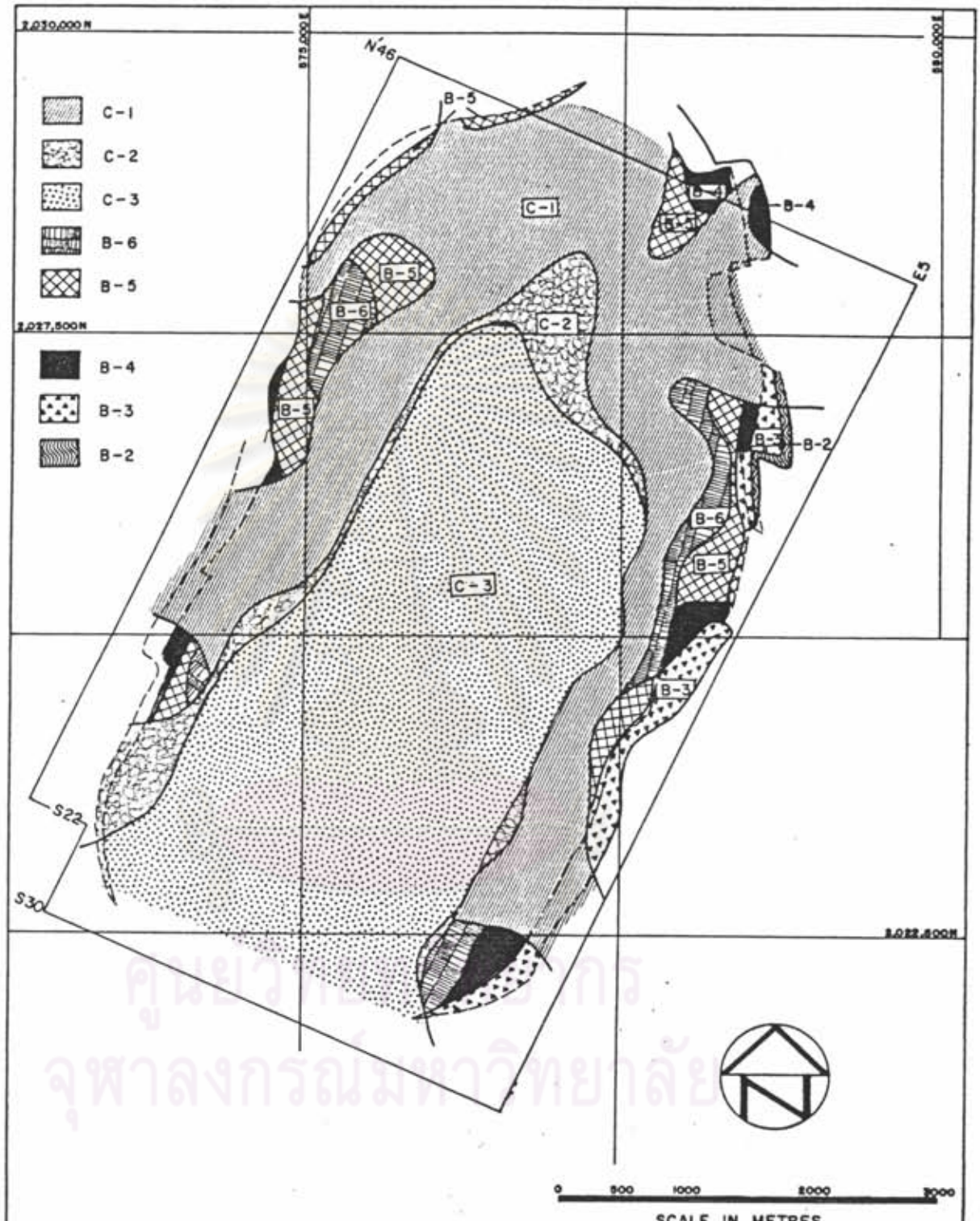
part. The B-1 Member, about 38-217 metres thick, is characterized by thick sequence of thin-to medium bedded claystone in the lower part, some coal bands in the middle part, and laminated to thin-bedded claystone in the upper part. The B-2 Member, about 10-60 metres thick, is the lower economically coal seam. Each bed of which is characterized by coal in the upper part and parting in the lower part except the B2.1 Bed is made up mainly of coal. The B-3 Member, about 15-38 metres thick, consists mainly of laminated to thin-bedded claystone with minor coal band. The B-4 Member, about 20-80 metres thick, is another economically coal seam which has been exploited. The B4.1 and B4.5 Beds are characterized by coal, the B4.2 and B4.3 Beds are characterized by coal in the upper part and parting in the lower part, and the B.4.4 Bed is the marker bed that makes up predominantly of parting with some coal intervention. The B-5 Member, about 60-100 metres thick, consists of laminated to thin-bedded claystone and silty claystone with some intraclasts, gastropod fossil and bioturbation in the lower and upper parts of the sequence. The B-6 Member, about 15-65 metres thick, is made up mainly of claystone, silty claystone and coal band with some micrite beds, small amount of siltstone-sandstone-conglomerate associations. The B-6 Member usually contains bioturbation, intraformational conglomerate, fish fragments and gastropods. The C-1 Member of 4-277 metres thick, and the C-3 Member of upto 190 metres thick are characterized by varicolored of fine-grained clastic rocks, whereas the C-2 Member contains additional coarse-grained clastic rocks. It is noted that the rocks of A-Formation, C-Formation and B-6 Member are weakly consolidated, but the others are consolidated and well compacted. All of sequence of the B-Formation are highly calcareous except coal bands.

The attitude of all the sequences are sub-horizontal except those which are located close to faults. The marker beds for litho-stratigraphic correlation in this area are all coal seams or bands, siliceous hard band within B4.1 Bed, two typical parting of B4.4 Bed and gastropod beds within B-1 Member. Besides, the lithology of each unit is rather unique which produces specific signature of geophysical logs.

The approximate subcrop boundary of each lithostratigraphic unit has been prepared and shown in the isopach map and structural contour map. Disregarding the surficial deposits of the unconsolidated upper succession the geological subcrop map of the Mae Moh Group in the study area has been presented in Figure 3.5.1a.

3.5.2 The unconsolidated upper succession

The unconsolidated upper succession lies unconformably the Mae Moh Group or pre-Tertiary rocks. It is generally exposed as small hills in the southern part of the study area at Ban Mae Pong, and some areas of residential quarters in the Mae Moh Lignite Mine. It comprises of unconsolidated sediments of gravel, sand, silt and clay. Clasts of gravel are generally rounded with low to moderately sphericity of sandstone, conglomerate, conglomeratic sandstone, chert, and volcanic rocks. In the southern part of the area, evidence from subsurface geology indicates that the thickness of this sequence in the vicinity of mine-grid W23 is over 50 metres, and the lithology obtained from geophysical logs is mainly characterized by fining-upward sequence. It is noted that top soil and recent channel sediments are also included in this succession.



Sedimentological Studies of Some Tertiary Deposits of Mae Moh Basin, Changwat Lampang	Subcrop Geological Map of the Mae Moh Basin
Pol Chaodumrong , Department of Geology Graduate School , Chulalongkorn University, 1985	Fig. 3.5.1 a

3.5.3 Fossil contents of Mae Moh Group

In this study, fossil samples have been collected from the upper part of the B-1 Member up to the B-6 Member of the active mine pit. They were identified by Mrs.Rucha Ingavat of Geological Survey Division, DMR. as gastropods of Paludina sp., Viviparus sp., Physa sp., Melanoides sp., Planorbis sp., fish fragments of cypiniforms and siluriforms, fragments of amphibian, and ostracods. The photographs of these fossils are shown in Appendix 4. Inaddition, observations of fossil assemblages from the stratigraphic boreholes indicate that fish fragments are present throughout the B-Formation. Gastropods are predominantly present close to the coal band. Paludina sp. occurs in the upper part of B-1 Member. Viviparus sp. and Melanoides sp. are the most common fossils of the B-Formation. The former is used as marker beds at the upper part of B-1 Member, and the latter is more predominantly present in the upper part than in the lower part of the sequence. Planorbis sp. is predominantly present in B4.4 Bed. Besides , gastropod fragments are reported from A-1 Member and C-3 Member. Ostracod is present in some parts of B-3, B-5 and B-6 Members. According to Ingavat (1981), the gastropod and fish fragments indicate the fresh water lacustrine environment of Miocene age.

Mastodon teeth are reported which could be referred to in this study as B4.4 and B4.5 Beds (Sithiprasasna, 1959). Photographs of these teeth were sent to Prof. Dr. G.H.R. von Koenigswald in Netherland and further identified as Stegolophodon praelatidens n.sp. of Lower to Middle Pliocene (Von Koenigswald, 1959). However, in 1983 a team of DMR. paleontologist and geologists with over-seas paleontologists were given the vertebrate fossils from the Mae Moh

mine geologist. Consequently, Ginsburg et al. (1983), and Ginsburg (1983) identified them as carnivora as Siamogale thailandica. The fossils in the collection of the Mae Moh mine, Ginsburg (1983) identified the rhinoceros as Rhinocerotini indet. cf. Gaindatherium and the mastodon teeth which had been further reevaluated by P.Tassy as only Stegolophodon. The Mae Moh lignite (B-2 and B-4 Member) is belived to be the upper part of the Middle Miocene (Ginsburg, 1983).