CHAPTER IV

ROCK UNITS OF THE STUDY AREA

This chapter is devoted to the stratigraphic correlation in the study area. The objective of this study is to gain the further insights into the general geology, and into the relationship between the rock types distribution and the structures.

In the present investigation, an attempt had been made to classify the sedimentary succession which composed mainly of limestones and subordinate argillaceous rocks, and bedded chert with the minor amount of fine-grained sandstones, and to identify the related igneous rock rocks. The observation was done on the rock types exposed in the field. The sedimentary rock samples were also collected and about 270 thin-sections were prepared for the study of their petrographic characteristics and essential mineral composition.

4.1 Classification of the Rock Types

The substantial classifications of the different rock types are as followed.

4.1.1 Limestones Classification

The classification of the limestones to be used in this study was described previously by Folk (1959). The reason of using Folk's classification system is merely to have it be coincided with that using in many previous works. In this classification system,

Folk divided the carbonate rocks into four main classes (Figure 10). The first two classes include the rocks composed largely of grains (allochem), termed the allochemical limestones. One of which is dominated by the sparite cement, the other by the micrite matrix. The third class is for the rocks lacking of large observable grains, termed the orthochemical limestones. This third group includes the micrite lime-mud carbonates. The fourth class is for the rocks made up of the in situ skeletal fabrics. For this last group, the autochthonous reef rocks includes the biolithites.

4.1.2 Classification of Argillaceous Rocks

Potter et al. (1980) proposed a classification of the fine-grained sedimentary rocks, based on the features of genetic significance, grain size and stratification as shown in Table 2. The classification of these rock types is done using the tetrahedron scheme (Krumbein and Sloss, 1963). In this tetrahedron, the quartz vertex represents the sandstone, the clay vertex, the shale, the carbonate vertex, the limestone, and the chert vertex, the chemically formed silica sediments. The four sides of the tetrahedron are established into four triangular diagrams to show the variations of rock types with the different proportions of the fundamental constituents (Figure 11).

4.1.3 Sandstone Classification

The classification systems for the sandstones are those of modified Pettijohn's (1954, 1957) (Figure 12 a), of modified Dott's (1964) (Figure 12 b), and of Folk's (1968) (Figure 12 c).

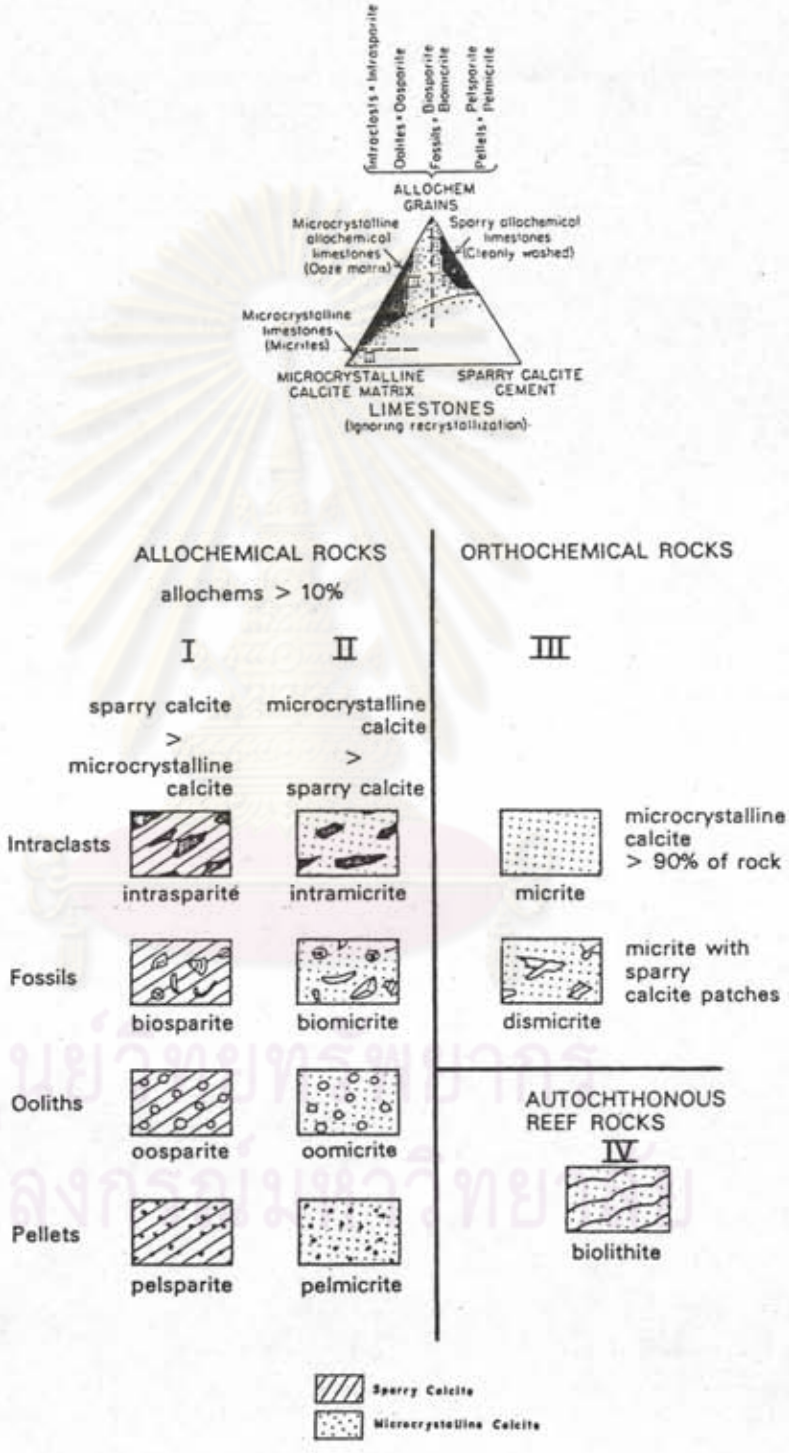


Figure 10 Graphic classification table of limestones (After Folk, 1959).

Table 2 Classification of argillaceous rocks
(After Potter et al., 1980)

Percentage clay-size constituents			0-32	33-65	66-100
Field Adjective			Gritty	Loamy	Fat or Slick
NONINDURATED	Beds	Greater than 10 mm	BEDDED SILT	BEDDED MUD	BEDDED CLAYMUD
	Lamines	Less than 10 mm	LAMINATED SILT	LAMINATED MUD	LAMINATED CLAYMUD
INDURATED	Beds	Greater than 10 mm	BEDDED SILTSTONE	MUDSTONE	CLAYSTONE
	Lamine	Less than 10 mm	LAMINATED SILTSTONE	MUDSHALE	CLAYSHALE
METAMORPHOSED	Degree of metamorphism LOW		QUARTZ ARGILLITE	ARGILLITE	
			QUARTZ SLATE	SLATE	
	HIGH		PHYLLITE AND/OR MICA SCHIST		

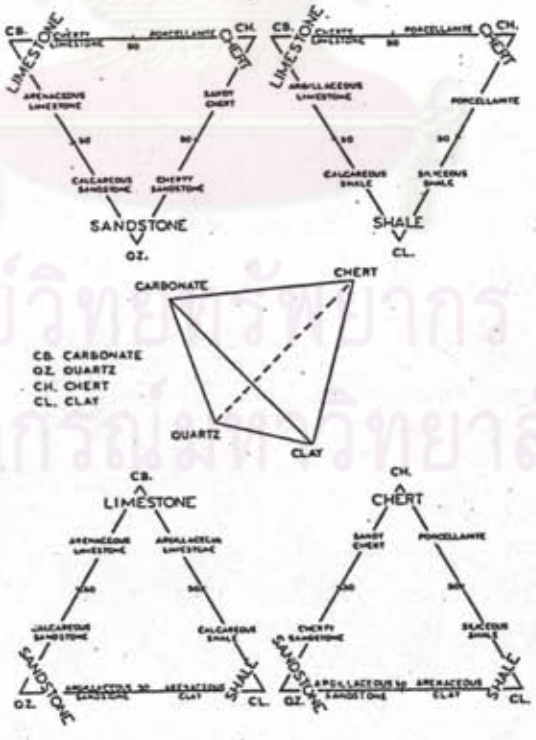
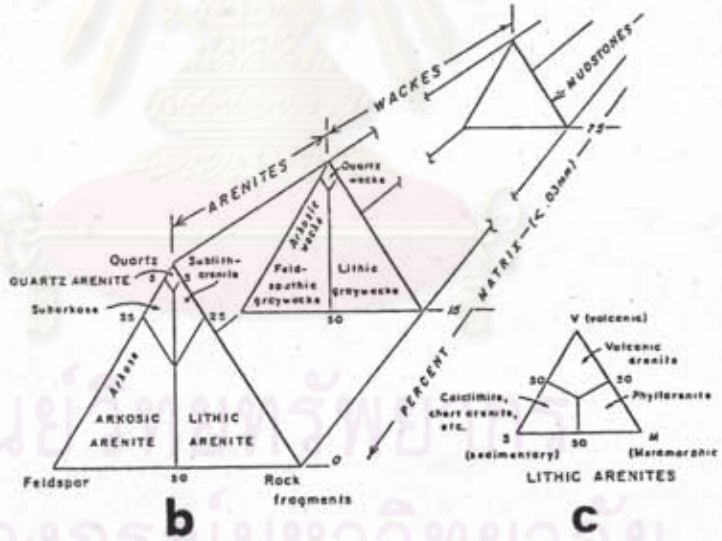


Figure 11 The fundamental tetrahedron for the carbonate-quartz-chert-clay system (After Krumbein and Sloss, 1963).

Cement or matrix		Detrital matrix exceeds 15% Chemical cement absent	Detrital matrix less than 15%. Voids empty or filled with Chemical cement		
Sand or detrital fraction	Feldspar exceeds rock fragments	Graywackes: Feldspathic graywacke	Arkosic Sandstones: Arkose	Subarkose or feldspathic Ss	Orthoquartzites: Chert <5%
	Rock fragments exceeds felds	Graywackes: Lithic graywacke	Lithic Sandstones: Subgraywacke	Protoquartzites	Orthoquartzites: Chert >5%
	Quartz content	Variable; generally <75%	<75%	>75% <95%	>95%

a



b c

Figure 12 The sandstones classification systems. (a) System proposed by Pettijohn(1954, 1957); (b) Classification of terrigeneous sandstones (Pettijohn, 1975 modified from Dott, 1964); (c) Subdivision of lithic arenites (After Folk, 1968).

According to Pettijohn's system, the sandstones are defined into several classes in terms of the proportion of detrital quartz, feldspar, and rock particles and on the presence or absence of an interstitial matrix. Those with 15 or more percent matrix constitute the "wacke"; those with less matrix are the "ordinary" (ortho) sandstone. In Dott's classification, three main families are definded as:(1) those in which quartz from 95 or more percent of the framework fraction, the quartz arenites (orthoquartzites); (2) those containing 25 or more percent feldspar which also exceeds the rock particles, the arkoses; and (3) those characterized by over 25 percent of the rock particles, the lithic sandstones (lithic arenites). The subclasses are also defined within the major families. These are, for examples, subarkoses, and sublithic sandstones or arenites. The lithic arenites class is subdivided according to Folk (1968) on the basis of the type of the rock fragments presented. The dominant rocks in the group are the graywackes, of which there are two further important subdivisions, the lithic graywackes in which the quantity of the rock particles exceeds that of feldspars, and feldspathic graywackes if vice versa. The quartzwackes are a relatively minor and rare class within the wacke group.

4.1.4 Volcaniclastic Sediments Classification

The coarse-grained volcaniclastic sediments, volcanic breccias and agglomerates are composed largely of the rock fragments or bombs. These of the medium-grained, the tuffs, consist of glass, mineral crystals or crystal fragments, and rock particles. They may therefore be classed according to the proportions of these components

(Figure 13 a). The further subdivision of the various possible mixtures may follow as in Figure 13 b (Pettijohn, 1975).

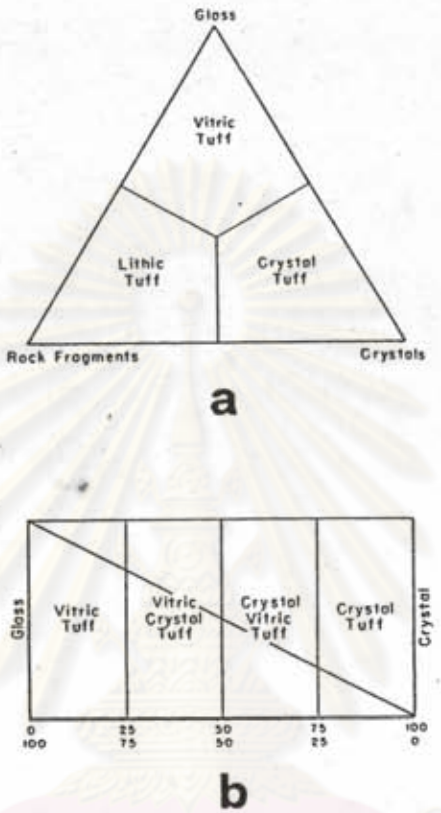


Figure 13 The tuffs classification system. (a) Nomenclature and classification of tuffs, (b) Further nomenclature and classification of vitric and crystal tuffs (After Pettijohn, 1975).

4.2 Sedimentary Rock Units

In the field investigation, the successive stratigraphy is generally described by the rock types of the units and subunits, the conformable relationship between the units, the associated fossils, size of beds (Table 3), etc.. According to the work of Hinthong (1981), the rock units of Ratburi Group which expose in the present study area are Phu Phe, Nong Pong, Khao Khad and Sap Bon formations and the igneous rocks from Khao Yai Volcanics and

Phra Ngam Diorite. However for some suitability, according to the field observation by the present writer, the sedimentary rocks in

Table 3 Classification of Bedding Thickness
(After McKee and Weir, 1953,
Modified by Ingram, 1954.)

Beds	very thick-bedded ——100 cm (about 3 ft)——
	thick-bedded —— 30 cm (about 1 ft)——
	medium-bedded —— 10 cm (about 4 in.)——
	thin-bedded —— 3 cm (about 1 in.)——
	very thin-bedded —— 1 cm (about ⅜ in.)——
Laminae	laminated —— 0.3 cm (about $\frac{1}{10}$ in.)——
	thinly laminated

the study area were re-grouped, from the oldest to the youngest, according to the lithologic and physical features, stratifications and structures into six informal units, X1 to X6. Each units were further subdivided into members as illustrated in Figure 14, totally 13 members. The subdivision was attempted wherever the extent of the rocks is obvious. The X1.1 and X1.2 members in this study are equivalent to Nong Pong Formation of Hinthong (1981) except the Southern part of X1.2 which is a part of Pang Asok, the southern part of X2.2, Phu Phe Formation, the southern part of X5.1 together with X5.2, X5.3 and X6.2, Sap Bon Formation, and all the rest, Khao Khad Formation.

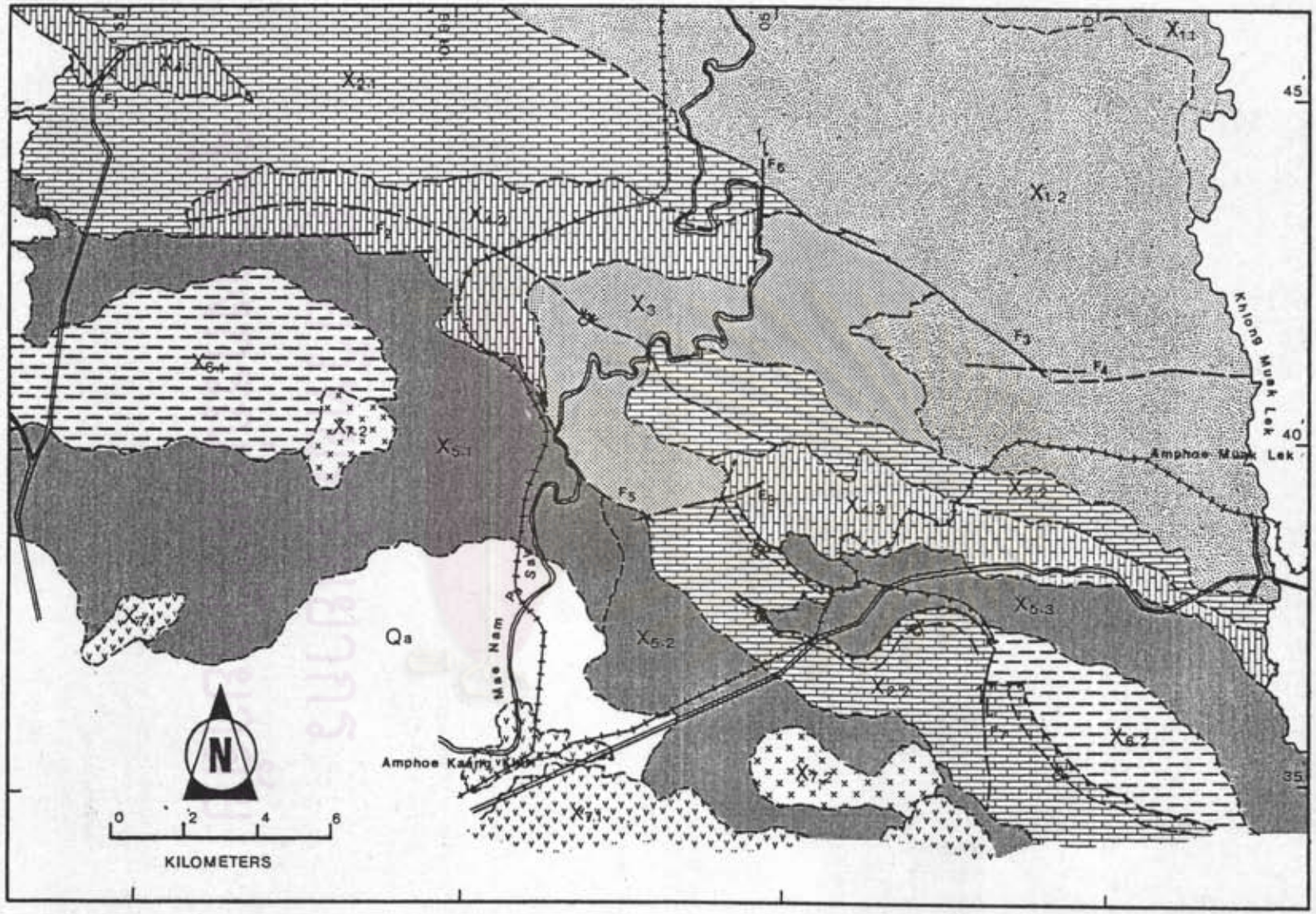


Figure 14 Geologic map of the study area showing the extention of 13 rock members.

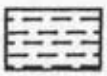
EXPLANATION

Sedimentary rock

Q_a

Alluvial gravel, mud, silt, and clay of floodplain and swamp deposits. — QUATERNARY

UNCONFORMITY

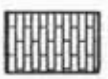


$X_{6.1}$, $X_{6.2}$

Shales, limestones with siltstone and chert interbeds. Shales may be calcareous or silty, brown, medium gray to black. Limestones: micrite and pseudosparite, some with fossils, thin to medium bed, medium to dark gray. Siltstone: reddish brown to brownish gray. Bedded chert: brownish gray to black. Fossils: fusulinids and crinoid stems.

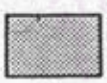
$X_{5.1}$, $X_{5.2}$, $X_{5.3}$

Limestones, shales and bedded chert with some sandstones. Limestones: pseudosparite and micrite, some with fossils, thin to massive bed, medium gray. Shales: oftenly calcareous or slaty, brown, medium to dark gray. Bedded chert: brown to black, partly porcellanite. Sandstones: graywacke, quartz arenite and quartz wacke, fine-to medium-grained, thin bed, brown to medium gray. Fossils: fusulinids and crinoid stems.



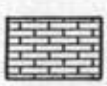
$X_{4.1}$, $X_{4.2}$, $X_{4.3}$

Limestones with less interbeds mudstone, shales, sandstones, siltstone, and porcellanite. Limestones: micrite to pseudosparite. Some with fossils, medium to massive bed, medium gray, with few chert nodules. Mudstone: brown to medium gray. Shales: may be calcareous, brownish gray to black. Sandstones: quartz wacke and lithic wacke, fine-to medium-grained, thin to medium bed, brown to medium gray. Siltstone: calcareous gray. Porcellanite: brown to light gray. Fossils: fusulinids, corals and crinoid stems. — PERMIAN



X_3

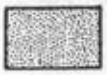
Limestones: micrite, pseudosparite, some with fossils, medium to massive bed, light to dark gray shale in the lower part. Fossils: fusulinids and crinoid stems.



$X_{2.1}$, $X_{2.2}$

Limestones with mudstone and intercalated tuffs with mudstone some with fossils pellets or intraclasts in part dolomitized medium to massive bed, medium gray with chert bands and nodules. Fossils: fusulinids, corals and crinoid stems.

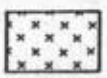
Figure 14 cont.



$X_{1.1}$, $X_{1.2}$

Shales, sandstones and limestones interbedded. Shales may be slaty, brown to medium gray. Sandstones: subarkose, sublith arenite, subgraywacke and graywacke, thin to medium bed, brown to light gray. Limestones: pseudosparite micrite, some with fossils, in part dolomitic, thin to massive bed, medium to dark gray, some chert nodules. Fossils: brachiopods and crinoid stems.

Igneous rock



$X_{7.2}$

Diorite

$X_{7.1}$

Rhyolitic Porphyry, Dacitic Porphyry, Andesitic Porphyry and Andesitic Tuffs.

post PERMIAN

Symbols

Rock boundary.

Overturned syncline, dashed where approximately located.

Fault, dashed where approximately located.

Thrust fault, dashed where approximately located.

River.

Road.

Railroad.

Figure 14 cont.

4.2.1 Rock Unit X1

This rock unit is the lowest of the stratigraphic succession and exposed in the northeastern part of the area. The physiographic feature is commonly observed to be gently to moderately rolling hills. The bedding planes mostly incline to the southern directions though the dipping into the other directions is not rare. From the field investigation, the outcrops are poorly exposed. However, the lithologic section was carefully measured. The X1 rock unit is subdivided further into two members, namely, X1.1 and X1.2 members (Figure 15).

4.2.1.1 X1.1 Member

The X1.1 member, the lowest member of the lithological sedimentary succession study area, is characterized by light to medium gray, yellowish brown and brownish gray shale and light to medium gray brownish gray and yellowish brown, and thin- to medium-bedded subarkose and sublith-arenite. They are interbedded with medium to dark gray and thin- to medium bedded pseudosparite, micrite and biosparite. The thickness of this member is approximately 236 meters. The unit was found to be distributed throughout to the northeastern part of the area. The body outline of this member is considered to be tabular with a varying thickness. As the outcrops are poorly exposed, the lithological characteristic of the member is accordingly limited. No attempt has been made to further subdivide this member into the smaller lithostratigraphic units.

4.2.1.2 X1.2 Member

The X1.2 member conformably overlies the X1.1 member with a gradational continuous contact. The lithology of this member is characterized by mostly medium gray, medium- to massive-bedded micrite, pseudosparite, biomicrite, biosparite and dolomitic biosparite, and yellowish to reddish brown, light to medium gray, greenish gray and gray shale and slaty shale, and yellowish and reddish brown, brownish gray and light to medium gray, thin- to medium bedded and fine- to medium grained subgraywacke and graywacke. Though the outcrops are so scatterred, the thickness was approximated to be 528 meters.

4.2.2 Rock Unit X2

This rock unit overlies the X1 unit, partly with a continucus gradational contact and partly a fault contact (F3-fault in Figure 14). The physiographic feature is composed mainly of moderate to high ridges with the valleys. The bedding planes, striking parallel to the ridge trend, and mostly dipping from southeast to southwest, some from northwest to northeast. The outcrops are generally sparse because of a very high degree of weathering. This rock unit is composed mainly of limestones and dolomitic biosparite. The ridges trend east-west in the western part and slightly change the course to southeast-northwest in the eastern part of the area. The varying thickness of the unit is approximately 700 - 745 meters. The limestones always contain the chert bands, chert nodules or lenses, with the igneous dikes and sills. The fossils, corals, crinoid stems and fusulinids, were only found in the chert.

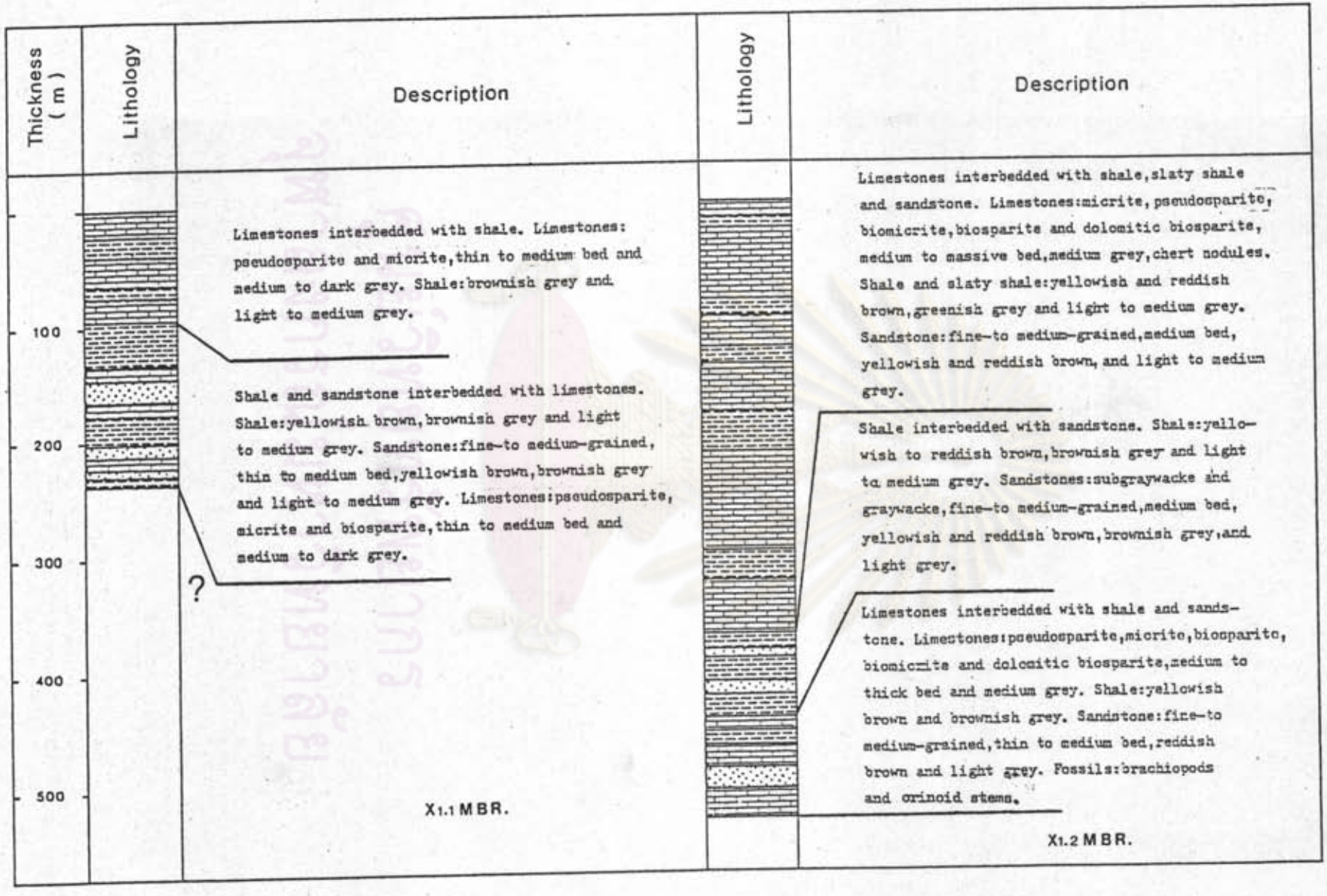


Figure 15 Stratigraphic columns of X1.1 and X1.2 members.

Figure 16 The subgraywacke of Xl.2 member at the grid reference 32682429, east of Ban Sap Pradu.

Figure 17 The slaty shale-sandstone interbeds of the Xl.2 member at grid reference 32072173, north of Khao Chan.

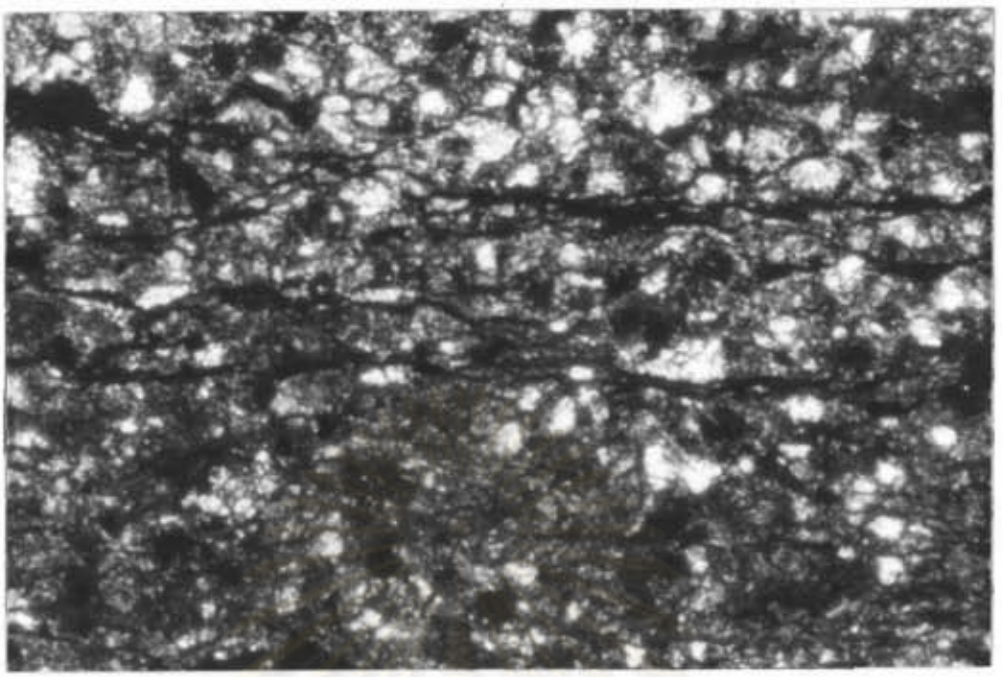


Figure 18 Photomicrograph of subgraywacke of X1.2 member at grid reference 34912547, west of Khao Sawang. (45x, crossed nicols)

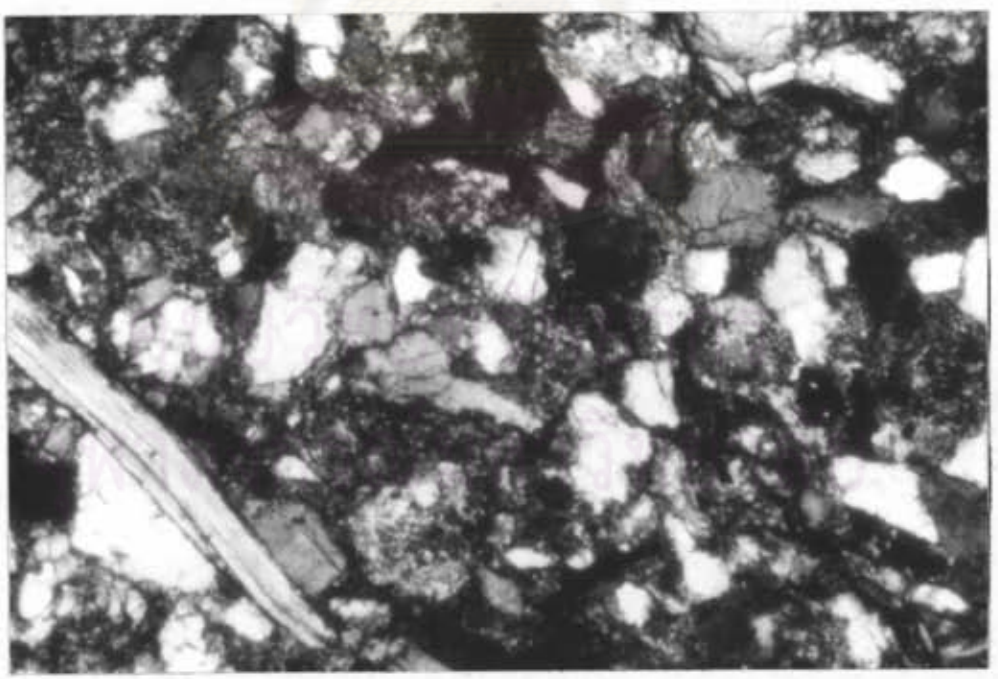


Figure 19 Photomicrograph of graywacke of X1.2 member at grid reference 32182407, east of Ban Sap Pradu. (45x, crossed nicols)

The dolomitic biosparite layer in this unit is used as a marker bed. The X2 unit is subdivided into X2.1 and X2.2 members on the basis of lithology and the separated locations of rock distribution as shown in Figure 20.

4.2.2.1 X2.1 Member

The X2.1 member overlies X1.2 member with a fault contact, the F3-fault (Figure 14). The orientation of the strata is rather uniformed, dipping southward. The lithology of this member is characterized by medium gray, thick- to massive bedded micrite, pseudosparite, biomicrite, biosparite, biopseudosparite, pelmicrite, intramicrite (?) and dolomitic biosparite, with chert bands and nodules, and yellowish green and greenish gray mudstone. The fossils of fusulinids, corals and crinoid stems are preserved in the chert. The outline of this member is considered to be a large lense-shaped body. The maximum thickness of the member is approximately 745 meters while the length is about 17 kilometers.

4.2.2.2 X2.2 Member

The X2.2 member conformably overlies the X1.2 member with a continuous gradational contact. The member mostly inclined to the south. The lithology of this member is characterized by medium gray, medium bedded micrite, pseudosparite, biomicrite, biosparite, dismicrite and pelmicrite, and yellowish and brownish green, yellowish gray and medium gray mudstone, and pale green, green and red tuff layers. The fossils of corals, fusulinids and crinoid stems were observed to be contained in the

chert. The outline of the member is considered to be tabular and the total thickness is 700 meters.

The tuff layers associating the limestone are especially useful. The layers are thinly laminated to medium bedded and are clearly recognized only in the X2.2 member. The outcrops containing the volcaniclastic layers could be observed near Khao On, Khao Mai Nuan, Khao Phu Phe, Khao Lom Phat, Khao Tham and Khao Nam Tok. The tuffs were thought to be originated by a sedimentary process. They were embedded and interbedded parallel to the limestone beds in a single zone, 5 to 30 meters thick. These tuffs are petrographically classified to be vitric, crystal and lithic tuffs, and mostly modified to be vitric crystal and crystal vitric tuffs. Moreover, they are used as an important marker bed in this rock region.

4.2.3 Rock Unit X3

The rock unit of X3 is recognized to be the most complex unit. It overlies the X1.2 member with both a fault (F3 - fault) contact and a continuous gradational contact, and underlies conformably the X2.2 member with a mixed gradational contact as observed in a location south of Khao Pha Daeng. The physiographic feature is generally mountatineous with Khao Pha Daeng, Khao Hin Dat and Khao Hin Pun. The bedding planes mostly inclined to the southwest directions. The lithology is characterized by light to medium gray, thick- to massive bedded micrite, preudosparite, biomicrite and biosparite, and dark gray to black shale. The general outline is determined to be lenticular. The thickness of approximately 752 meters is measured for the unit.

No attempt has been made to further subdivide this rock type into the smaller lithostratigraphic units. In the present study, the rock unit X3 is also called the X3 member to be conincided with the members of the other units (Figure 20).

4.2.4 Rock Unit X4

This rock unit mixes complicately with the rocks of X2 and X3 with a mixed gradational contact. The physiographic feature composed mainly of moderate to high ridges with valleys. The beds mostly dip to the south and southwest directions. The outcrops are generally poor. The rock type of X4 is subdivided into 3 equivalent members, the X4.1, X4.2 and X4.3 members based on the lithology and their separate locations (Figure 31). The varying thickness is from 94 to 491 meters. The outline of these members are both lense- and tabular shaped.

4.2.4.1 X4.1 Member

The X4.1 member is lense-shaped and lies within the X2.1 member with a mixed gradational contact. The outcrops are clearly exposed at the road cut on Highway 21 between Kilometers 11 and 12. The lithology is generally characterized by the yellowish gray and medium gray, medium bedded micrite, dismicrite, biomicrite and pseudosparite with some chert nodules, light to medium gray calcareous shale, yellowish and brownish gray, to light gray calcareous siltstone, yellowish and greenish gray, light to medium gray, thin bedded mudstone, and yellowish and brownish gray, mostly light gray and fine-grained quartz wacke and lithic wacke. The section is measured to be approximately 94 meters thick.

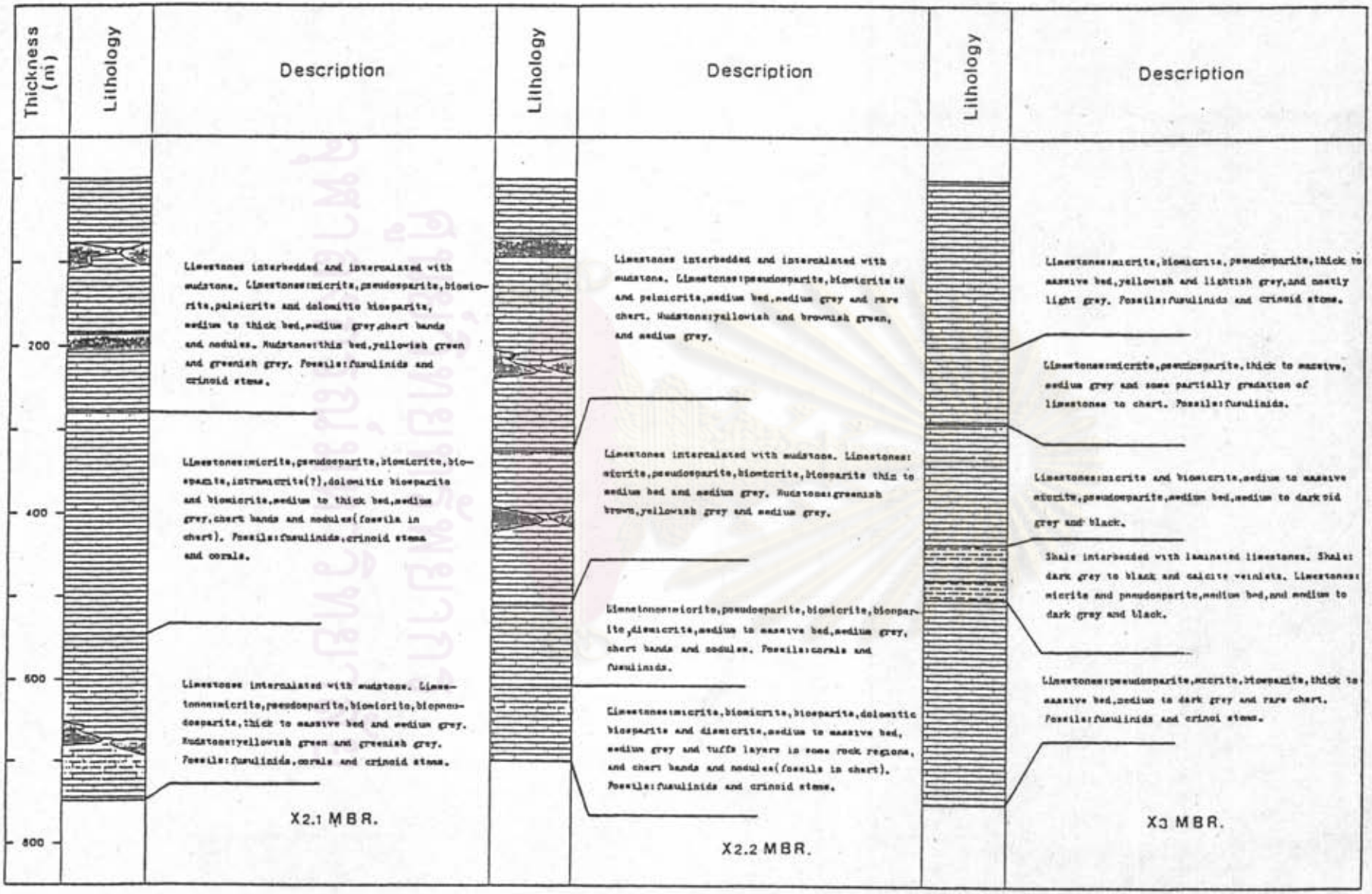


Figure 20 Stratigraphic columns of X2.1, X2.2 and X3 members.

Figure 21 Strings of chert nodules and lenses developed parallel to the beds of limestone of X2.2 member at grid reference 32483103, Khao Chan.

Figure 22 Chert nodules, lenses and bands developed parallel to the beds of limestone of X2.2 member, grid reference 29161409, Khao Tham.

Figure 23 Tuff layers interbedded with biomicrite of X2.2 member at grid reference 21561958, Khao On.

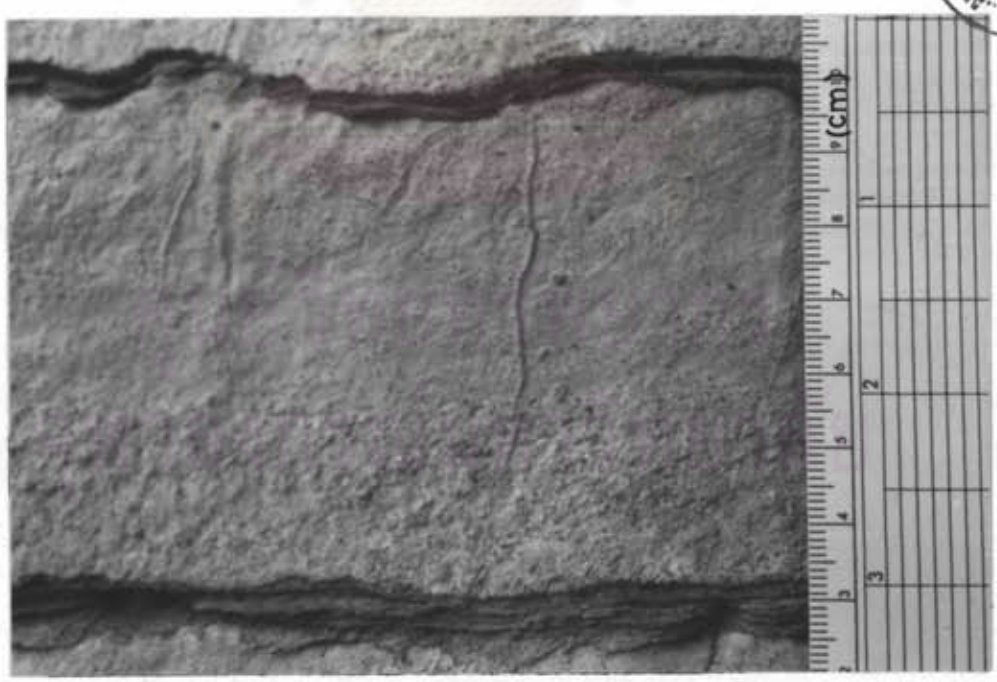


Figure 24 Tuff layers interbedded with biomicrite of X2.2 member at grid reference 28121669, Khao Phu Phe.

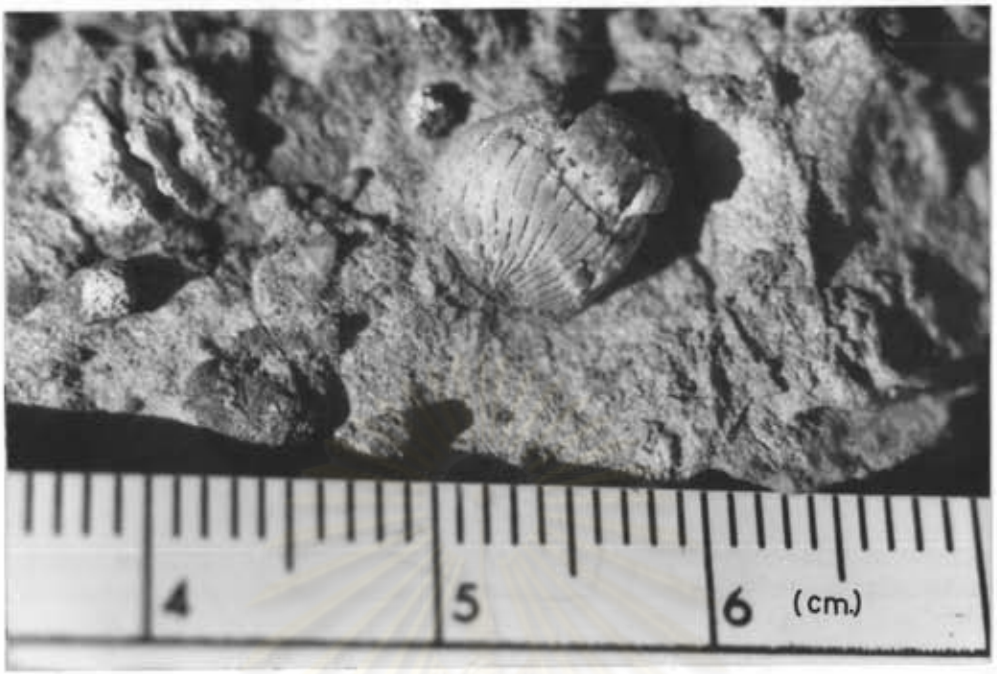


Figure 25 The fusulinid in X2.1 member at grid reference 20383039, Khao Nong Thom.

Figure 26 The crinoid stem (?) in X2.2 member at grid reference 32692084, Khao Chan.

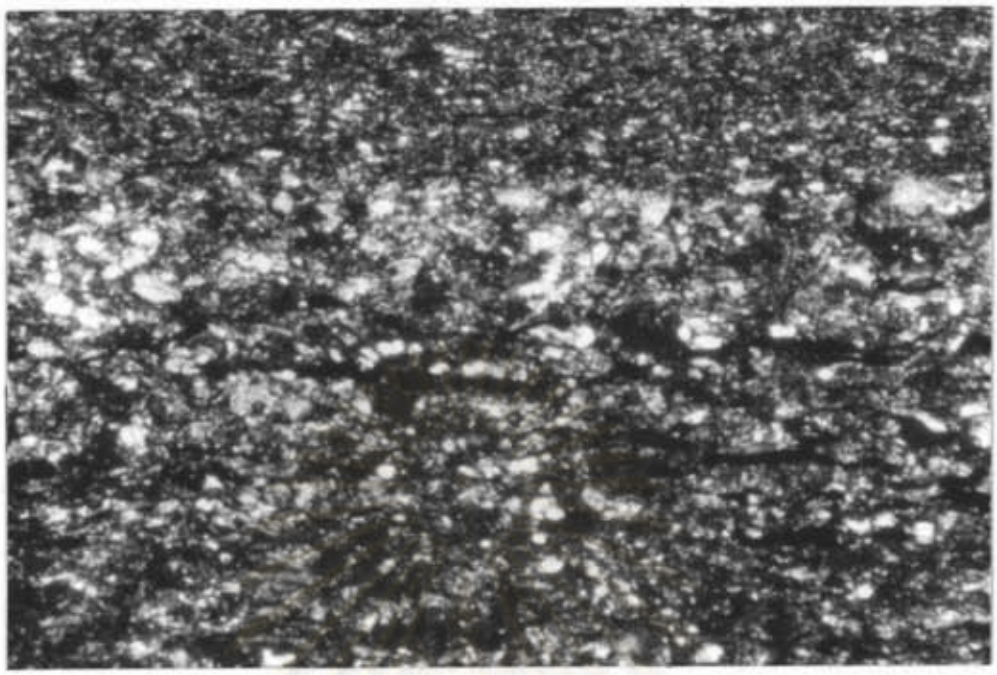


Figure 27 Photomicrograph of calcareous shale of X2.1 member at grid reference 05903270, beside Highway 21. (45x, crossed nicols)

Figure 28 Photomicrograph of the typical dolomitic biosparite of X2.1 and X2.2 members. (45x, crossed nicols)

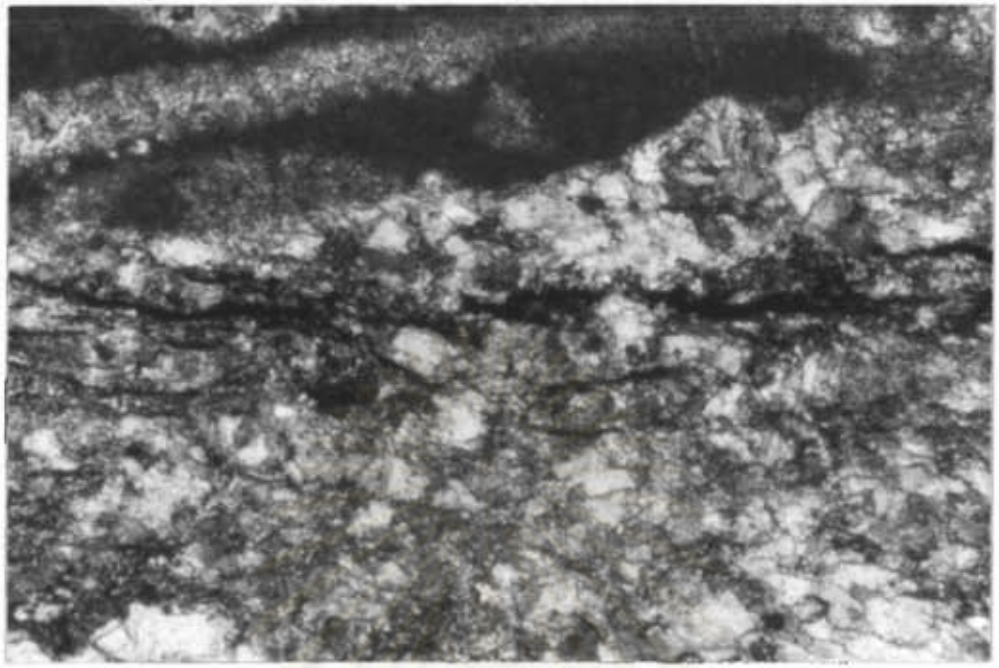


Figure 29 Photomicrograph showing the stylolytic seam in biomicrite of X2.2 member at grid reference 34422062, Khao Makok (45x, crossed nicols).

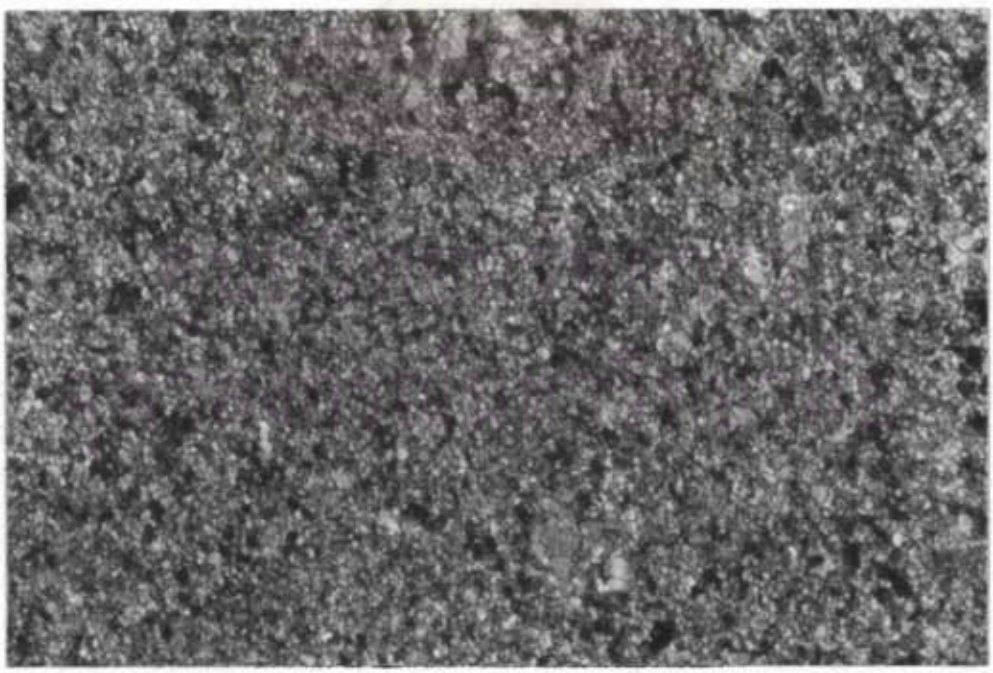


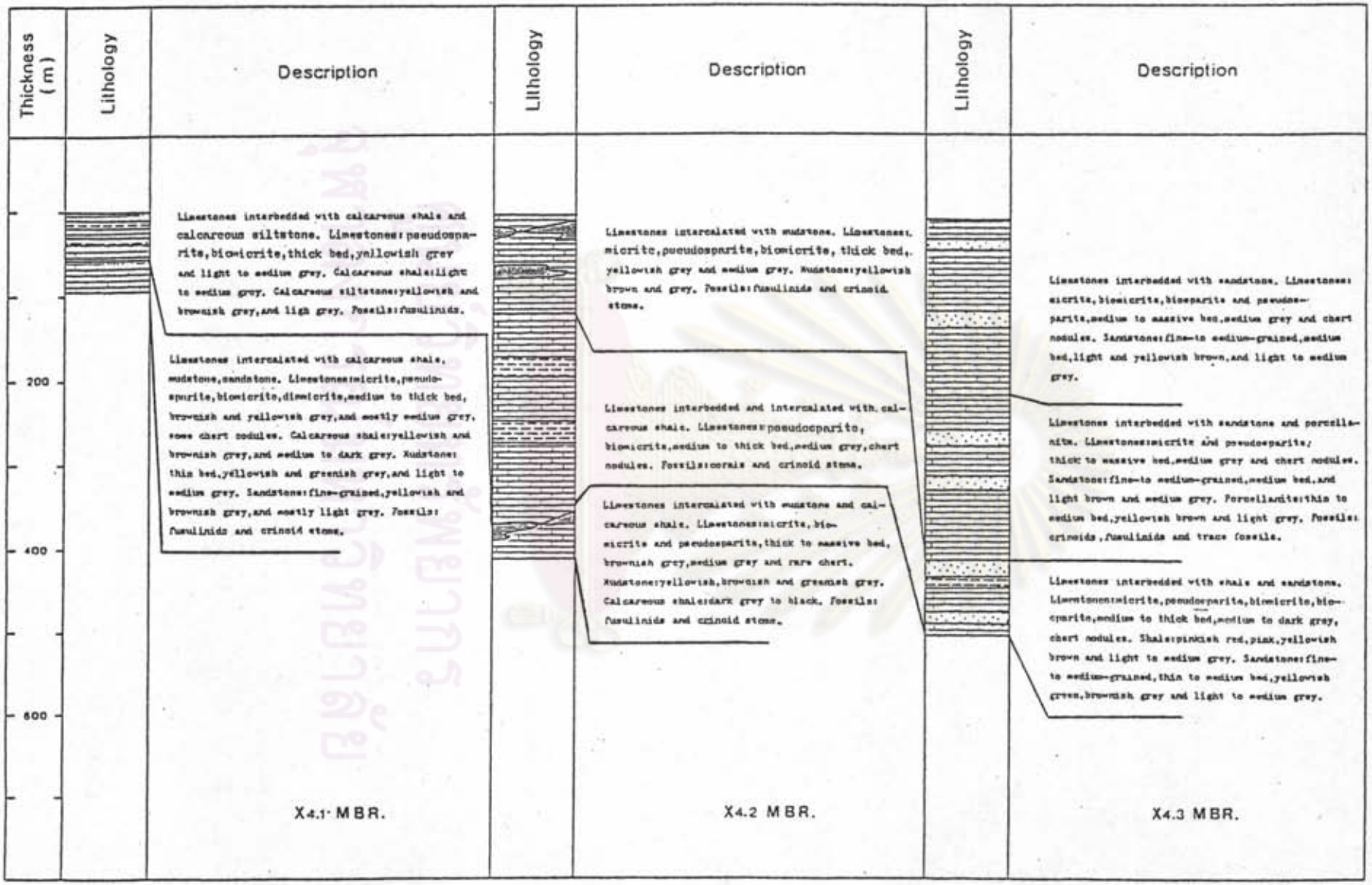
Figure 30 Photomicrograph of micrite of X3 member at grid reference 19662150, Khao Pun (45x, crossed nicols).

4.2.4.2 X4.2 Member

The X4.2 member is rather of elongated lense-shaped or tabular shaped. This member conformably overlies the X2.1 member with a mixed gradational contact, and underlies the X3 member with an abrupt contact. The lithology of this member is commonly characterized by yellowish and brownish gray, mostly medium- to thick bedded micrite, pseudosparite, and biomicrite with some chert nodules, yellowish brown to yellowish brownish and greenish gray mudstone, and dark gray to black calcareous shale. The fossils of fusulinids, crinoid stems and corals are also observed. The thickness of the member was measured to be approximately 411 meters.

4.2.4.3 X4.3 Member

The X4.3 member conformably overlies the X2.2 member with a mixed gradational contact. The topographic feature is generally moderate to high mountainouous areas which locate along the eastern side of the study area. The lithology is characterized by mostly medium gray, medium- to massive bedded micrite, biomicrite, biosparite and pseudosparite with some chert nodules, light and yellowish brown, light to medium gray, medium bed and fine- to medium grained of sublith-arenite and quartz wacke, pinkish to yellowish brown and light to medium gray shale, and yellowish brown and light gray, and thin- to medium bedded porcellanite. The fossils of crinoid stems and fusulinids were also



Fiugre 31 Stratigraphic columns of X4.1, X4.2 and X4.3 members.

observed. The lithological section is measured to be approximately 491 meters thick.

4.2.5 Rock Unit X5

The topography of the X5 unit is generally gently rolling hills and occupies the southern part of the area. The outline of the unit is largely of a tabular shape. The outcrops are poorly exposed, therefore the lithological characteristic of this member is also limited accordingly. This rock type is subdivided into the X5.1, X5.2 and X5.3 members (Figure 32). The X5.1 and X5.2 members are continuous, but with the different lithology. The X5.3 member is in a separate location from the other 2 members of the X5 unit. The bedding lanes are mostly inclined to the southeast and southwest directions. The lithological section is carefully measured to be approximately 387 - 1242 members.

4.2.5.1 X5.1 Member

The X5.1 member conformably overlies X2.1 member with a continuous gradational contact, generally overlies X4.1 member with a fault contact (F2 - fault) and a conformable yet abrupt contact and probably overlies X3 member with the F5 - fault contact. The terrain of X5.1 is mostly flat. The lithology is commonly characterized by light colored, yellowish, blackish and reddish brown, black thin bedded chert, medium gray, thin- to thick bedded micrite, pseudosparite and biomicrite, and yellowish brown

and light to medium gray shale. The thickness is approximately 387 meters.

4.2.5.2 X5.2 Member

The X5.2 member conformably overlies the X2.2 member with an abrupt contact, and X3 with F5 - fault contact. The outcrop is generally poorly exposed. The topography is flat and gently rolling. The lithology is characterized by medium gray, medium bedded, micrite, pseudosparite, biomicrite, and biosparite, yellow, green, red, pink and gray to black calcareous shales, brownish gray and light to dark gray shale and slaty shale which is similar to calcareous shale in color, yellowish brown and light to medium gray, thin- to medium bedded, fine- to medium-grained sandstones of quartz arenite and quartz wacke, and yellowish brown, light to medium gray, mostly thin bedded chert. The total thickness of the section is approximately 1,242 meters.

4.2.5.3 X5.3 Member

The X5.3 member conformably overlies the X4.3 member with a mixed gradational contact (Figure 33). The topographic feature is mostly the rolling hills. The outcrops are generally poor. The lithology is predominately characterized by reddish and yellowish brown, yellowish green brownish and greenish gray, and light colored shales, medium gray, medium bedded micrite, biosparite and biomicrite, and greenish, yellowish, reddish and

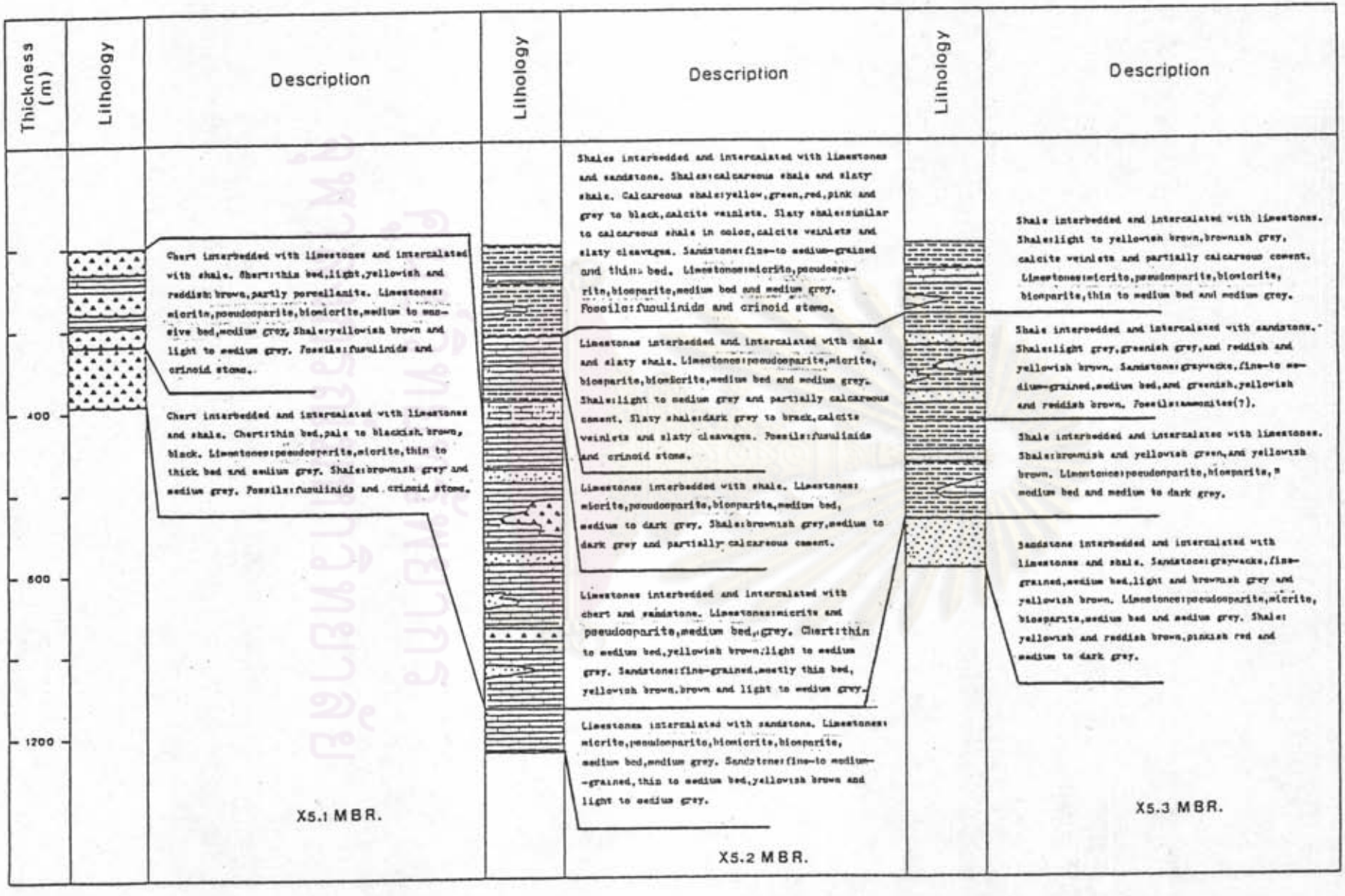


Figure 32 Stratigraphic columns of X5.1, X5.2 and X5.3 members.

Figure 33 The mixed gradational contact between X4.3 and X5.3 members at Siam City Cement Co. Ltd. quarry, grid reference 24711935.

Figure 34 The cross bedding indicating a normal sequence in biosparite at the mixed gradational contact between X4.3 and X5.3 members at the Siam City Cement Co. Ltd. quarry, grid reference 24711943.

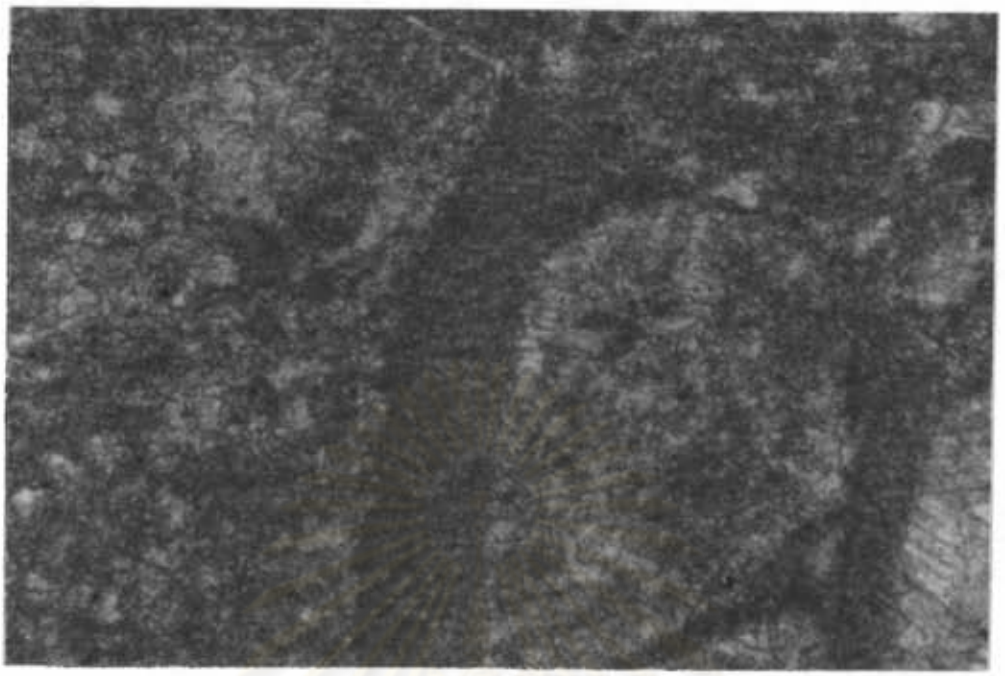


Figure 35 Photomicrograph of biomicrite of X5.1 member at grid reference 09861757, Khao Hin Pun. (45x, uncrossed nicols)

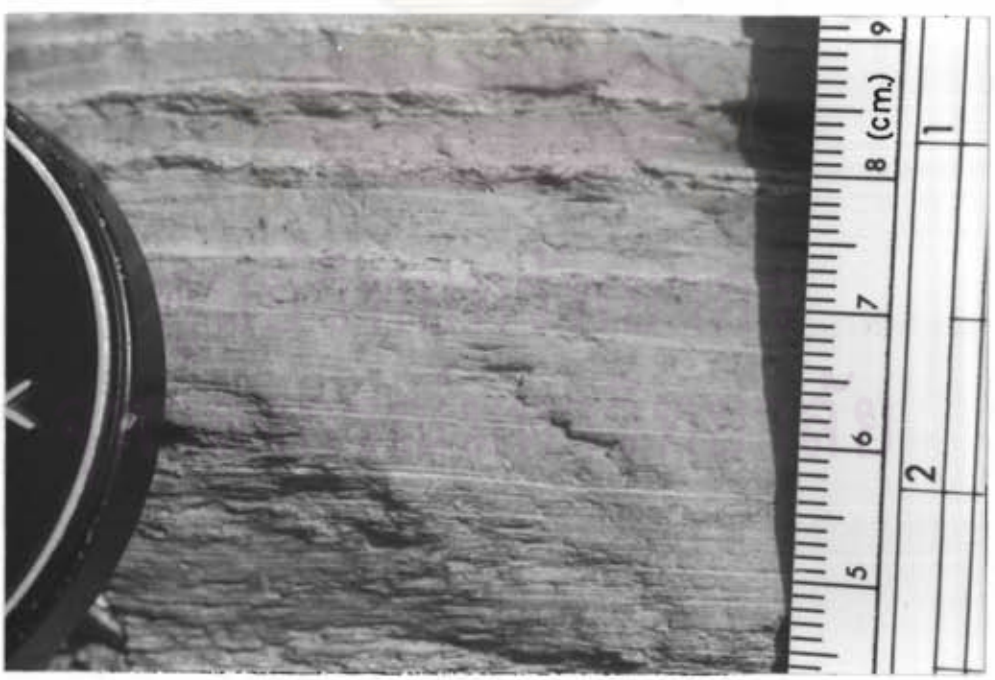


Figure 36 Thinly laminated to laminated argillaceous limestone of X5.2 member at grid reference 20101685, the shale pit of Siam Cement Co. Ltd.

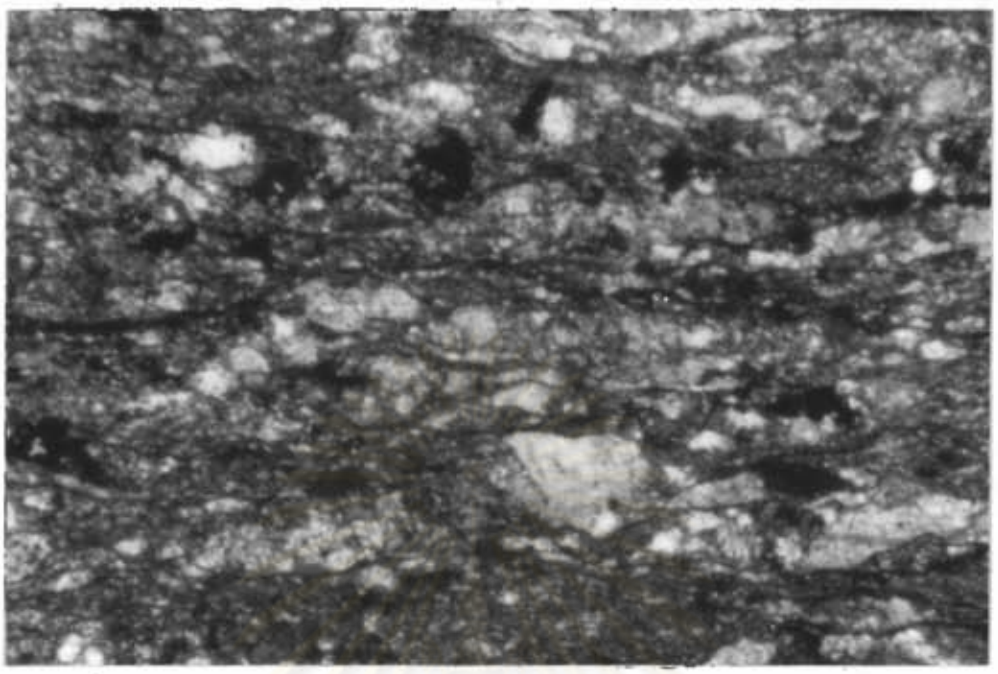


Figure 37 Photomicrograph of calcareous shale of X5.3 member at grid reference 23851779, Khao Mai Nuan (45x, crossed nicols).

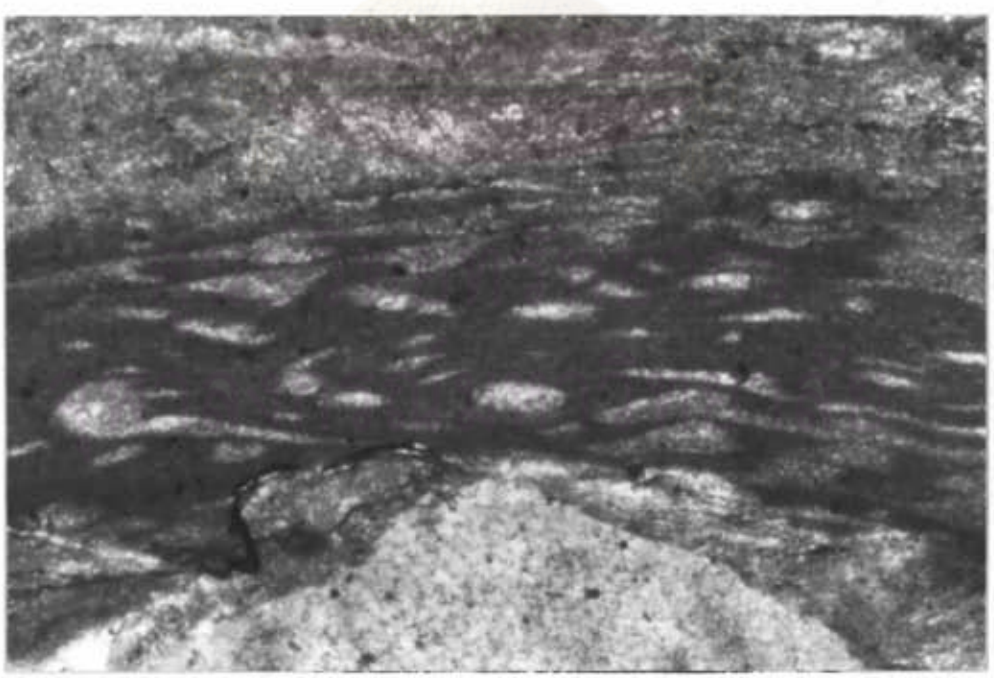


Figure 38 Photomicrograph of biomicrite with the deformed fusulinids of X5.3 member at grid reference 26781850 (45x, uncrossed nicols).

light brown, medium bedded and fine- to medium grained sandstone. The thicknesss is measured to be approximately 794 meters.

4.2.6 Rock Unit X6

The rock unit is the uppermost unit of the stratigraphic succession in the study area. The topographic feature is of the rolling hills. The outline of the unit is assumed to be lense-shaped. The unit locates to the west and east of the area and was subdivided into X6.1 and X6.2 members based on the lithology and the separate extent (Figure 39). The bedding planes mostly dip to the southeast and southwest. The exposures are commonly poor. However, the section was measured to have a varying thickness of 181 to 474 meters.

4.2.6.1 X6.1 Member

The X6.1 member lies within the X5.1 member with a continuous gradational contact. The lithology of this member is characterized by medium gray to black calcareous shale, brownish gray and dark gray to black silty shale, reddish brown to brownish gray thin bedded siltstone, and gray to black thin bedded chert. The section is measured to be approximately 181 meters thick.

4.2.6.2 X6.2 Member

The X6.2 member conformably overlies the X5.3 member with a mixed gradational contact. The lithology of rock unit is characterized by brownish gray, medium gray to black calcareous shale, yellowish and redish brown, and light to medium gray shale, pinkish red, reddish brown, light and brownish gray, thin

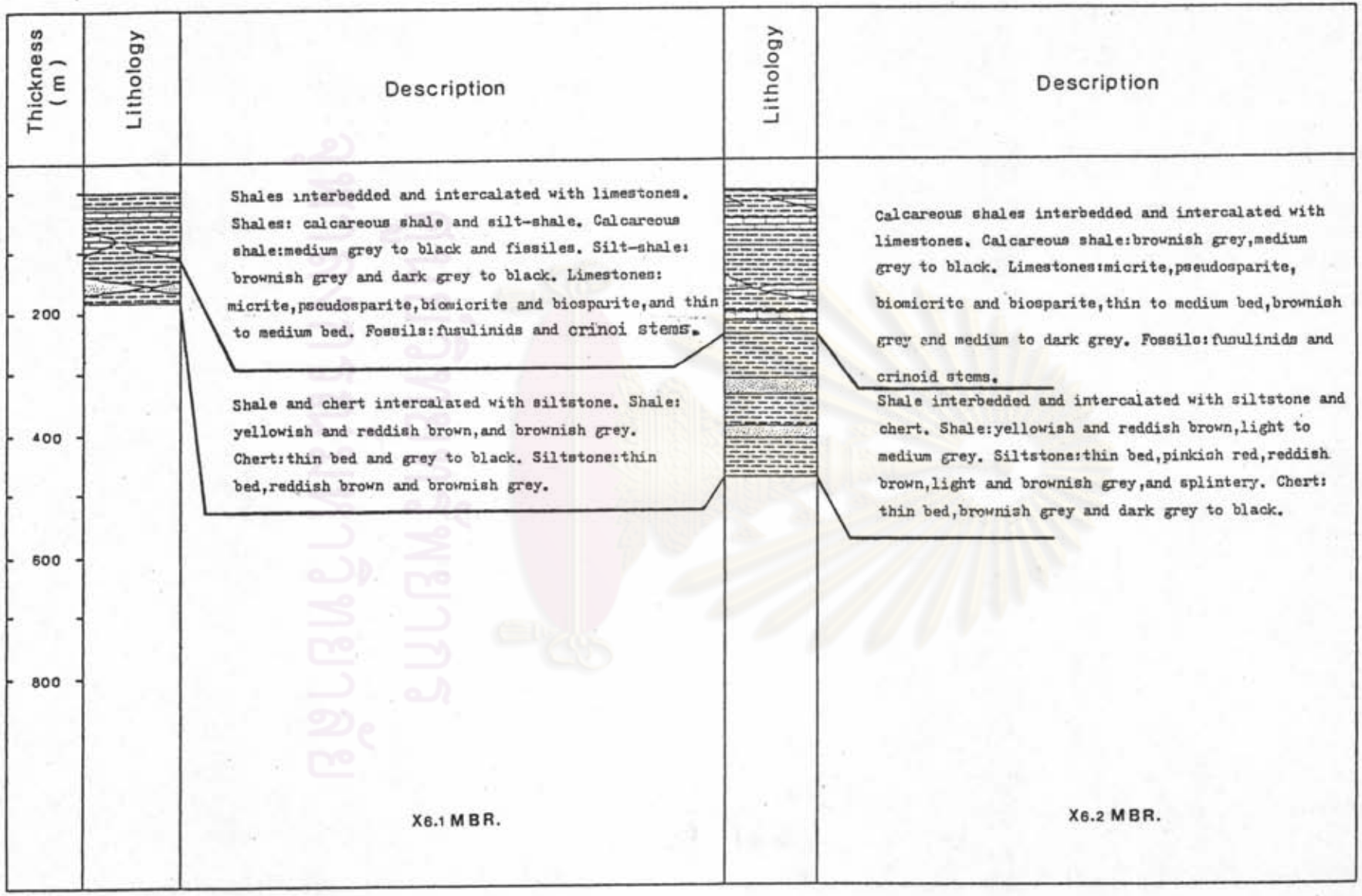


Figure 39 Stratigraphic columns of X6.1 and X6.2 members.

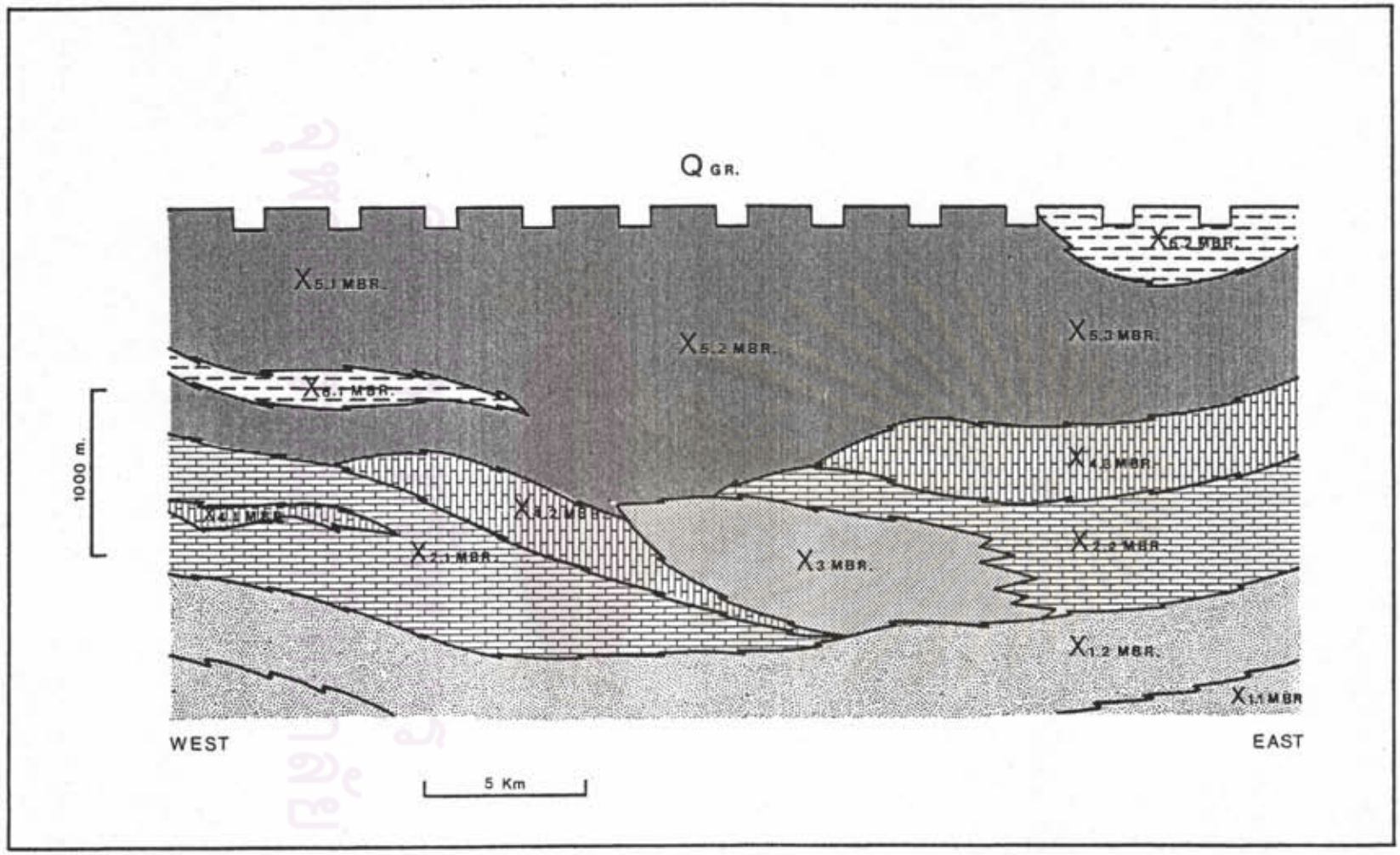


Figure 40 Generalized stratigraphic cross section of the study area.

bedded siltstone, and brownish gray, medium to dark gray, thin bedded micrite, pseudosparite, biomicrite and biosparite. The thickness was measured to be approximately 474 meters.

A generallized geologic cross-section was drawn (Figure 40) to illustrate the stratigraphic relationship of all 13 rock members. From the present observation the outlines of the rock units and their members are tabular- and lense-shaped, while the contacts between the units, wherever observed, are usually gradational. Since the section is relatively limit compared to the entire regional stratigraphic section, it does not conclusively support the land-side hypotheses of either Tittirananda (1976) - Wielchowsky and Young (1985) or Bunopas and Vella (1983). The succession of the rock units from the northeast (the oldest) to the southwest (the youngest) may neither do this since the arrangement of the succession is,in the most part (?), controlled by the tectonic displacement occurred in the folding/faulting event(s, ?) which followed the genesis of the sedimentary rocks (See further).

4.3 Igneous Rocks

The igneous rocks in the study area and its vicinities fall into two categories, the plutonic and volcanic rocks. The volcaniclastic layers generally found conformably associating the volcanic rocks, are grouped in the "volcanic" rocks also. The volcanic rocks belong to Khao Yai Volcanics and compose mainly of rhyolite, andesite, rhyolitic and andesitic prophyries, tuff, volcanic breccia and agglomerate. The plutonic rock is the diorite of Phra Ngam Diorite. Both igneous rock groups are probably of the Permo-Triasic

age. The plutonic bodies intruded while the volcanic rocks unconformably overlied the Permian sediments (Hinthong, 1981). In Figure 14 the volcanic unit is designated X7.1, and the intrusive, X7.2. Twenty-seven thin-sections of the volcanic rocks and fourteen thin-sections of the intrusive rocks are petrographically classified on the basis of the texture and mineral constituents in according to the IUGS classification. Four types of the X7.1 volcanic rocks are recognized. These are the rhyolitic porphyry, dacitic porphyry, andesitic porphyry and andesitic tuff. These rocks expose in the southern part of the study area and near Khao Sung. The X7.2 intrusive rock, the diorite, occurred as the plugs (perhaps the tops of a single buried batholith ?) at Khao Man, and at an area 2 Kilometers west of Khao Phra Phutthabat Noi. These phugs intruded the Permian carbonate/clastic unit with the thermal-metamorphic phenomena. The petrographic study on both rock groups are as followed.

4.3.1 Volcanic Rocks

Megascopically, these rocks are slightly porphyritic to porphyritic with the fine-grained groundmass. The rocks are reddish brown, pale green, greenish brown and pale to dark green in fresh color, and grayish brown, light gray, dark gray and dark brown in color on the weathered surface.

Microscopically, the rocks commonly exhibit a hypocrystalline and holocrystalline, and porphyritic texture. They are composed predominantly of plagioclase, orthopyroxene and quartz with subordinate K-feldspars (sanidine, orthoclase and microcline),

epidote, chlorite, sericite and calcite, and opaque minerals. The modal percentage of the phenocrysts of plagioclase, K-feldspars, quartz and orthopyroxene are 5 - 40, 15 - 20, 10 - 25 and 5 - 15 respectively. The size of plagioclase phenocrysts commonly ranges from 0.5 to 1.5 mm, and about 0.5 - 0.8 mm. for the orthopyroxene phenocrysts. Texturally, the plagioclase commonly occurs as the anhedral, subhedral and euhedral crystals. Some of the plagioclase grains show a zonation and are partially sericitized. The orthopyroxene is hyperstene and forms the subhedral prismatic grains. The quartz is commonly found as the anhedral grains or as interstitially infilling crystal aggregates, and frequently shows moderately undulatory extinction. Some of the quartz crystals have been resorbed to be embayed quartz. The K-feldspars are occurred as the subhedral to anhedral grains of sanidine, orthoclase and microcline. The most common secondary minerals are chlorite and sericite. The chlorite was noted to be an alteration products of the pyroxene. The fine grained chlorite has a pale green to green pleochroism. The sericite and calcite are associated with plagioclases as their alteration products. The amount of opaque mineral is about 3 - 5%. It occurs as the subhedral and or subhedral grains having an average size of 0.2 mm.

The groundmass of this rock is mostly a mixture of microlite, devitrified glass, glass and plagioclase laths. In places, it displays a well-marked flow structure and spherulitic texture.

The tuff layers found in X2.2 member are not included here under this topic.

4.3.2 Intrusive Rock

Megascopically, this rock has a medium- and coarse-grained porphyritic texture. It is dark green in fresh color and blackish brown, reddish brown on the weathered surface.

Microscopically, it is generally hypautomorphic holocrystalline and medium- to coarse-grained. It is composed essentially of plagioclase (45 - 60%) with An content 35 - 40, hornblende (35 - 55%), diopside (1 - 5%) and augite (1 - 5%). The accessary minerals consist of orthoclase, biotite, muscovite, sphene, epidote and opaque minerals. Some plagioclase is also observed to be spherulitic, zoning and poikilitic. Quartz and pyroxene inclusions in hornblende are commonly recognized. In addition, the pyroxene is partly altered to become chlorite. The opaque minerals are presumably magnetite and other minerals.

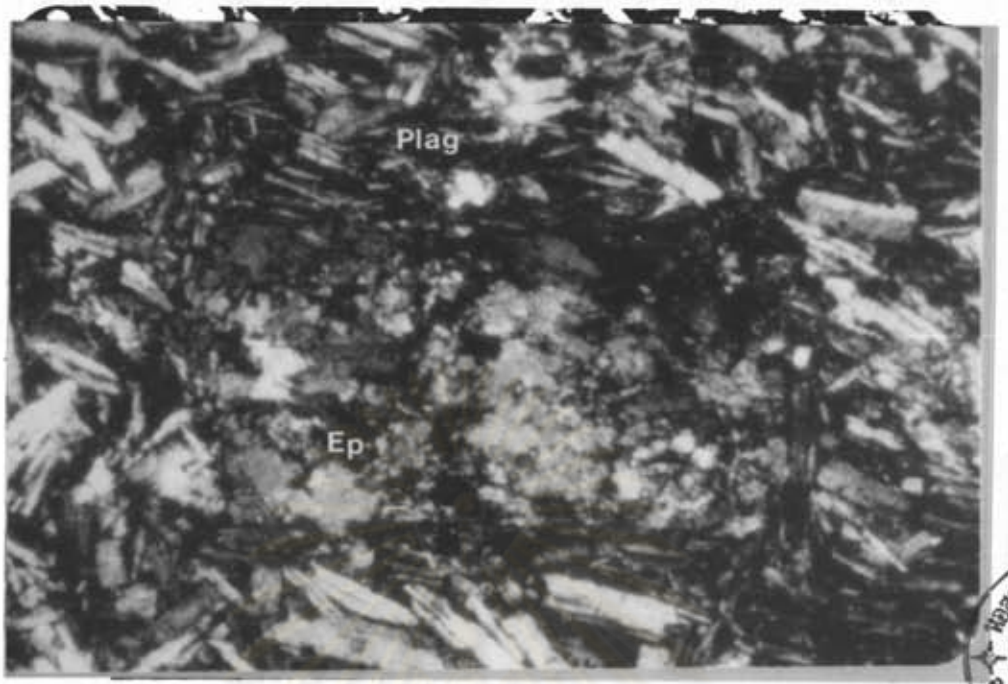


Figure 41 Photomicrograph showing replacing epidote (Ep) in plagioclase (Plag) in andesitic porphyry of X7.1 member at Khao Pong, grid reference 21881297. (45x, crossed nicols)

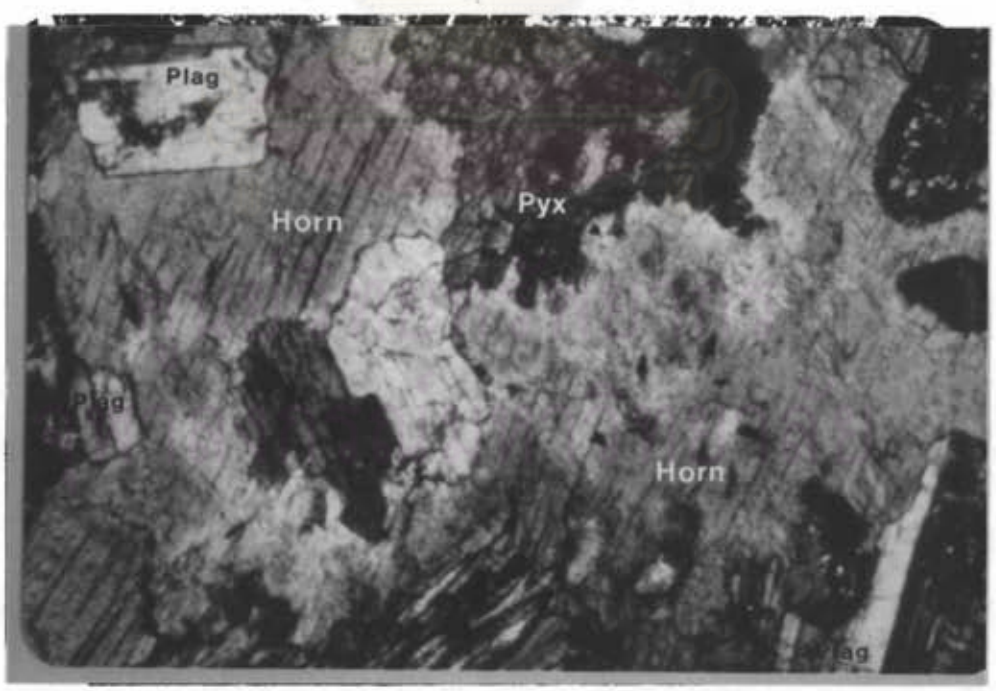


Figure 42 Photomicrograph showing pyroxene (Pyx) inclusions in hornblende (Horn) and plagioclase (Plag) laths of Diorite of X7.2 member at Khao Man, grid reference 24721423. (45x, crossed nicols)