

## CHAPTER III

### LITHOSTRATIGRAPHY OF THE MAE HONG SON AREA

The strata in any sedimentary sequence can be subdivided on the basis of lithology, geometry, paleocurrent, sedimentary structure, and fossil, or their time relationships. Accordingly, five kinds of unit have been established. They are lithostratigraphic unit, biostratigraphic units, chronostratigraphic units, unconformity-bounded units, and magnetostratigraphic units. In this study, the sedimentary sequences have been classified mainly on the basis of lithostratigraphy. A lithostratigraphic unit is a body of rocks that is defined and recognized on the basis of its observable and distinctive lithologic properties or combination of lithologic properties and its stratigraphic relations.

#### 3.1 Stratigraphic classification and nomenclature

In this study, an attempt has been made to classify sedimentary sequence in the southern part of the Amphoe Muang Mae Hong Son area into different lithostratigraphic units in order to fulfill the sedimentological purpose of the study. Boundaries separating lithostratigraphic units may be placed at transition, abrupt and erosional contacts, which in return reflect the changes of conditions in depositional environment.

The ultimate objective of subdividing the strata is to identify all of them and then to assemble a framework of non-overlapping units for designating hierarchies of lithostratigraphic units employed in the present study to cover the unit. However, with regard to the nomenclature of lithostratigraphic units, informal names have been applied for the purpose of tentative reference.

Bunopas (1976) proposed the term "Mae Sariang Group" to be composed chiefly of basal red conglomerate, followed by gray shale, and interbedded gray siltstone and fine-grained sandstone, and sandy shale, gray and red sandstone and frequent beds of limestone. As stated in Chapter I, a few workers mapped and studied rocks of the Mae

Hong Son area in different ways. They also proposed rocks in the same areas with different ages and boundaries. Therefore in this study, compiled all the previous published information onto our interpreted Landsat map as shown in regional geological map (Figure 2.15 in Chapter II). The more detailed geological map were then enlarged in order to relate with the measure.

In order to establish lithostratigraphy of the Mae Sariang Group, totally 7 sections were measured in detail. The lithostratigraphic units are described and defined as suggested in the International Stratigraphic Guide (Hedberg, 1994) and detailed measured rock sections, distributed throughout this study area, are graphically represented using the keys from Selly (1996) (Figure 3.1), and attitudes of beds, fractures and faults are expressed in terms of strike direction/dip angle.

### **3.2 Measured section**

This study embraces two parts, namely, field investigation and laboratory work. Detailed mapping was performed based upon topographic maps at a scale of 1:50,000 (Ban Huai Pong, 4547 II; Amphoe Khun Yuam, 4546 I; Ban Mae La Luang; 4546 II; Amphoe Mae La Noi; 4545 I; and Amphoe Mae Sariang, 4545 II) of the Royal Thai Survey Department (RTSD). In addition, geological maps reported by Charoenprawat et al. (1985), Boriphatkhosol et al. (1990), Jindasuth et al. (1990), and Department of Mineral Resources (1999) were used as guidelines for detailed structural and stratigraphic data. Stratigraphic investigations were conducted mainly along main roads, and streams. GPS data were recorded for precise stratigraphic locations. During the 3 field-season investigation, about 110 rock samples have been collected from 7 measured sections within the southern part of the Amphoe Muang Mae Hong Son area (Figure 3.2). Detailed locations of these sections are shown bellows.

- Section A is at Ban Huai Pong (grid reference 885065 to 910042, map Sheet 4547 II)
- Section B at Ban Sape (grid reference 811933 to 857895, map sheet 4546 I)
- Section C at Ban Pra Tu Muang (grid reference 798801 to 830803,

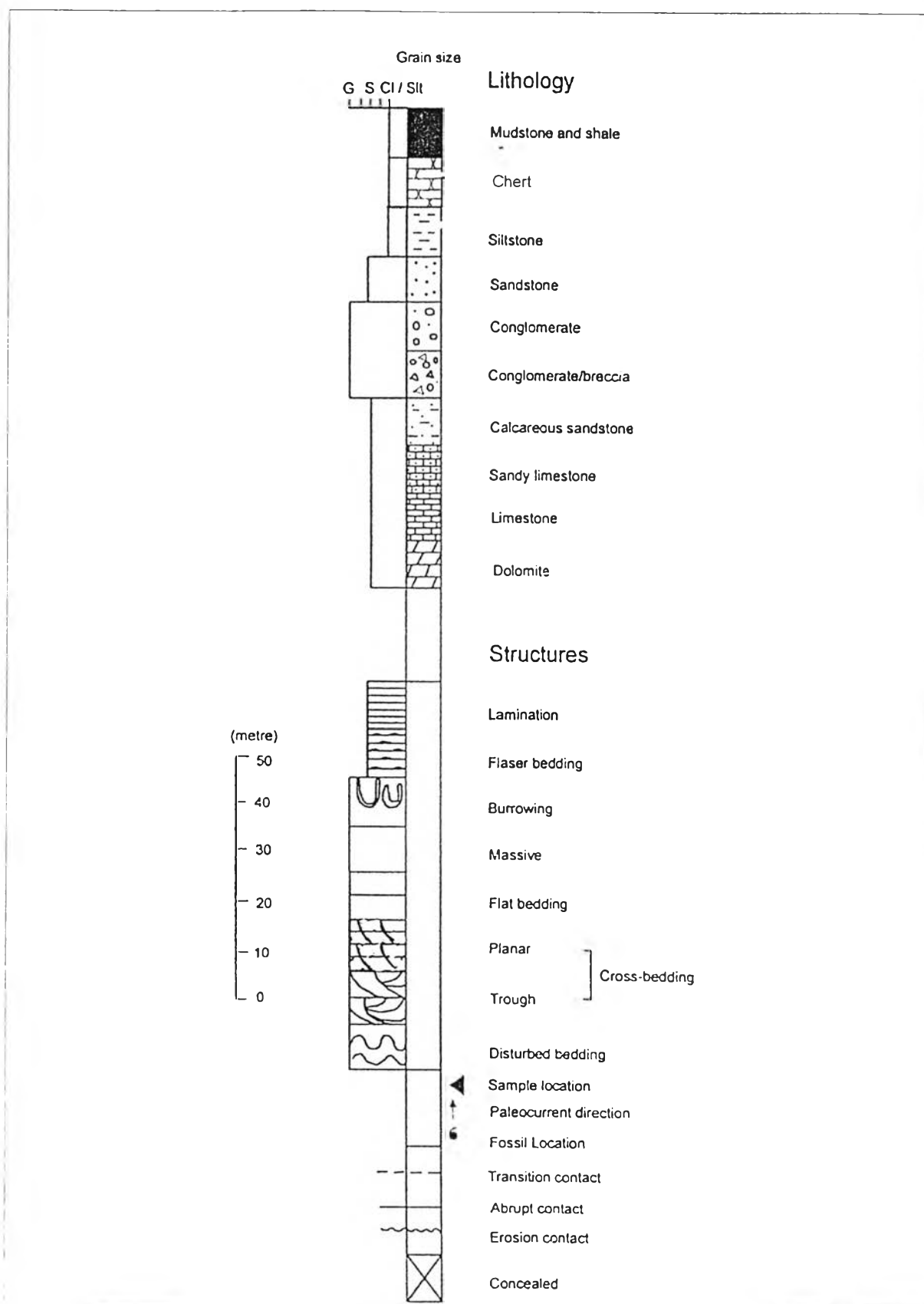


Figure 3.1 Detailed measured sections, illustrated throughout the thesis, are drawn using the above keys (modified from Selly, 1996).

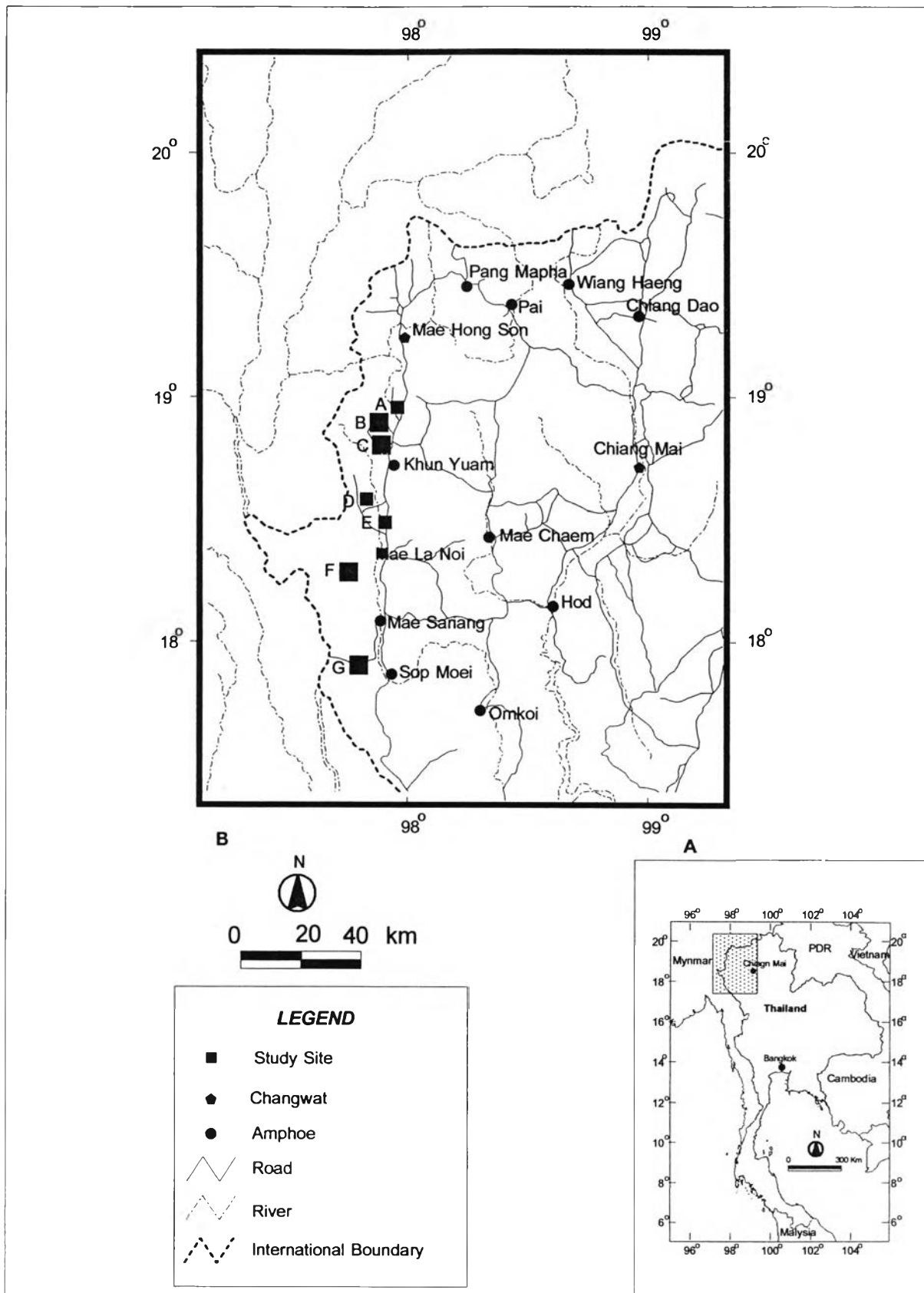


Figure 3.2 Map showing the study area (black box in A) and locations (B) illustrating the network of the national and provincial highway.

map sheet 4546 I)

- Section D at Ban Huai Na (grid reference 835481, map sheet 4546 II)
- Section E at Huai Hin Lak Fai (grid reference 886379, map sheet 4545 I)
- Section F at Ban Mae Leab (grid reference 812322 to 834303, map sheet 4545 I)
- Section G at Huai Pho (grid reference 799926 to 826938, map sheet 4545 II)

Topography of the study area is generally high mountainous and high terrace, the maximum elevation is at Doi Khun Mae Ki (1,203 meters MSL). The southern part of the Amphoe Muang Mae Hong Son area is between latitudes 18° 00' 16" N to 19° 09' 41" N, and longitudes 97° 48' 33" E to 97° 58' 48" E.

### **3.2.1 Section A** (Figures 3.3a-3.3c)

Section A is located at Ban Huai Pong about 60 kilometers south of Amphoe Muang Mae Hong Son, Changwat Mae Hong Son. As shown in Figure 3.3a, the area surrounding the section A consists of lithologies ranging in age from Carboniferous to Quaternary. Carboniferous rocks include mainly conglomerate, sandstone, and shale. Triassic and Jurassic rocks are largely variegated colors of sandstone interbedded siltstones and limestones. Young Quaternary deposits include unconsolidated gravel, sand, and silt/clay of alluviums and colluviums. Based upon detailed stratigraphic mapping (Figure 3.3b), the Triassic strata lie unconformably over the Carboniferous strata with the fault contact. The Triassic sequence from older to younger include siliceous shale intercalated with mudstone, sandstone, and shale. These Triassic rocks average strike of 170 and dip (Figure 3.4) to 40. The 2 samples collected from calcareous mudstone contain abundant *Halobia* sp. (Figure 3.5) The total thickness is approximately 110 metres and 5 rock samples. Figure 3.3b shows a cross section at Ban Huai Pong where the Triassic clastics strata dip mostly to the west.

Figure 3.3c and Table 3.1 display a detailed columnar section based on the geologic cross section (Figure 3.3b) indicating that black chert bed (about 80 m-thick) is the oldest and underlies yellow very fine-grained sandstone (about 5 m-thick). Then at the upper part

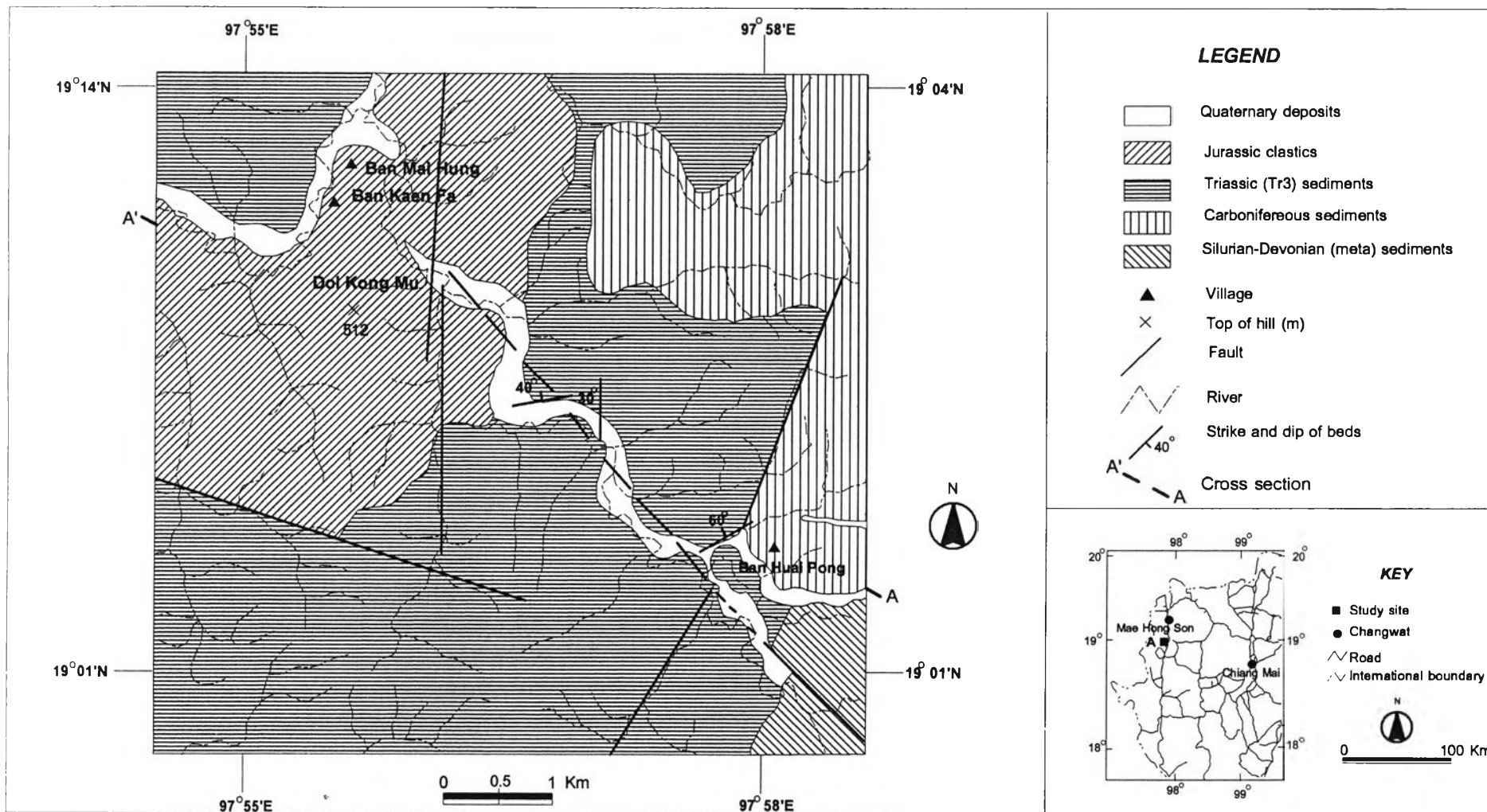
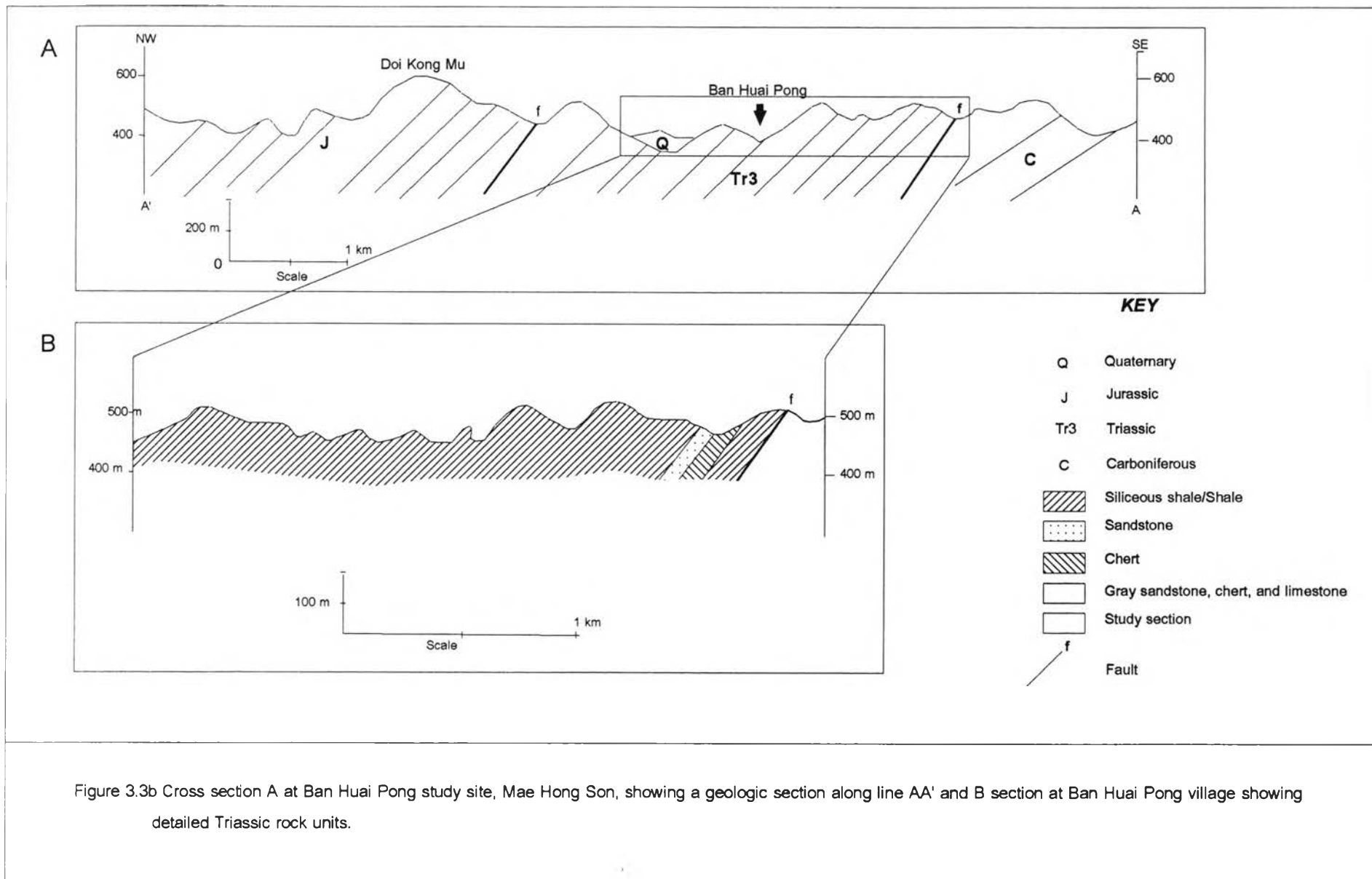


Figure 3.3a Geological map of Ban Huai Pong site (modified after Charoenprawat et al., 1985).



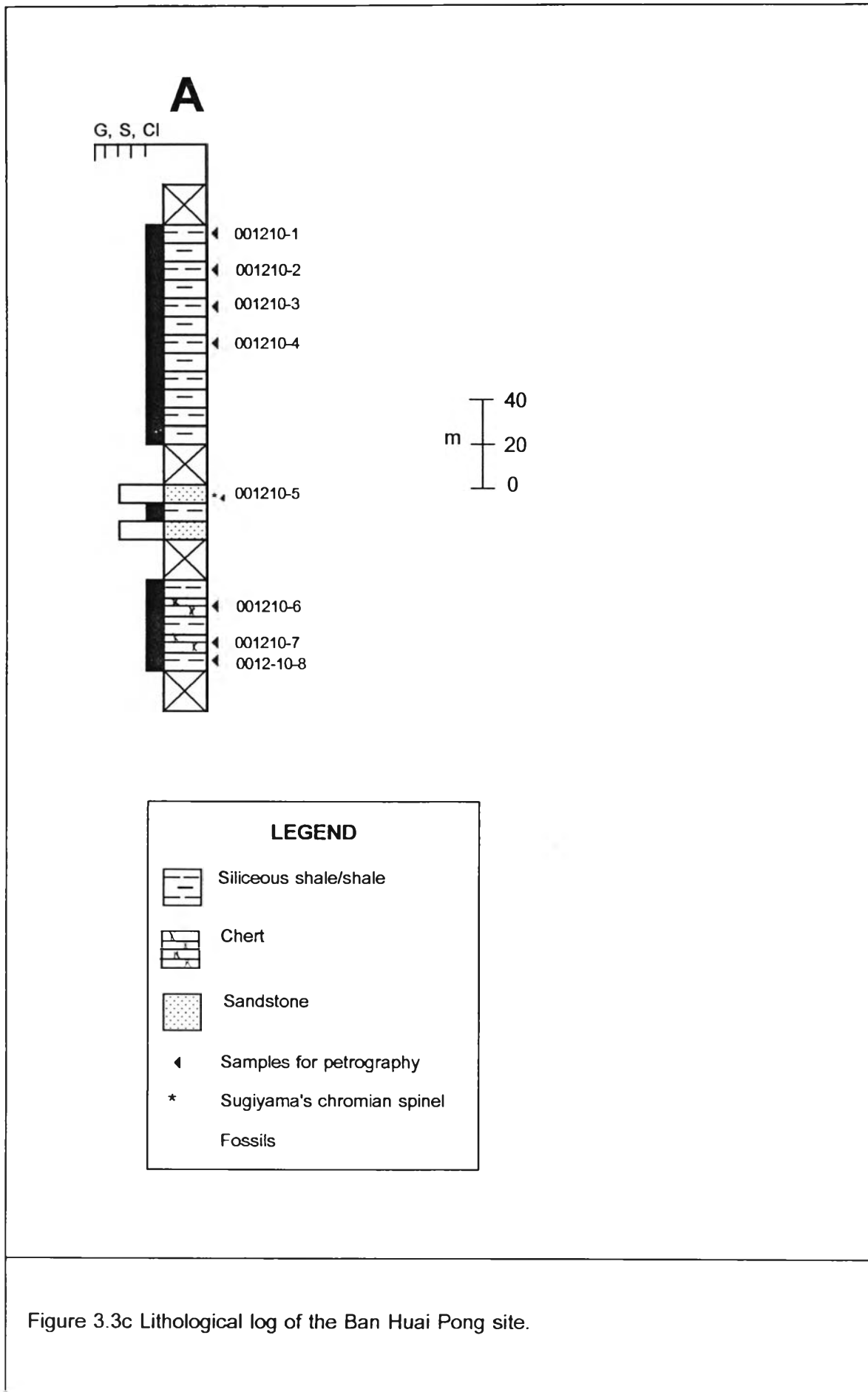


Figure 3.3c Lithological log of the Ban Huai Pong site.





Figure 3.4 The location of measured section, Section A at Ban Huai Pong, Amphoe Muang Mae Hong Son (grid reference 885065 to 910042, map sheet 4547 II).

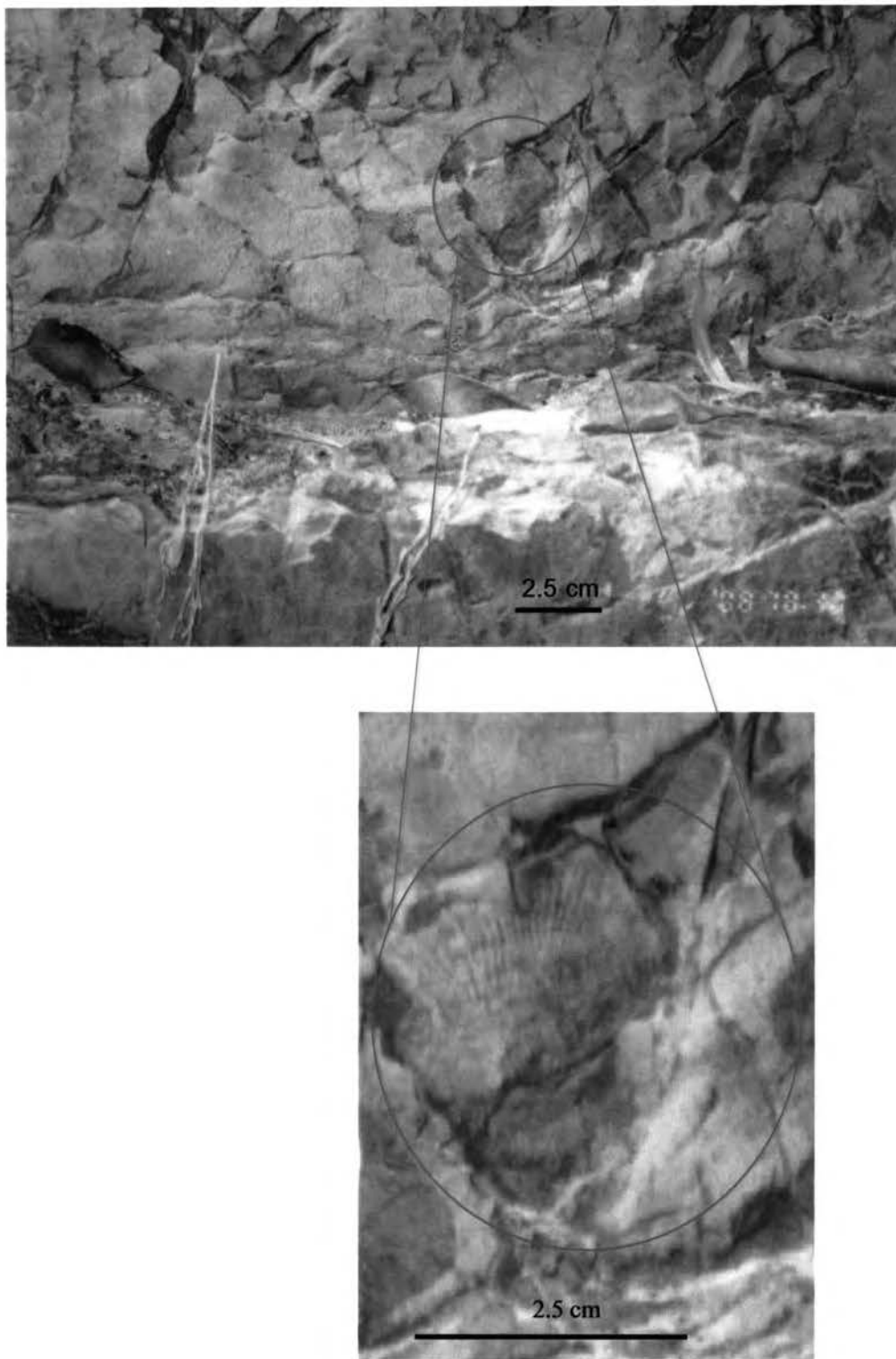


Figure 3.5 Calcareous mudstone with abundant fossils of *Halobia* sp.(red circle).

**Table 3.1** Detailed measured section A (Ban Huai Pong Site), grid references 885065 to 910042 (4547 II)

Section of sedimentary rocks of the Mae Sariang Group, Mae Hong Song.

Thickness (m)

(118 meters ) (from top to bottom)

Thickness (m)	Unit No.	Description
>80	4	Siliceous shale, black, thin-bedded, bedding 330/40, sample no. 001210-4, interbedded with mudstone, dark gray, thin bedded
5	3	Sandstone, yellow, medium-grained, medium-bedded, quartz, feldspar, muscovite, and detrital chromian spinels composition, bedding 15/80, sample no. 001210-5, and 001210-6
18	2	Chert, black, medium-bedded, bedding 210/65, sample no. 001210-7, interbedded with mudstone, dark gray, thin bedded
>5	1	Mudstone, brown, bedding 200/35, <i>Halobia</i> sp., sample 001210-8

the section is denoted by 20 m-thick black siliceous shale at the bottom part and 5 m-thick, brown mudstone at the top.

### **3.2.2 Section B** (Figures 3.6a-3.6c, and 3.7)

Section B is (about 5 km long) 50 km south of section A, around Ban Sape site. Figure 3.6a is a geological map covering the section B occupied by rocks of Triassic to Quaternary. The Triassic rocks which occupied much of the investigated area, consist largely of shale, siltstone, sandstone and conglomerate. The youngest sequence is Quaternary unconsolidated deposits occurring mostly along streams and of foothill to the southeastern corner of the mapped area. In general, the Triassic sequence strikes averagely  $330^{\circ}$  and dips with the angle of  $40^{\circ}$  to the southeast. Few normal faults are observed almost in the middle part of the surveyed area (Figure 3.6b). The Triassic sequence includes mainly white, fine- to coarse-grained sandstone with interbedded brown, thinly bedded shale (see Table 3.2). Matrix-supported conglomerates are observed in the lower part of the sequence with an anticlinal structure (Figures 3.6b and 3.6c). Size clasts of clasts in conglomerate vary from granule to cobble (or 2 to 5 cm), and most of the clasts are subrounded quartz, chert, and sandstone. A total of 17 samples were collected for mesoscopic analysis.

### **3.2.3 Section C** (Figures 3.8a-3.8c, and 3.9)

Section C (with 5-km in length) is situated at Ban Pratumuang, Amphoe Khun Yuam, Mae Hong Son. This measured section with good exposures is along the Office of the Accelerated Rural Development road from Ban to Phae to Ban Pra Trumuang of Amphoe Khun Yuam, Mae Hong Son. Figure 3.8a displays the 1:50,000 geologic map covering the section C which are mainly composed of sedimentary rocks of Triassic to Quaternary. Chert and clastics sediment are of Triassic unit. Red conglomerates belong to Jurassic sequence and are overlain unconformably by unconsolidated fluvial-dominant Quaternary deposits. Detailed stratigraphic measuring section (Figures 3.8b and 3.8c, Table 3.3) at Ban Pra Trumuang indicates that Triassic sequence commences with black bedded

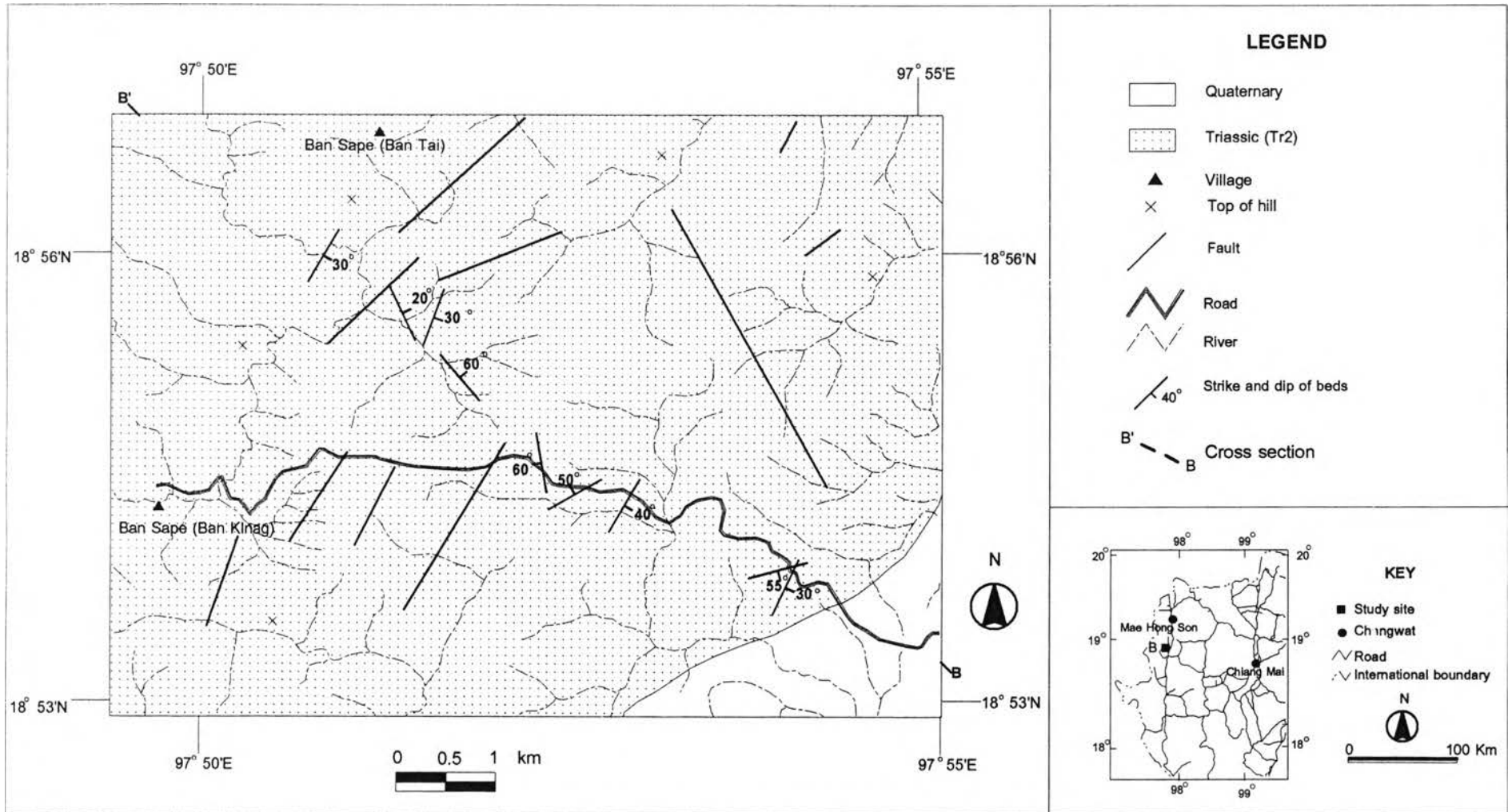
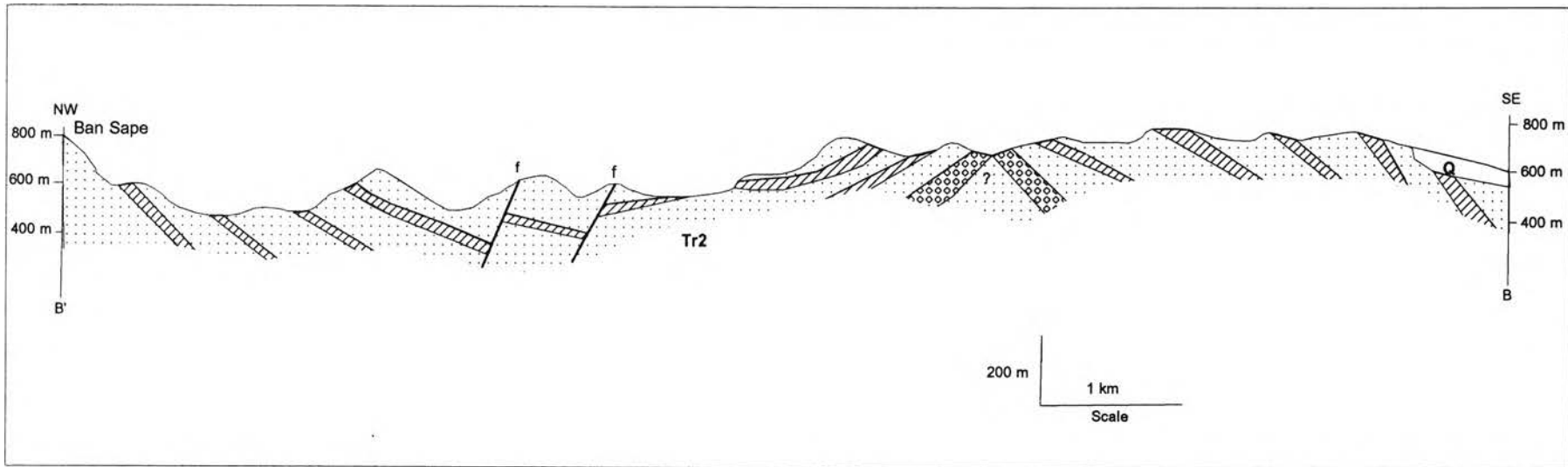


Figure 3.6a Geological map of Ban Sape site (modified after Boriphatkhosol et al., 1990).



**KEY**





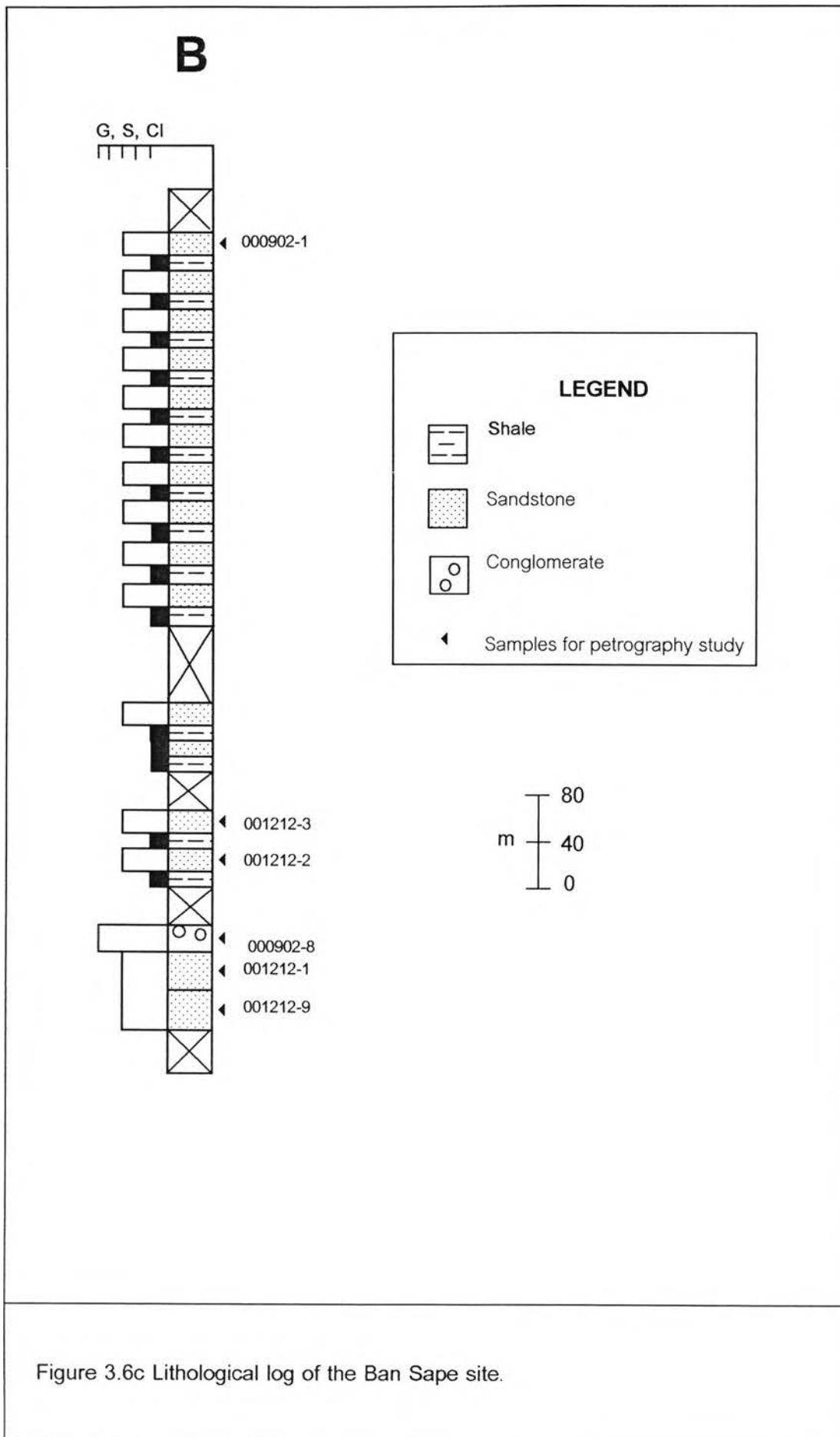
Q	Quaternary		Shale
Tr2	Triassic		Sandstone
	Fault		Conglomerate

Figure 3.6b Cross section B at Ban Sape study site, Khun Yuam, showing geological section along BB'.





A



B

Figure 3.7 The location of measured sections. (A, B) Section B at Ban Sape, Amphoe Khun Yuam (grid reference 811933 to 857895, map sheet 4546 I).



**Table 3.2** Measured section B, grid reference 811933 to 857895 (4546 I)

Section of sedimentary rocks of the Mae Sariang Group, Khun Yuam of Mae Hong Son.

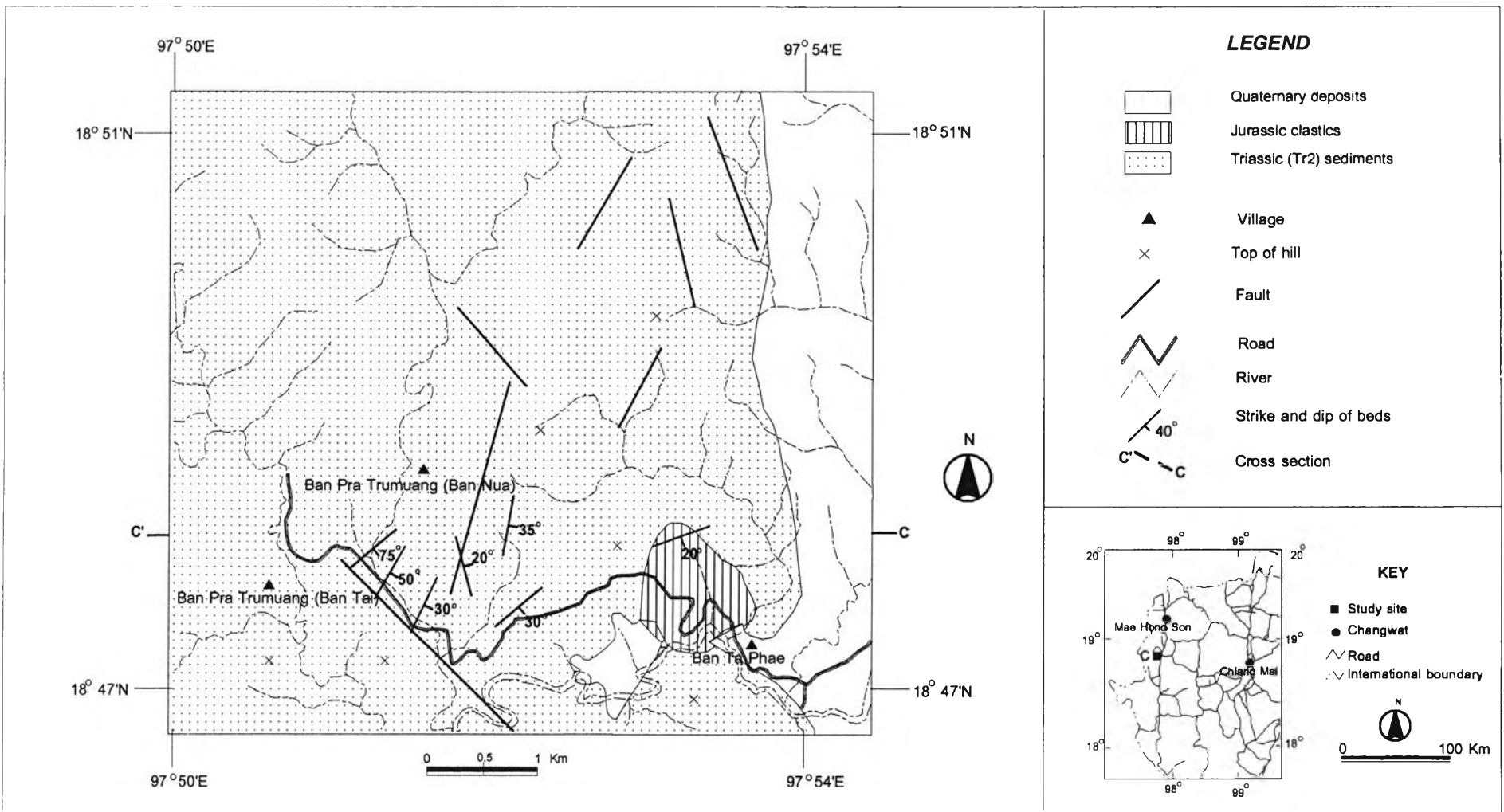
Thickness (m)

(514 meters) (from top to bottom)

Thickness (m)	Unit No.	Description
6	1	Sandstone, white, coarse-grained, medium bedded, quartz, and feldspar composition, bedding 30/35, sample no. 0000829-7, interbedded with mudstone, brown, medium-bedded
34	2	Sandstone, brown, very fine-grained, medium-bedded, quartz, dark minerals, and feldspar composition, bedding 330/20, sample no. 000902-1, interbedded with mudstone, brown, thin-bedded
5	3	Sandstone, white, medium bedded, sample no. 000902-2, and 000902-3, interbedded with gray mudstone, thin bedded
10	4	Sandstone, white, medium-grained, medium-bedded, quartz, feldspar, and dark minerals composition, bedding 90/20, sample no. 000902-4, interbedded with gray mudstone, thin-bedded
20	5	Sandstone, white, medium-grained, very thick-bedded, quartz, feldspar, and dark minerals composition, bedding 80/30, joint 160/85, and 280/50, sample no. 000902-5, interbedded with brown mudstone.
15	6	Sandstone, white, medium-grained, quartz, feldspar, and dark minerals composition, bedding 310/60, joint 230/50, and 130/40, sample no. 000902-6

**Table 3.2 (cont.) Measured section B**

Thickness (m)	Unit No.	Description
350	7	Mudstone, light gray, very thick-bedded, interbedded with sandstone, sample no. 000902-7
10	8	Sandstone, white, medium-grained, quartz, feldspar, rock fragment, muscovite, and dark minerals composition, sample no. 001212-7
9	9	Sandstone, white, very fine-grained, medium-bedded, quartz, and dark minerals composition, bedding 170/25, sample no. 001212-6, interbedded with mudstone, brown, thin-bedded
5	10	Sandstone, white, fine- to medium-grained, medium-bedded, quartz, and feldspar composition, bedding 230/40, sample no. 001212-4, and 001212-5
10	11	Sandstone, white, coarse-grained, quartz, rock fragment, and feldspar composition, bedding 30/20, sample no. 001212-3
10	12	Sandstone, white, very fine-grained, quartz, feldspar, and dark minerals composition, joint 30/20, sample no. 001212-2
5	13	Conglomerate, red, sample no. 000902-8
10	14	Sandstone, white, coarse-grained, quartz, feldspar, rock fragment, and dark minerals, bedding 80/55, joint 215/35, and 150/70, sample no. 001212-1
40	15	Sandstone, purple, fine-grained, thin-bedded, bedding 30/30, joint 140/85, and 210/50, sample no. 000902-9



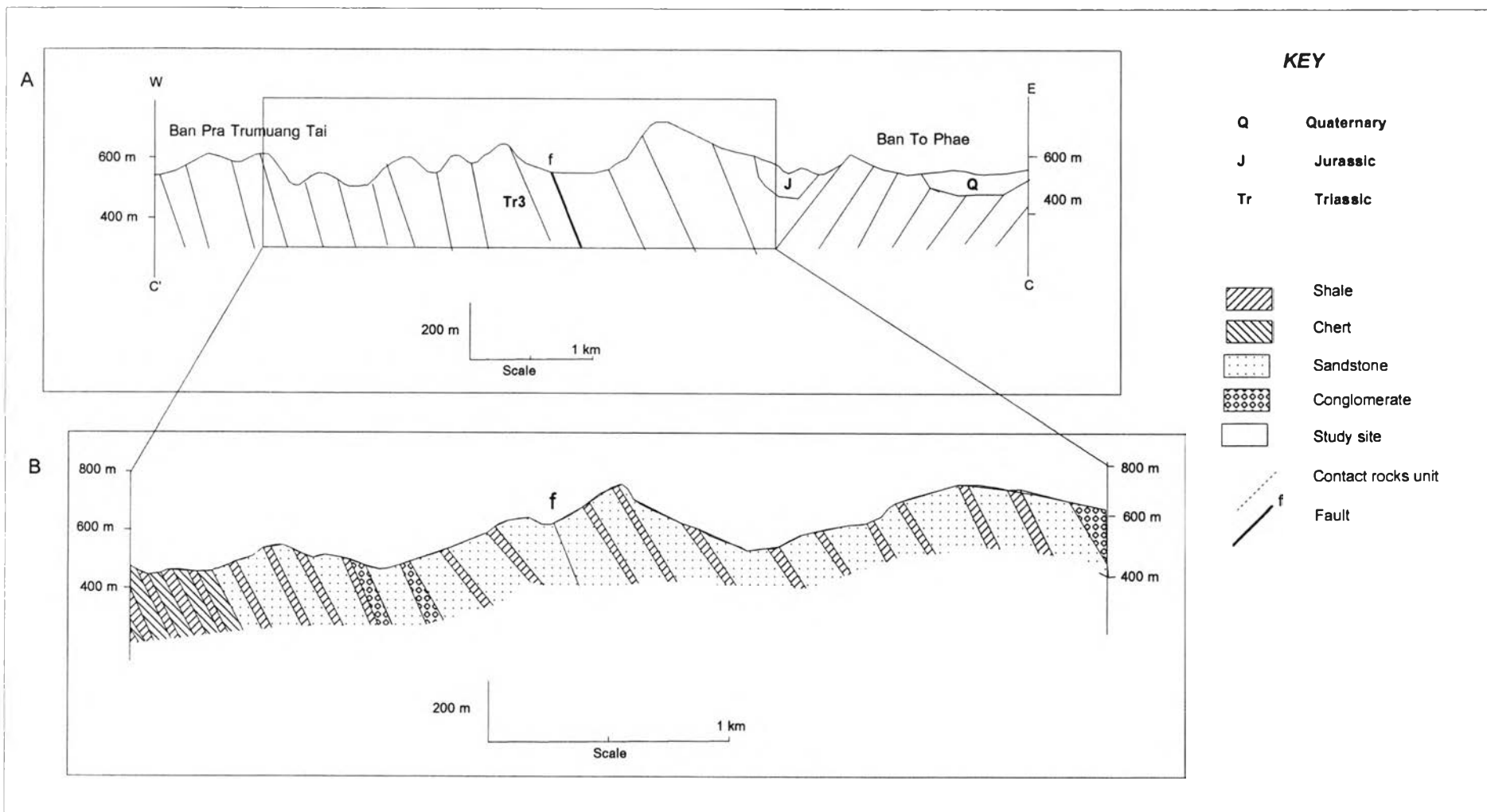
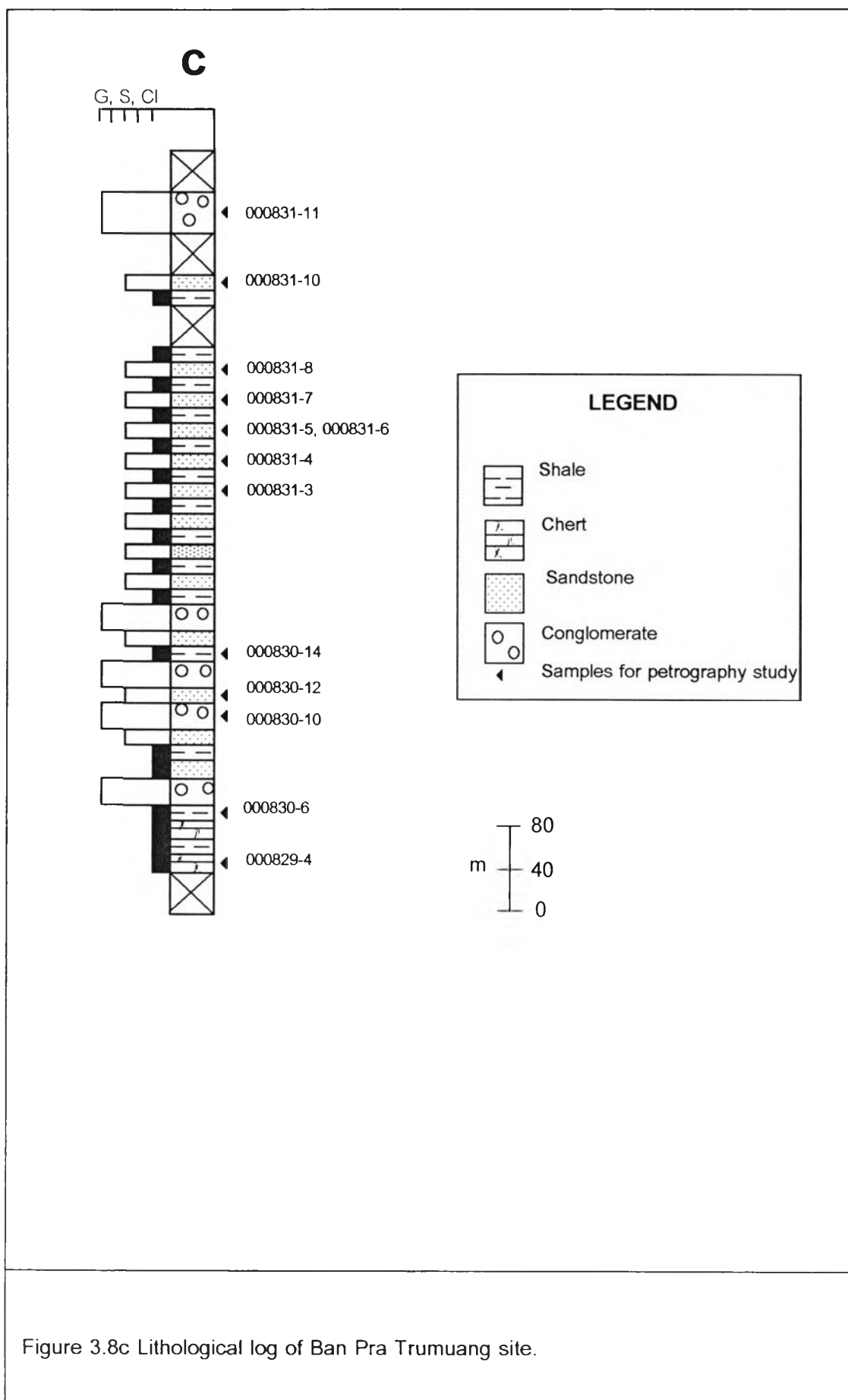


Figure 3.8b Cross section C at Ban Pra Trumuang, Khun Yuam, showing A geological section along line CC' and B section at Ban Pra Trumuang village showing detailed Triassic rock units.



A



B



C



D



Figure 3.9 The location of measured sections. (A, B, C, and D) Section C at Ban Pra Trumuang, Amphoe Khun Yuam (grid reference 798801 to 830803, map sheet 4546 I).

**Table 3.3** Measured section C, grid reference 798801 to 830803 (4546 I)

Section of sedimentary rocks of the Mae Sariang Group, Khun Yuam of Mae Hong Son

Thickness (m)

(766.5 meters) (from top to bottom)

Thickness (m)	Unit No.	Description
50	1	Conglomerate, red, 2-8 mm, quartz, feldspar, and chert composition, sample no. 000831-11
100	2	Concealed (soil cover)
50	3	Sandstone, white, medium-grained, thin-bedded, quartz, and feldspar composition, bedding 50/20, sample no. 000831-10, interbedded with mudstone, light gray, thick lamination
200	4	Concealed (soil cover)
20	5	Sandstone, brown, fine-grained, thick-bedded, quartz, feldspar, and dark minerals composition, bedding 10/35, sample no. 000831-8, interbedded with mudstone, purple, thin-bedded.
15	6	Sandstone, white, fine-grained, very thick-bedded, sample no. 000831-7
100	7	Sandstone, white to purple in lower part, fine-grained, very thick-bedded, quartz, rock fragment, and feldspar composition, bedding 20/30, flute casts in upper part, sample no. 000831-5, 000831-6, interbedded with mudstone, white, thin-bedded
500	8	Concealed (soil cover)
10	9	Sandstone, dark brown, fine-grained, thick-bedded, quartz, feldspar, and dark minerals composition, bedding 10/40, sample no. 000831-4
2	10	Mudstone, black
20	11	Sandstone, light gray, medium- to coarse-grained, quartz, feldspar, and dark minerals composition, bedding 30/35

**Table 3.3** (cont.) Measured section C

Thickness (m)	Unit No.	Description
150	12	Sandstone, light gray, medium-grained, quartz, and feldspar composition, very thick-bedded, sample no. 0000831-3, interbedded with mudstone, black, very thick-bedded, bedding 0/20, fracture 310/75 and 245/70
300	13	Concealed (probably sandstone and mudstone)
50	14	Sandstone, white, coarse-grained, quartz, feldspar, and dark minerals, thick-bedded, bedding 340/45, fracture 85/55, sample no. 000831-2, interbedded with mudstone, gray
10	15	Sandstone, white, medium-grained, quartz, feldspar, and dark minerals composition, faulting 130/60, and 310/75, sample no. 000831-1
50	16	Sandstone, white, fine-grained, quartz, feldspar, and dark minerals composition, , very thick-bedded, bedding 45/30, fracture 220/60, sample no. 000830-15, interbedded with mudstone, gray, thin-bedded
15	17	Sandstone, white, fine-grained, quartz, and feldspar composition, thick bedded, lamination, fold axis 30/45 interbedded with mudstone, brown, thin-bedded
5	18	Sandstone, white, fine-grained, quartz, and feldspar composition
15	19	Mudstone, greenish-gray, and purple, medium-bedded, bedding 345/40, sample no. 000830-14
20	20	Conglomerate, brown, matrix-supported, chert, and quartz composition
5	21	Mudstone, brown, thin-bedded, bedding 10/55, fracture 310/55
4	22	Sandstone, white, very fine-grained, medium-bedded, quartz, and dark minerals composition, bedding 350/20, joint 95/75, sample no. 000830-12, interbedded with mudstone, gray, medium-bedded



**Table 3.3** (cont.) Measured section C

Thickness (m)	Unit No.	Description
20	23	Conglomerate, brown, matrix-supported, chert, and quartz composition, fault 0/50, 85/80, 15/70, sample no. 000830-10, interbedded with sandstone, brown, coarse-grained, cross bedding, quartz, and rock fragments, sample no. 000830-11
10	24	Chert, brown, bedding 345/25, interbedded with mudstone, brown
1	25	Mudstone, purple, fault 340/65
10	26	Chert, brown, medium-bedded
5	27	Mudstone, purple
0.5	28	Chert, brown
1	29	Mudstone, light gray
20	30	Conglomerate, brown, matrix-supported, chert , and quartz composition
30	31	Chert, brown, medium-bedded, sample no. 000830-6, interbedded with mudstone, purple, thin-bedded, bedding 175/75
10	32	Mudstone, brown
20	33	Chert, brown, thin-bedded, interbedded with mudstone, gray
10	34	Sandstone, brown, medium-grained, quartz, feldspar, dark minerals, and muscovite composition
60	35	Sandstone, brown, medium-grained, thick to very thick-bedded, quartz, feldspar, dark minerals, and muscovite composition, graded bedding, sample no. 000830-5, interbedded with mudstone, dark gray, thin-bedded, bedding 10/35, joint 250/75, sample no. 000830-4
3	36	Sandstone, white, coarse-grained, quartz, feldspar, and dark minerals composition, bedding 50/50, joint 135/65, sample no. 000830-2
10	37	Concealed (soil cover)
15	38	Chert, black, sample no. 000829-4

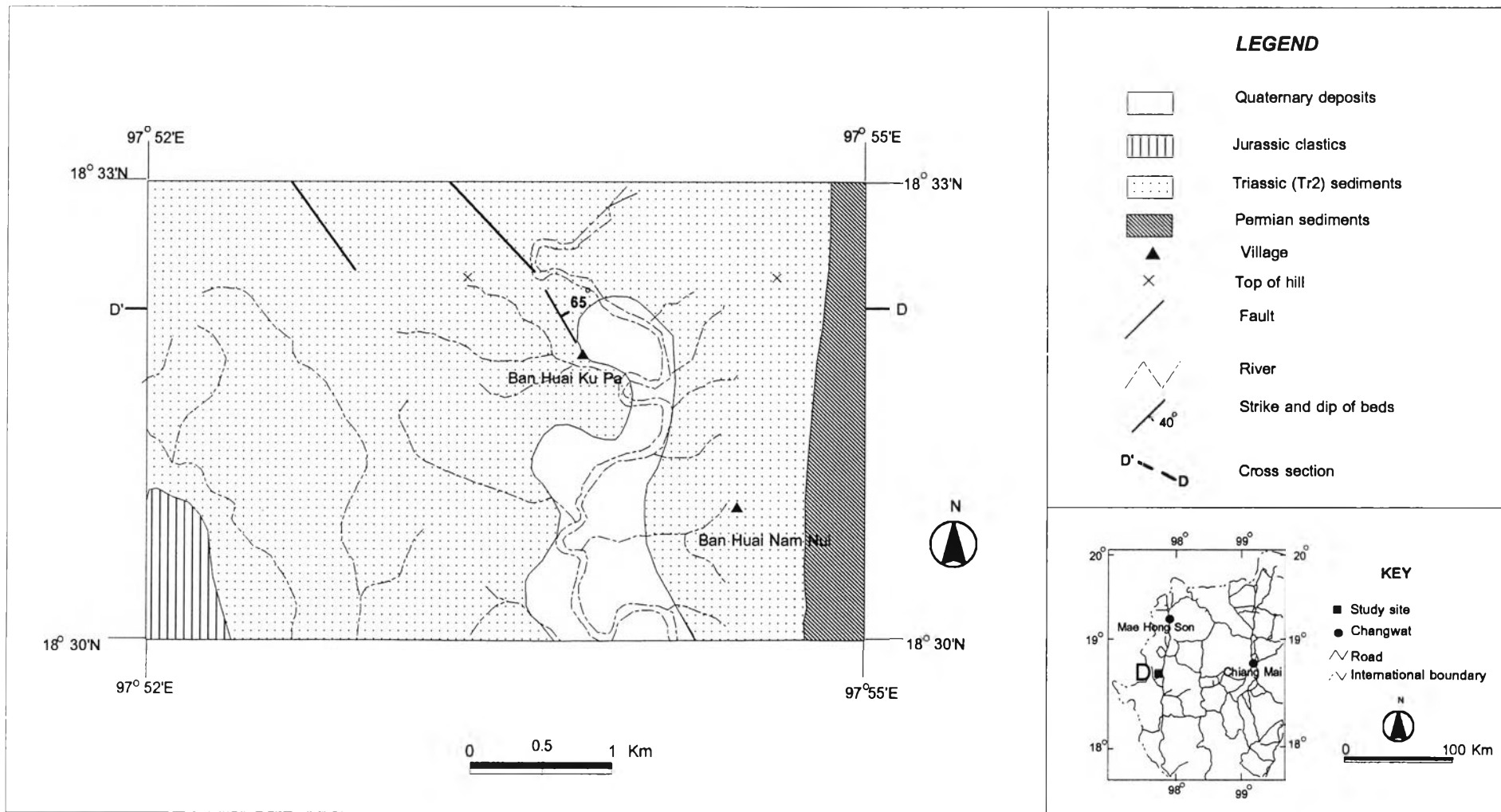
chert (40 m-thick) in the lower section interbedded vary colored sandstone and shale with brown clast-supported conglomerate (50 m-thick), in the upper section. Most clasts are subangular, gravel to pebble size quartz, and chert. The sandstone is brown to white well-bedded, fine- to medium-grained, and composed largely of quartz and feldspar. Generally, this Triassic section strikes almost north-south to northeast-southwest and dips at low angles (about 35°) to the east. A total of 17 rock samples were collected for mesoscopic description.

#### **3.2.4 Section D** (Figures 3.10a-3.10c)

Section D, about 200 m-long, is located at Ban Huai Na, Amphoe Mae La Noi of Mae Hong Son. The measured section is along the road cut at Ban Huai Na (grid reference 835481, map sheet 4546 II, Figure 3.10a). Figure 3.10a illustrates the 1:50,000 geologic map covering the section D which contains sediments of Permian to Quaternary. The Permian strata include sandstone, siltstone, and shale with interbedded chert and mainly are exposed to the east of the mapped area in the north-south direction. The Triassic unit comprises almost similar rocks and occupies largely in the central and western parts of the study area. Unconsolidated alluviums and colluviums of gravels to clays constitute Quaternary deposits. Structurally, the rock strata strike northwest and dip at moderate angles (about 45°) to the northeast. A more detailed stratigraphic investigation (see Figures 3.10b and 3.10c) shows that the Triassic strata observed include thinly bedded black chert with interbedded mudstone (about 10 m-thick) in the lower section and mainly well bedded brown, red and light gray fine- to medium-grained sandstone contains quartz, feldspar, and mica minerals, with the total thickness of 61 m in the upper section (Table 3.4). The overall thickness is about 107 m.

#### **3.2.5 Section E** (Figures 3.11a-3.11c)

Section E, about 150 m long, is situated at Huai Hin Lak Fai, Mae La Noi of Mae Hong Son. Figure 3.11a displays the 1:50,000 geologic map covering the section E which comprises sediments of Lower Paleozoic to Quaternary. The Lower Paleozoic sequence consists largely of metaclastic strata of sandstone and shale. The Triassic sequence is



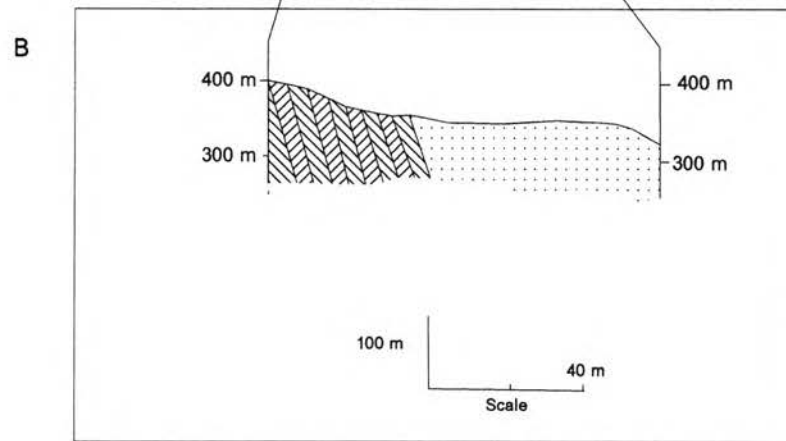
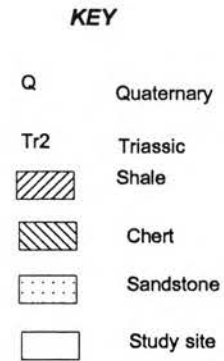
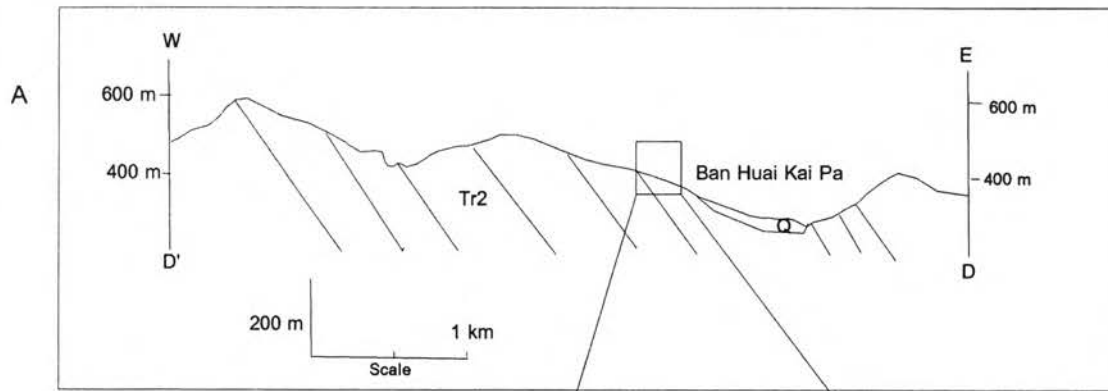
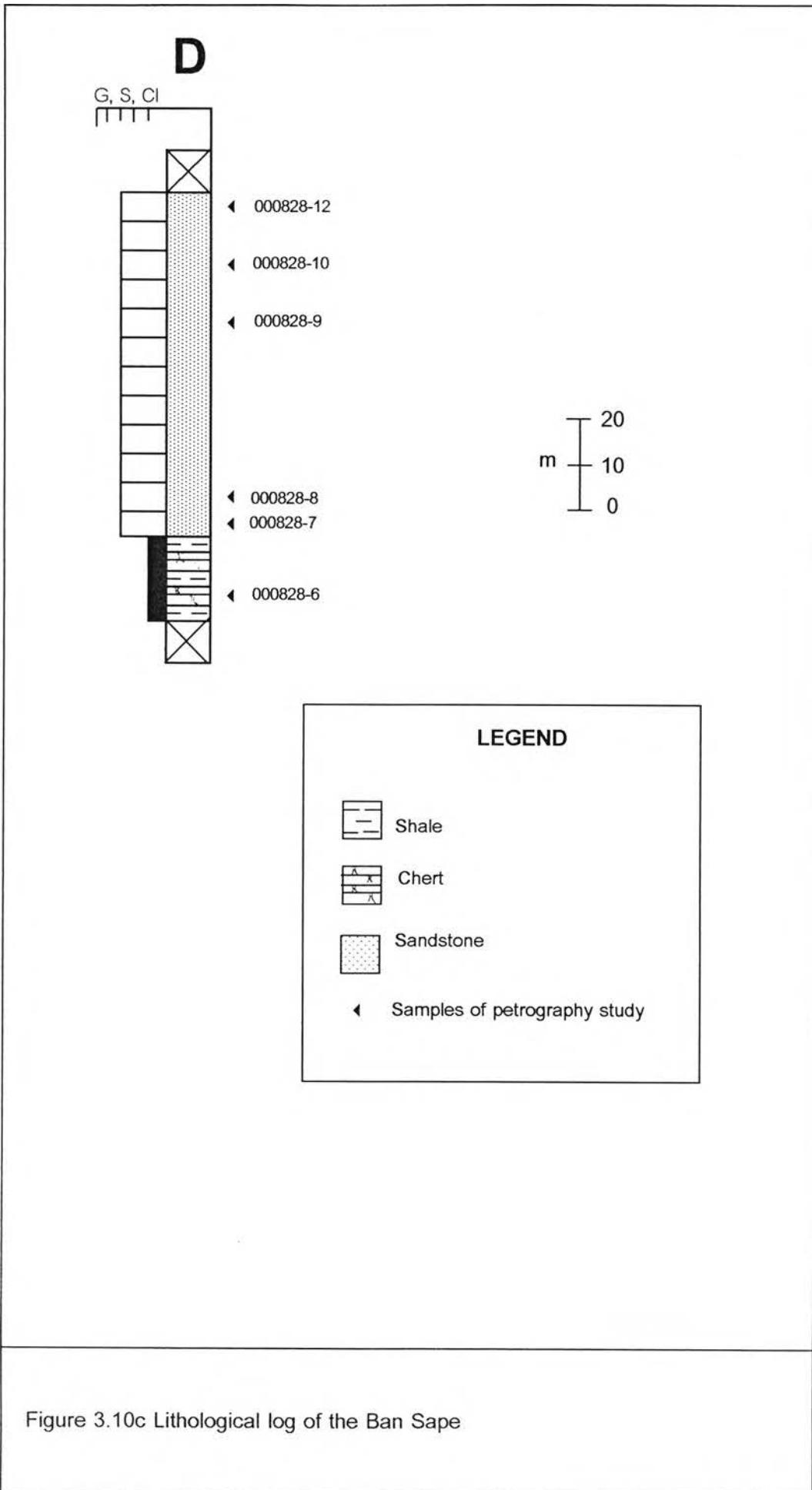


Figure 3.10b Cross section D at Ban Huai Na study site, Mae La Noi, showing A geological section along line DD' and B section at Ban Huai Na village showing detailed Triassic rock units.





**Table 3.4** Measured section D, grid reference 835481 (4546 II)

Section of sedimentary rocks of the Mae Sariang Group, Mae La Noi of Mae Hong Son

Thickness (m)

(107 meters) (from top to bottom)

Thickness (m)	Unit no.	Description
>2	1	Conglomeratic Sandstone, brown, quartz, dark minerals, chert, and muscovite composition, sample no. 000828-12
30	2	Sandstone, white, quartz, feldspar, dark minerals, and muscovite composition, sample no. 00082811
23	3	Sandstone, white, coarse-grained, quartz, feldspar, dark minerals, and muscovite composition, bedding 310/90 sample no. 000828-10
5	4	Conglomerate sandstone, purple, quartz, dark minerals, and muscovite composition, sample no. 000828-9
3	5	Sandstone, light gray, fine-grained
3	6	Sandstone, red, fine-grained
25	7	Sandstone, brown, medium-grained, quartz, dark minerals, and feldspar composition, sample no. 000828-8
10	8	Chert, black, thin-bedded, interbedded with mudstone, black, thin-bedded
4	9	Sandstone, black, coarse-grained, thin-bedded, quartz, and rock fragment composition, sample no. 000828-7
2	10	Chert, black, thin-bedded, sample no. 000828-6

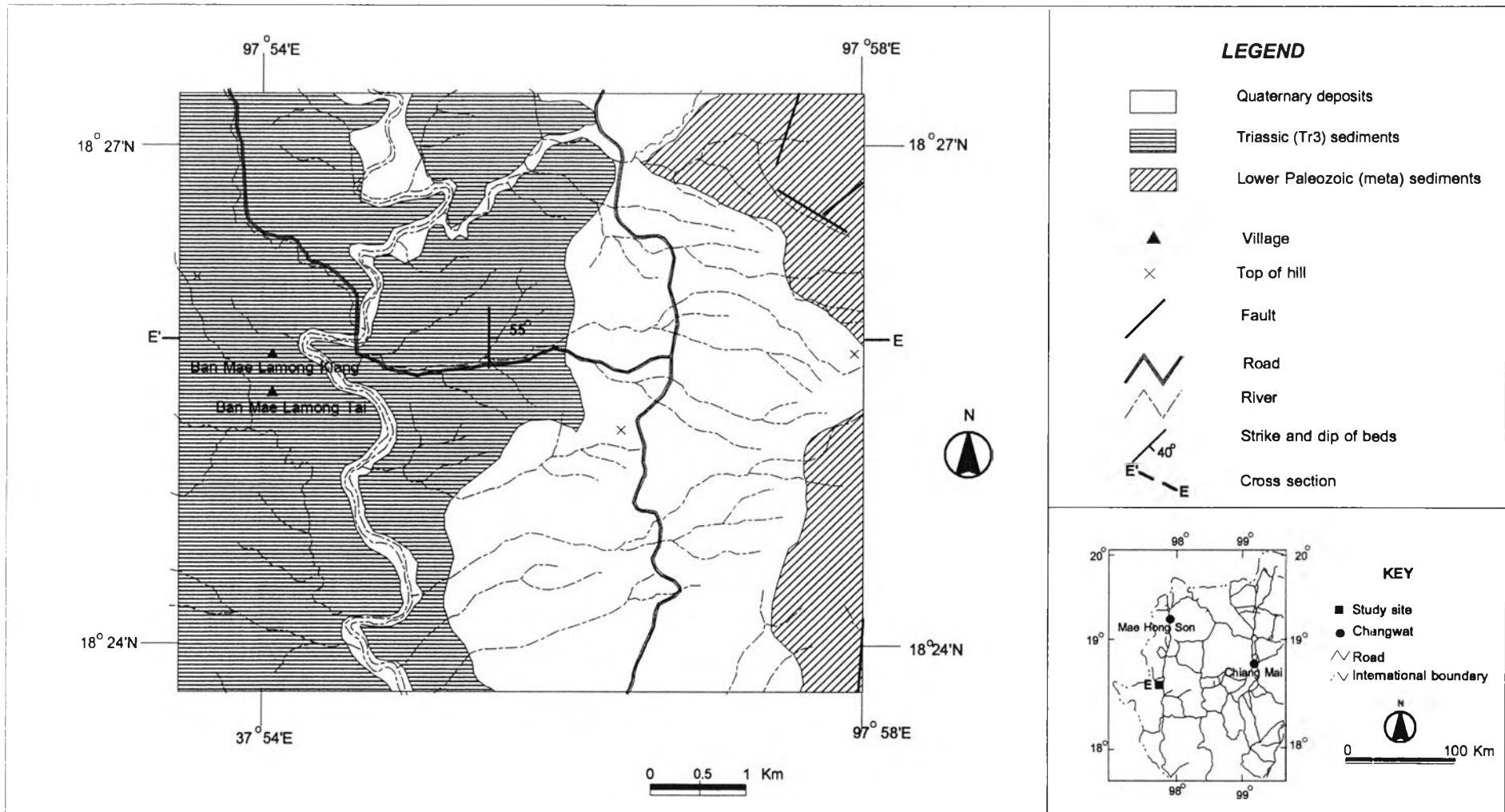
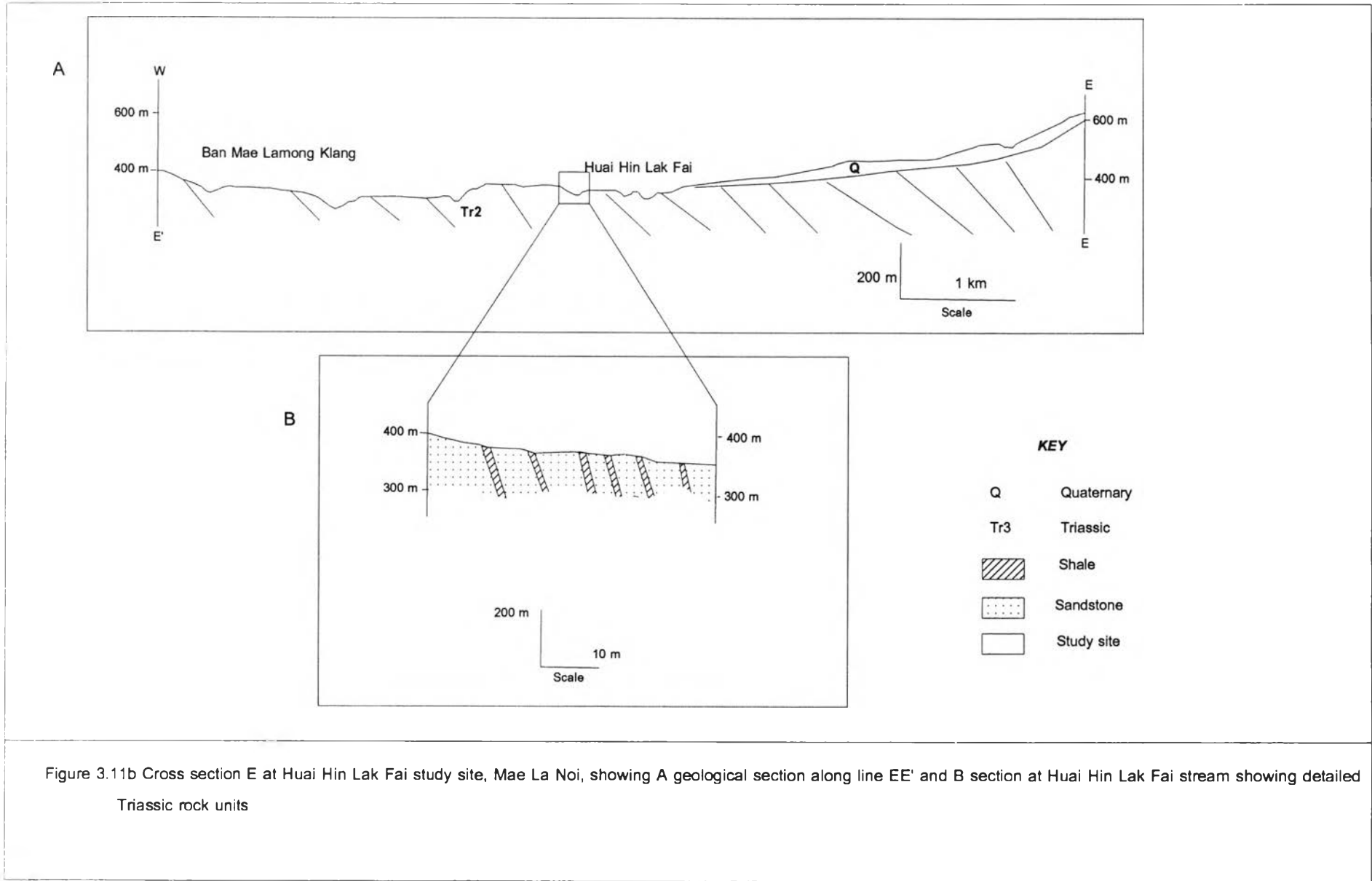


Figure 3.11a Geological map of Huai Hin Lak Fai site (modified after Jindasuth et al., 1990).





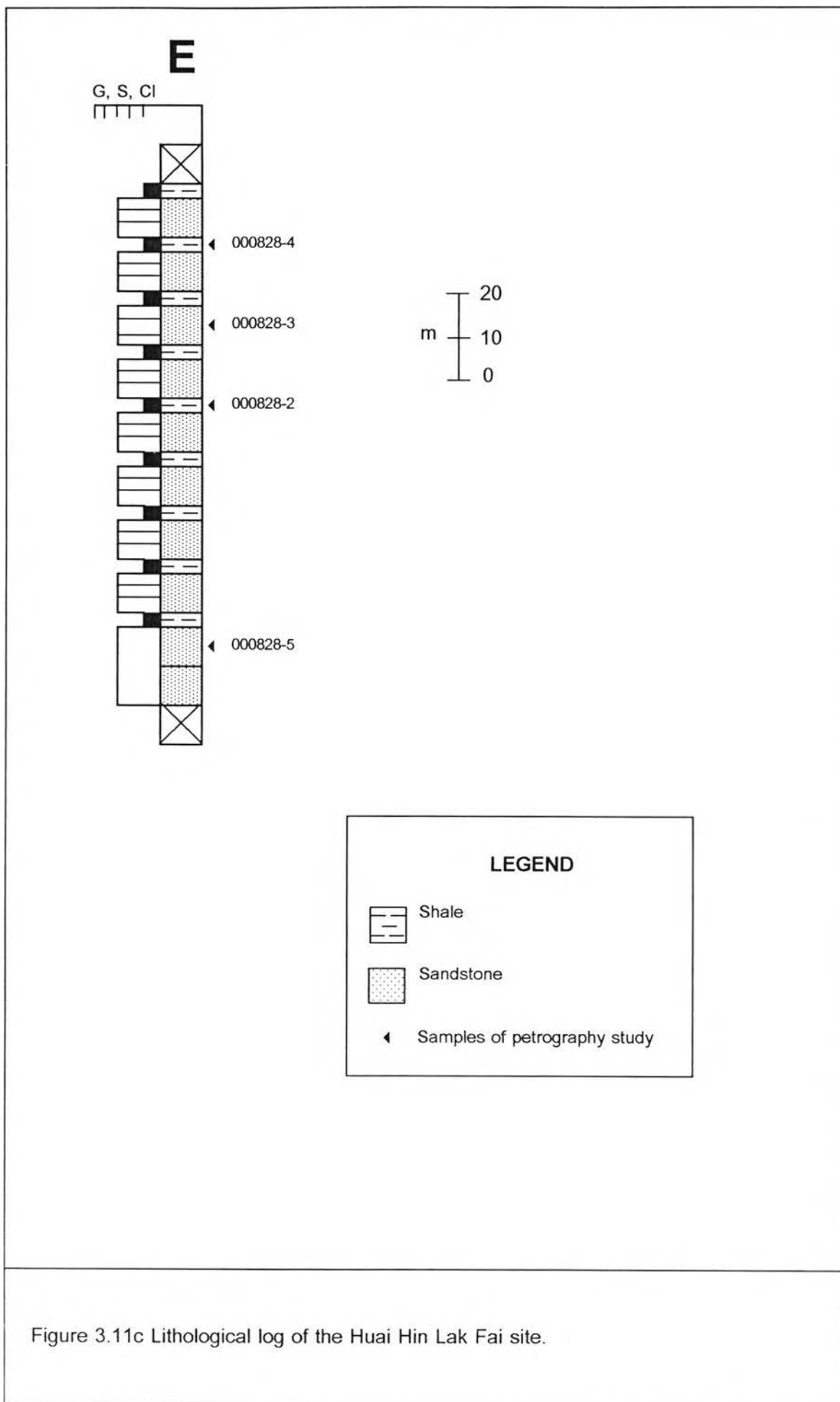


Figure 3.11c Lithological log of the Huai Hin Lak Fai site.

**Table 3.5** Measured section E, grid reference 886379 (4545 I)

Section of sedimentary rocks of the Mae Sariang Group, Mae La Noi of Mae Hong Son

Thickness (m)

(51) (from top to bottom)

Thickness (m)	Unit no.	Description
		Concealed (soil cover)
>6	1	Calcareous Mudstone, dark gray, sample no. 000828-4
3	2	Sandstone, dark gray to black, medium-grained, quartz, feldspar, rock fragments composition, sample no. 000828-3
34	3	Calcareous Mudstone, black, medium-bedded, interbedded with sandstone, black, thin-bedded, quartz, and feldspar composition, sample no. 000828-2
>8	4	Sandstone, dark gray to black, fine-grained, very thick-bedded, quartz, dark minerals, and feldspar composition, sample no. 000828-5
	5	Concealed (soil cover)

composed chiefly of sandstone and shale with some chert and limestone beds and lens. The detailed stratigraphic (Figure 3.11b) measured section at the small creek to Huai Hin Lak Fai indicates that the total thickness is about 51 meters and the unit belongs to the  $Tr_3$  unit which comprise mainly thickly bedded, black to dark gray sandstone interbedded with black to dark gray, medium-bedded, calcareous mudstone. (Figure 3.11c and Table 3.5). Four rock samples have been collected from the measured section. Generally, the strata of this Triassic unit strike almost north-south and dip at moderate angles (about  $55^\circ$ ) to the east.

### **3.2.6 Section F** (Figures 3.12a-3.12c, and 3.13)

Section F is located along the Office of the Accelerated Rural Development road from Ban Tha Song Khwae to Ban Mae Leab, Mae La Noi of Mae Hong Son. Fig. 3.12a shows the geologic map (scale 1:50,000) covering the section F comprising sediments of Triassic to Quaternary. The Triassic sequence is sandstone, chert, shale and limestone lens. Quaternary deposits are mainly gravel to clay deposits of alluvial and colluvial origins. The more detailed stratigraphic sections along the exposed outcrops at road quarries and along creeks indicate two major Triassic units-namely  $Tr_1$  in the western part and  $Tr_2$  unit in the eastern part (Figure 3.12b). As shown in Figure 3.12c, and Table 3.6, the older Triassic unit ( $Tr_1$ ) includes thinly-bedded, whitish gray to light brown chert with thinly bedded orange mudstone and shale. The younger Triassic unit ( $Tr_3$ ) includes thinly- to medium-bedded whitish gray to black siliceous shale with very thickly bedded, fine- to coarse-grained brownish sandstone containing quartz, feldspar, and mica mineral. Most strata of the section F strike average north-south and dip at moderate angles (about  $40^\circ$ ) to the east.

### **3.2.7 Section G** (Figures 3.14a-3.14c, and 3.15)

Section G, about 5 km long, is located along road No. 1194, km 20 to km 25 from Mae Sariang to Ban Mae Sam Leab, Mae Sariang, Mae Hong Son. Figure 3.9a displays the 1:50,000 geologic map covering sediments of Permian to Quaternary ages. The Permian rock unit, exposed in the western mapped area, includes massive limestone, sandstone, and shale. The overlying Triassic unit comprises shale, chert, and thin limestones and is

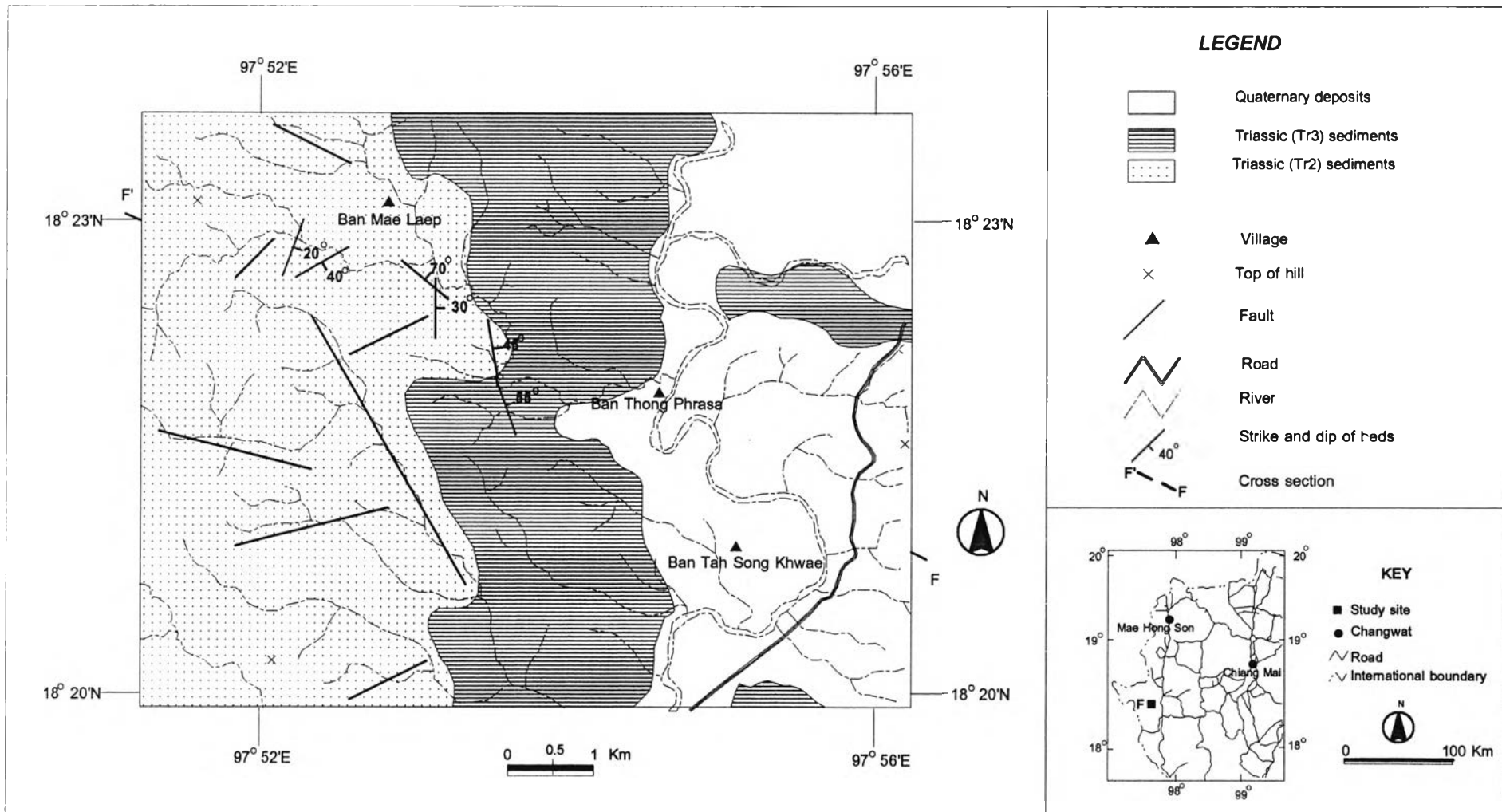


Figure 3.12a Geological map of Ban Mae Laep site (modified after Jindasuth et al., 1990).

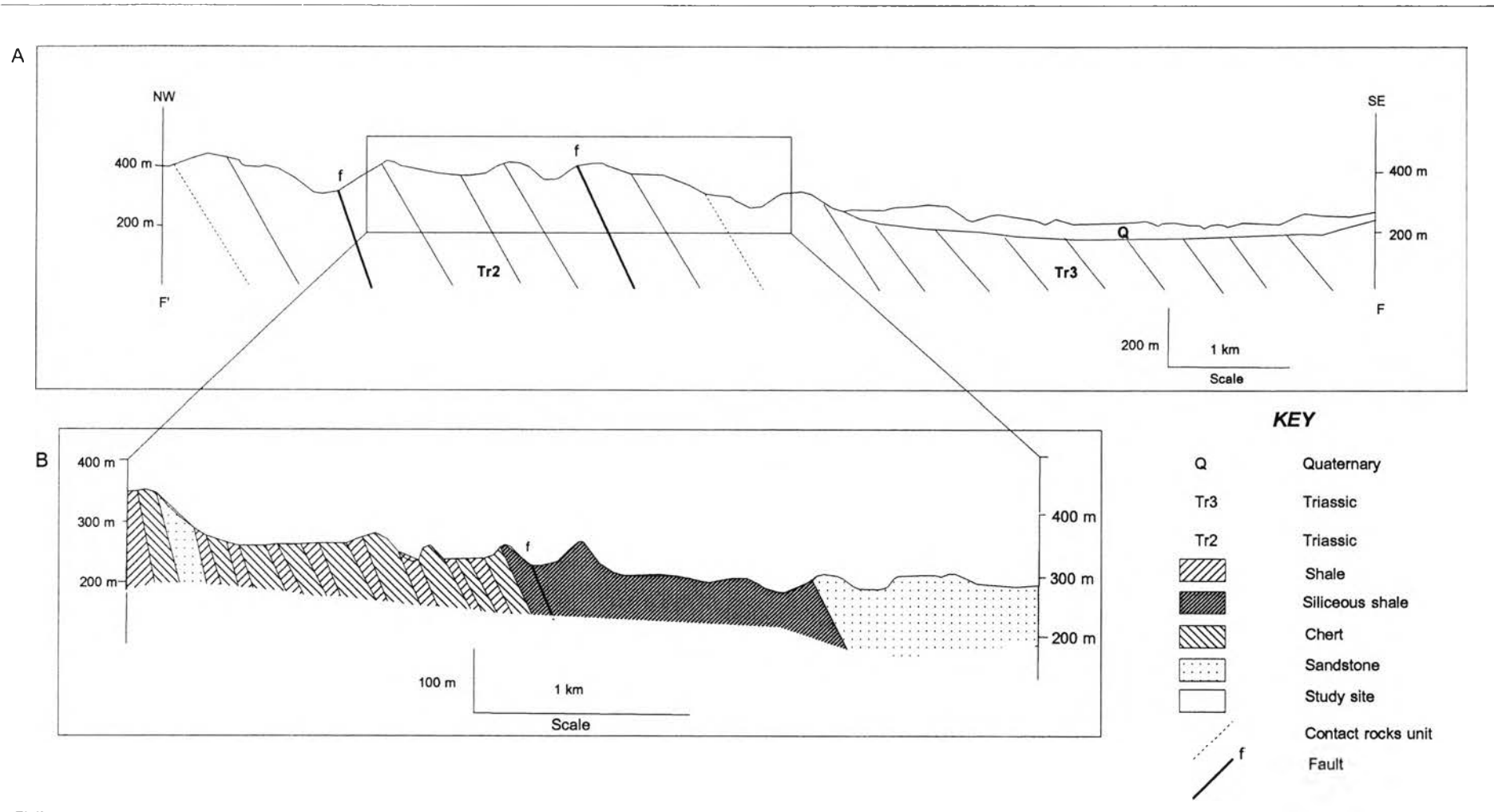


Figure 3.12b Cross section F at Ban Mae Leab study site, Mae La Noi, showing A geological section along line FF' and B section at Ban Mae Leab village showing detailed Triassic rock units.

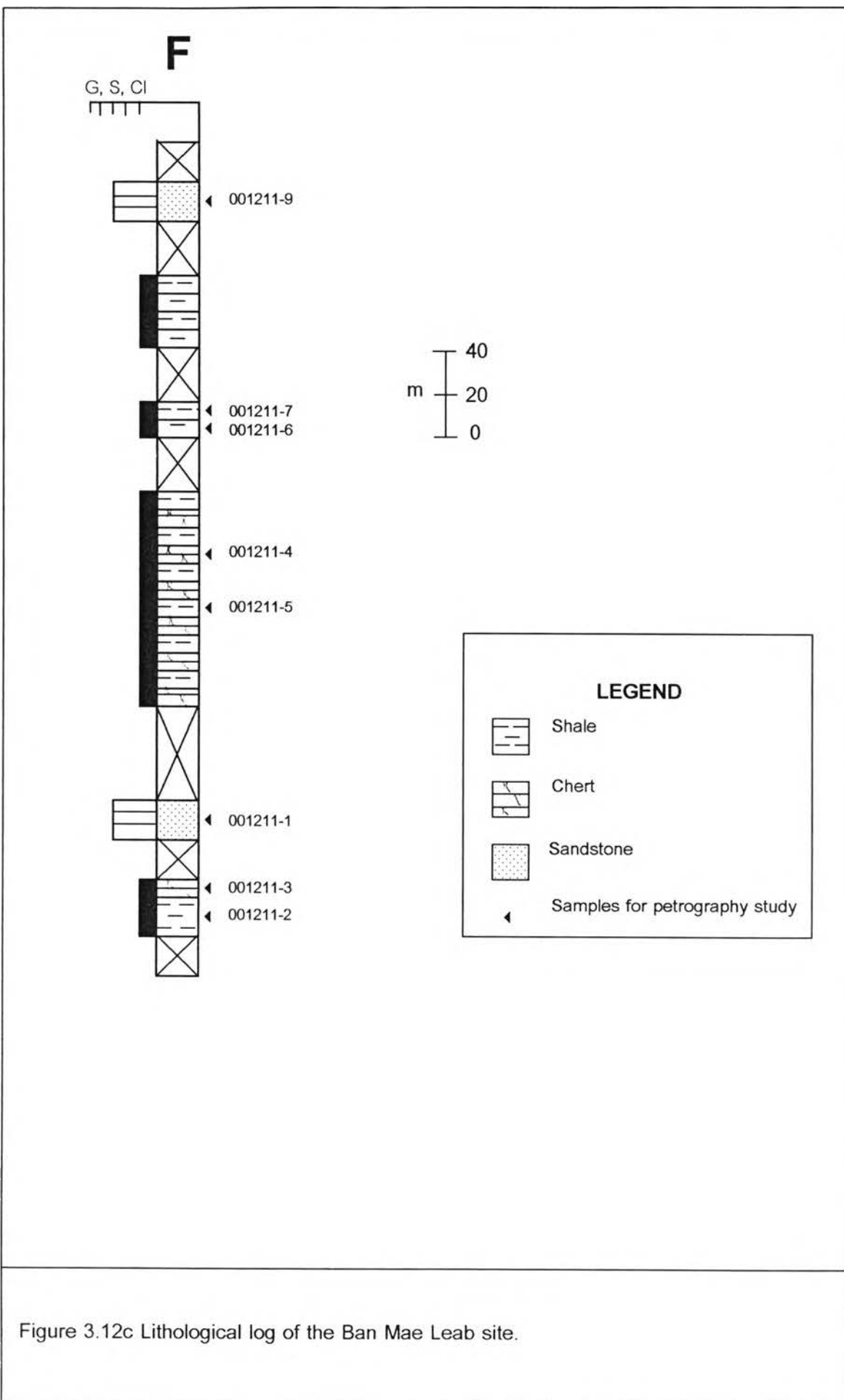


Figure 3.12c Lithological log of the Ban Mae Leab site.



**A**



**B**

Figure 3.13 The location of measured sections. (A, B) section F at Ban Mae Leab, Mae La Noi (grid reference 812322 to 834303, map sheet 4545 I).

**Table 3.6** Measured section F, grid reference 812322 to 834303 (4545 I)

Section of sedimentary rocks of the Mae Sariang Group, Mae La Noi of Mae Hong Son.

Thickness (m)

(274 meters) (from top to bottom)

Thickness (m)	Unit No.	Description
1,000		Concealed (soil cover)
15	1	Sandstone, brown, fine- to coarse-grained, very thick-bedded, quartz, feldspar, muscovite, and dark minerals composition, bedding 340/85, sample no. 001211-9
1,000	2	Concealed
39	3	Siliceous shale, whitish gray, medium-bedded, bedding 350/45, sample no. 001211-8
530	4	Concealed (soil cover)
30	5	Siliceous shale, black, thin-bedded, bedding 10/30, sample no. 001211-6, and 001211-7
250	6	Concealed (soil cover)
140	7	Chert, brown, sample no. 001211-4, interbedded with mudstone, green, thin-bedded, bedding 300/70, sample no. 001211-5
1,120	8	Concealed (soil cover)
10	9	Sandstone, white, thin-bedded, quartz, feldspar, and dark minerals composition, bedding 60/40, sample no. 001211-1
300	10	Concealed (probable mudstone, and chert)
10	11	Chert, light brown, thin-bedded, sample no. 001211-3
30	12	Mudstone, orange, thin-bedded, bedding 20/20, sample no. 001211-2



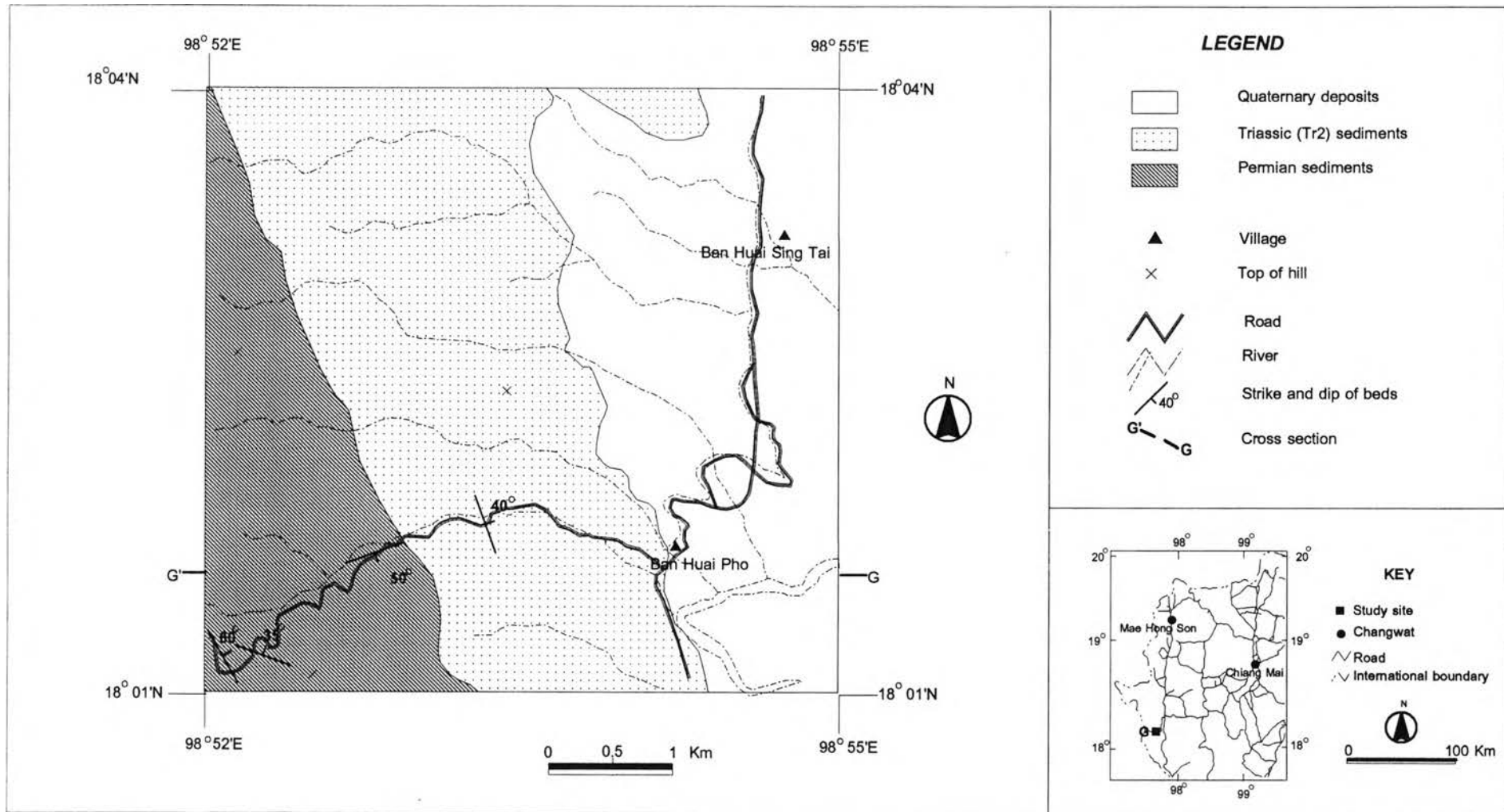


Figure 3.14a Geological map of Ban Huai Pho site (modified after Department of Mineral Resources, 1990).

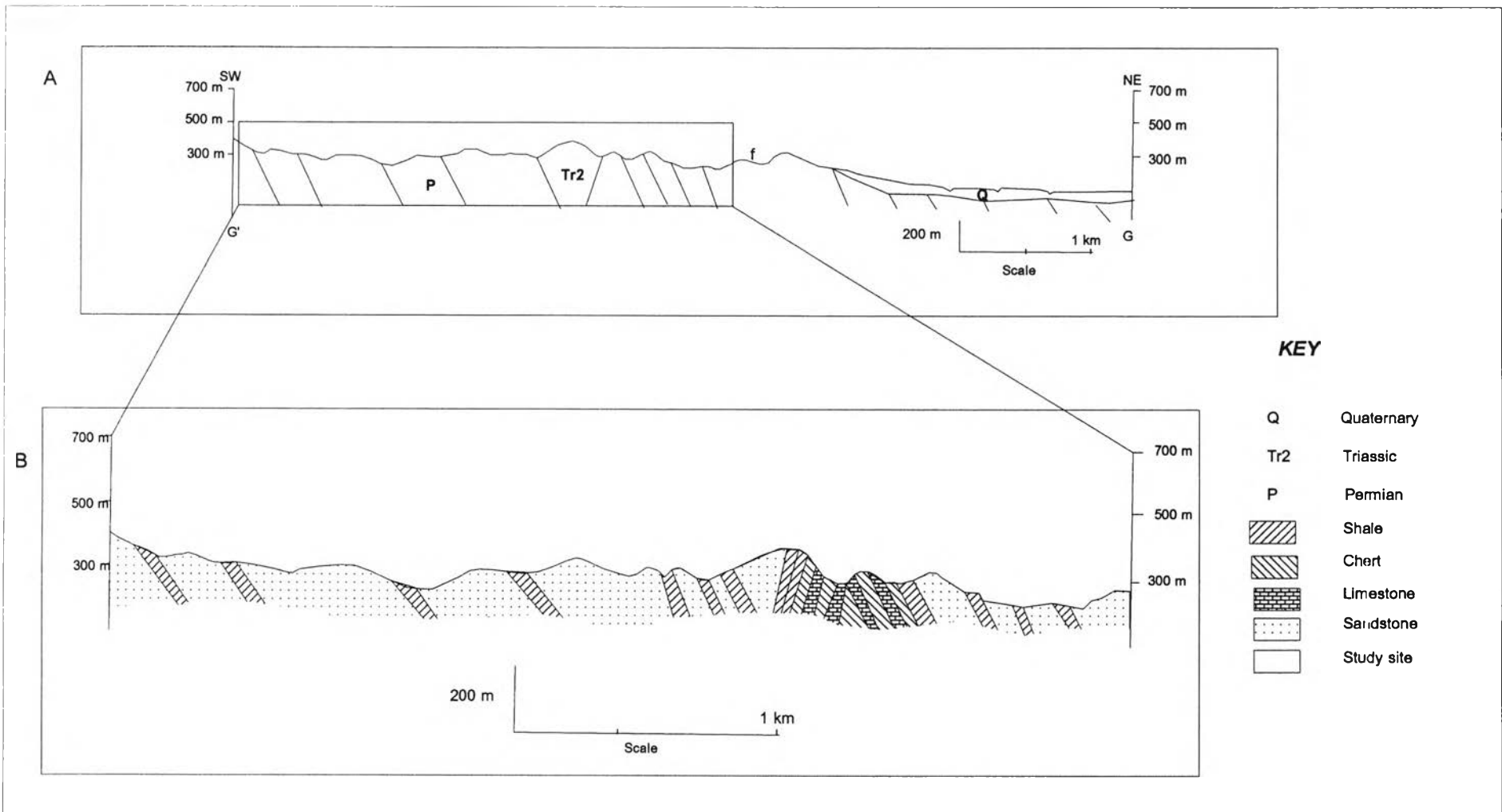


Figure 3.14b Cross section G at Ban Hui Pho study site, Mae Sariang, showing A geologic section along line GG' and B section at Ban Hui Pho village showing detailed Triassic rock units.

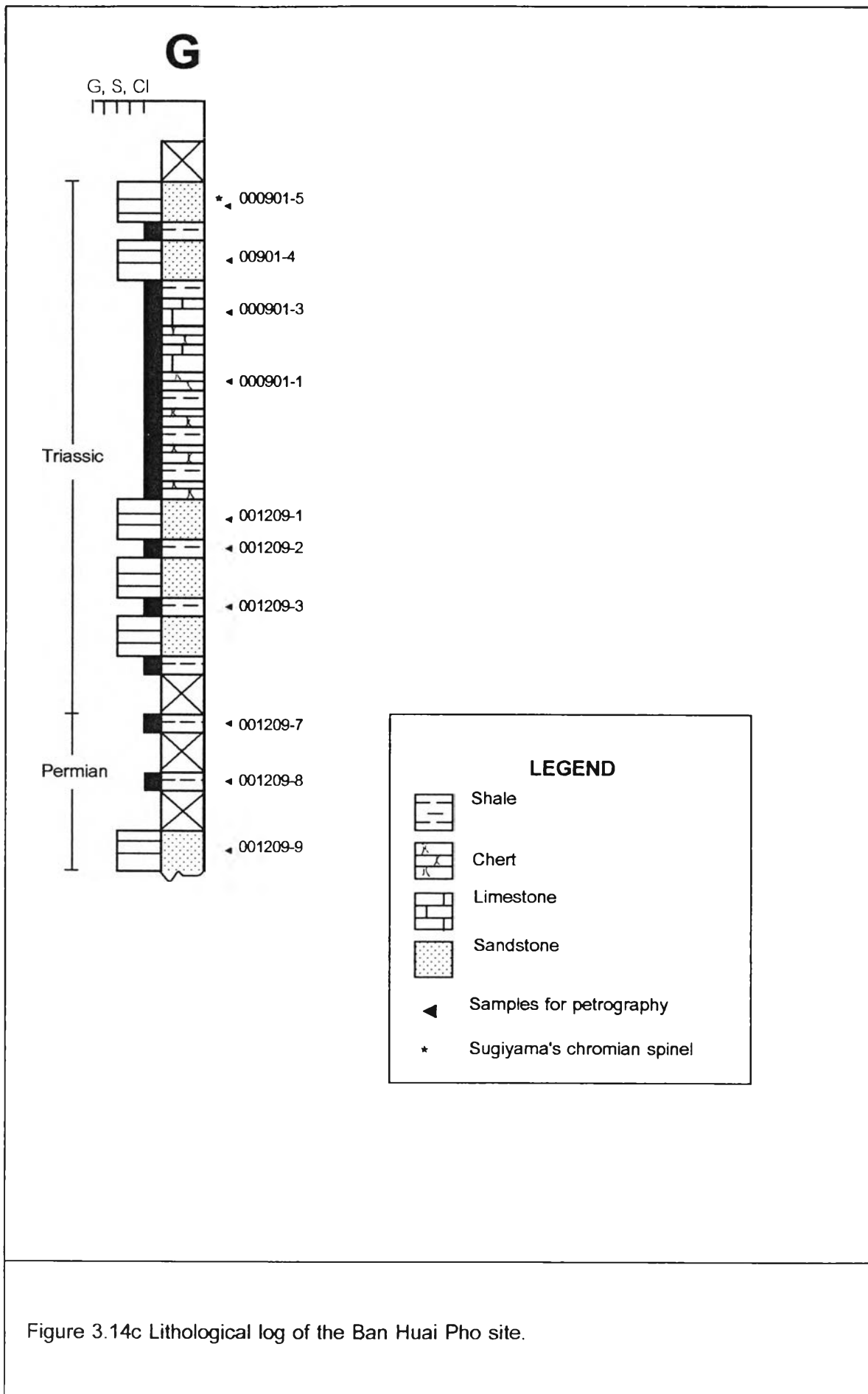


Figure 3.14c Lithological log of the Ban Huai Pho site.

**A****B**

Figure 3.15 The location of measured sections. (A,B) Section G at Ban Huai Pho, Amphoe Mae Sariang (grid reference 799926 to 826938, map sheet 4545 II).

observed in the middle part. The Quaternary alluvial deposits mainly occur in the eastern mapped area, particularly at Ban Huai Pho and Ban Huai Sing Tai. The more detailed stratigraphic section (see Figs. 3.14b and 3.14c, Table 3.7) indicates that the Permian rocks are white to dark gray, medium-bedded sandstone interbedded with yellowish to dark gray, thinly bedded, mudstone. The Triassic rocks (about 185 m-thick) are mainly black bedded chert with dark gray to brown mudstone and brown medium-grained sandstone interbeds. About 15 rock samples were collected from this measured section. Structurally, the anticline with the north-trending axis found in only one location about km 20.5

### **3.3 Composite section**

Under the present study, an attempt has been made to combine and correlate the sedimentary sequences of all 7 measured sections of the Mae Sariang Group. The combined section of the Mae Sariang Group is divided into 3 formations based on lithological characteristics, and the synthesis of combined section is illustrated in Figures 3.16 and 3.17.

The total thickness of the Mae Sariang group based on 7 measured section, varied above 900 metres. The more detailed description of individual units are explained in the following section.

### **3.4 Stratigraphy**

The so-called Mae Sariang Group (Bunopas, 1976) is proposed for sandstone, shale and limestone with the thickness of totally 850 meters earlier mapped as Triassic rocks in the Mae Sariang-Mae Hong Son area by Baum et al. (1970). This sequence unconformably overlies Upper Paleozoic rocks with the red basal conglomerate. The rocks are main on the west of the Mae Hong Son Fault (Charusiri, 1989), 150 km. long and 40 km. wide. It is here separated from the Mae Moei Group to the south and southwest because of lithological differences.

**Table 3.7** Measured section G, grid reference 799926 to 826938 (4545 II)

Parts of the Permian rocks and Triassic sedimentary unit of the Mae Sariang Group, Mae Sariang of Mae Hong Son

Thickness (m)

(217 meters) (from top to bottom)

Thickness (m)	Unit No.	Description
>20	1	Sandstone, black, fine-grained, quartz, darks minerals, muscovite, detrital chromian spinels composition, sample no. 000901-6, and 000901-5
35	2	Shale, brown
13	3	Sandstone, brown, medium-grained, quartz, feldspar, and dark minerals composition, sample no. 000901-4
2	4	Limestone, dark gray, sample no. 000901-3
30	5	Concealed (soil cover)
5	6	Mudstone, brown
20	7	Chert, black, bedding 310/30, sample no. 000901-1
20	8	Sandstone, yellow, fine-grained, quartz, feldspar, and muscovite composition, sample no. 001209-1
20	9	Mudstone, dark gray, sample no. 001209-2
20	10	Calcareous Mudstone, yellowish gray, sample no. 001209-3
12	11	Mudstone, dark gray, bedding 130/55, sample no. 001209-4 (Permian)
15	12	Sandstone, dark gray, fine-grained, sample no. 001209-5, interbedded with mudstone, black, sample no. 001209-6 (Permian)
115	13	Concealed (soil cover)
19	14	Mudstone, dark gray, thin-bedded, bedding 65/50, sample no. 001209-7 (Permian)
760	15	Concealed (probable mudstone)
5	16	Mudstone, yellow, sample no. 001209-8 (Permian)

**Table 3.7 (cont.) Measured section G**

Thickness (m)	Unit No.	Description
400	17	Concealed (soil cover)
11	18	Sandstone, white, fine-grained, medium-bedded, quartz, feldspar, muscovite, and dark minerals composition, bedding 310/50, sample no. 001209-9 (Permian)

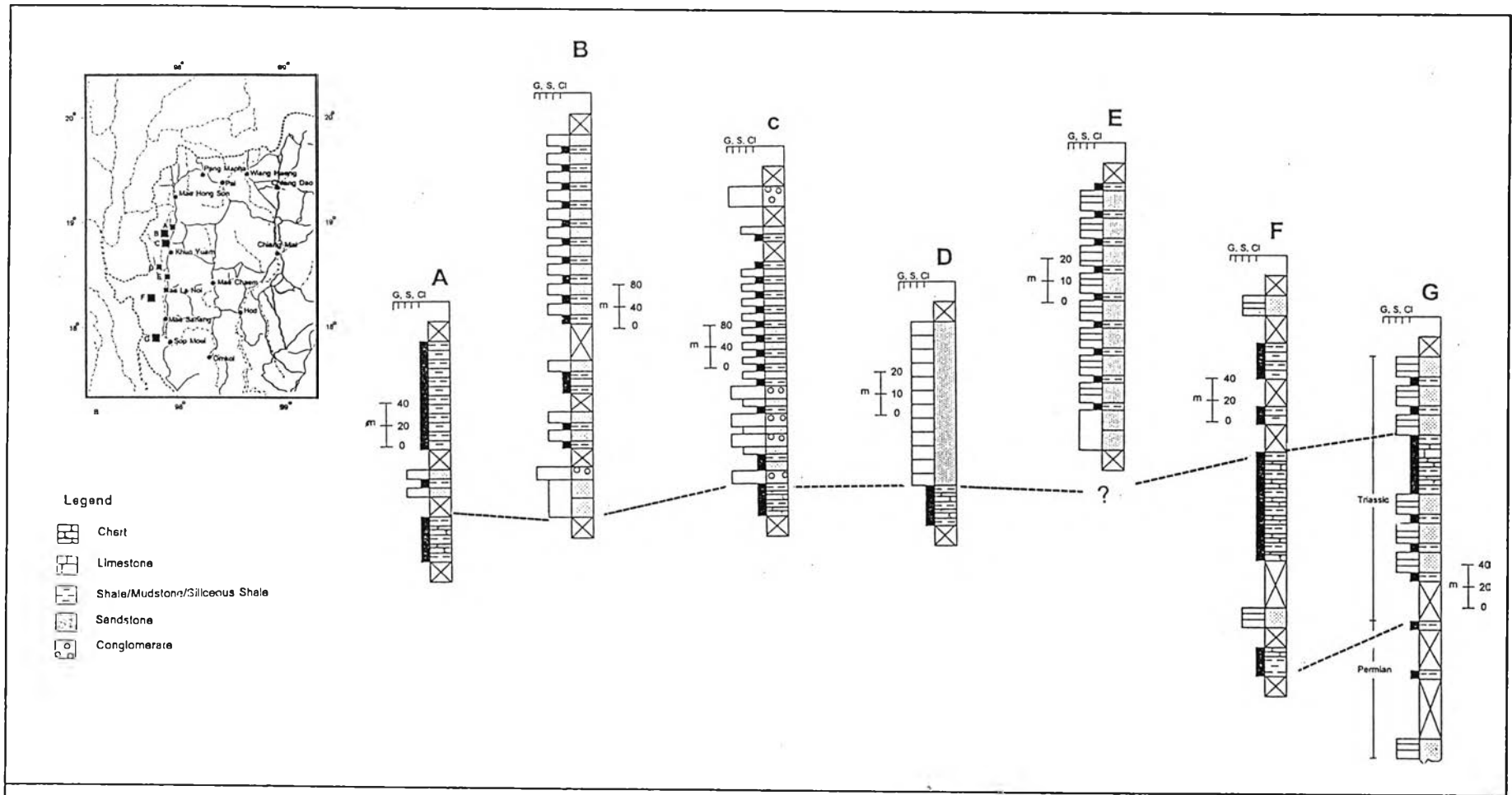


Figure 3.16 Correlation diagram for the Triassic rocks at the southern part of Amphoe Muang Mae Hong Son.



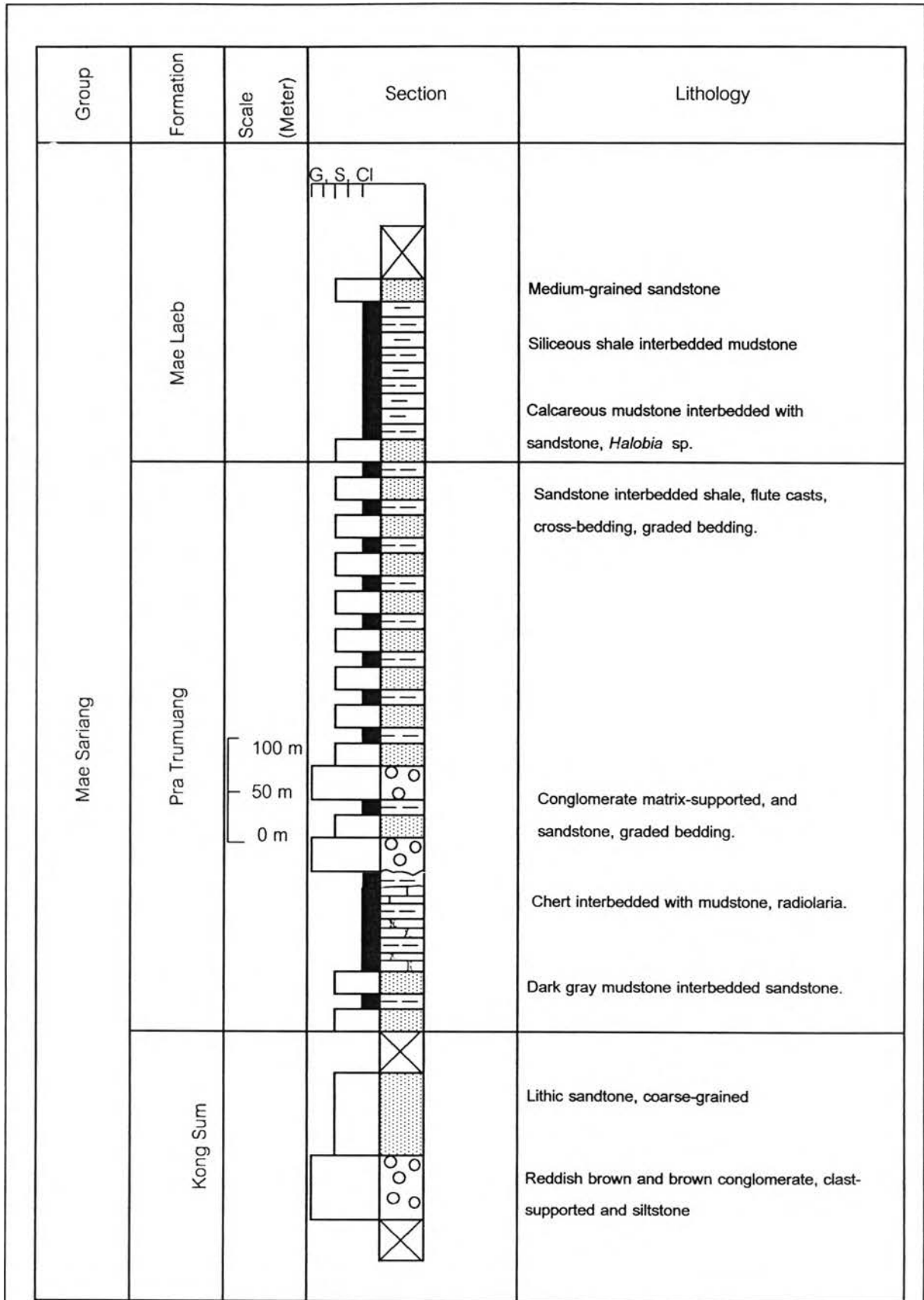


Figure 3.17 Composite section of the Mae Sariang Group.

The geology of the region has been described previously by various works; i.e. Baum et al. (1970), Bunopas (1976), Hahn and Siebenhüner, 1982, Charusiri et al. (1992), Tofke et al. (1993), Caridroit et al. (1993), Chonglakmani (1999), and Meesook et al. (2000) etc.

The western and eastern parts are mainly Upper Paleozoic clastic/limestone. Intrusive rocks are exposed along the eastern margin of Mae Hong Son-Mae Sariang Fault Zone. Small exposures of Cenozoic basalt occur at Ban Tha Ria about 30 km south of the Mae Sariang district.

The sandstone classification (Figure 3.18) comes from Folk (1974). Sediment maturity, both composition and textural, of sandstones was recognized after petrographic studies. The compositional maturity is after Pettijohn (1975) as the textural maturity is received from Folk (1959).

Based on field and remote-sensing investigations from this study together with the previous works, marine Triassic lithostratigraphy in the southern part of Amphoe Muang Mae Hong Son, Mae Hong Son can be divided into 3 formations namely, in ascending order : the Kong Sum formation ( $Tr_1$ ), the Pra Trumuang formation ( $Tr_2$ ), and Mae Leab formation ( $Tr_3$ ). The Kong Sum formation consists 2 lithofacies: the lower conglomerate and the lithic sandstone lithofacies. The Pra Trumuang formation consists of 4 lithofacies; dark gray mudstone and sandstone, chert interbedded mudstone, conglomerate interbedded sandstone, and sandstone and shale. The Mae Leab formation consists 3 lithofacies; calcareous mudstone and sandstone, siliceous shale interbedded mudstone, and medium sandstone. The siliceous shale interbedded mudstone lithofacies with abundant invertebrate fossils, bivalve of *Halobia* sp. Stratigraphically and paleontologically (Hahn & Siebenhüner, 1982; Kamata, 2002), the age of the Mae Sariang Group are assigned as Middle to Upper Triassic. The total thickness is above 900 meters. The correlation charts of all measured sections are presented in Figure 3.16. Described stratigraphy in this research study are shown below.

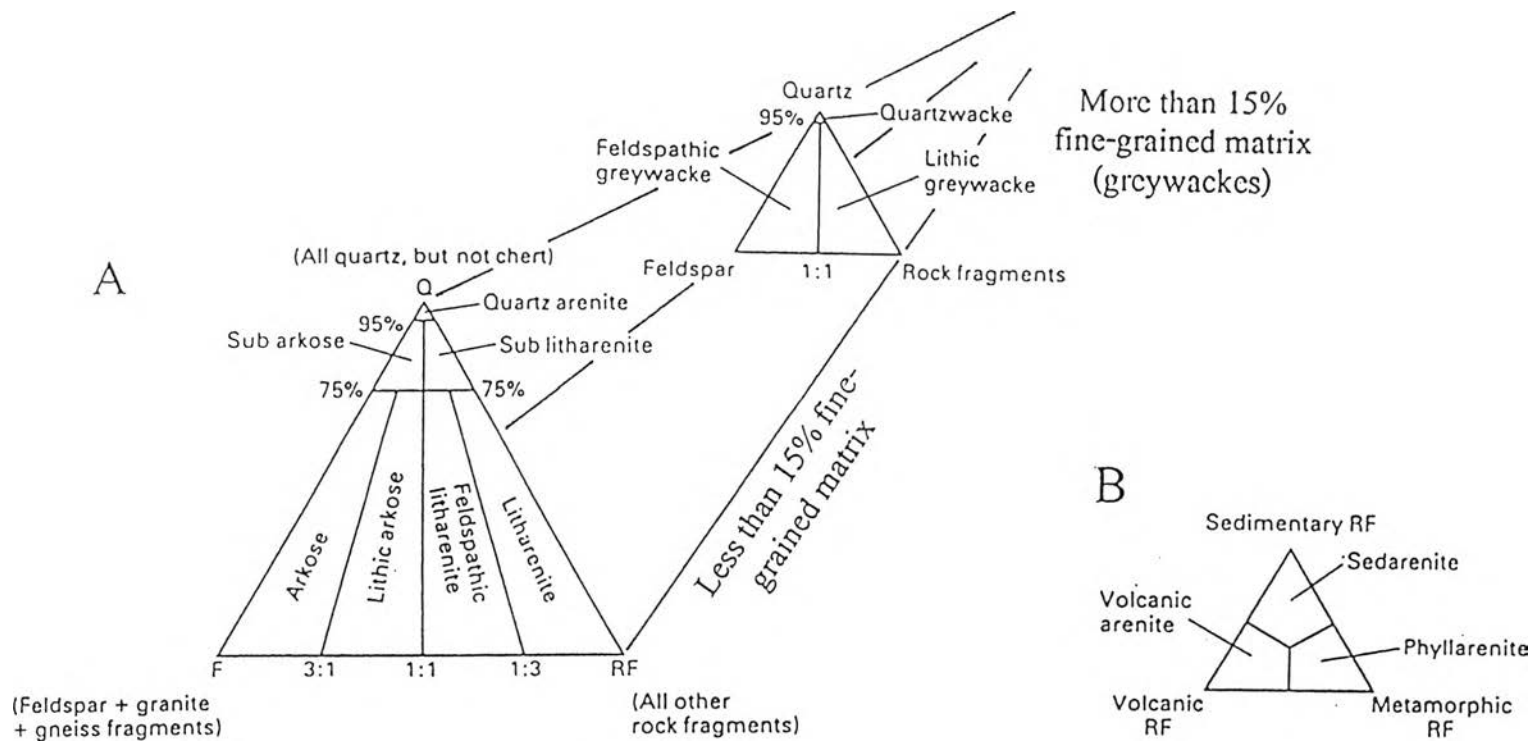


Figure 3.18 Diagram of most famous classification of sandstone (after Folk, 1974).

## **Mae Sariang Group**

As stated earlier the Mae Sariang Group of mainly Triassic age is subdivided into 3 formations in ascending order, as-the Kong Sum formation, the Pra Trumuang formation, and the Mae Leab formation, respectively. These 3 formations orientated roughly in the north-south direction (see Figure 3.19) The type sections are composite based on several road cuttings and stream exposures, west of Amphoe Muang Mae Hong Son, Amphoe Khun Yuam, Amphoe Mae La Noi, and Amphoe Mae Sariang. The best exposure is along Highway 108 from km 30 to km 150.

### **3.4.1 The Kong Sum formation (or Tr<sub>1</sub> unit)**

Based on the detailed study of Jindasuth et al. (1990), the Kong Sum formation, also called herein as the Tr<sub>1</sub> unit for convenience is considered as the oldest unit. It can be further subdivided into 2 lithofacies as lower conglomerate lithofacies and lithic sandstone lithofacies. Investigation based on enhanced Landsat TM5 reveal that the western unit (or the Tr<sub>1</sub> unit), shows high topography with high slopes, high denudation, and E-W spaced fracture in direction. Comparing to other formations, the Tr<sub>1</sub> unit occupies about 40 % of the regional study area (see Figure 3.19)

#### **3.4.1.1 Lower conglomerate lithofacies**

Lower conglomerate lithofacies is observed clearly in and around Ban Kong Sum. This lithofacies over lies unconformably the older unit, and consists largely of thickly bedded, reddish brown siltstone interbedded with pebbly sandstone. Clasts are mostly chert, limestone, and sandstone varying in size from 1 to 10 cm. Sorting is moderate, and subangular to subround clasts are quite common, at Huai Mae Lamong. The conglomerate is mostly clast-supported. Both sandstone and siltstone contain feldspar. At present, it is difficult to assign the age of this lithofacies. Although age determination based on fossils is not available, Triassic age is proposed for this lithofacies.

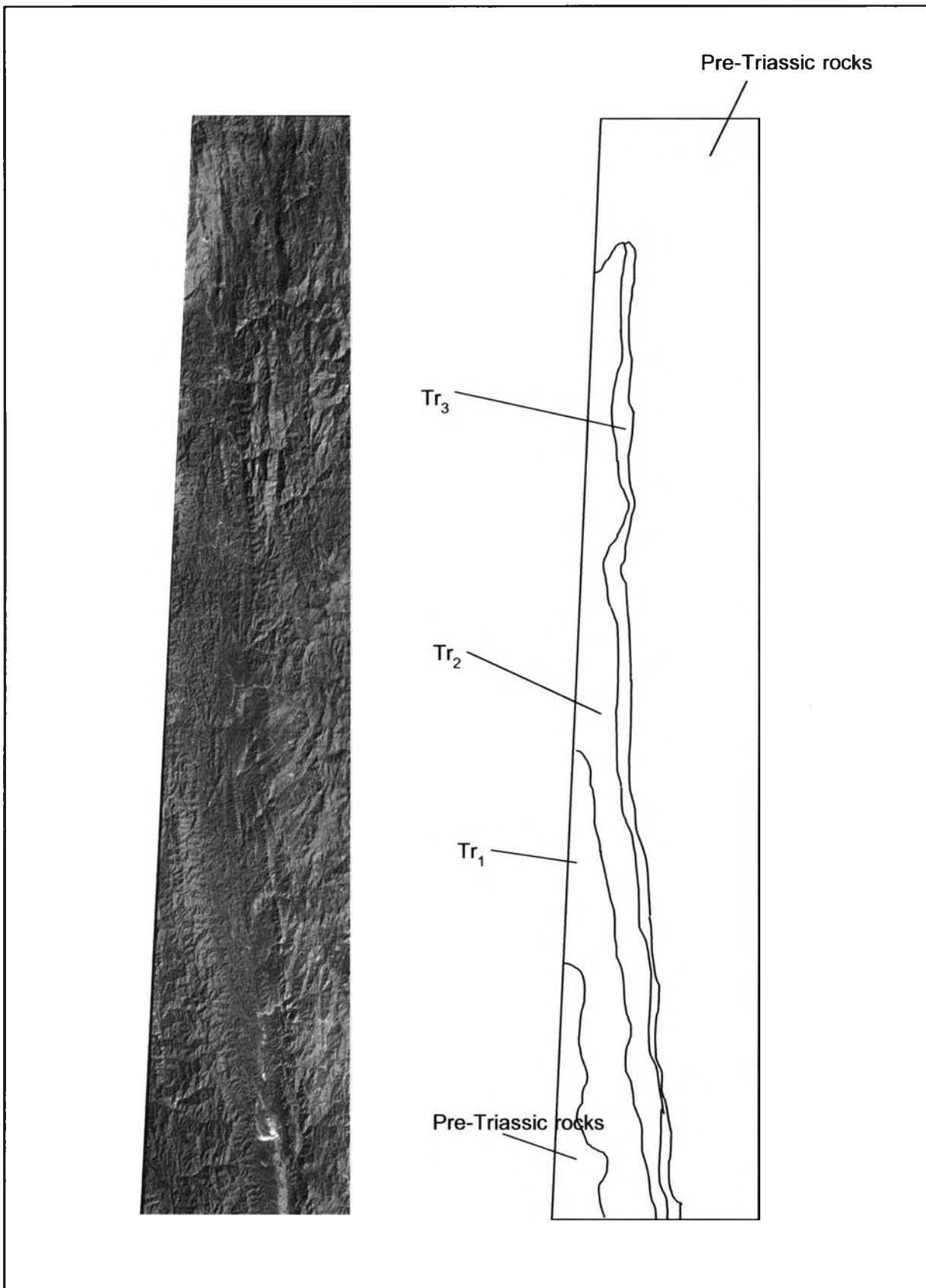


Figure 3.19 Interpret Triassic rocks from image satellite scale 1:250,000 consists Triassic ( $Tr_1$ ,  $Tr_2$ , and  $Tr_3$ ) and Pre-Triassic.

### 3.4.1.2 Lithic sandstone lithofacies

Lithic sandstone lithofacies is found in the north-south trend, particularly between Ban Kong Sum and Amphoe Mae La Noi. The rock sequence consists of thick-bedded (up 4-40 cm-thick), gray-colored, fine- to coarse-grained lithic sandstone with graded bedding. This sandstone is always interbedded with thinly out blackish gray, shale such as at grid no. 728-264 and 647-281 near Ban Kong Sum. The other interesting feature is the limestone interbedded as massive, gray-colored and lens-shaped beds with slump structure in some parts. Limestone is sandy and graded to thick-bedded gray sandstone with graded bedding. This sandstone is interbedded with gray mudstone with cross lamination and load casts. Structurally, the whole sequence are folded. Important fossils such as *Halobia* sp. and *Daonella* cf. *sumatrensis* suggest Upper Triassic. Based on the report Hahn & Siebenhüner (1982), most of fossils are *Crinoidea* indet (Wolfart), *Halobiidae* indet (Wolfart), *Halobia* cf. *comata* BITTERN?, *Halobia* cf. *austriaca* MOJSISOVICS, *Halobia* sp., ex gr. *sturiaca* MOJSISOVICS, and *Daonella* sp.. These fossils indicate the age of Anisian–Early Carnian (or Middle to Upper Triassic).

### 3.4.2 The Pra Trumuang formation (or the Tr<sub>2</sub> unit)

Outcrops in the middle part collectively called the Tr<sub>2</sub> unit are more widely exposed several kilometers long on the west of the eastern part which roughly follows the north-south trending Mae Sariang-Mae Hong Son Fault. Detailed study on enhanced spaced-borne image (Landsat TM5) indicates that the Tr<sub>2</sub> unit is characterized by moderate topography, low slope and NNW-SSE spaced fracture in direction. These mark contrasting features to those of the Tr<sub>1</sub> unit. In general, the attitude of the rocks strikes varying from NNW-SSE to NNE-SSW, with the average in the N-S trend. Due to the fact that rock strata of the Tr<sub>2</sub> unit overlie those of the Tr<sub>1</sub> unit, so the Tr<sub>2</sub> unit seems younger than the Tr<sub>1</sub> unit. As shown in Figure 3.19 strata belonging to the Tr<sub>2</sub> unit distribute about 50 % of the total study area.

In some parts of the middle succession, a few index fossils such as bivalve were observed in shale. Their ages of bivalves, which are justified on few sport-locations, are

mostly Early Triassic (Buam et al., 1970). Based upon the lithological and structural relations, the middle part can be stratigraphically divided into 4 lithofacies from bottom to top, as described below:

3.4.2.1 Dark gray mudstone and sandstone lithofacies

3.4.2.2 Chert interbedded mudstone lithofacies

3.4.2.3 Conglomerate interbedded sandstone lithofacies

3.4.2.4 Sandstone and shale lithofacies

3.4.2.1 Dark gray mudstone and sandstone lithofacies

The dark mudstone interbedded with sandstone from the lower part of the Pra Trumuang formation (Figure 3.20). Its thickness is about 60 m. The lithofacies are characterized by thin-bedded dark gray mudstone intercalated with thin-bedded intercalated with thin-bedded dark gray sandstone. The sandstone is composed mainly of quartz, feldspar, and rock fragments. Most of quartz are fine-grained, round and poorly sorted with siliceous cements.

3.4.2.2 Chert interbedded mudstone lithofacies

The chert interbedded mudstone is characterized by gray chert intercalated with thin-bedded mudstone, however, interbedded gray limestone in some parts. The thickness ranges approximately from 16 to 148 meters. The measured sections are at Ban Pra Trumuang (Amphoe Khun Yuam sheet, 4546 I), Ban Mae Leab (Amphoe Mae La Noi sheet, 4545 I), and Ban Huai Pho (Amphoe Mae Sariang sheet, 4545 II)(Figure 3.21).

Paleontologically, Kamata et al. (2002) reported that fossils of radiolarian found in this lithofacies, indicate the age of Early(?) to Late Triassic.



Figure 3.20 Dark gray mudstone and sandstone lithofacies, showing moderate stratified mudstone at Ban Huai Pho, Amphoe Mae Sariang.



A



B



C



Figure 3.21 The chert interbedded mudstone lithofacies, (A) at Ban Pra Trumuang site; (B) at Ban Huai Na site; (C) at Ban Huai Pho site.

### 3.4.2.3 Conglomerate interbedded sandstone lithofacies

As shown in Figure 3.22, the conglomerate interbedded sandstone lithofacies is a predominantly conglomerate interbedded sandstone and shale with the thickness of 97 m. This lithofacies unconformably overlies the chert interbedded mudstone lithofacies and is unconformably overlain by the Sandstone and shale lithofacies.

Characteristic of conglomerate interbedded sandstone lithofacies is a predominantly conglomerate interbedded sandstone and shale, and thin- to medium-bedded sandstone. Conglomerates are matrix-supported and clasts are made up mainly of chert and quartz whose size varies from 0.2 to 5.0 cm. The sandstone is light gray to yellowish brown, thin-bedded, and medium-bedded, medium-grained consisting mainly of quartz, feldspar, and dark minerals with common graded bedding, and usually shows sharp contacts with overlying reddish brown mudstone. The lowermost part of this unit is marked by conglomerate interbedded sandstone. Ban Pra Trumuang and Ban Sape are considered as the type localities in this remarked work.

### 3.4.2.4 Sandstone and shale lithofacies

The lithostratigraphic columns from the measured section are shown in Figure 3.23. The sandstone and shale lithofacies is a predominantly sandstone interbedded shale. This lithofacies unconformably overlies the conglomerate interbedded sandstone lithofacies. The sandstone and shale lithofacies is characterized by medium- to very thick-bedded sandstone with interbedded thin-bedded shale with graded bedding, cross bedding, and flute casts (Figure 3.24). The sandstone is white to light gray, medium to very thick-bedded, consisting mainly of quartz, feldspar, and rock fragments. The shale is gray to brown, thin-bedded. The lower most part of this unit is white sandstone interbedded brown shale. Good exposures are observed at Ban Pra Trumuang of Amphoe Khun Yuam. The overall thickness this lithofacies is estimated about 484 to 512 meters.

**A****B**

Figure 3.22 The conglomerate interbedded sandstone lithofacies, (A) at Ban Sape site;(B) at Ban Pra Trumuang site.

A



B



C



Figure 3.23 The sandstone and shale lithofacies, (A) at Ban Sape site; (B, C) at Ban Pra Trumuang site.

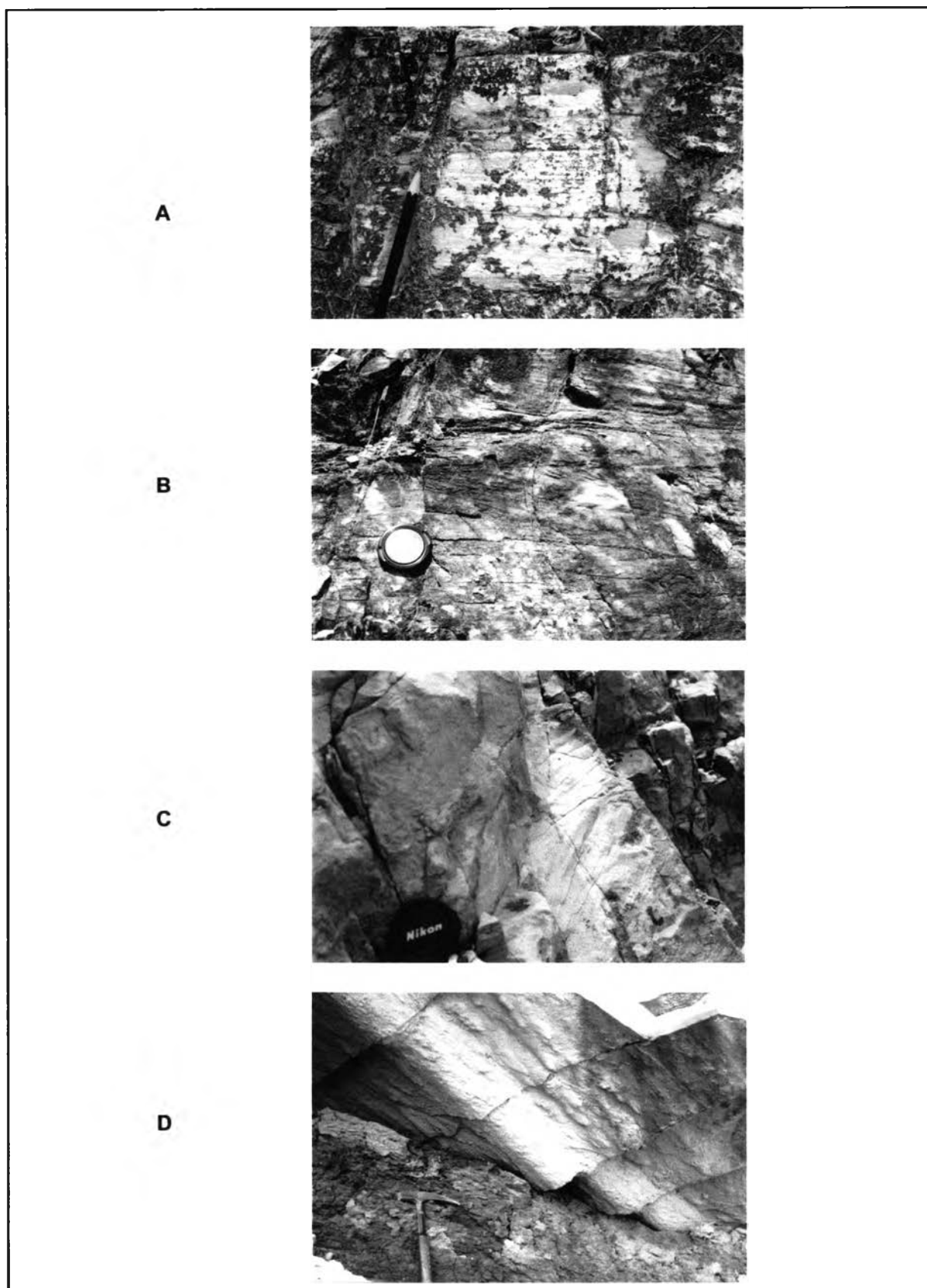


Figure 3.24 The sandstone and shale lithofacies, (A) cross bedding at Ban Sape site; (B, C) cross bedding at Ban Pra Trumuang site; (D) flute casts at Ban Pra Trumuang site.

### **3.4.3 The Mae Leab formation (Tr<sub>3</sub> unit)**

The Mae Leab formation refers to the sequence between the middle part (Tr<sub>2</sub> unit) of Triassic rocks and the Jurassic clastic rocks. These formation occurs in much smaller amount, about 10% of the total studied Triassic rocks. It is exposed locally at Ban Huai Pong (measured section A), Ban Huai Hin Lak Fai (measured section E), and Ban Mae Leab (measured section F) (Figure 3.25).

The eastern part is collectively called the Tr<sub>3</sub> unit due to its sequence lying over the Tr<sub>2</sub> (or middle unit). Geologic cross-sections (see Figure 3.12b) indicate that the Tr<sub>2</sub> strata significantly dip to the east, suggesting that the Tr<sub>3</sub> unit is younger than the Tr<sub>2</sub> unit. Detailed study on enhanced Landsat TM5 image data reveals that the Tr<sub>2</sub> unit display low topography with low slope, and N-S fractures in direction. The Tr<sub>3</sub> unit has the thickness of about 118 m. Important fossils on Cephalopoda, Conodonta, *Posidonia* sp., and *Halobia* sp. (see Hahn and Siebenhüner, 1982). It indicate the age of Middle to Late Triassic. The Tr<sub>3</sub> unit can be divided into 3 lithofacies as the calcareous mudstone interbedded sandstone, the siliceous shale interbedded mudstone, and the sandstone in ascending order.

#### **3.4.3.1 Calcareous mudstone and sandstone lithofacie**

Calcareous mudstone and sandstone lithofacies form the lower part of the Mae Leab formation (Figure 3.26). Lithofacies are characterized by medium-bedded mudstone intercalated with thin-bedded sandstone. Apart from quartz, clay and micaceous mineral, calcite is also present as calcareous cement in mudstone. The sandstone is composed mainly of quartz, feldspar, and rock fragments with siliceous cements. Most of the clasts are very fine-grained and well sorted.

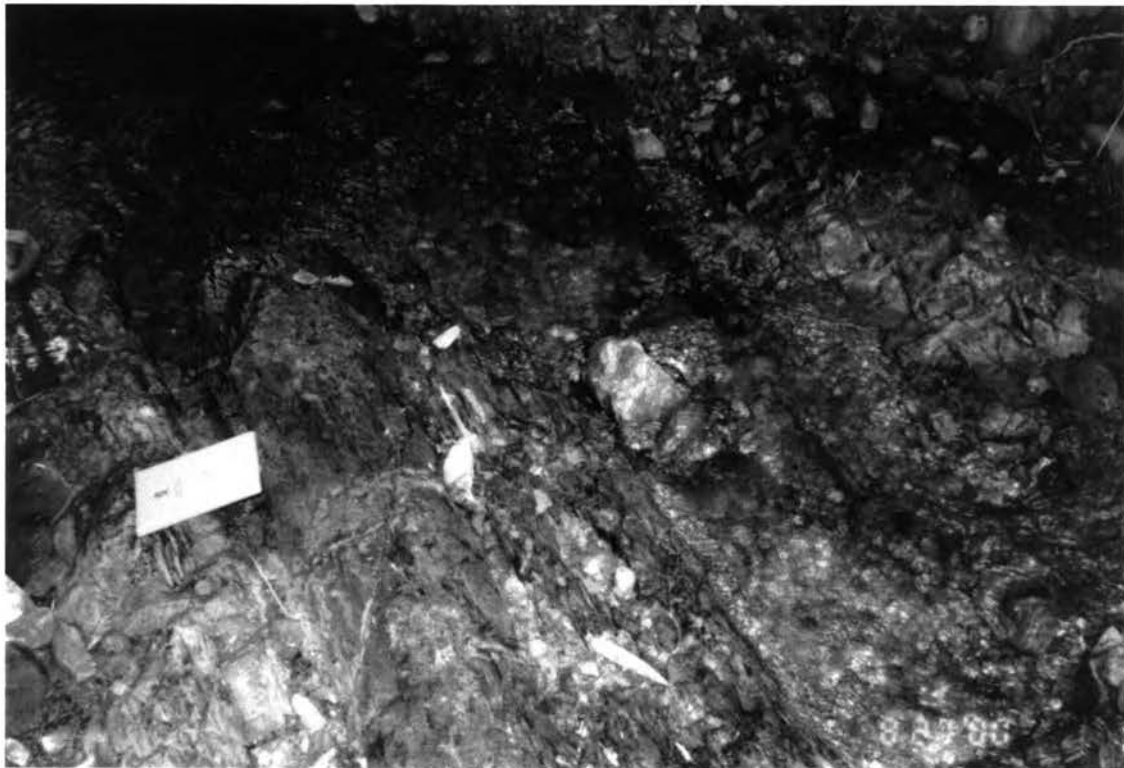
#### **3.4.3.2 Siliceous shale interbedded mudstone lithofacies**

It is usually characterized by black, thin-bedded, siliceous shale interbedded (Figure 3.27) with black thin-bedded mudstone. The lithofacies has the thickness of above 80 meters.



**A****B**

Figure 3.25 The Mae Leab formation, (A) dark gray mudstone at Ban Huai Pong site; (B) siliceous shale interbedded shale at Ban Mae Leab site.



Figuer 3.26 Calcareous shale and sandstone lithofacies at Huai Hin Lak Fai site.





Figure 3.27 Siliceous shale interbedded mudstone lithofacies, showing well stratified siliceous shale and mudstone, at Ban Huai Pong site.

### 3.4.3.3 Medium-grained sandstone lithofacies

The above 20 m-thick sequence is characterized at the lower part by mainly white sandstone. The sandstone strata occur at the top part of the sequence. This sandstone is principally composed of quartz, feldspar, and rock fragments, brown, medium- to coarse-grained, subround, poorly sorted, medium- to thick-bedded, and parallel bed type.

## **3.5 Geological structures of the Mae Hong Son area**

Regional geological structure of northern Thailand mainly orientates in the N-S direction for rocks ranging in age from the Pre-Cambrian to Recent (Figure 2.16). The granites along the eastern part of the northern Thailand are mainly Triassic whereas those in the eastern part of Triassic granite are Carboniferous.

The major geological structures include folds, fractures, and faults which mainly orientates in the north-south direction.

Within the study area, various geological structures are measured and described throughout the area including beds, faults, and fractures. After that, data of attitudes are compiled and analyzed using Schmidt method for computing and equal area projection technique, and the "NETPROG version 4.0" software.

### Bed

The bedding planes recognized in all outcrops of the study area are shown in Table 3.8. The major trend of bedding has a common north-south orientation.

From the stereographic projection plots, two trends are defined in the study area. Most of the dip angles are between 20-80 degree for all rock units, whereas the Permian rocks are between 30-50 degree. For the Triassic rocks, the dip angles are between 20-80 degree. The value of dip angles of the Pra Trumuang formation are between 20-80 degree.

**Table 3.8** Attitude of bedding, fracture, fault in study area (dip direction/dip angle)

Section	Bedding	Fracture	Fault
A (Ban Huai Pong)	260/40, 180/30, 50/80, 210/65, 200/35	10/90, 95/50	-
B (Ban Sape)	30/35, 330/20, 25/30, 310/60, 170/50, 170/25, 230/40, 30/20, 80/55, 30/30	230/50, 130/40, 70/75, 30/20, 215/35, 150/70, 140/85, 210/50	-
C (Ban Pra Trumuang)	90/25, 55/50, 220/40, 10/35, 175/75, 20/60, 345/25, 350/20, 10/55, 20/30, 45/30, 340/45, 0/20, 350/20, 30/35, 10/40, 10/35, 50/30, 75/20	320/90, N-S, 135/60, 145/55, 20/40, 95/75, 310/55, 220/60, 130/60, 310/75, 85/55, 310/75, 245/70, 90/85, 220/85, 135/70, 215/70	10/50, 0/85, 340/65, 0/50, 85/80, 15/70, 60/70,
D (Ban Huai Na)	310/90	N-S	-
E (Huai Hin Lak Fai)	5/55	60/40	215/15
F (Ban Mae Leab)	20/20, 60/40, 300/70, 10/30, 350/45, 240/85	N-S, 40-220, 190/85, 250/80, 30/70, 270/60	-
G (Ban Huai Pho)	130/55, 65/50, 290/35, 310/50, 340/40, 310/30	240/65, 200/45, 60/85, 180/60, 110/45, 30/40, 230/40, 200/60, 0/65	140/60

For the Mae Leab formation, the average dip angle is between 30-80 degree. The dip angle of all rock units are summarized in Table 3.9 and Figure 3.28.

### Faults

From the field investigations, the trend of faults is NE-SW direction, and the attitude of fault planes is shown in Table 3.8.

The rosette diagram plots (Figure 3.29) of fault planes in the study area show that the NE-SW set is the major fault system whereas the N-S system is the minor fault system.

### Fractures

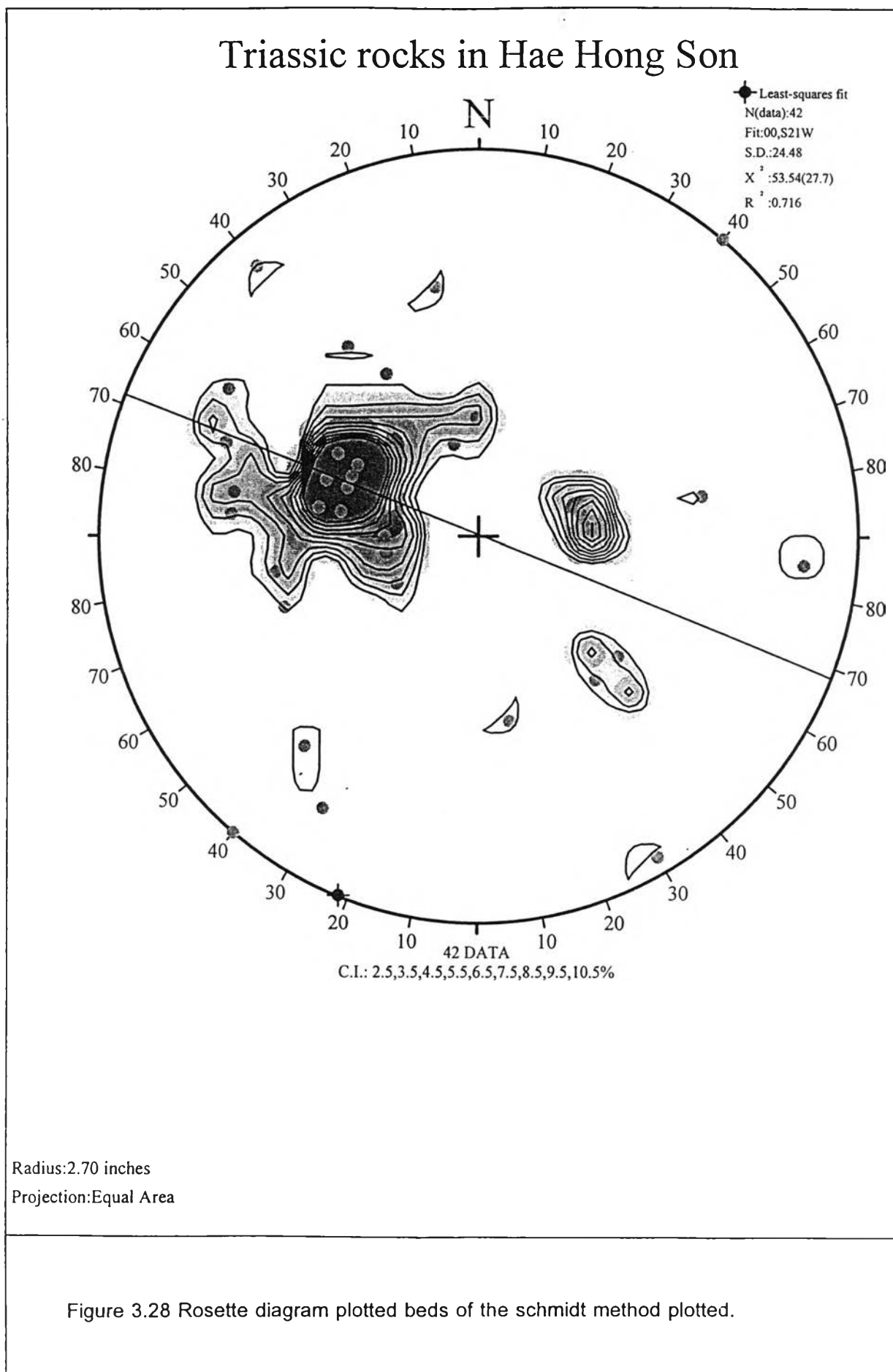
From the field investigations, the fractures of the study area (Fig. 3.30) are mainly in NE-SW and N-S directions. All directions of fractures of rock units (the Pra Trumuang formation and Mae Leab formation) are shown in Table 3.8.

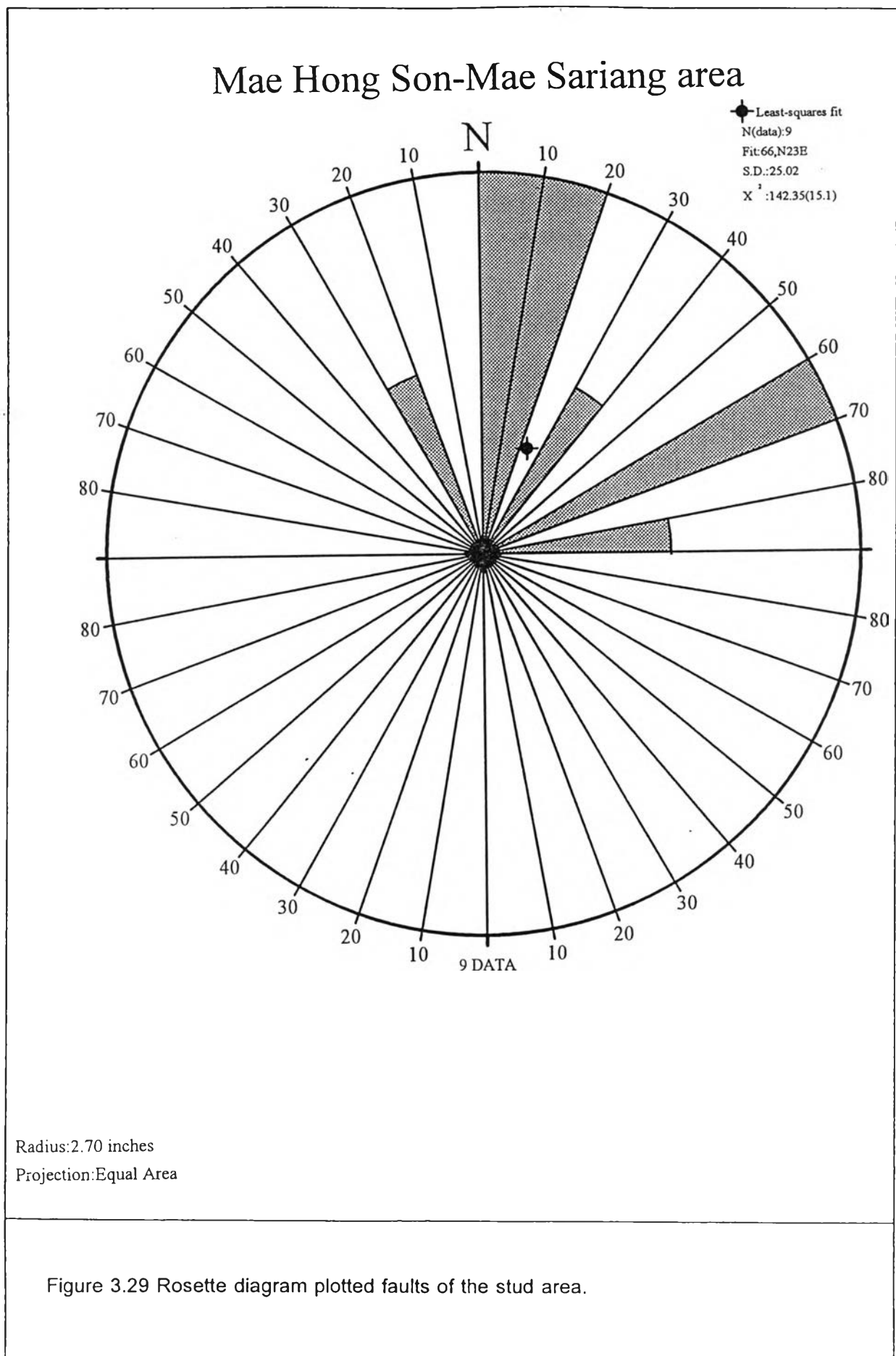
## **3.6 Petrography**

In order to fully understand the lithological characteristics of the Mae Sariang Group, about 65 hand-specimen samples have been collected for detailed microscopic study. Locations of rock sample collected represent all formation and lithofacies (Figures 3.3c, 3.6c, 3.8c, 3.10c, 3.11c, 3.12c and 3.14c). The thin-section examination is focussing upon the mineral composition, textures, and microstructures. The detailed petrographic description of the representative samples are as follows:

### Permian rocks

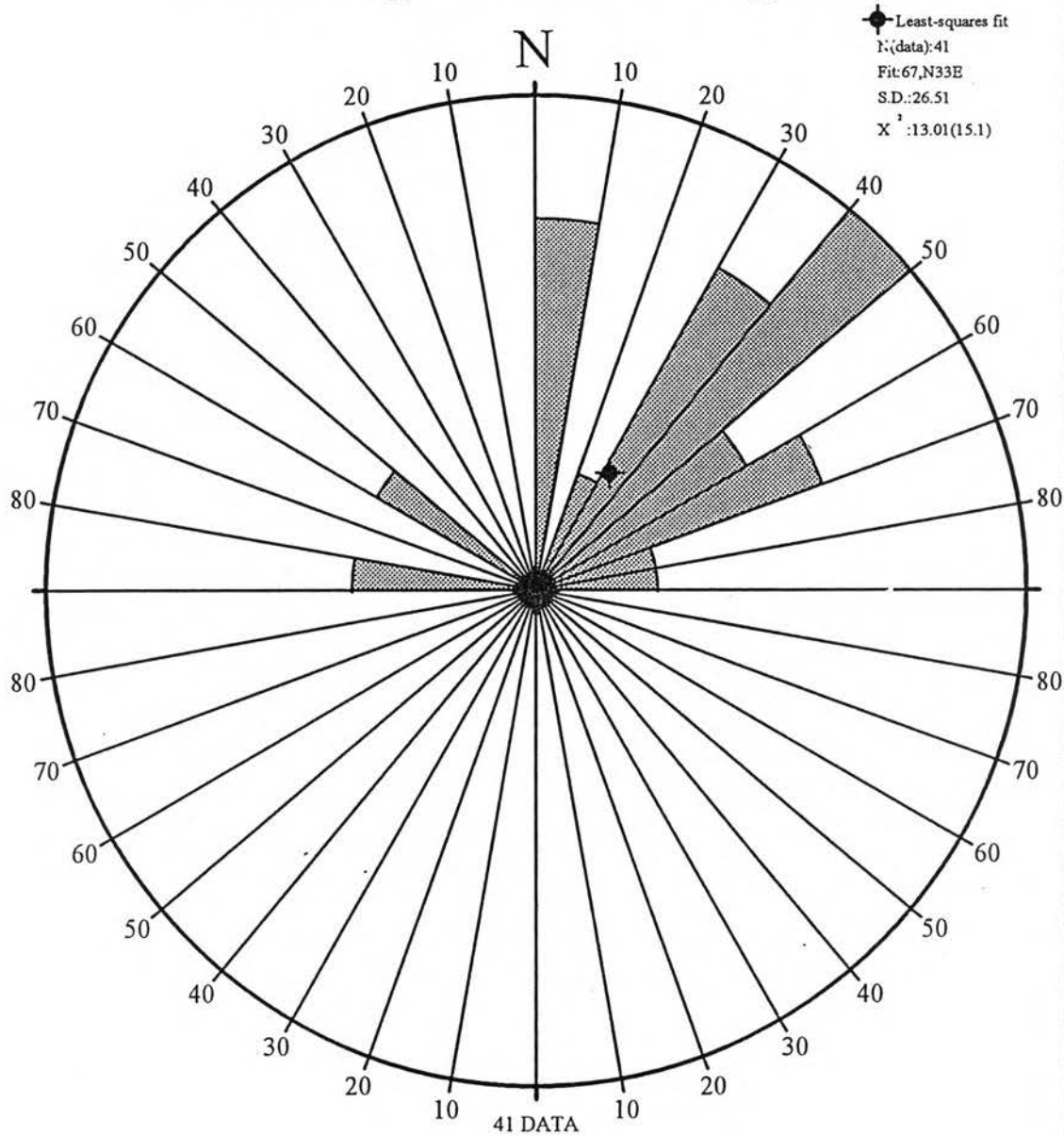
Microscopic studies of Permian rocks reveal that they are commonly arkose and mudstone. The arkose and mudstone is confined in thin-bedded at the upper part of succession of Permian clastics of Ban Huai Pho (section G).







### Mae Hong Son-Mae Sariang area



Radius:2.70 inches  
Projection:Equal Area

Figure 3.30 Rosette diagram plotted fractured of the study area.

**Table 3.9** Dip angle of mainly Triassic rock strata from each measured section.

Section	Dip angle (degree)
A (Ban Huai Pong)	30-80
B (Ban Sape)	20-60
C (Ban Pra Trumuang)	30-75
D (Ban Huai Na)	90
E (Huai Hin Lak Fai)	55
F (Ban Mae Leab)	20-85
G (Ban Huai Pho)	30-55



Petrographically, arkose (Figure 3.31, sample 001209-5, of measured section G) contains clastic texture of mainly quartz (65%), feldspar (25%), and rock fragments (10%) with siliceous cement. Most of quartz are medium-grained, subround, and poorly sorted.

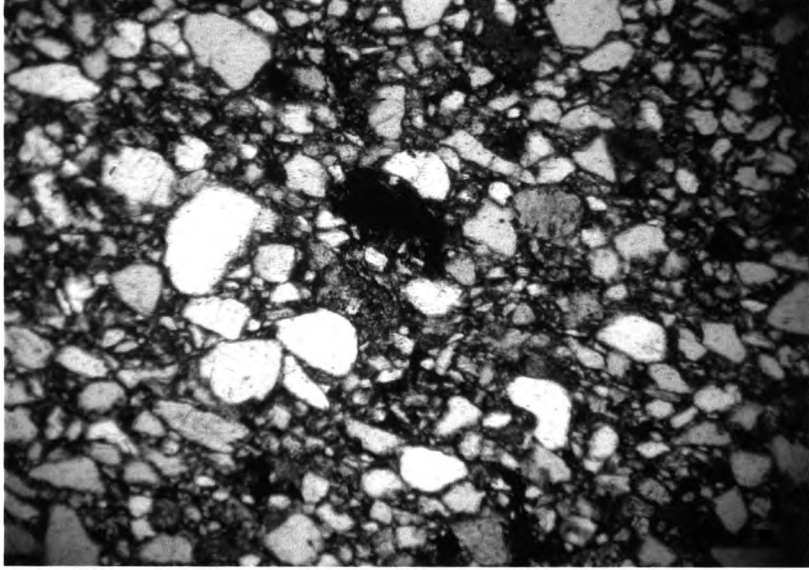
### Mae Sariang Group

The details of petrographic study of the Mae Sariang Group is focussing upon representative rock samples collected from measured sections under the present investigation. The lithofacies are defined on the bases of lithology, geometry, sedimentary structure, and fossils associations in order to reconstruct their depositional environment. The Mae Sariang Group consists of 3 formations; the Kong Sum formation, the Pra Trumuang formation, and the Mae Leab formation in ascending order. The Kong Sum formation consists of lower conglomerate and lithic sandstone lithofacies. The Pra Trumuang formation consists of dark gray mudstone and sandstone, chert interbedded mudstone, conglomerate interbedded sandstone, and sandstone and shale. The Mae Leab formation is composed of calcareous mudstone and sandstone, siliceous shale interbedded mudstone, and medium sandstone. The lithologies are named after the classification developed by Folk (1959, 1974), and Pettijohn (1975). The lithofacies are summarized in Table 5.1.

#### **The Kong Sum formation**

Based on the detailed study of Jindasuth et al. (1990), the Kong Sum formation can be further subdivided into 2 lithofacies as lower conglomerate lithofacies and lithic sandstone lithofacies. The lower conglomerate consists largely of thickly bedded, reddish brown siltstone interbedded with pebbly sandstone. Clasts are mostly chert, limestone, and sandstone varying in size from 1 to 10 cm. Sorting is moderate, and subangular to subround clasts are quite common at Huai Mae Lamong. The conglomerate is mostly clast-supported. Both sandstone and siltstone contain feldspar. The Lithic sandstone lithofacies is composed of thick-bedded (up 4-40 cm-thick), gray-colored, fine- to coarse-grained lithic sandstone with graded bedding.

a) Without nicols



b) Under crossed nicols

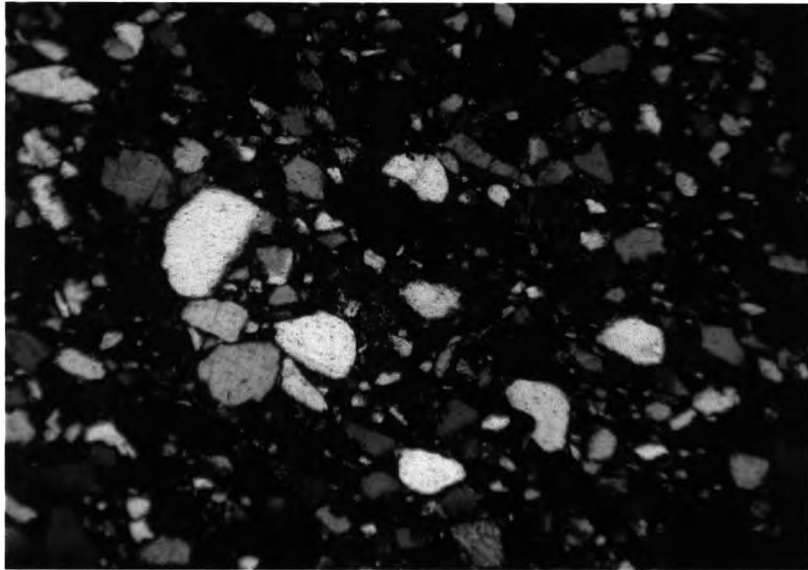


Figure 3.31 Photomicrograph of poorly sorted, medium-grained arkose of Permian rocks, Sample no. 001209-5, showing clasts of quartz feldspar, and rock fragments, x40-.

## **The Pra Trumuang formation**

### Dark gray mudstone and sandstone lithofacies

The dark gray mudstone and sandstone lithofacies is confined to the lower part of the Pra Trumuang formation (measured sections C, D, F, and G). It consists of dark gray mudstone and lithic graywacke with well-bedded.

Petrographically, Lithic graywacke (Figure 3.32, sample 001209-1) consists of clastic texture and mainly of quartz (40%), feldspar (20%), and rock fragments(40%). Most of quartz are fine-grained, round, and poorly sorted.

The distribution of mudstone interbedded sandstone is Ban Huai Pho (measure section G).

### Chert interbedded mudstone lithofacies

The distribution of chert interbedded sandstone lithofacies is common in this lithofacies of the Pra Trumuang formation, i.e., at Ban Pra Trumuang (measured section C), Ban Huai Na (measured section D), Ban Mae Leab (measured section F), and Ban Huai Pho (measured section G) and thickness varies considerably from place to place. Megascopically, dark gray color of chert and mudstone are common.

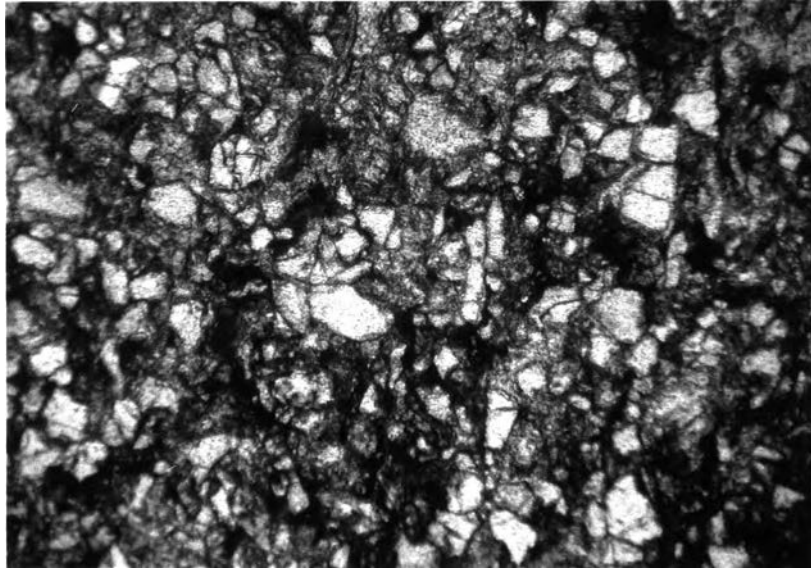
Petrographically, chert is composed mainly of non-clastic texture with micro quartz and radiolaria (Figure 3.33, sample 000829-4).

### Conglomerate interbedded sandstone lithofacies

The conglomerate interbedded sandstone lithofacies consists of conglomerate and sandstone. The clasts comprise of quartz, and chert with matrix-supported texture.

Petrographically, the conglomerate with matrix-supported texture and clasts

a) Without nicols



b) Under crossed nicols

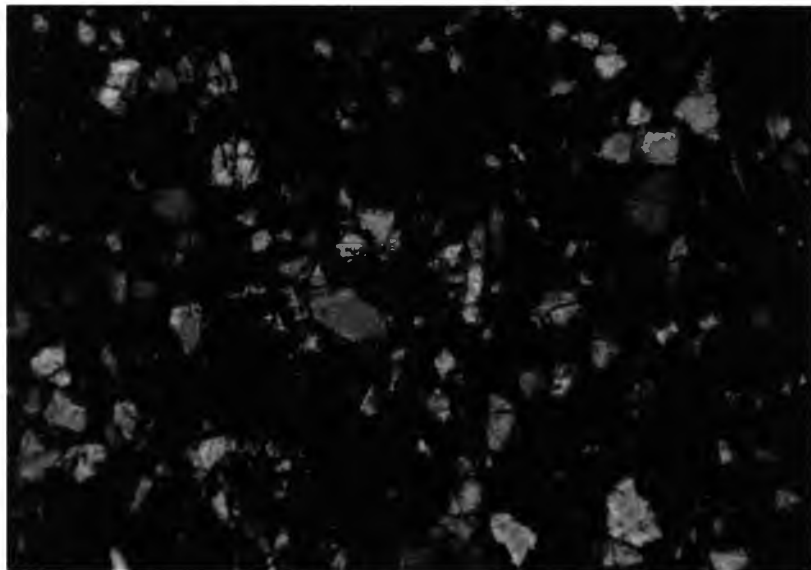
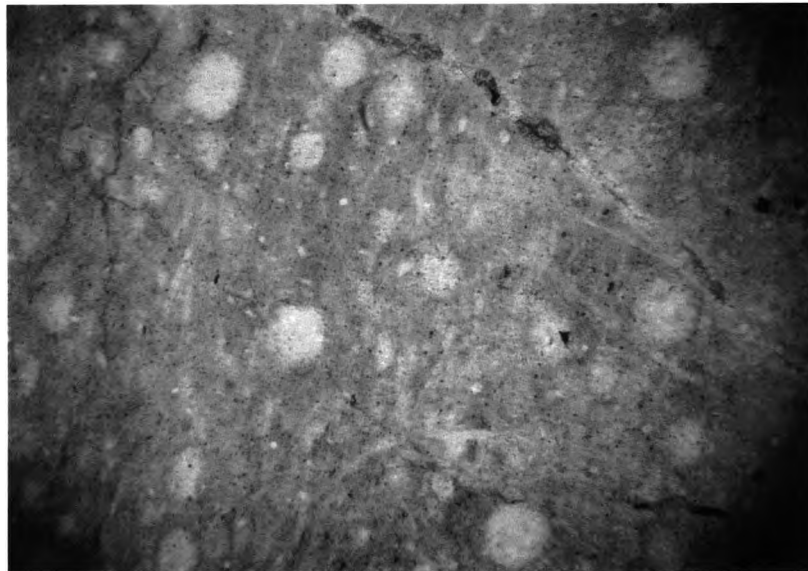


Figure 3.32 Photomicrography of moderate sorted, fine-grained lithic arkose of dark gray mudstone and sandstone, Sample no. 001209-1, showing of quartz, feldspar, and rock fragments, x40.

a) Without nicols



b) Under crossed nicols

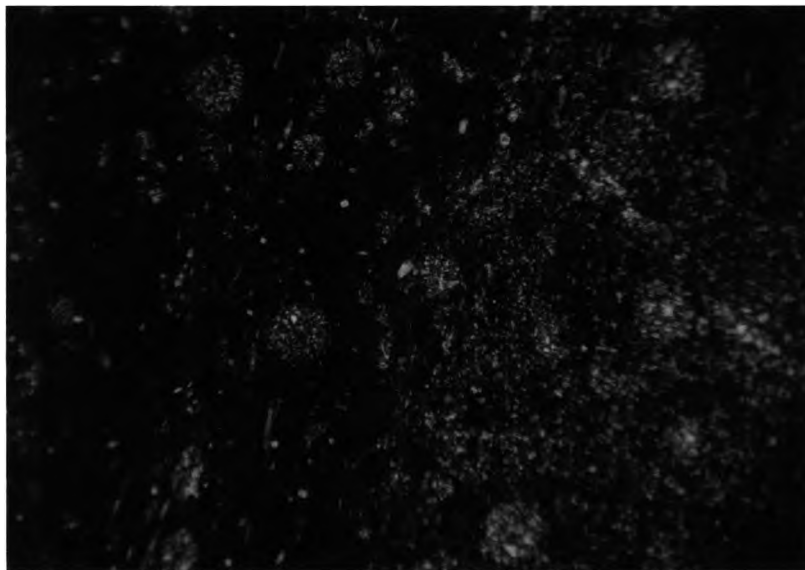


Figure 3.33 Photomicrography of chert of chert interbedded mudstone, Sample no. 000829-4, showing radiolarian and non-clastic texture, x40.

are made up to chert, and quartz of average gravel to pebble sizes. The chert is confined as clasts of conglomerate at Ban Sape (measured section B), and Ban Pra Trumuang (measured section C).

#### Sandstone and shale lithofacies

The sandstone and shale lithofacies is mainly consisting of white to light gray arkose to litharenite. The litharenite is recognized in the upper and middle parts of unit at Ban Sape (measured section B), and Ban Pra Trumuang (measured section B).

Petrographically, the litharenite (Figure 3.34, sample 000830-15) mostly consists of quartz (30-60%), feldspar (5-40%), and rock fragments (10-60%).

The detrital grains are fine- to medium-grained, subround to round, moderate sorted, with ferroigneous and silicate cement.

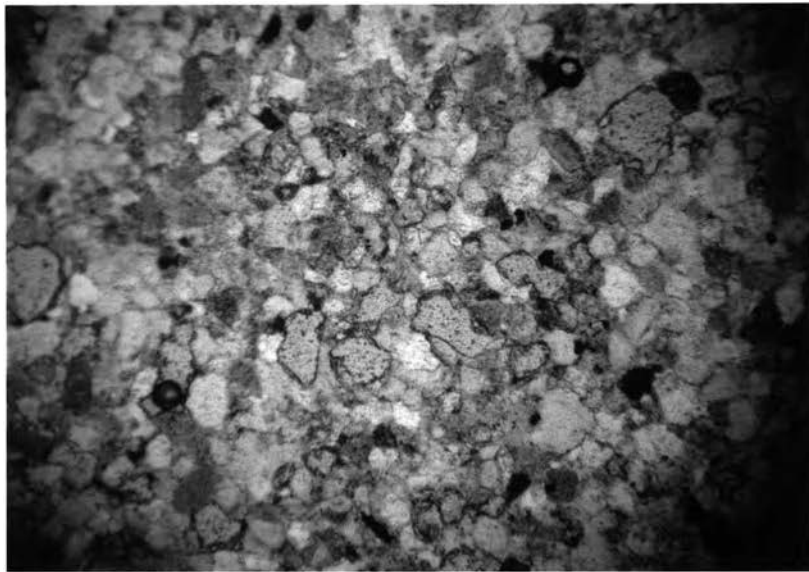
### **The Mae Leab formation**

#### Calcareous mudstone and sandstone lithofacies

The calcareous mudstone and sandstone lithofacies are confined to the lower part of the Mae Leab formation (measured section A and E) and the lithology of this lithofacies is characterized as graywacke.

Petrographically, arkose (Figure 3.35, sample 000828-3) contains clastic texture and mainly of quartz (65%), feldspar (10%), and rock fragments. Most of quartz are very fine-grained, round, and poorly sorted.

a) Without nicols



b) Under crossed nicols

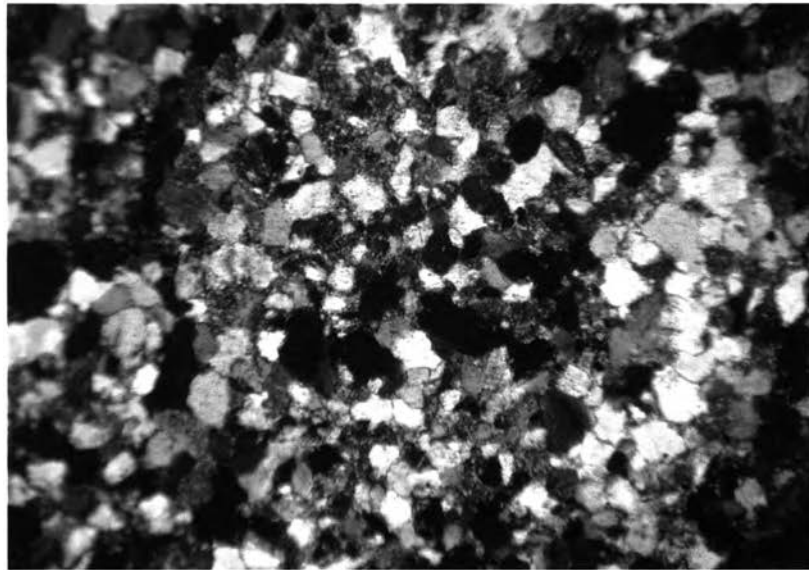
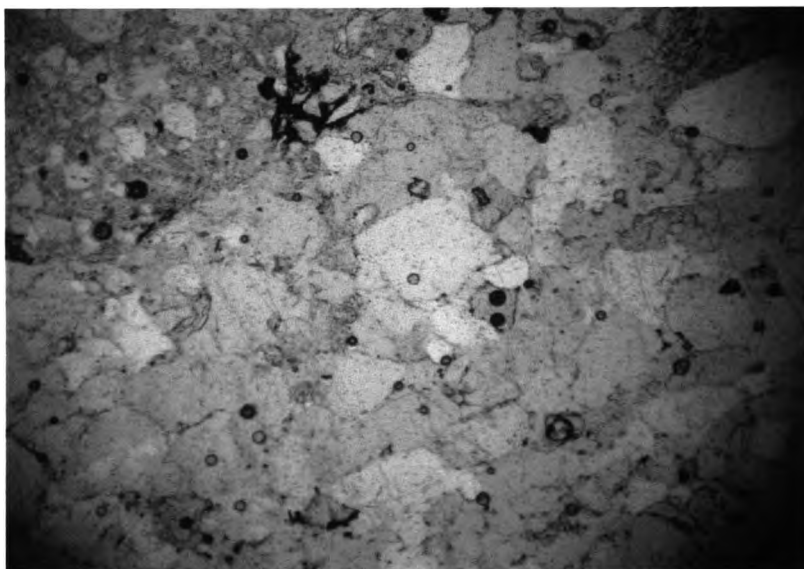


Figure 3.34 Photomicrography of well sorted, fine-grained feldspathic litharenite of Sandstone interbedded shale, Sample no. 000830-15, showing clasts of quartz, feldspar, and rock fragments, x40.

a) Without nicols



b) Under crossed nicols

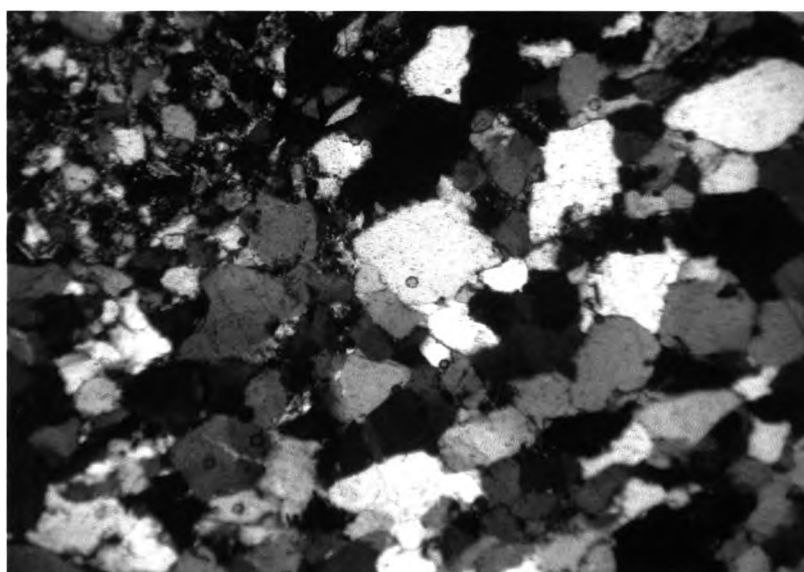


Figure 3.35 Photomicrography of well sorted, medium-grained arkose (Sample no. 000828-3), showing clasts of quartz, feldspar, and muscovite, x40.



#### Siliceous shale interbedded mudstone lithofacies

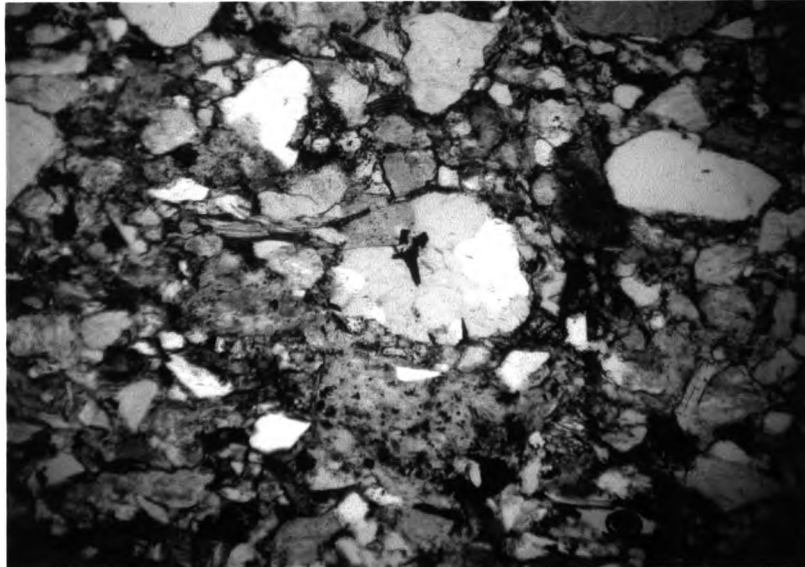
The siliceous shale and mudstone lithofacies are confined to the middle part of the siliceous shale-dominant unit. This lithofacies is mainly consisting of black siliceous shale and mudstone.

#### Medium-grained sandstone lithofacies

The microscopic studies of this lithofacies is confined to medium- to thick-bedded sandstone, white with fining upward sequence. The distribution of this lithofacies is at measured section F, Ban Mae Leab.

Petrographically, litharenite contains clastic texture of mainly quartz (30%), feldspar (20%), and rock fragment, with siliceous cement. Most of quartz are medium-grained. (Figure 3.36, sample 001211-9).

a) Without nicols



b) Under crossed nicols

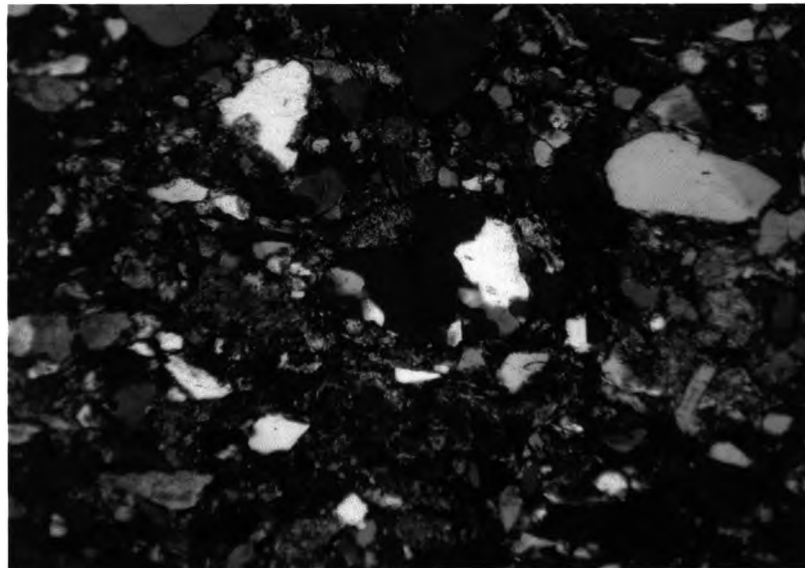


Figure 36 Photomicrograph of poorly sorted, medium-grained arkose (Sample no. 001211-9), showing clasts of quartz, feldspar, and rock fragments.