CHAPTER IV

NEOTECTONIC EVIDENCES

In this chapter neotectonic evidences are depicted in more detail. Evidences gathered from satellite image data, aerial - photographic information and field evidences are described and form the main matter for this study. The other evidences such as epicenter locations, heat-flow data and hot - spring locations are the additional supports for the neotectonic evidences. However, the other useful evidence is that of the TL- and ESR- dating results. All of these results are compiled and used for the next chapter for detailed discussion and interpretation.

4.1 Results from Satellite Image Interpretation

In this study, both digitally enhanced Landsat TM5 and JERS radar image data are applied, and digital enhancement process are used for image processing and analysis by earthview program. However, visual interpretation is regarded the prime and most effective for identification of neotectonic features. For the Landsat images, the false coloured composite - blue, green and red are digitally added to the data image bands of 7, 5 and 4, respectively, following the work of Charusiri et al. (1996). However, some landsat data, for examples that show in Fig. 4.2 of with composite colors blue, green and red are applied to bands 3,4 and 5 (Fig. 4.2a) and to bands 2,3 and 4 (Fig. 4.2b), respectively. For the JERS image data, automatic enhancement process is performed with the assistance of the computer programme provided by Seiki (1997, person. comm.). However, detail description of individual processes will not be mentioned herein, since it is out of the scope to this thesis study.

The advent of image study and interpretation is to assist in delineating large - scale neotectonic features and to define the fault segmentation. These tectonic features or landforms can be subdivided into two types - primary and secondary. The primary landforms include fault scarps and escarpments, facet spurs, range fronts, etc. and the secondary features include offset streams, triangular facet, pressure ridges, beheaded streams, etc. The fault segment can be defined following Stewart and Handcock (1994) as the fault traces comprising a series of roughly continuous, linear strands separated by zones of fault intersection or termination that mark segment boundaries. The segmentation of fault involves the identification of individual segments that appear to have continuity, character and orientation. This perhaps suggest that a segment will rupture as a unit (see Slemmons, 1982). In this study, the point where a fault die out along strike is stated as fault termination, and the point where a fault segment cuts or abuts against a pre-existing structure at the high angle to the fault zone, is regarded as cross - fault intersection (see also Bruhn et al., 1990).

The fault segment can be delineated based upon criteria proposed by McCalpin (1996). This is depicted in Table 4.1.

Table 4.1 Types of fault segments and the characteristics used to define them.

Type of segment[a]	Characteristics used to define the segment[a]	Likelihood of being and earthquake segment[b]
1 Earthquake	Historic rupture limits.	By definition, 100%[c]
2 Behavioral	1 Prehistoric rupture limits defined by multiple, Well-dated paleoearthquakes.	High
	2 segment bounded by changed in slip rates recurrence intervals, elapsed times, sense of displacement, creeping versus locked behavior, fault complexity.	Mod. (26%)
3 Structural	Segment bounded by fault branches, or intersections with other faults, folds or cross-structures.	Mod.-High (31%)
4 Geologic	1 Bounded by Quaternary basins or volcanic fields. 2 Restricted to a single basement or rheologic terrain. 3 Bounded by geophysical anomalies, 4 Geomorphic indicators such as range-front morphology, crest elevation.	Variable[d]
5 Geometric	Segments defined by changes in fault orientation, stepovers, separations, or gaps in faulting.	Low-Mod. (18%)

[a] Classification follows the segment boundary types of dePolo et al. (1989, 1991) and Knuepfer (1989).
[b] Percentages = percent of cases where historic ruptures have ended at this type boundary, as opposed to rupturing through it (Knuepfer, 1989, Table 3).
[c] However, restriction of a single historic rupture to the segment does not mean that all future ruptures will be similarly restricted.
[d] Small number of observations, accuracy questionable (Knuepfer, 1989, Table 3).

Based upon both types of interpreted image data, there are 5 fault segments (Figure 4.1) as determined from the current investigation, viz. Sangkhla Buri, Kanchanaburi, Thong Pha Phum, Mae Nam Noi, and Khwae Noi Segments. Delineation of segments involves identification of discontinuities in the fault. The discontinuity can be subdivided from two categories- geometric (e.g., intersection, branch, termination) and in homogeneous (e.g., width, displacement rates, stress regime). These two categories are borrowed from seismologists who have used these terms for asperities and barriers (Aki, 1984). In this research the criteria used herein are mainly geologic, structural and geometric. However, such a fault segmentation employed herein is quite similar to the one earlier mentioned as the "geometric fault segmentation" by Schwartz (1988). It is recognized from this study that fault traces can be characterized by marked changes in both geometry and continuity. Additionally, it is found that continuity of a fault trace can be disrupted by segment branches where the main fault splits into two or more lines. Therefore, an abrupt deviation in the orientation of fault traces (or the so-called fault bend or segment bend) is also applied in the current investigation. In Thailand the analyses of faults by subdivision into segments are first described and applied by Fenton et al. (1997) based upon geomorphic expression, structural style, and sense of offset.

The detailed descriptions of individual fault segments are shown below.

4.1.1 Sangkhla Buri Segment

The term "Sangkhla Buri" is the name of the district located in the northernmost part of the study area (Figure 4.1) very close to Myanmar border. Both Landsat and JERS image data indicate that fault traces belonging to the Sangkhla Buri Segment are quite continuous and align in the similar direction. The total length of the segment is estimated at about 57 km. Its northern extension can be clearly traced northwestward to southern Myanmar (Figure 4.2). The image data also depict that the fault trace becomes better observed in Myanmar than those existing in Thailand. However, in Thailand the length of this segment is about 8 km. The average orientation of the Sangkhla Buri segment is about N30W. There are several small fault traces, about 3-12 km, detected from satellite data. There are also two other fault traces that become deviated from or subparallel to the main fault with their orientation within the range of N10E and N60E. The former consists of at least 10 individual discontinuous faults with the range of length between 1 to 24 km, and the latter comprising 20 discontinuous faults with the length varying from 1 to 30 km.

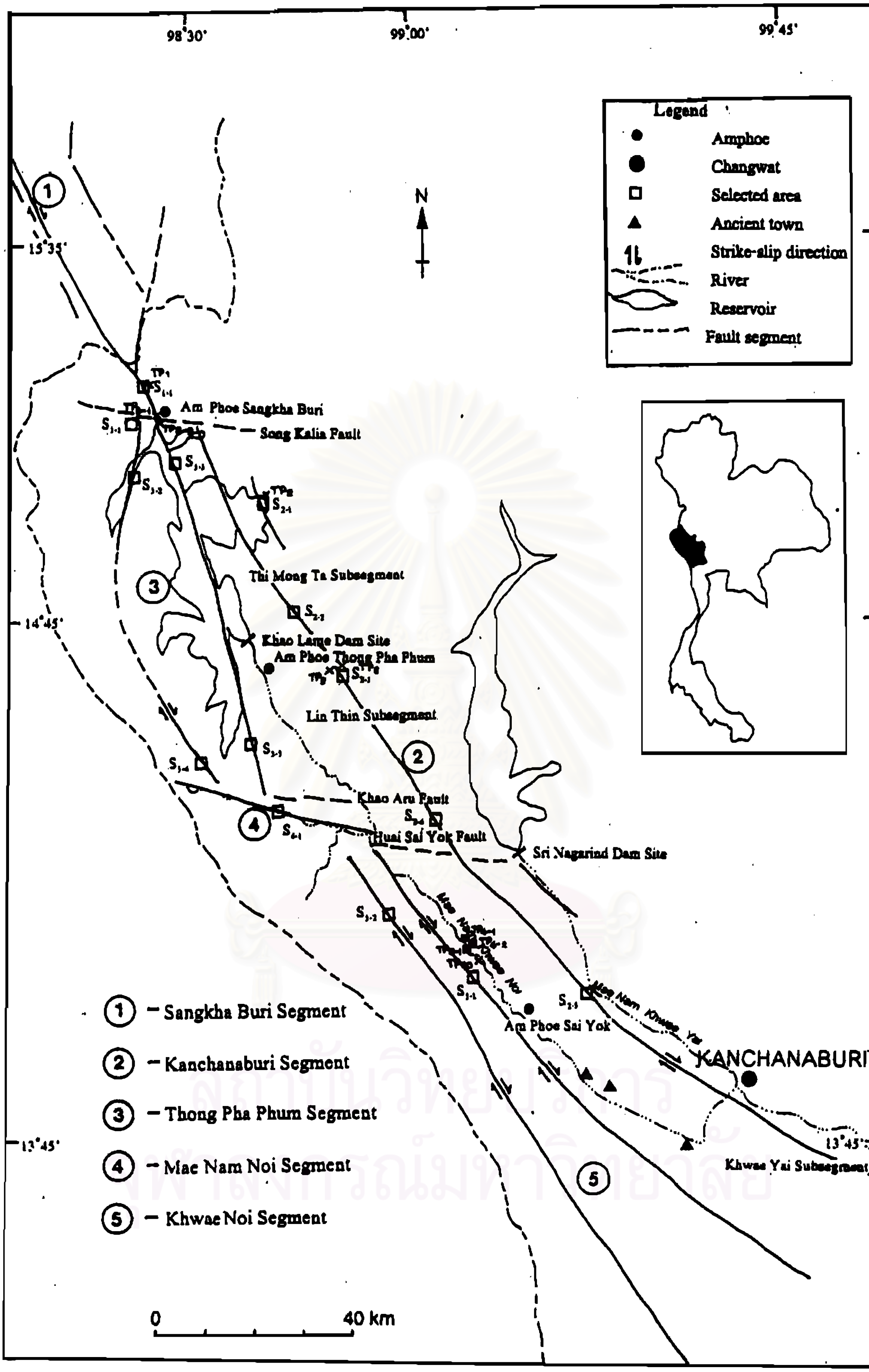


Figure 4.1 Map of the Three Pagoda area showing the location of samples collected for TL (X), ESR (■) datings, and districts

The sharp and clearly defined Song Kalia Fault, of which its direction is about N60-70W, marks the southern end of the fault. The Song Kalia fault is about 30 km long and seems composed chiefly of small groups of fault traces. Other two faults are also recognized, mainly almost parallel to the main fault. They are mostly discontinuous and approximately 15 km long.

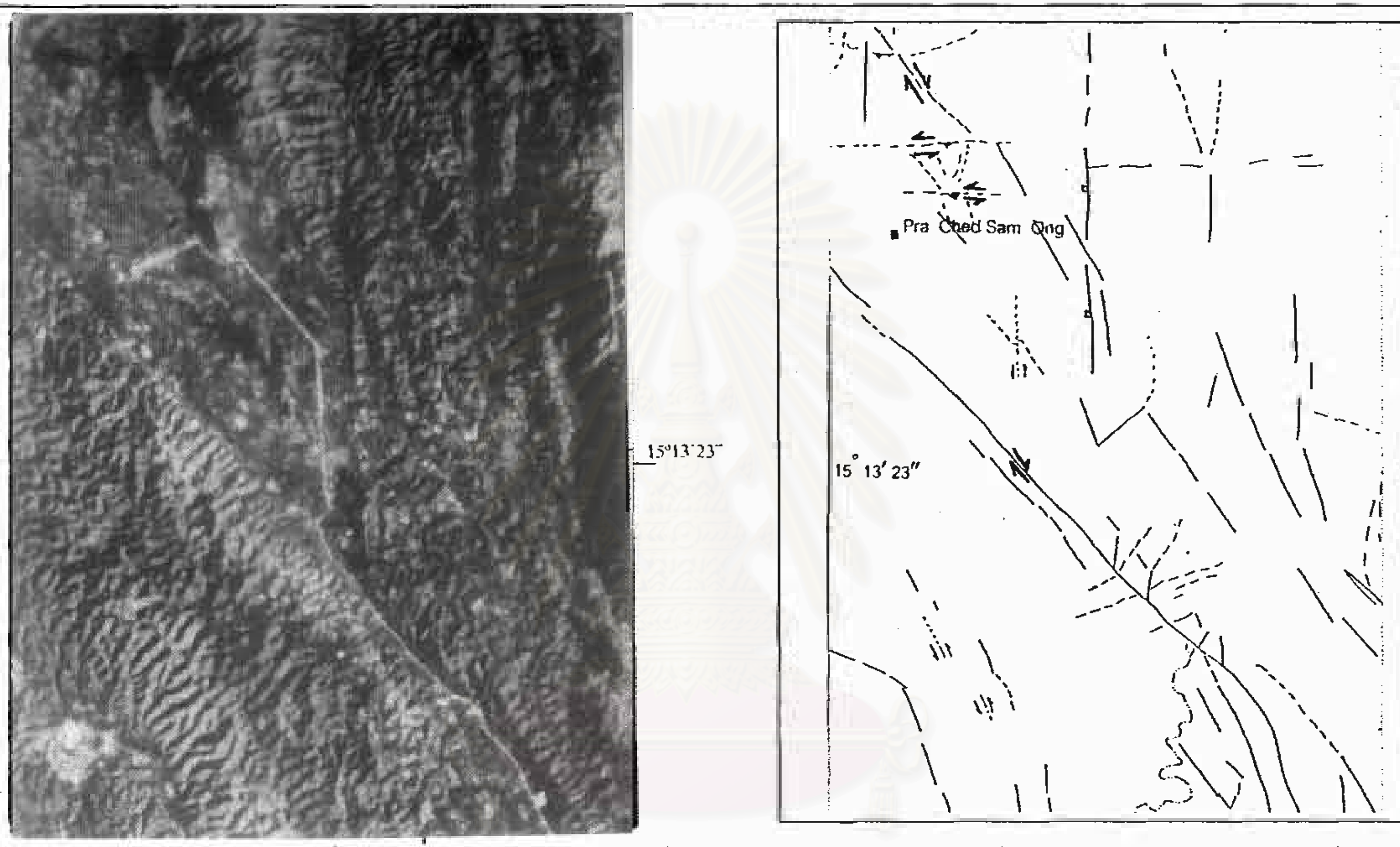
The other important neotectonic feature is structural fold and vergents. These deformation features are determined clearly from the remote sensing data. In the northern part of the segment, the folds are asymmetry and their axes orientate in N10W and N-S directions. The N10E- trending asymmetry fold (or vengeance) is observed as well in the middle portion of the segment. In the south of the main segment, folds show their main axes in the N30W direction.

In the light of geomorphology, satellite image data demonstrate that triangular facets show almost similar size, shape, and geometry. Mostly they aligned in the same direction facing to the main fault. Offset streams are almost parallel to one another along most parts of the main fault, providing a good evidence of local strike -slip tectonics for this fault segment. Drag folds are also observed close to the main fault, implying that the dextral movement of the Sangkhla Buri Segment at least may have a close genetic relationship to these drag-related deformation. The nature and style of drags strongly indicate the dextral movement of the fault.

Geologically, the main fault cut across several lithologies, including clastic rock, and limestone (see Figure 4.2). It is also important to note herein that the discontinuous, short, and small fault traces slightly oblique to the main fault cross cut clastic lithology and, though poorly-defined, show a left-lateral sense of movement. No such faults have been observed to cross cut younger Cenozoic deposits, probably suggesting the older age of faulting. However, the dextral movement along these small faults are also observed.

4.1.2 Kanchanaburi Segment

Unlike its northern and associated Sangkhla Buri Segment, the Kanchanaburi Segment (Figure 4.3) seems to be more continuous and longer in Thailand than the Sangkhla Buri Segment. The average orientation of the Kanchanaburi Segment is about N 40 W, slightly different from that of its northern segment. Among the fault segments identified in this study, the Kanchanaburi segment is the longest segment as identified from satellite images.



(a) 98°22'12" (b)

Figure 4.2a Satellite image data showing orientation of Sangkla Buri Segment.
(a) Landsat TM5 (band 3, 4, and 5, composite colours, blue green and red, respectively).
(b) lineament interpretation of Sangkla Buri Segment.

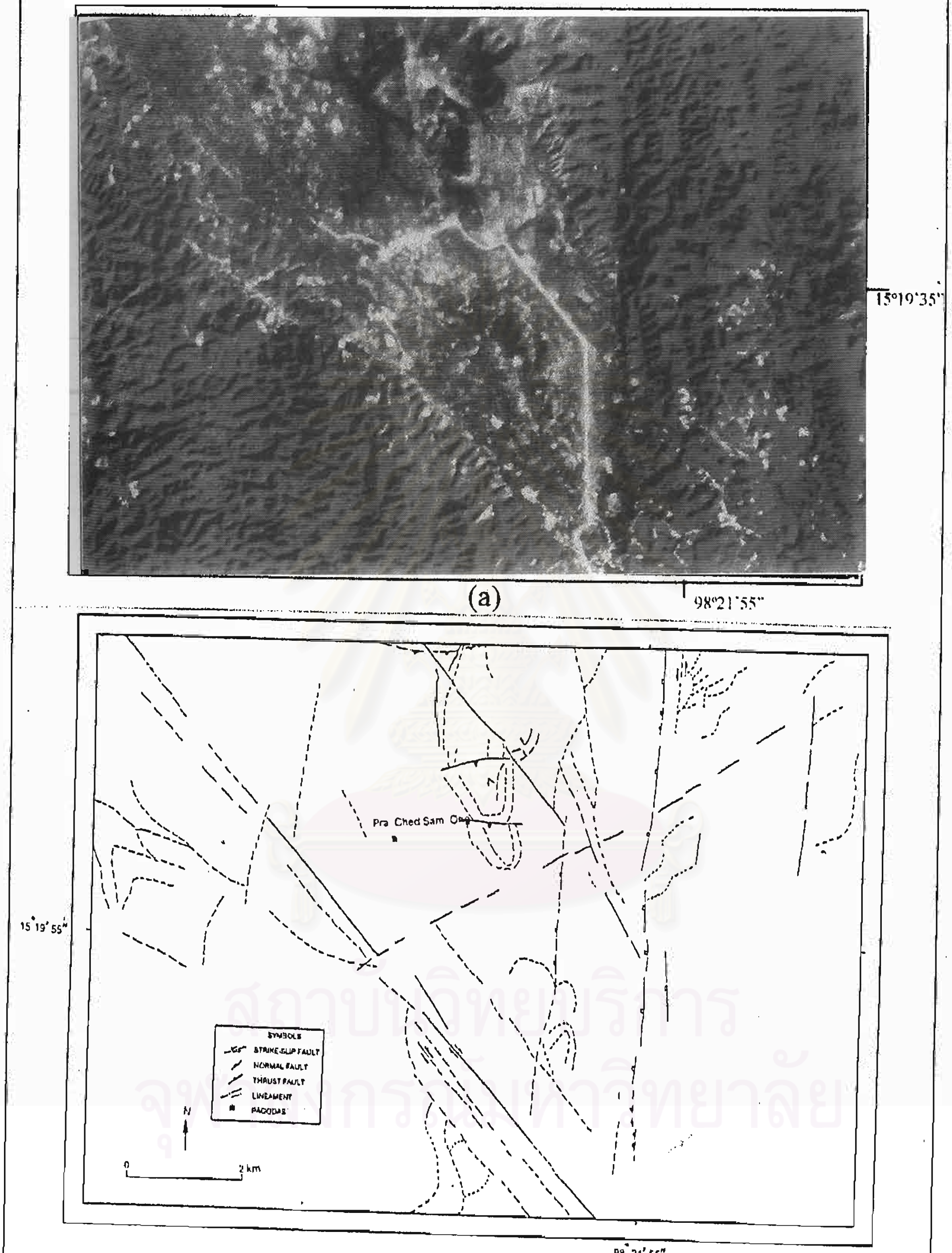
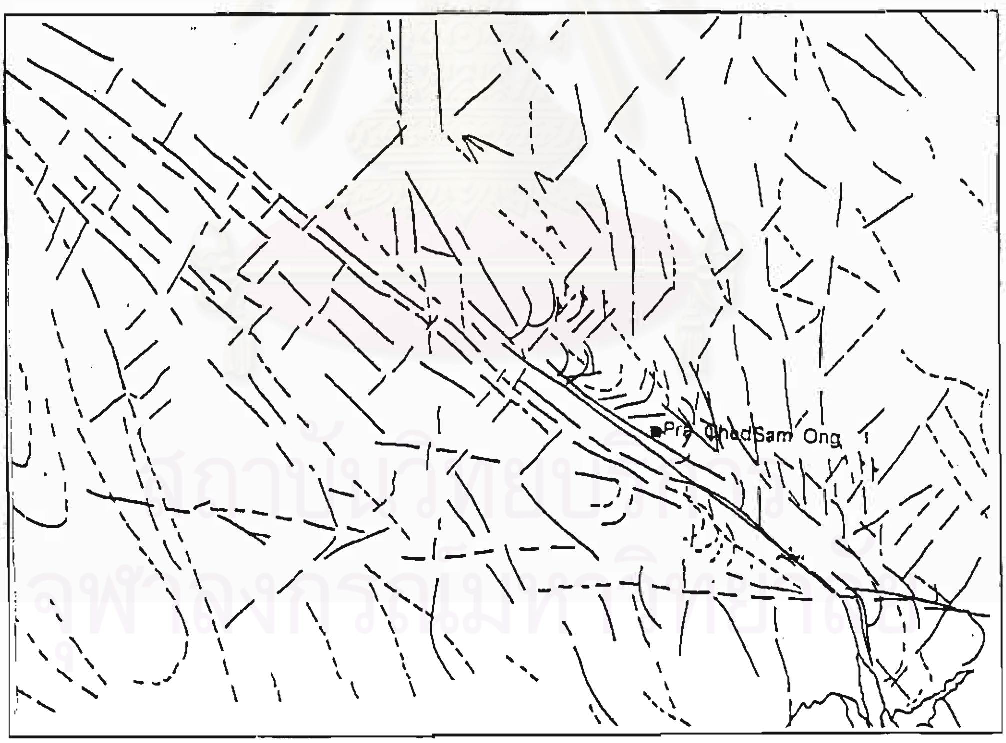


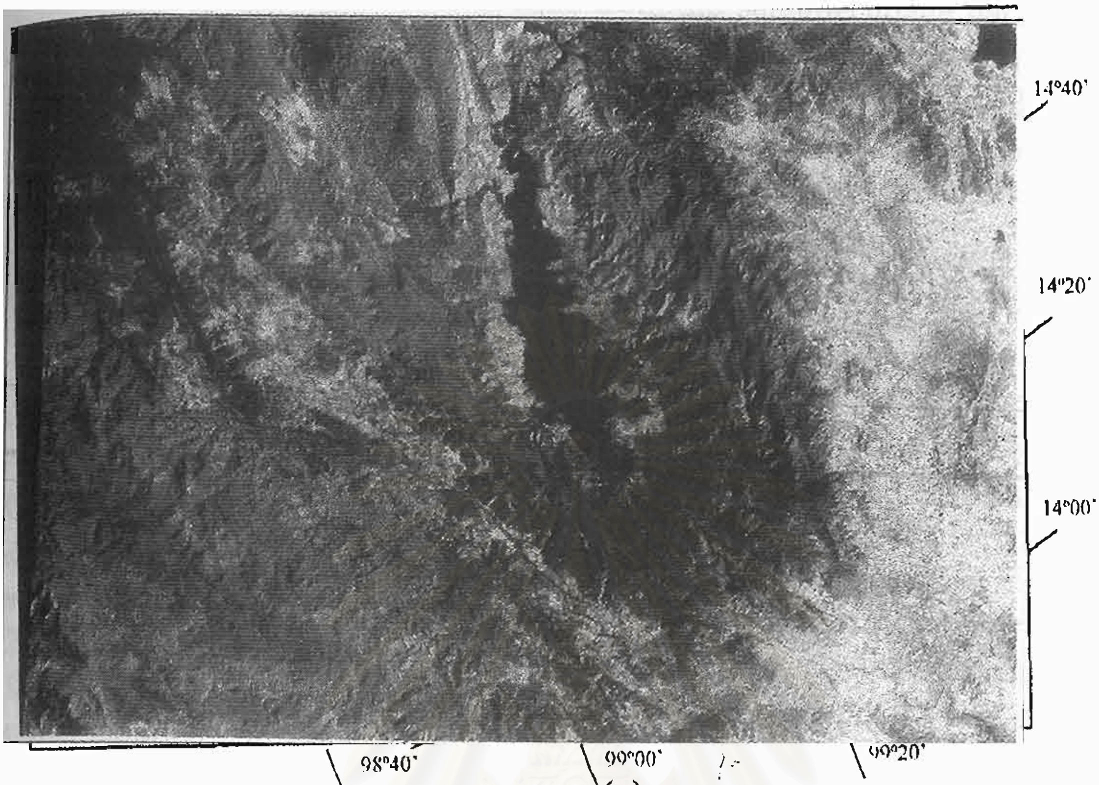
Figure 4.2b Satellite image data showing orientation of Sangkla Buri Segment.
(a) Landsat TM5 (band 2, 3, and 4. composite colours. blue green and red, respectively).
(b) lineament interpretation of Sangkla Buri Segment.

(a)

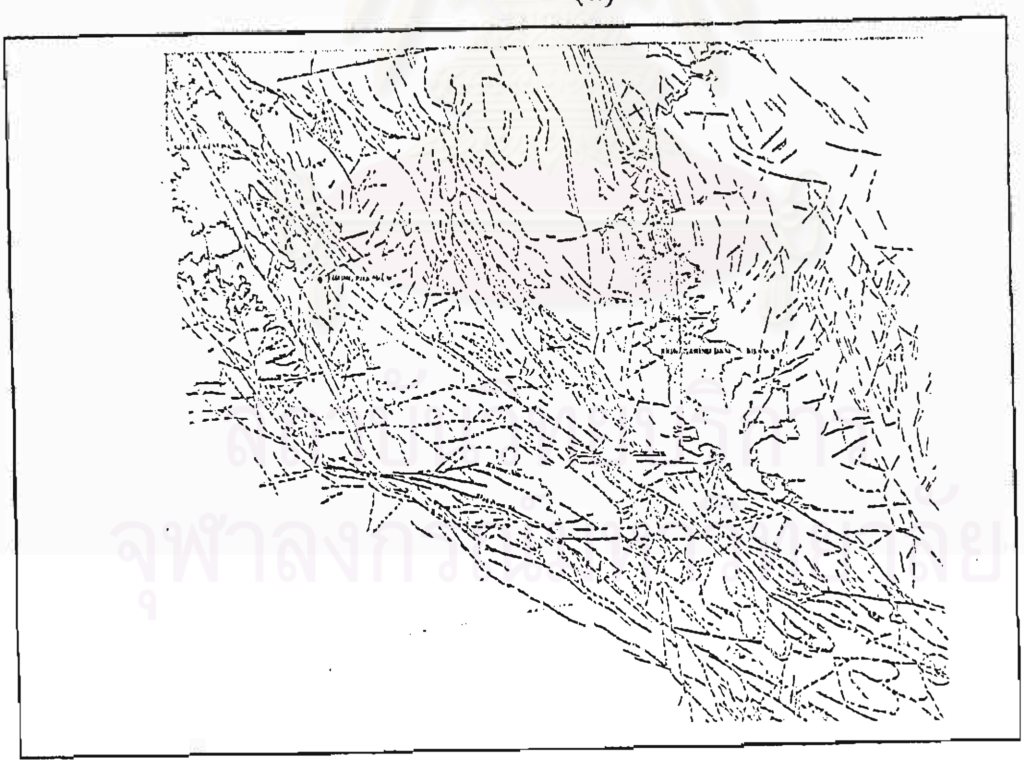


(b)

Figure 4.2c Satellite image data showing orientation of Sangkla Buri Segment.
(a) JERS radar image.
(b) lineament interpretation of Sangkla Buri Segment.



(a)



(b)

Figure 4.3 Satellite image data showing location of Kanchanaburi Segment.
(a) Lansat TM5 image (bands 7-5-4, colour composite red-green-blue, respectively).
(b) lineament interpretation of Kanchanaburi Segment.

The Kanchanaburi Segment is separated from the Sangkhla Buri segment by the Song Kalia Fault. The Kanchanaburi Segment displays a better-defined continuous lineament, as seen from the satellite image data. Based upon geometry relationship, it is divisible into 3 major fault traces (subsegments) which show almost continuity to one another, including Thi Mong Tha, Lin Thin, and Khwae Yai Subsegments. These names, except for the last one, are taken from the local language, which has been used by local villagers originally at Thai- Myanmar border.

1 Thi MongTha Subsegments

This continuous sub-segment fault is quite distinct in satellite images, starting in the northern part with the abutment of the ENE-trending Song Kalia Fault. To the central part of the Thi Mong Tha subsegment, its trace passes the Khao Laem reservoir (see Figure 4.4). The Thi Mong Tha subsegment cuts across clearly bedrocks of Silurian to Devonian ages for about 18.75 km. Then it passes through small and narrow Cenozoic basins at Ban Koeng Sada, Ban Lia Chia, Ban Thi Mong Tha, and Ban Pom Pi Nai villages, with the length of about 10 Km. Further to the central part, with the length of about 15 km, the fault cuts across isolated and rather small ridges of Permian rocks which the major rocks are limestones. To the south for about 13.75 km, the fault follows the contact boundary between the Cambrian clastics to metaclastics and the Cenozoic deposits.

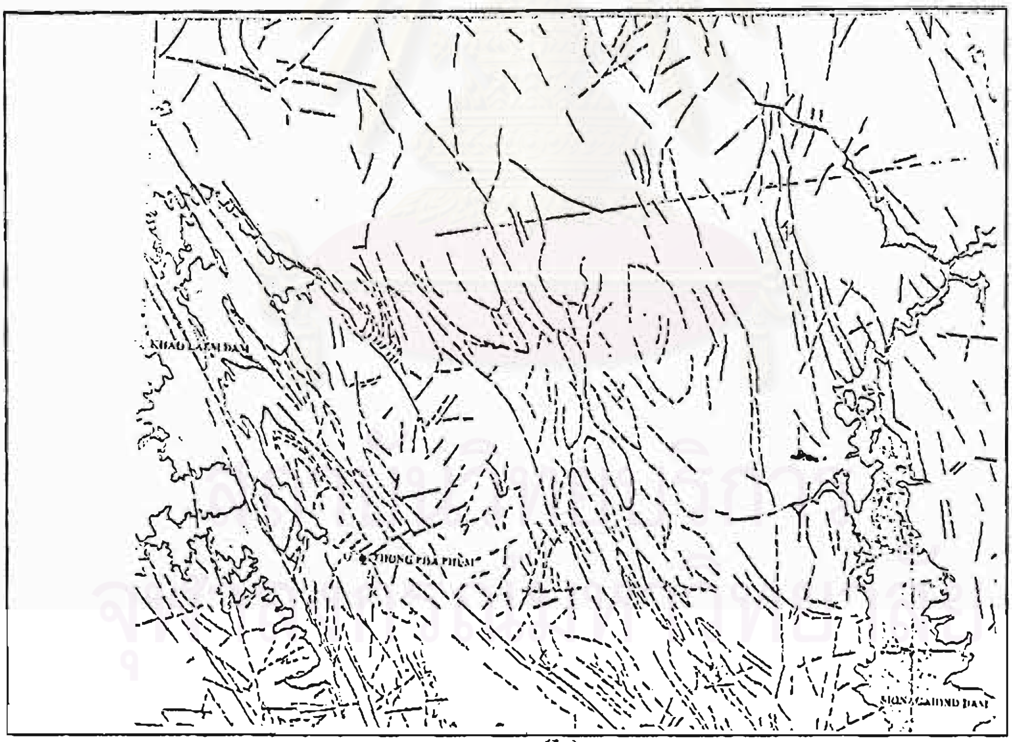
In general, orientation of the Thi Mong Tha subsegment fault varies from N20W in the northern portion to N40W in the southern portion. In the middle portion it becomes curvilinear with orientation between 25 to 35 degree from the north. The overall length of the fault as traced from Landsat image data is about 67.5 km.

Several small faults are found almost parallel to the Thi Mong Tha subsegment. These faults are normally discontinuous and cut across the bedrocks. They are about 7 traces ranging in length from 1 to 12.5 km and with the average of 8.5 km. There are also a number of small faults (at least 10 lines) which lie obliquely to the main Thi Mong Tha subsegment fault. Their lengths vary from 1 to 5 km and main trend is averagely N 30 E.

2 Lin Thin Subsegment

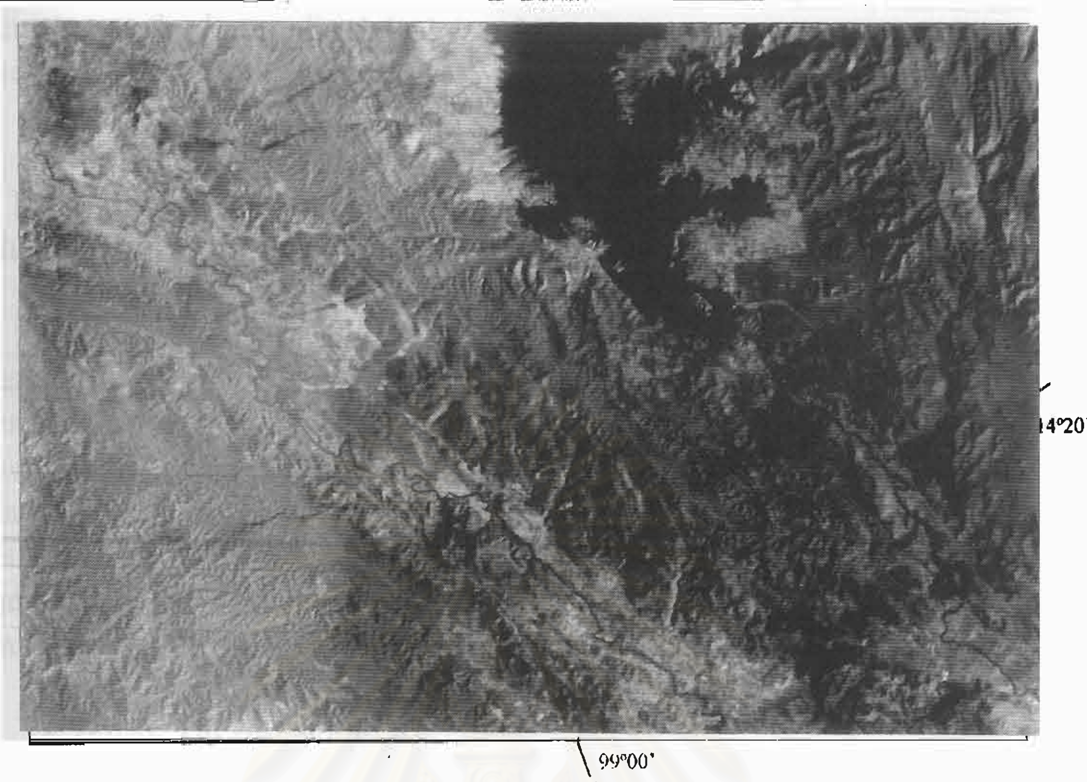
Southward extension of the Thi Mong Tha subsegment is the Lin Thin Subsegment (see Figure 4.5) whose total length is approximately 62.5 km, and its main orientation lies close to the Srinakharin dam site to the east and the Thong Pha Phum district to the west. The Lin Thin fault follows the contact

(a)

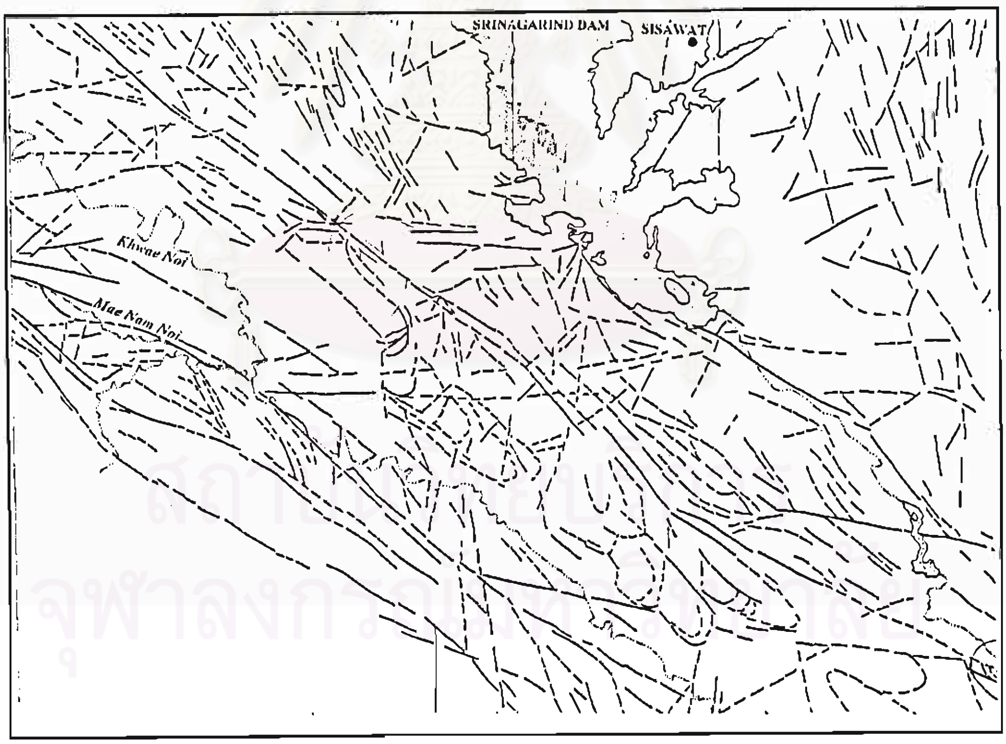


(b)

Figure 4.4 Satellite image data showing location of Thi Mong Tha subsegment.
(a) Lansat TM5 image (bands 7-5-4, colour composite red-green-blue, respectively).
(b) lineament interpretation of Thi Mong Tha subsegment.



(a)



(b)

Figure 4.5 Satellite image data showing location of Lin Thin subsegment.
(a) Lansat TM5 image (bands 7-5-4, colour composite red-green-blue, respectively).
(b) lineament interpretation of Lin Thin subsegment.

between Permian carbonates and Cambrian clastics. The southernmost part terminates at the large alluvial plain of Kanchanaburi city where the Khwae Yai subsegment fault is located (see below).

Due to the curvilinear nature similar to the Thi Mong Tha subsegment, Lin Thin subsegment commences with its orientation at about N 40 W in the north, and then to the south its orientation becomes N 55 W.

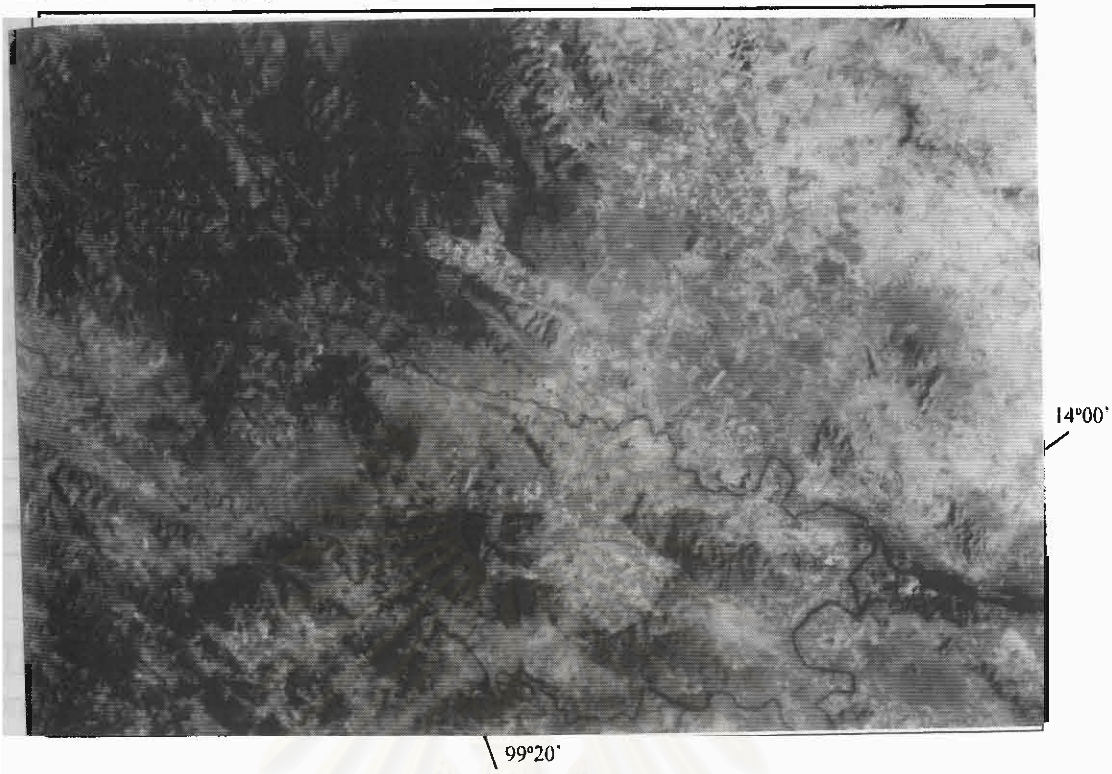
There are small sets of minor faults almost parallel to the main one. Observation from satellite images indicates that at least 7 faults with discontinuous length varying considerably from 1 to 17.5 km. Some of the small, discontinuous, and shorter fault sets are found orientated themselves obliquely to the main fault. One trends in the N 75 to 85 W and with the length of individual faults at about 1 to 5 km. Among these, the outstanding one as seen in satellite image is Huai Sai Yok Fault (see below). The other is in the N 30 E with the overall trace length of about 1to 4 km.

3 Kwae Yai Subsegment

Khwae Yai subsegment takes its name from the main and most important river for Kanchanaburi people. This subsegment fault can be traced continuously and clearly following the Khwae Yai River with the Sai Yok district to the west and Kanchanaburi city to the east, as shown in satellite image information (Figure 4.6), from the south of the Lin Thin subsegment to the city of Kanchanaburi in the southern part of the segment. This subsegment shows its main fault trace within the alluvial plain of the Khwae Yai River. However, this fault can be traced southeastward to the Lower Chao Praya Basin- the central alluvial plain of Thailand. Its exact location of the fault to the south, which can be proved solely upon airborne and seismic geophysical evidences (Figure 3.6), as well-documented very recently by Tulyatid and Charusiri (1999), is also quite interesting, however, due to the rather limited scope of this current investigation, it will not be explained herein.

Based upon satellite image information, its is visualized that the main Khwae Yai fault orients itself in the N 55W direction and with the totally estimated length of about 67.5 km. The information also indicates that the fault traces are mostly discontinuous, somehow suggesting.

There is only one another fault running almost parallel to the main Khwae Yai subsegment fault. Though this smaller fault has its length of about 5 km, it can be observed as a faint and discontinuous fault trace as observed from the satellite image.



(a)

(b)

Figure 4.6 Satellite image data showing location of Khwae Yai subsegment.

(a) Lansat TM5 image (bands 7-5-4, colour composite red-green-blue, respectively).

(b) lineament interpretation of Khwae Yai subsegment.

The Khwae Yai Subsegment, the longest subsegment of the Kanchanaburi segment, has the overall length of about 197.5 km as traced from both TM and radar image data. Along the eastern and western sides of the Khwae Yai subsegment, there are varieties of recognizable-size folds and vergences whose axes align mostly in N20W and N30W, respectively.

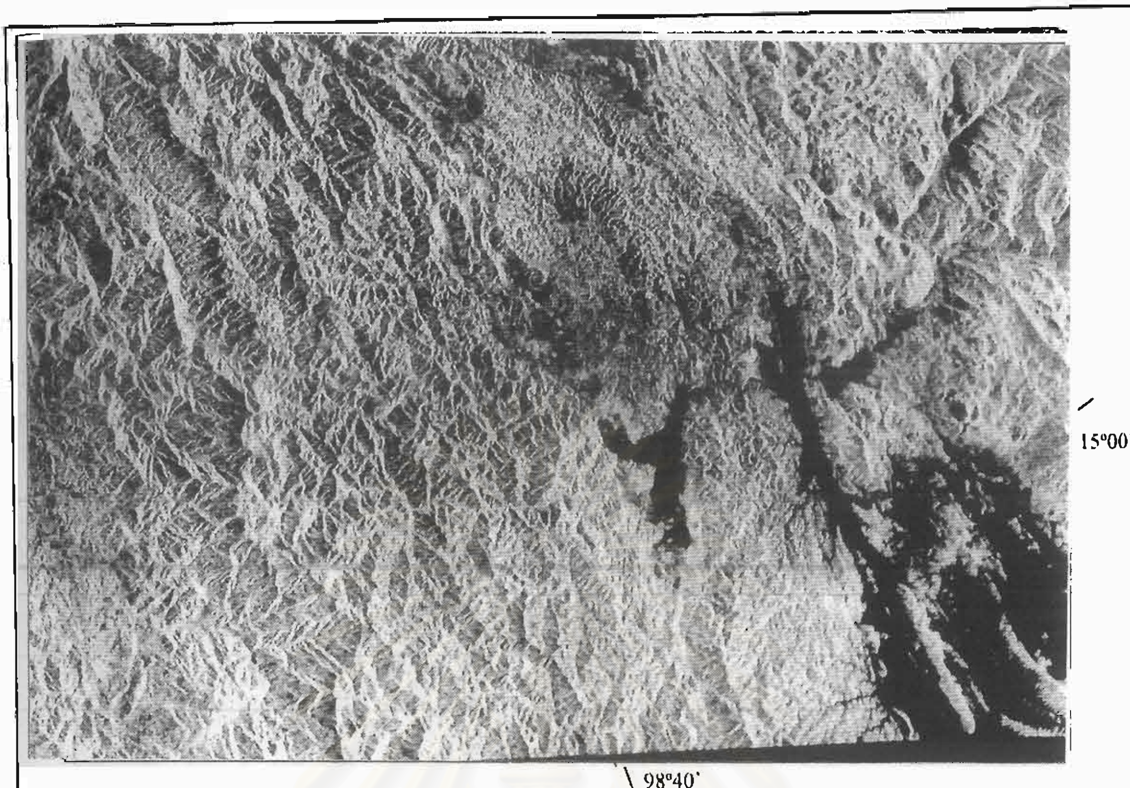
Several morphotectonic evidences can be recognized from enhanced remote-sensing and field data. Among them, the most outstanding features are triangular facets and fault scarps. In the light of orientation of structural folds, it is quite likely that the fault depicts the oblique style of movement with both dip- and strike- slip components.

4.1.3 Thong Pha Phum Segment

The term "Thong Pha Phum" is derived from a permanent stream running to Thong Pha Phum district, located in the middle part of the study area. Information gathered form satellite image data, particularly those of the JERS ones indicate that the Sangkhla Buri Segment is a quite prominent (see Figures 4.7a, 4.7b) continuous fault with its average orientation in the range of N15 to 25W direction and the total length of about 69 km. Starting from the southern side of the Song Kalia Fault, the Sangkhla Buri segment runs through the Khao Laem reservoir, as detected from JERS images. The fault continues southward with a slight bend at the bearing of N10W and following the contact zones between the Permian rocks to the east and Cenozoic unconsolidated deposits to the west.

There are two other kinds of minor faults, belonging to the Thong Pha Phum Segment, one in the west and the other in the east. The minor faults in the west displays a relatively continuous fault trace with a length of 1 to 17.5 km, and runs almost parallel to the main Thong Pha Phum fault. At the northern part of the fault, whose orientation is in the N20W direction, passes along the contact boundary between the Jurassic-Triassic clastics and alluvial plain of Cenozoic age. It continues southward with a slight curve bend with its alignment in the N25W and passes only similar clastic rocks of Jurassic-Triassic ages. The other much smaller faults can be traced discontinuously and almost parallel to the main fault. They are approximately 1 to 4 km long.

There are 4 other minor faults to the east of the main fault. Enhanced image data inform that the faults whose length varies considerably from 1 to 18.75 km, are rather discontinuous. Their major orientation is in the N20W direction. In general these faults cut across the clastic rock.



(a)

(b)

Figure 4.7a Satellite image data showing location of Thong Pha Phum Segment.
(a) JERS radar image.
(b) lineament interpretation of Thong Pha Phum Segment.

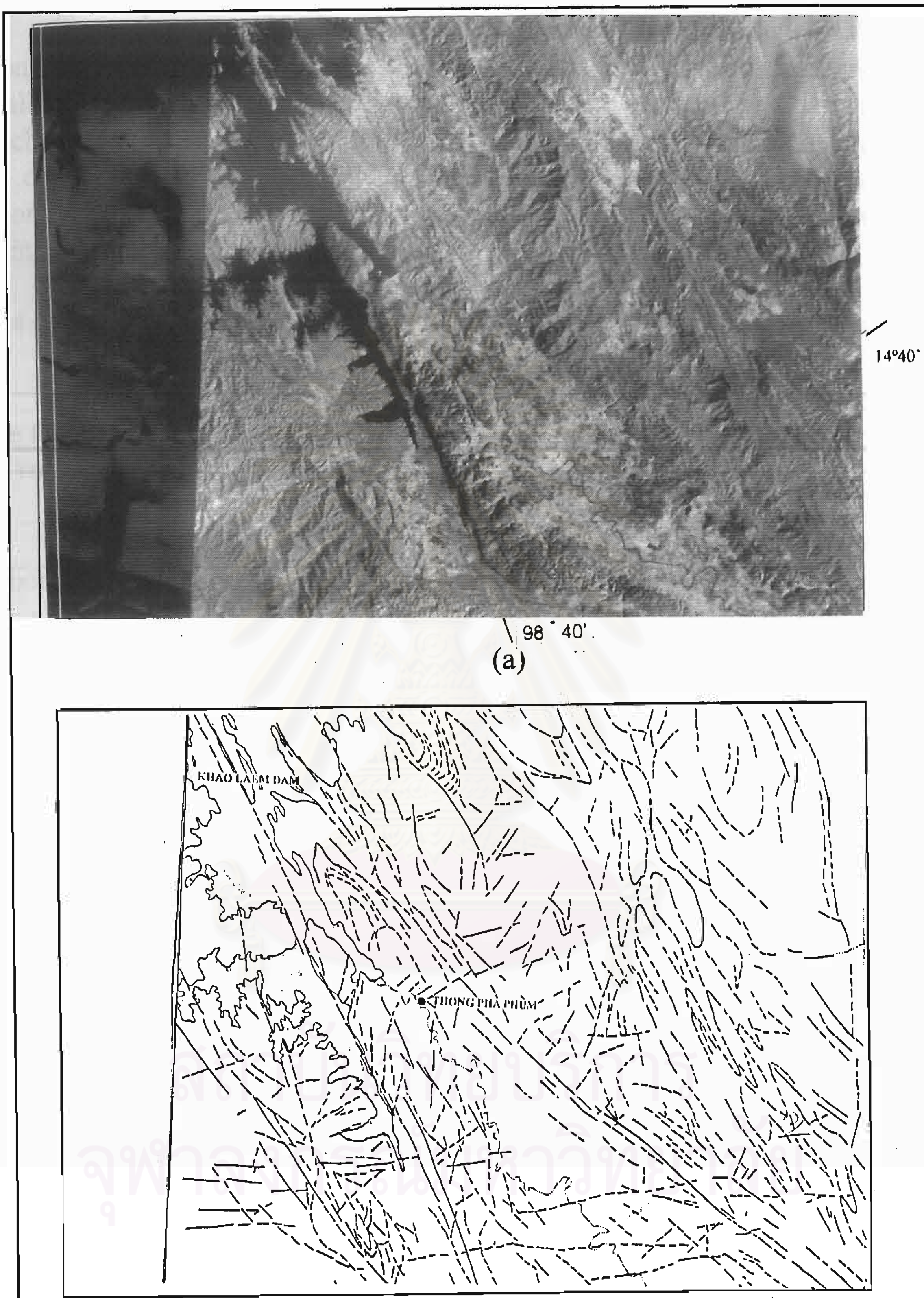


Figure 4.7b Satellite image data showing location of Thong Pha Phum Segment.
(a) Lansat TM5 image (bands 7-5-4, colour composite red-green-blue, respectively).
(b) lineament interpretation of Thong Pha Phum Segment.

Two other sets of faults which run obliquely at an acute angle to the main Thong Pha Phum Segment, include the N20E fault set which consists of 17 parallel minor faults and have the length of about 1 to 10 km. These minor faults, which exhibit relatively discontinuous nature, pass through Permian limestone. The other fault set orientates in the N80W to E-W direction and consists of 7 minor fault varying in traceable length of about 1 to 17.5 km. These faults are cutting across Permian limestone.

4.1.4 Mae Nam Noi Segment

Result from aerial photographic interpretation shows that these faults have the continuity passing the end of the Thong Pha Phum Segment to the Huai Sai Yok Fault (see Figure 4.8).

The major fault line passed the old age rocks starting from Devonian-Carboniferous clastics. Then it is passing Triassic clastic rocks and then the fault runs along Mae Num Noi, passing Permian carbonates contact and Triassic clastic rocks. It terminates at the Huai Sai Yok fault (N 80).

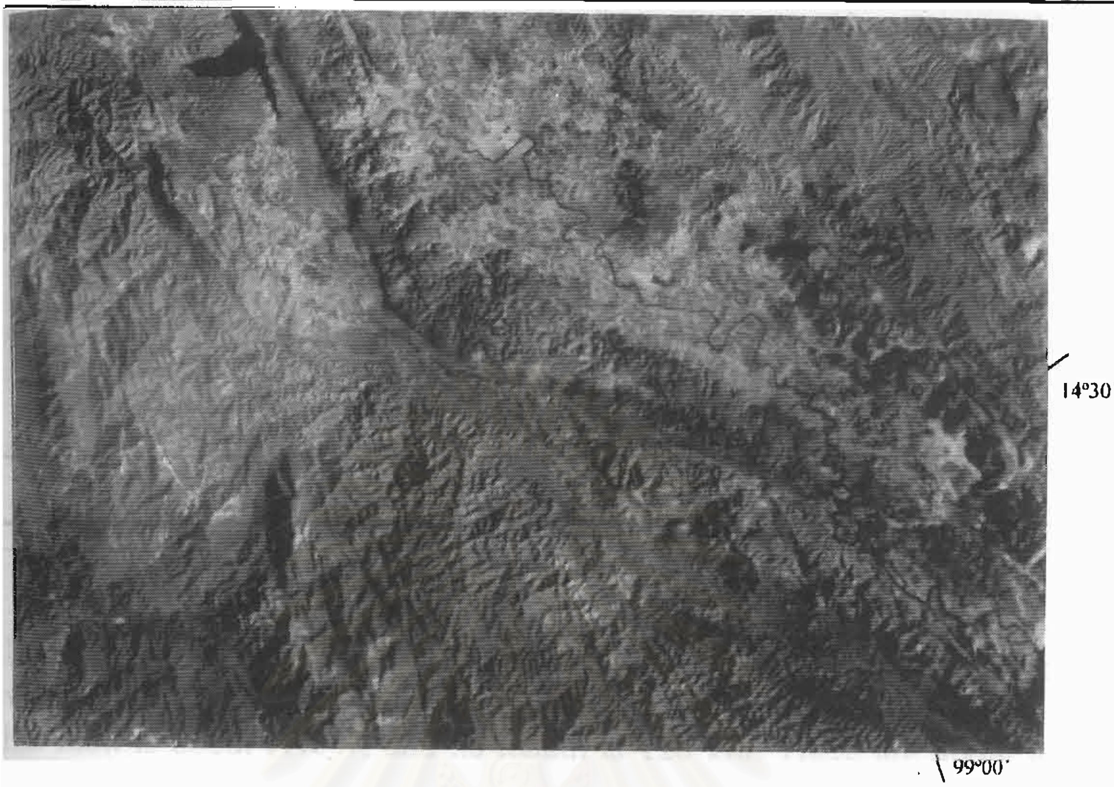
This major fault direction starts from N70W and is gradually curved until meeting the end of this segment. It trends N60W and is about 31.25 kilometers continually long.

There are two-fault lines parallel to this major fault. It is continually 11 kilometers long. But these faults are not quite clear both from the remote-sensing image and field data.

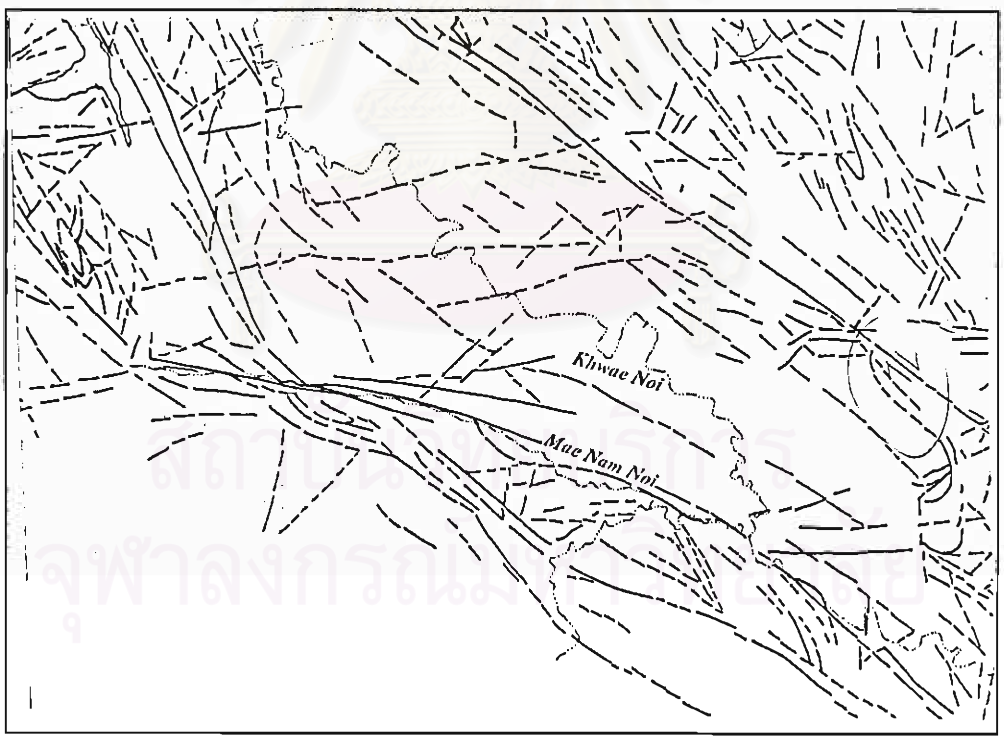
Below, the other small fault sets belonging to the Mae Nam Noi segment.

There are 4 fault traces whose trend is N60E. They are about 2.5-18.95 kilometers long; but do not show continual trends. For the N-S set, there are about 4 fault traces. They are about 2.5-7.5 kilometers long and are not continuous. The other 2 fault traces run in the N40E direction. They are about 1.75-75 kilometers long and are not continuous.

Fold and vergent structures are also recognized particularly at the fault zone. In general the vergent has the width of about 2.5 km and its major axis mostly aligns in the W direction.



(a)



(b)

Figure 4.8 Satellite image data showing location of Mae Nam Noi Segment.

(a) Lansat TM5 image (bands 7-5-4, colour composite red-green-blue, respectively).

(b) lineament interpretation of Mae Nam Noi Segment.

The geomorphology depicts the triangular facet, fault scarp, and drag folds immediately at the fault. These information strongly support the fault movement in the Quaternary period.

This major fault is oblique, because it shows movements of both dip slip and strike-slip components. The sense of movement is interpreted to be right lateral, although in limestones the sense becomes left - lateral.

4.1.5 Khwae Noi Segment

Information gathered from satellite image data indicates that the segment (Figure 4.9) is from the south of Huai Sai Yok Fault to the Kanchanaburi Plain.

There are two main major faults as described below.

1. The eastern major fault which starts from the south of Huai Sai Yok Fault and runs across Permian limestones. Then this fault is running into the alluvial plain that is continually parallel to Mae Nam Kwae Noi. The orientation of this fault is about N40W, and its length is 120 km. There are about 4 minor faults running parallel to the major fault. Their total length is approximately 2.5 to 10 km. Mostly, they are traced discontinuously.

2. The western major fault which has its starting point from the south of Mai Nam Noi Segment. At the beginning of the fault, it runs into Triasscic clastic rocks (Tr) and through the Cenozoic alluvial plain. Then it runs along the boundary between limestones (Permian) and Upper Palozoic clastic rocks (DC). At the end of this fault, it is parallel to the boundary between clastic rocks and the alluvial plain in the long basinal direction.

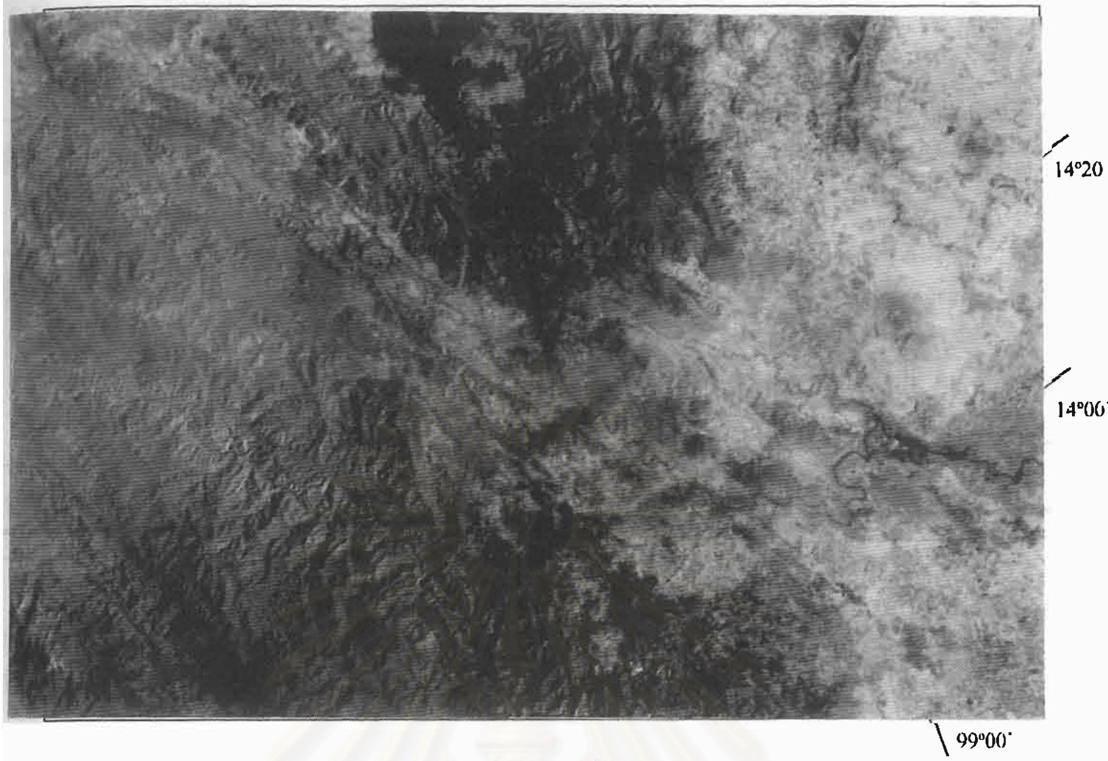
The orientation of the beginning of the fault is N50W and then slightly bends until it reaches N40W direction. This fault length is 125 km (in Kanchanaburi only).

There are approximately 7 minor faults belonging to this fault with the length verying from 2.5 up to 45 km.

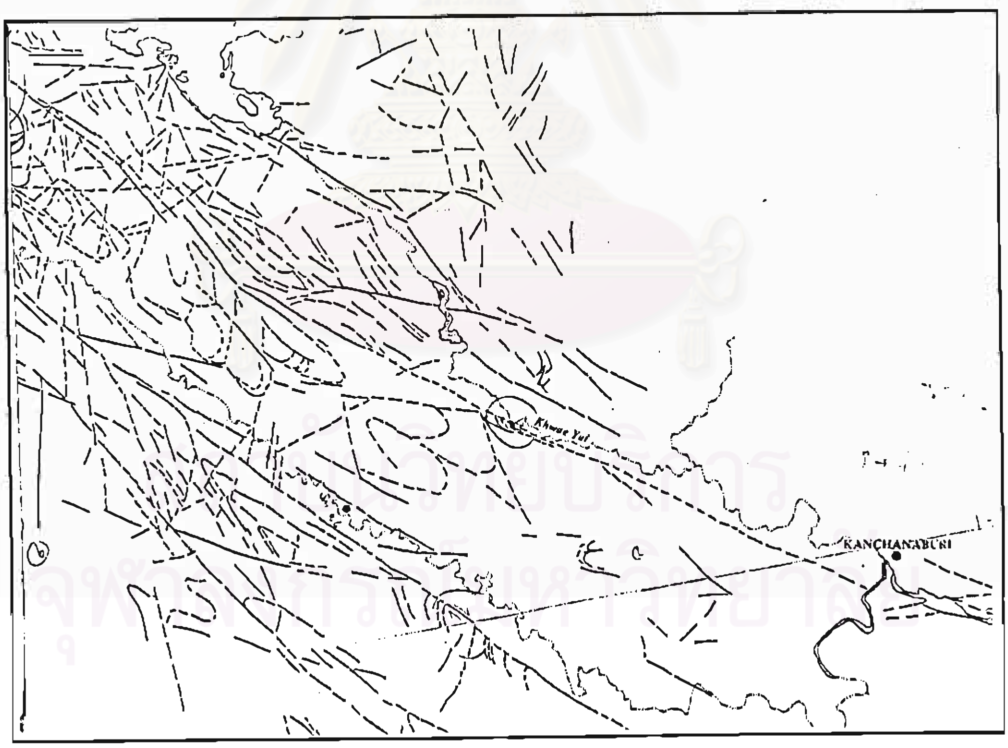
It was found from the Khwae Noi Segment that there are some traces at angles to the major fault as below.

There are 14 fault traces with N40E orientation are determined. These are 2.5 to 17.5 km long and discontinuous.

There are 5 fault traces with N70E orientation are recognized. These are 2.5 to 7.5 km long and discontinuous.



(a)



(b)

Figure 4.9 Satellite image data showing location of Khwae Noi Segment.
(a) Lansat TM5 image (bands 7-5-4, colour composite red-green-blue, respectively).
(b) lineament interpretation of Khwae Noi Segment.

With the N70E orientation, four traces are discovered. They are 2.5 to 22.5 km long and always discontinuous.

There are 3 traces with E-N orientation. They are about 3.95 to 5 km long and frequently discontinuous.

There are 3 traces with N60W orientation. They are about 10 to 25 km long and frequently discontinuity.

Two main fold structures are recognized on the segment as stated below.

The N25W fold axis was found at the eastern side of the western major fault.

The N30W fold axis was observed between the eastern and western sides of the major fault in the middle range. It was also recognized that the fold axis is on the west side of the western major fault.

Several morphotectonic evidences are identified by remote-sensing application. They are triangular facets, fault scarps and drag fold traces, all of which follow close to the fault. All these evidences indicate the movement to the right during Quaternary – Late Tertiary periods.

These major faults of this segment depict the oblique sense of movement with both dip-slip and strike-slip components in the right lateral style.

4.2 Results from Aerial photographic Interpretations

From satellite images study, faults can be classified into 5 (fault) segments, and each segment shows its special characteristics. The aerial photographs were applied here in order to increase more detailed information on traceable faults/fractures and to clarify more morphological evidences on geomorphology in some interesting areas.

The statements below denote the outstanding areas in individual segments from the current study by using aerial photographic interpretation.

4.2.1 Sangkhla Buri Segment

Only one area is selected for aerial photographic investigation.

S1-1 area (Figure 4.10)

This area lays in the bottom line of Sangkhla Buri Segment. Information gathered from satellite image data shows that there is a prominent triangular facet which can be extraordinarily observed. This facet also continues into Myanmar and offset streams were encountered.

The direction of major fault trace information which was interpreted by aerial photographs is nearly similar to that of the satellite image data; that is N30W.

Along the fault a set of triangular facets or facet spurs was recognized in clastic rocks and appears continually long and quite distinct. The width of the base of the triangular facet is estimated at about 200 m, and its height is about 175 m.

The triangular faces can be traced along the fault approximately at 7.5 km. Landsat data show the extension of this fault to Myanmar. The triangular-facet dip direction faces in the N45E and N30E directions.

Mostly the observed traceable fault - scarps are in clastic rocks which are in general steeper than the triangular facets. Therefore, it is believed that this fault scarp is younger than triangular facet. This fault scarp can be found at this segment termination near Song Kalia fault which is connecting to the triangular facets continuing to Myanmar. This fault scarp has its continuous length at about 2.2 km and its direction is N55E.

The offset stream found in this area has its drainage (temporary drainage) flowing in the NE directio. When it meets the fault trace, drainage changes its direction into SE and flows back to the old direction (NE). Then the drainage unites its course with the main drainage, running into SE direction.

In this studied area, the offset stream traces are mostly parallel. There are 5 major fault trends. Based upon the drainage flow data, it is believed that it performs a dextral offset about 84 m in a lateral sense at grid reference 368-848.

The minor fault paralleling to the major fault in the west cuts into the clastic rocks with the length of 14 km, and has the normal flowing drainage (impermanent) to NE. Then, it flows into the NW direction when it passes the fault trace and then flows back to its original direction (NE). There are about 8 offset streams that can be detected in this area. Seven of the faults run with sinistral offset and only one show dextral sense of movement. Due to this data, it is noted that the movement along this fault is left lateral at about 83 m. However, most of the minor faults paralleling to the major fault move to the right.

A shutter ridge was found in response to the fault movement with the slip of about 50 m, so the hill or ridge can obstruct stream drainages and debris, as found in the west of the major fault trace.

From all examined geomorphic evidences, it can be summarized that the major fault trace is an oblique fault with dip-slip movement based upon the evidences of triangular facets and strike-slip movement which move right-laterally by the appearance of offset stream and shutter ridges.

The minor fault traces parallel to the major fault trace cut into the old clastic rocks and show both sinistral and dextral movements, but the latter is more common.

4.2.2 Kanchanaburi Segment

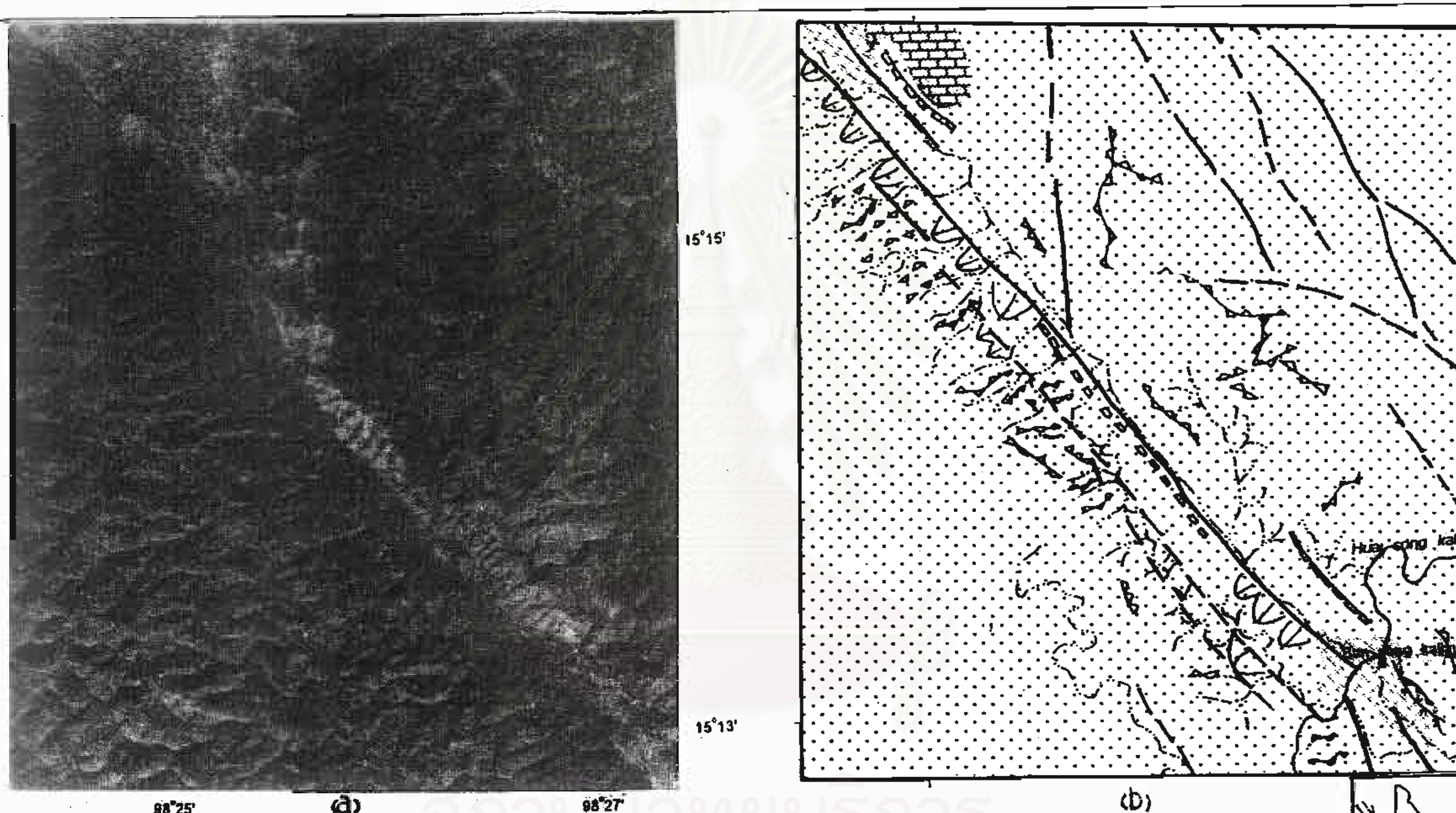
The Kanchanaburi Segment is quite a long fault segment which runs almost passing the Kanchanaburi cit. In this study, the Kanchanaburi segment can be subdivided into 3 subsegments including Thi Mong Tha, Lin Thin, and Khwae Yai Subsegments. A total of 5 areas are selected for detailed remote-sensing analysis.

1 Thi Mong Tha Subsegment

There are 3 areas selected for the aerial photographic interpretation.

S2-1 Area (Figure 4.11)

Information gathered form satellite data shows that there is a fault trace cutting through the rim of Khow Laem Dam, and the high hill, which also performs the character of fault scarp. Moreover, this area is on the upper part of Kanchanaburi Segment.



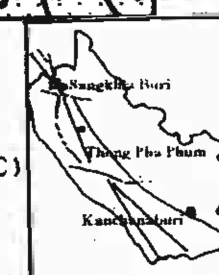


Figure 4.10 An area in Sangkhla Buri Segment selected for detailed morphologic analysis.
a) aerial photographs of area S1-1 (Area 6 sheet 20 strip 73 no. 15658).
b) morphotectonic interpretation of area S1-1 of map sheet 4639II.
c) location of area S1-1 in Kanchanaburi.

From aerial photograph study, there exists several morphotectonic evidences. The major fault trace at N35W is detected which is similar to the fault trace interpreted by the use of satellite images.

To the east of the Thi Mong Tha village, triangular facets along the traceable fault show the average base length of approximately 0.15 km and plane height of approximately 0.175 km.

The 0.7 km-long continuous triangular facet has S45W dip direction and occurs mainly in clastic rocks.

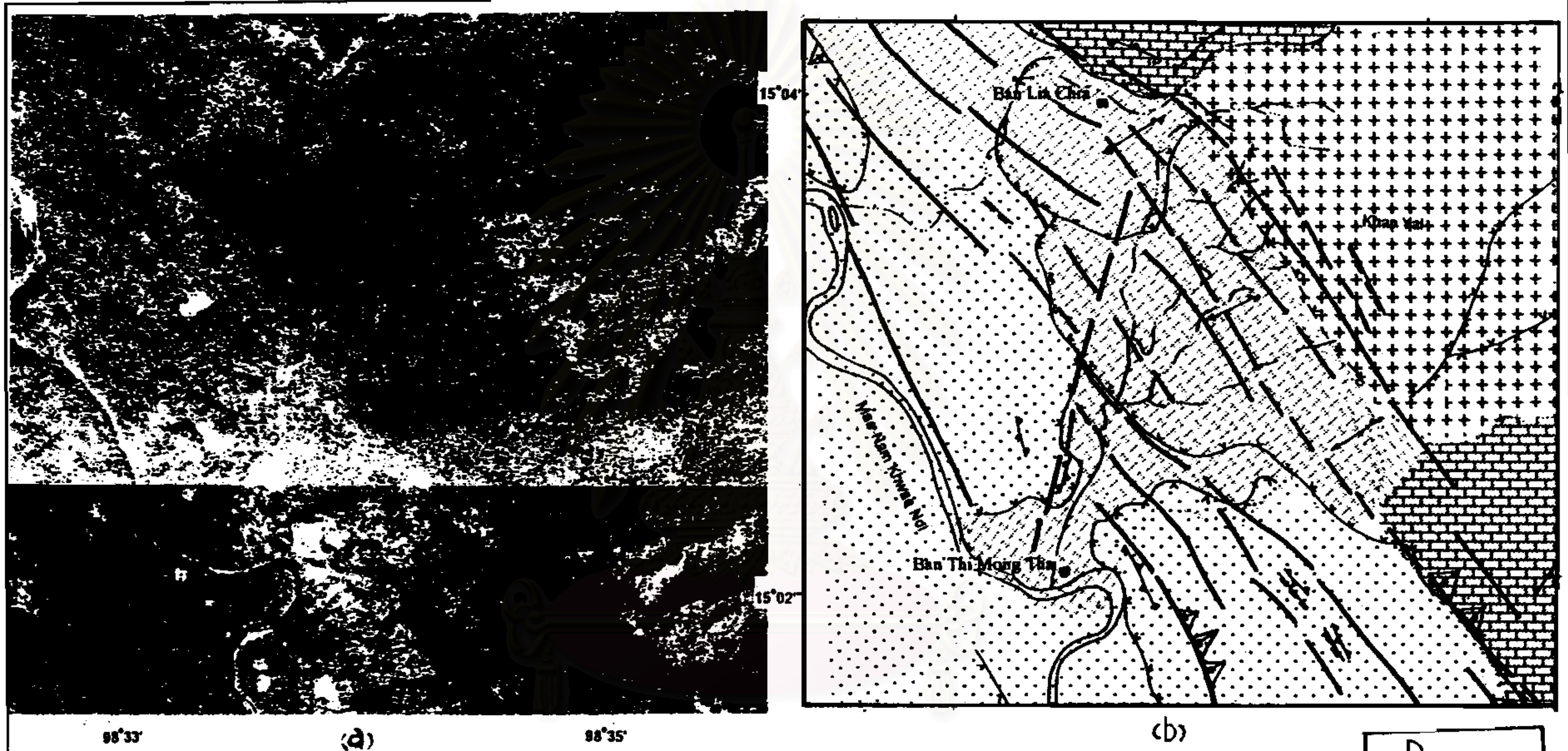
Quite distinct fault scarps are found along the fault trace in this studied area and occur in 3 different types of rocks, immediately along limestones, granites and clastic rocks. The more complicated detail is listed below.

Long and clear fault scarp in limestones is extraordinary steep and somewhat discontinuous. Its total length of the scarp is about 2 km. It is hard to state that how old the fault scarp in this area is due to the continuous action of running and underground water.

Fault scarps in granites in this area are also somewhat steep and aligns continuously, with the overall length of 2.5 km. Due to the fact that some mineral components in granite are very endurable to weathering and erosion, so scarps can maintain their forms as they do. But this causes the difficulty in age determination of the scarp.

Fault scarps in clastics are sometimes steep and rather continuous. The morphology of fault scarps in clastic rocks indicates that these fault scarps should not be so much old. Because clastic rock type is easy to weather and erode, so fault traces cutting through the clastic area is possibly not too old. The length of this fault scarp is estimated at 0.35 km. The dip-direction of fault scarp in this area is generally SW.

The large alluvial fan was found with the major fault trace cutting through it. Due to a careful study, there is also some offset stream in the alluvial fan. Most of the drainages flowing down from the mountain are stream gullies and flow in the SW direction. When they run through the fault trace, it was found that the flowing direction changes to NW and then changess back to the former one (SW). All of the drainages run into one unity and then run down to the main river which is Mae Nam Khaew Noi (it is thought as the part of Khao Laem Dam, which is currently all over flooded). There are 3 drainages running with NW dextral offset and the average deflection is measured at about 112.5 m.



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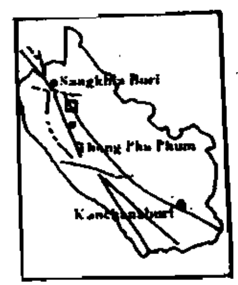


Figure 4.11 An area in Thi Mong Tha subsegment selected for detailed morphologic analysis.
a) aerial photographs of area S2-1 (Area 6 sheet 20 strip 75 no. 15729).
b) morphotectonic interpretation of area S2-1 of map sheet 4639III.
c) location of area S2-1 in Kanchanaburi.

In the northern part of this area, two fault steps were observed in the granite fault scarp. This probably suggests that the fault movement occurred in this area at least 2 times.

The fault trace found in this area is likely to be oblique fault featuring dip-slip movement due to the evidence of triangular facet and with the strike-slip movement in the right lateral style due to the apperance of offset stream.

S2-2 Area (Figure 4.12)

Information gathered from satellite image data exhibits that in this area there are several fault traces cutting into clastic rocks. Moreover, they are located in the middle portion of Thi Mong Tha Subsegment.

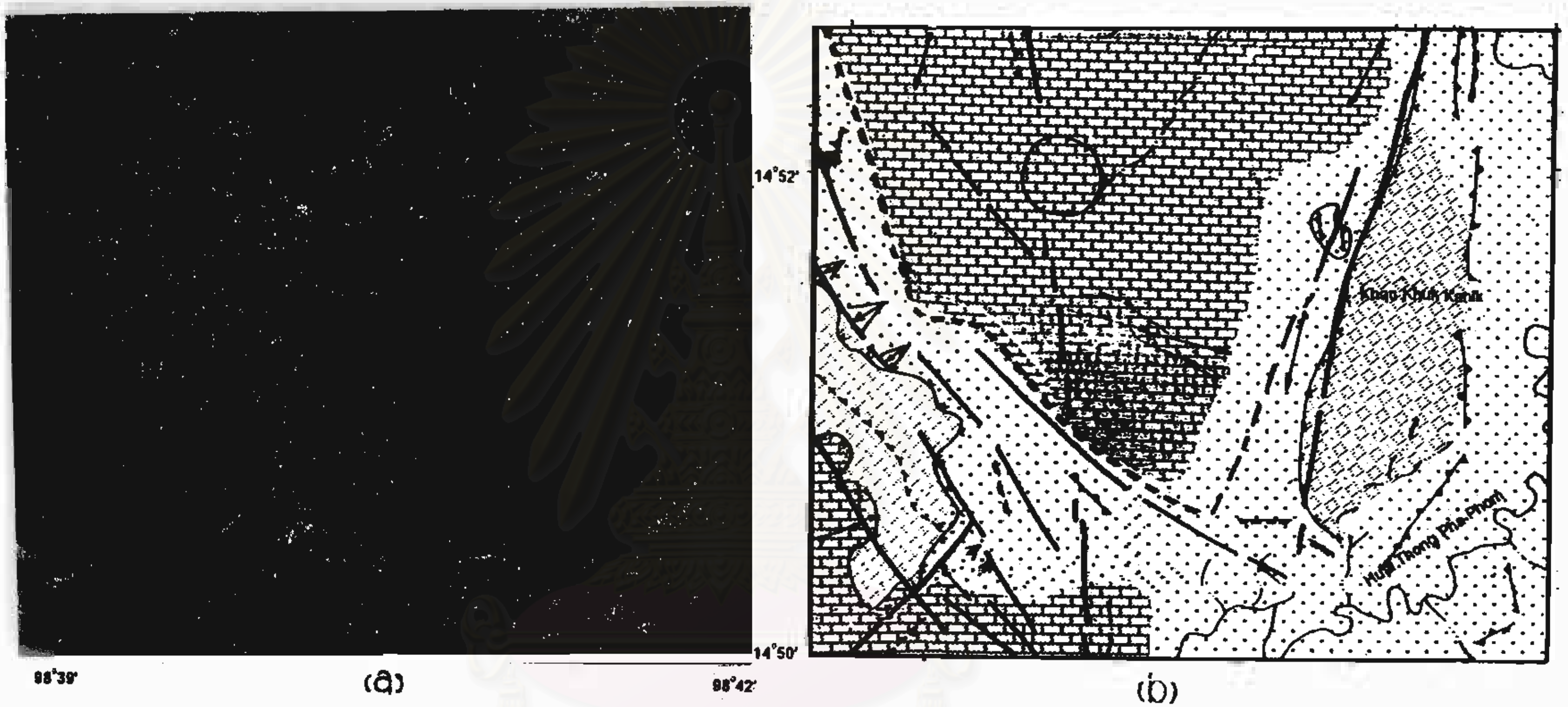
There are two fault traces in the direction of N35-40W and N15-20E. It is obvious that the result of these faults are similar to those from the satellite image study.

In this area, a set of triangular facets is found both in limestone and clastic rocks along the traceable fault. Triangular facets in clastic rocks are longer than those found in limestones. The former one has its base width at about 0.175 km, and its plane height at 0.15 m. This triangular facet is 13 km continuously long, and its dip directions are S30W and S40W. There is also another side of this triangular facet which is in the west of the fault facing N40E.

Mostly, the fault scarps in this area are found in limestones. They are highly steep and very continuous with the estimated length of 5.5 km. Dip directions found in this fault scarp are S30W and S5W.

One recognized offset drainage has the water running all year. It runs to the SSE and many offset streams are usually found in this area, giving rise to the fault in the direction of NE-SW. The drainage reflects a change of direction from its original SSE to the new SW, and then flows in the SSE course as usual.

Almost of the offset trends indicate the right movement and their offset is approximately 90 m. As for the NW-SE fault traces, the offset stream is seldom found. Fault traces in NE-SW move in the style of oblique which the dip- and strike-slip component and the right lateral movement as indicated by the offset streams.



(C)


Figure 4.12 An area in Thi Mong Tha subsegment selected for detailed morphologic analysis.
a) aerial photographs of area S2-2 (Area 6 sheet 22 strip 78 no. 16493).
b) morphotectonic interpretation of area S2-2 of map sheet 4738IV.
c) location of area S2-2 in Kanchanaburi.

S2-3 Area (Figure 4.13)

Data available from satellite image data show that, there is a traceable fault which aligns following the boundary between hills and plains. Moreover, the triangular facets are found in a long lineament.

The aerial photographic investigation shows that the fault trace shows its facets in N35W which correspond very well with that of the major fault trace interpreted from the satellite images.

A set of triangular facets found in clastic rocks is highly steep and is believed to be not too much old. The average base is 0.3-0.5 km wide, the average height is 0.2-0.3 km, and the average length is1.75 km continuously. Dip direction of triangular facet is in the direction of S30W and S60W.

Alluvial fans are not distinctive. It is also found that there is a fault trace cutting through this fan.

Offset streams found along the major fault support the believe that the drainage running down from the mountain has its direction on SW. When the drainage passes the fault trace, the change in the direction occurs to the NW direction and some of the drainages to SSW. Then all drainages unite together in the direction of SW and meet the Mae Nam Khaew Noi. The part of the river flows from N to S and doesn't bend too much.

There are approximately 5 parallel drainages in the offset stream moving dextral (as the above stated data), and their offsets are estimated at 85 m.

Two fault steps were observed in the hill part of this area. It is above the triangular facets, so it is expected that at least two times of the fault movement are determined in this area.

The fault trace in this area is likely to be oblique with dip-slip movement identified by triangular facets and strike-slip component in a right lateral style identified by offset streams.

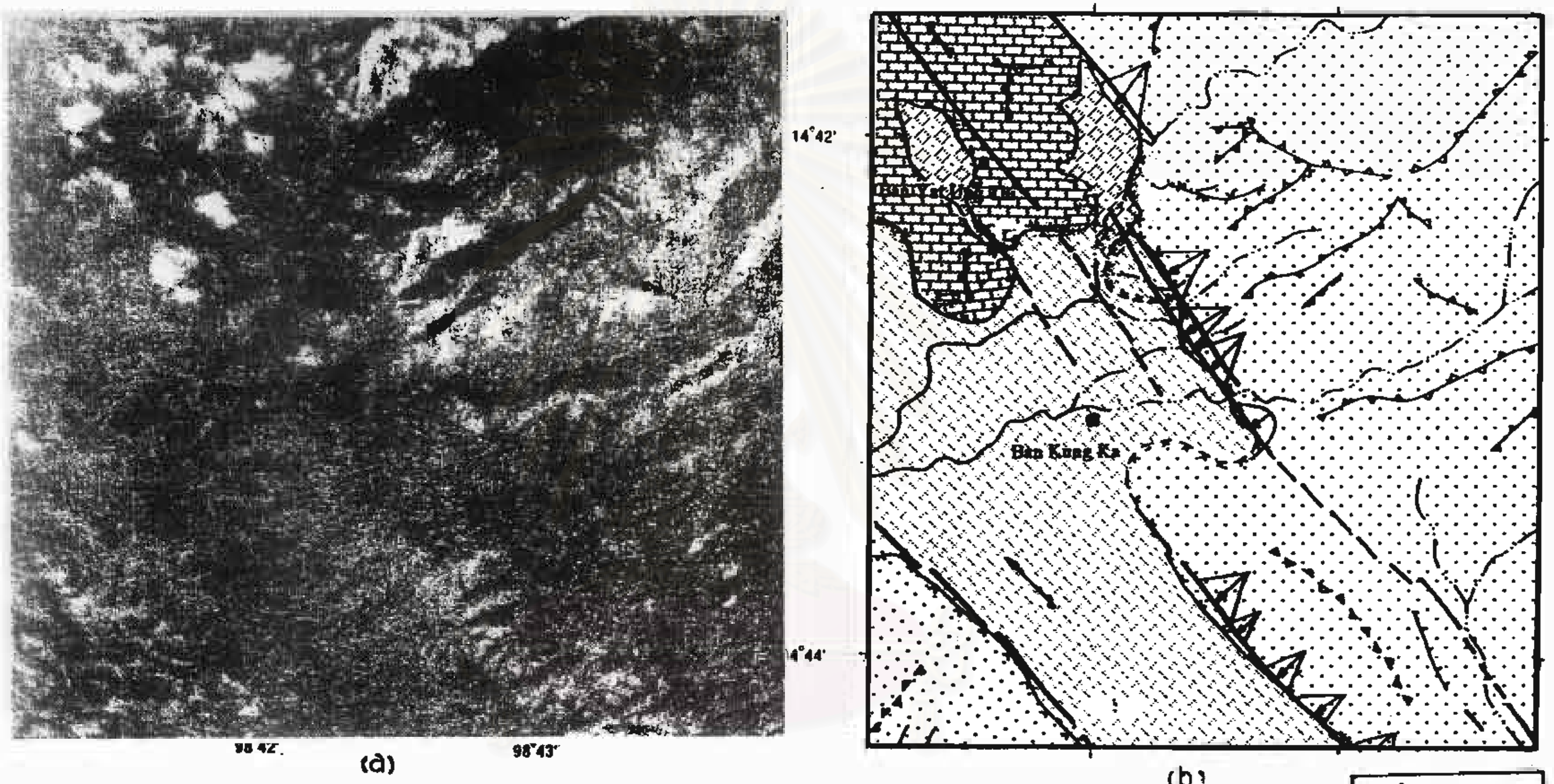


Figure 4.13 An area in Thi Mong Tha subsegment selected for detailed morphologic analysis.
a) aerial photographs of area S2-3 (Area 6 sheet 22 strip 80 no. 16562).
b) morphotectonic interpretation of area S2-3 of map sheet 4738III.
c) location of area S2-3 in Kanchanaburi.

2 Lin Thin Subsegment

There is one area studied by using aerial photographs as noted below.

S2-4 Area (Figure 4.14)

This area is in the upper part of the subsegment. Information collected from satellite image data shows the fault trace cutting into clastic rocks. Offset stream are found in the large river and a fault scarp is in the joint area of clastic rocks.

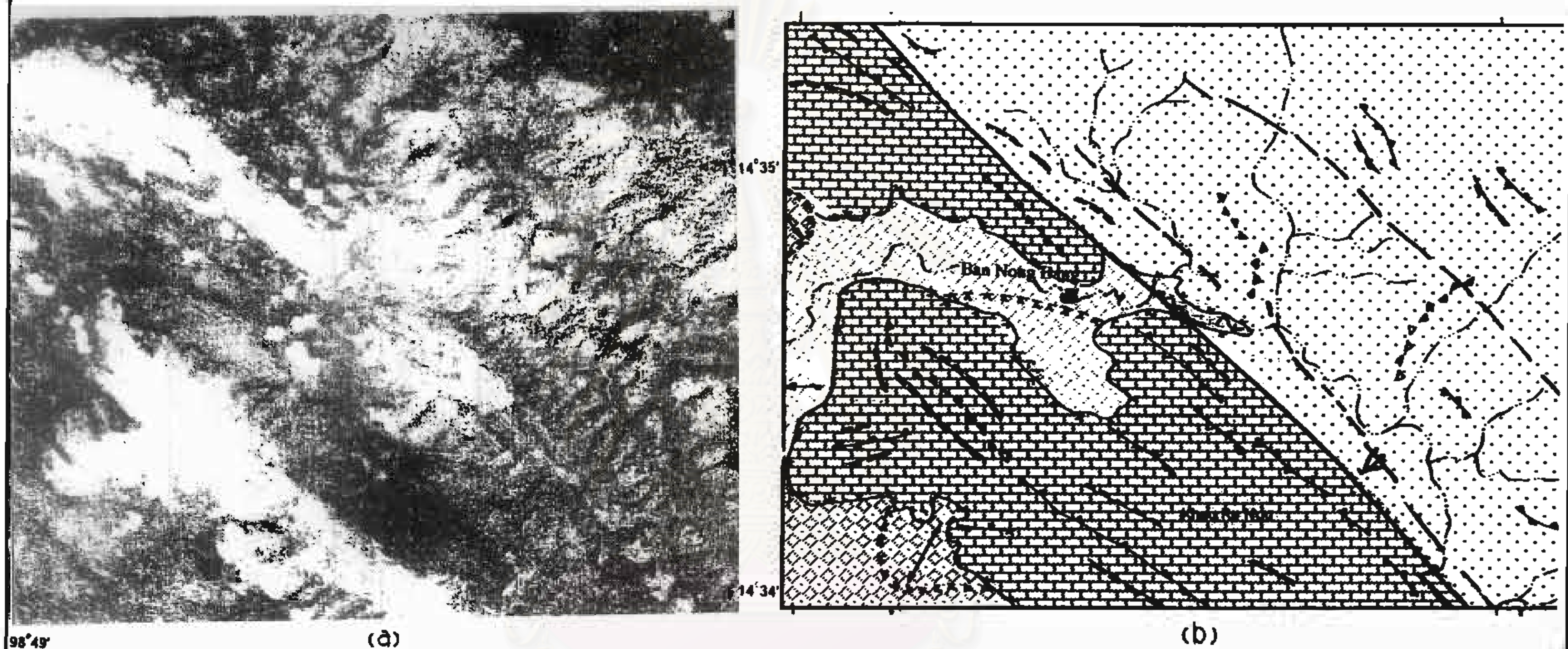
Aerial photograph ananlysis give some supporting evidence that most of the fault scarps in the area are continuous and long. One obvious fault scarp is found in limestone on the western side of the major fault. Based on the delicate study, it is figured out that there is a fault step on the limestone hill which stays higher than the major fault trace. Moreover, this fault step is not quite continuous and not so long with the dip direction to N45E.

A fault scarp in clastic rocks on the eastern side of the major fault is also continuously long, but not too obvious. The fault step was found in the same characteristic with the dip direction of S40W. At least, it indicates 2 times of the fault movement. Oblique and discontinuous triangular facets were observed in clastic rocks.

The most outstanding offset stream is the one occurring at the Lin Thin creek which is the all-year water running from E to W in average. When it is near Mae Nam Khaew Noi, it in turn runs to SW. Offset stream trace was also recognized in the hilly area where the fault cut through it. Usually this drainage runs to the west, but when it passes this fault trace, it turns to NW. When it already passed the fault trace, the drainage will change its flow to the former west. Based on this feature, it makes belief that this drainage has the dextral offset.

Between the boundary of limestone and clastic rocks, there exists a major fault passing along the V- shaped valley where the stream runs along the fault trace in the direction of NW.

Fault traces in this area are oblique with the strike-slip trace in the right lateral style due to the deflection nature of the offset streams.



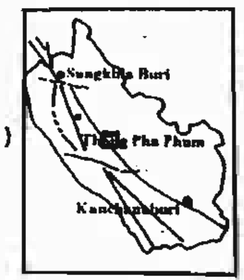


Figure 4.14 An area in Lin Thin subsegment selected for detailed morphologic analysis.
a) aerial photographs of area S2-4 (Area 6 sheet 22 strip 82 no. 16684).
b) morphotectonic interpretation of area S2-4 of map sheet 4738II.
c) location of area S2-4 in Kanchanaburi.

3 Khwae Yai Subsegment

There is one study area, which was selected for the application of aerial photographs.

S2-5 Area (Figure 4.15)

This area is located at the beginning part of this subsegment. Information gathered from satellite images data depicts the major fault trace passing into the alluvial plain parallel to Mae Nam Khwae Yai.

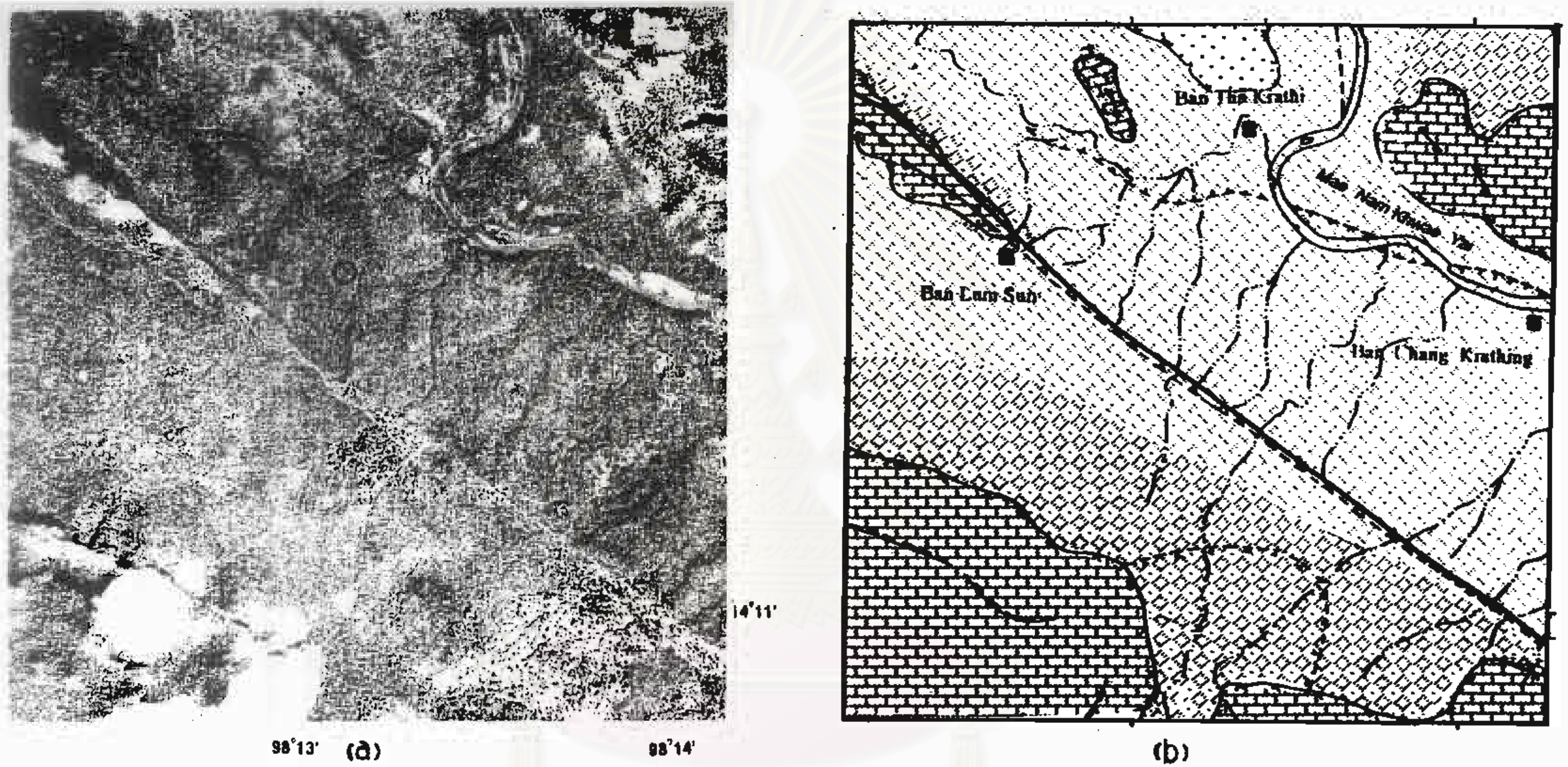
Aerial photographic study indicates that the fault trace examined is in N55W, which is similar to the data from the satellite images.

Because the fault trace cuts through the plain, it makes the difficulty in finding the paleoseismic evidences. However, in this area, beheaded streams are encountered at which there exists the marked change in slope of stream course due to faulting. There are total newly created 9 drainages that run into Mae Nam Khwae Yai. It is approximately 4.25 long and flows in the NE direction.

Offset streams of temporary or ephemeral drainages with the flowing direction from SW to NE, are also found. Some of the drainages flow from the hill and the other flow from the minor scarp. A careful consideration indicates that when drainage meets fault trace, it expresses its flowing direction to NE from the former SW. Then it suddenly changes to SE and after that change its flow direction to NE. Sense of fault movement based upon the offset stream is to the right. There are about 6 offset drainages, and the offset is measured at about 30 m.

On the eastern side of the Khwae Yai River, 4 stairs of stream terraces are found. This perhaps indicates multiple stages of tectonic uplift occurring in the Mae Nam Khwae Yai area.

In conclusion, the traceable faults in this area are oblique. Dip-slip nature is proved by beheaded streams, and strike-slip nature shows the right lateral style as proved by offset streams.



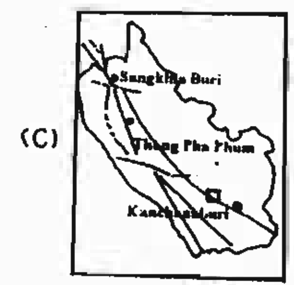


Figure 4.15 An area in Khwae Yai subsegment selected for detailed morphologic analysis.
a) aerial photographs of area S2-5 (Area 1 sheet 3 strip 16 no. 1868).
b) morphotectonic interpretation of area S2-5 of map sheet 4837III.
c) location of area S2-5 in Kanchanaburi.

4.2.3 Thong Pha Phum Segment

There are 5 studied areas are chosen for aerial photographic interpretation.

S3-1 Area (Figure 4.16)

It is in the upper side of this segment. Information gathered from satellite images data expresses that there are small continuously long triangular facets and fault traces.

Investigation using aerial photographs study shows that fault traces orient in N10W, and the northern part of these faults is bending to west and becomes part of folding. So, it is possible that there will be the fold axis is in the N5W.

The small triangular facet was observed with the base width at about 0.175 km, and height at about 0.2 km, and a series of steps constitute to the length of approximately 3.6 km.

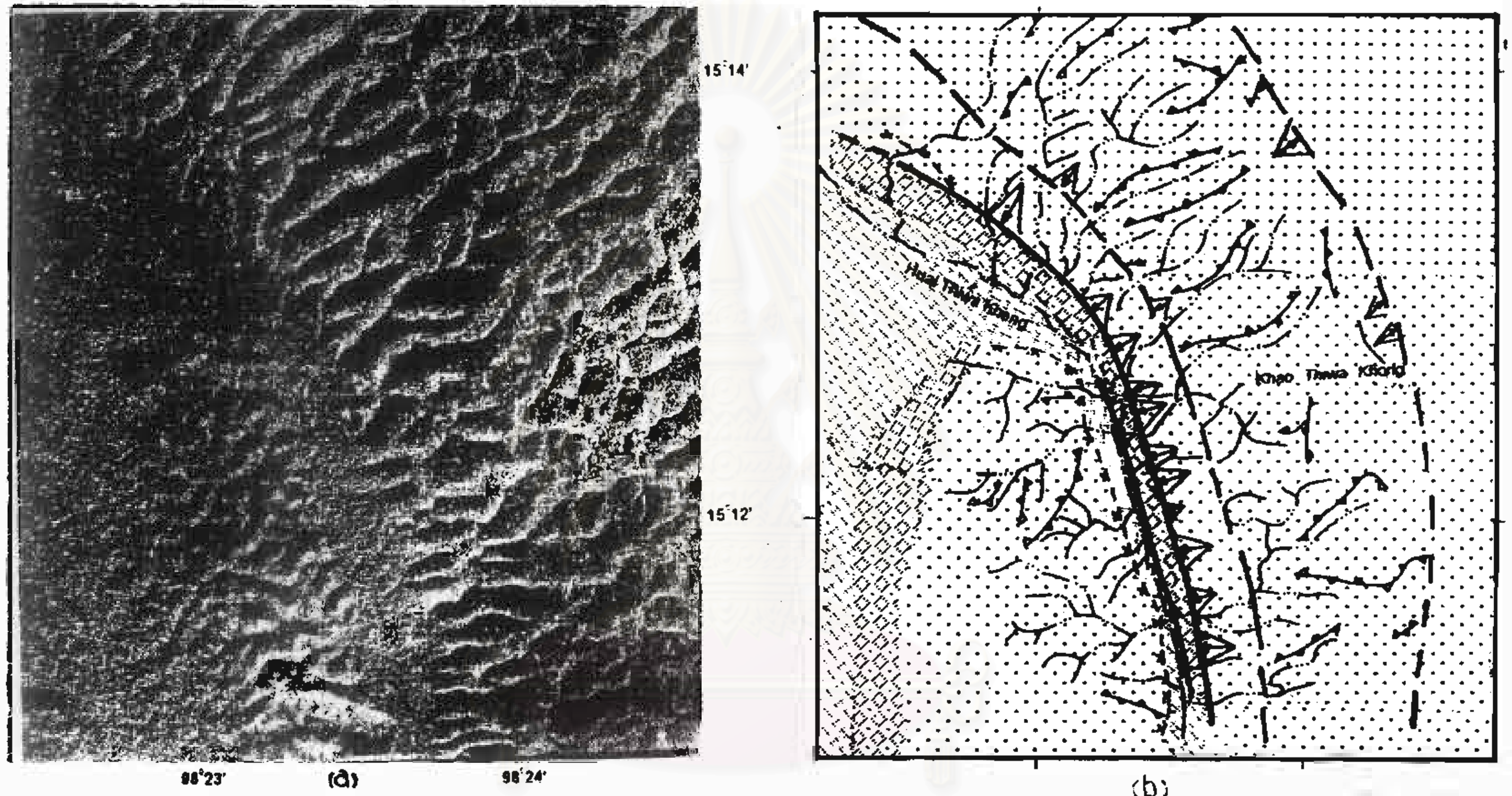
Dip direction along the fault plane starts from N80W and then bends little by little until the dip direction turns to be at N20W, becoming one part of fold.

A small shutter ridge is encountered and it is likely to move to the left based upon delicate consideration.

Only one set of offset streams in this area is detected from gully stream running parallel to each other from E to W and from NE to SW. When they meet the fault trace, they generally change the direction from NNW to SSE. And then again the flowing direction is changed from E to W and NE to SW as usual. Later they join with the main drainage flowing from N to S. Based on these evidences, it is believable that the offset is likely to be left lateral and the value of offset is estimated at 80-83 m.

Two fault steps are recognized the upper side of the triangular facet. This perhaps indicates 3 times of fault movement.

In summary, the fault in this area moves obliquely and shows the left lateral strike-slip movement according to the offset-stream evidence.



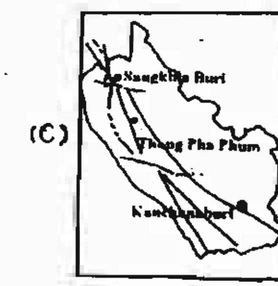


Figure 4.16 An area in Thong Pha Phum Segment selected for detailed morphologic analysis.
a) aerial photographs of area S3-1 (Area 6 sheet 20 strip 73 no. 15657).
b) morphotectonic interpretation of area S3-1 of map sheet 4639II.
c) location of area S3-1 in Kanchanaburi.

S3-2 Area (Figure 4.17)

This area in the upper west side of the Thong Pha Phum segment. Information gathered from satellite image data indicate that the fault in this area runs along the boundary between the clastic rocks trace and alluvial plain with the well-preserved triangular facet.

Aerial photographic study informs that the fault trace observed is in the N10E direction corresponding to that interpreted from the satellite images.

The long-continuous almost N-trending series of the triangular facets is found to the east of Ban Malai and Ban Ku Phu Du following Mae Nam Kai Khi Yai. This triangular facet set occurs in clastic rocks and facet slope is quite steep. The average base is 0.1-0.25 km wide and the facet is about 0.1-0.2 km high with the estimated continuous length at 1.4 km. The dip direction of this triangular facet is about N80W and S95W. The other set followss the northern set, it is recognized to the NE part of Ban Kui Cha Tho.

Almost all offset streams intermittently flow parallel to one another from E to W. When it flows across the fault, it changes the direction to NNW and then turn to NW and when it passes another fault trace which is at the most end of triangular facet connecting to the border of the basin. Once the stream course already passes the fault trace, it runs into NWW again and meet the main river which runs from N to S (at present this stream is occupied by Khao Laem reservoir). From all above stated evidences, it is believed that the fault is possibly right lateral and the offset is measured at about 100m.

Two steps of faults are also encountered next to the triangular facets almost up to the mountain peak. It is, therefore, inferred that there were at least 3 faulting events taking place in this area.

In conclusion, the fault trace of the S3-2 area is generally oblique with its strike-slip component in the right lateral style.

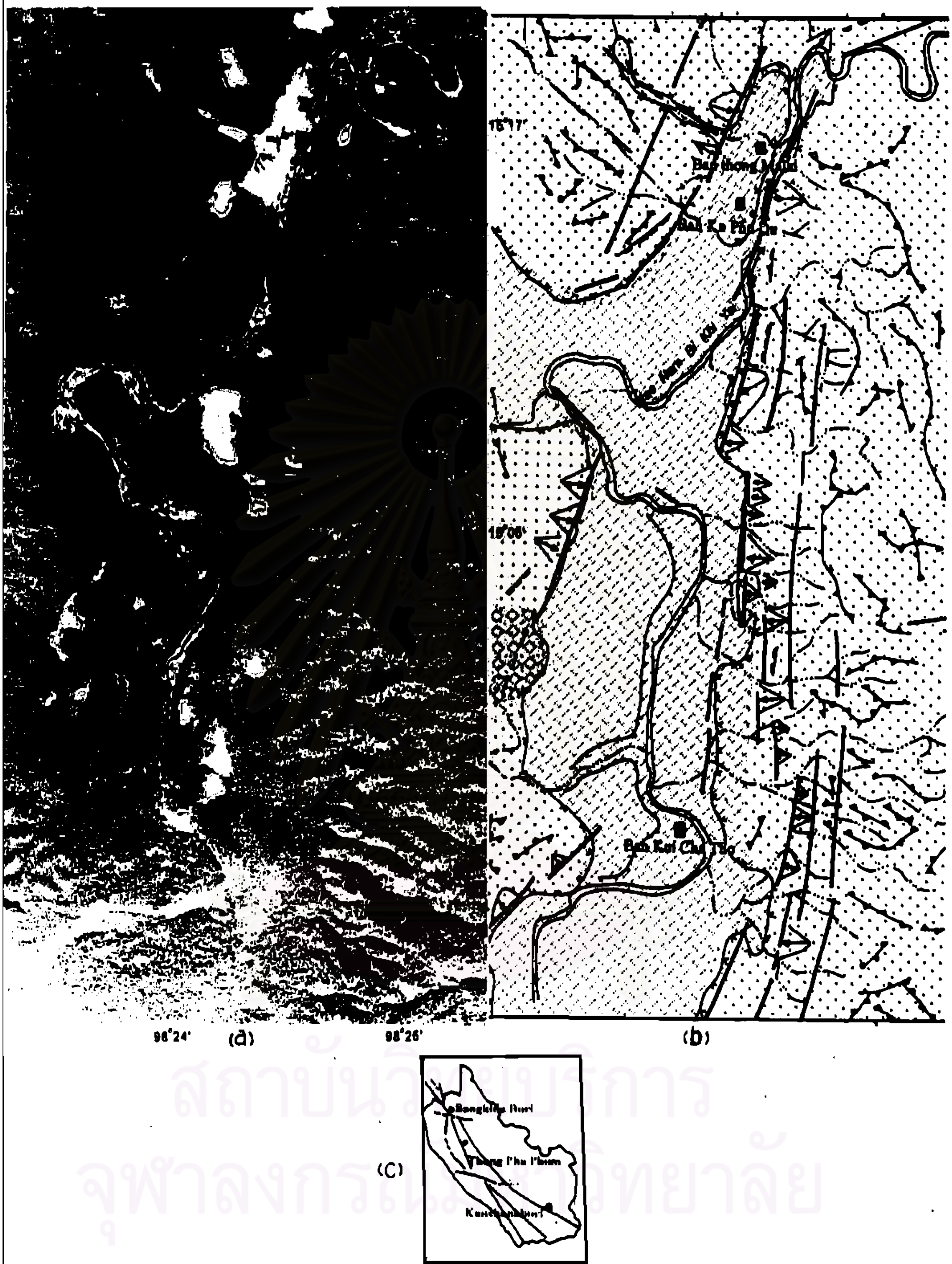


Figure 4.17 An area in Thong Pha Phum Segment selected for detailed morphologic analysis

a) aerial photographs of area S3-2 (Area 6 sheet 20 strip 75 no.15726).

b) morphotectonic interpretation of area S3-2 of map sheet 4639 II

c) location of area S3-2 in Kanchanaburi

S3-3 Area (Figure 4.18)

This area is in the northern part of the east of this segment. Information deduced from satellite-image data informs that fault trace passes both clastic rocks and alluvial plains.

Investigation based on aerial photographs demonstrates that the fault traces mostly align in the N-S direction similar to the data from the satellite images.

Fault scraps recognized are not continuous and mostly occur in clastic immediately to the west of Mae Nam Khwae Noi bewteen Wang Ka, Ban Mon, and Ban Lawa. Due to the indurablity nature of the clastics to surface processes, the fault scarps are therefore deeply eroded. Each fault scarp in every part is about 0.3 km long.

The dip direction of the fault scarp is to the west. No offset stream is found in this investigated area

There are 2 fault steps encountered next to the fault scarp. Therefore, it is reasonable to note that these fault traces may be related to at least 3 times of the outstanding fault movement.

S3-4 Area (Figure 4.19)

This area is located southward to the west of the Segment. Information taken from satellite image data shows that there is a fault in this area following a temporary stream in the clastic-rock zone. Moreover, fault scarps and triangular facets were found connected to each other.

Aerial photographic interpretation reveals that the fault trace orientates in N30W.

A series of continuous triangular facets is observed in the high-steep clastic rocks. Their bases are approximately 0.16-0.25 km wide, and the facets are estimated at 0.15-0.225 km high. Their continuity is about 1.675 km long with the estimated N65-45E for the dip direction.

A set of fault scarps, which occurs in Permian limestones, has the average dip direction of WSW, and the continuity of the scarp is about 1.975 km long. No offset stream has been observed in this area.

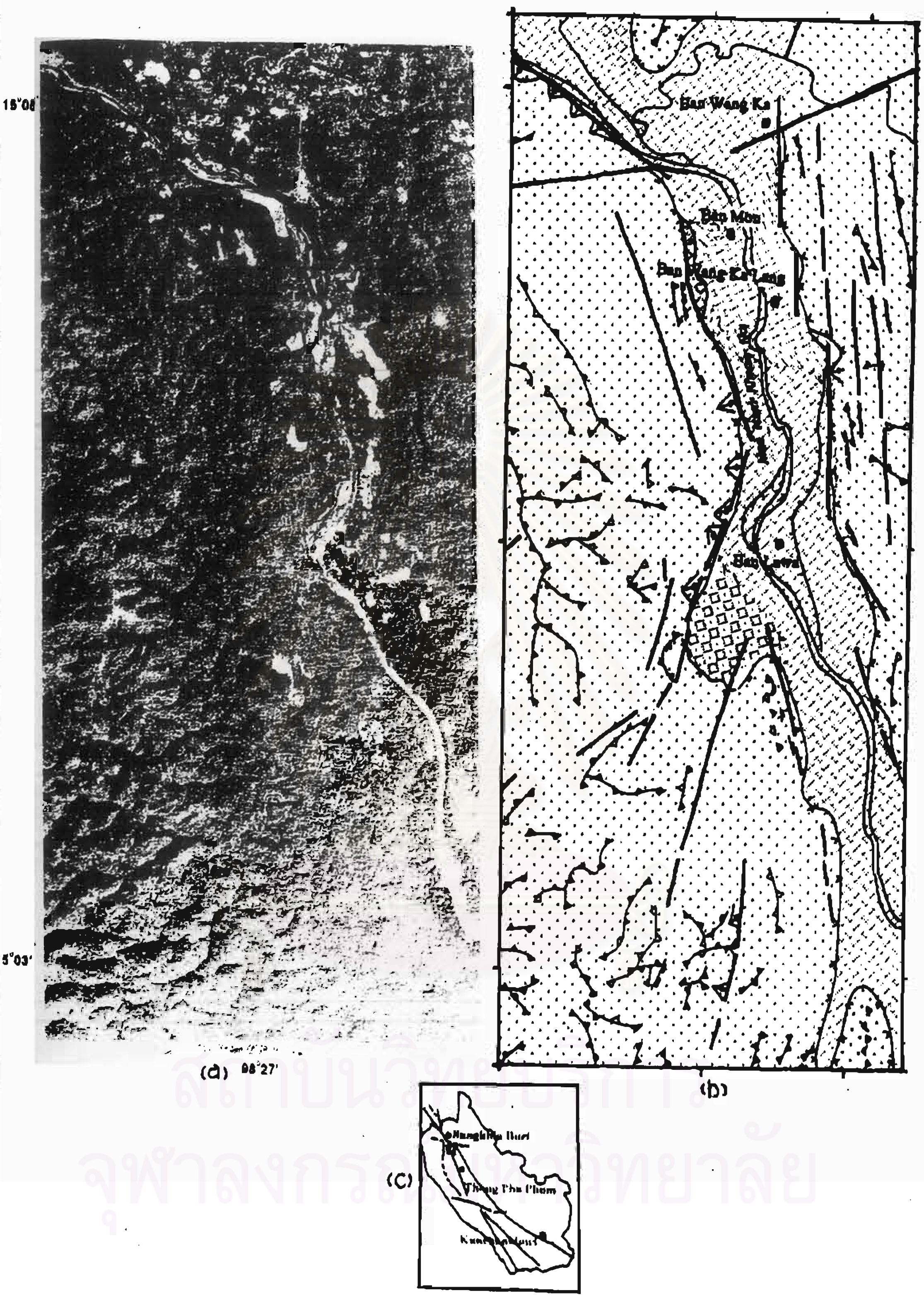
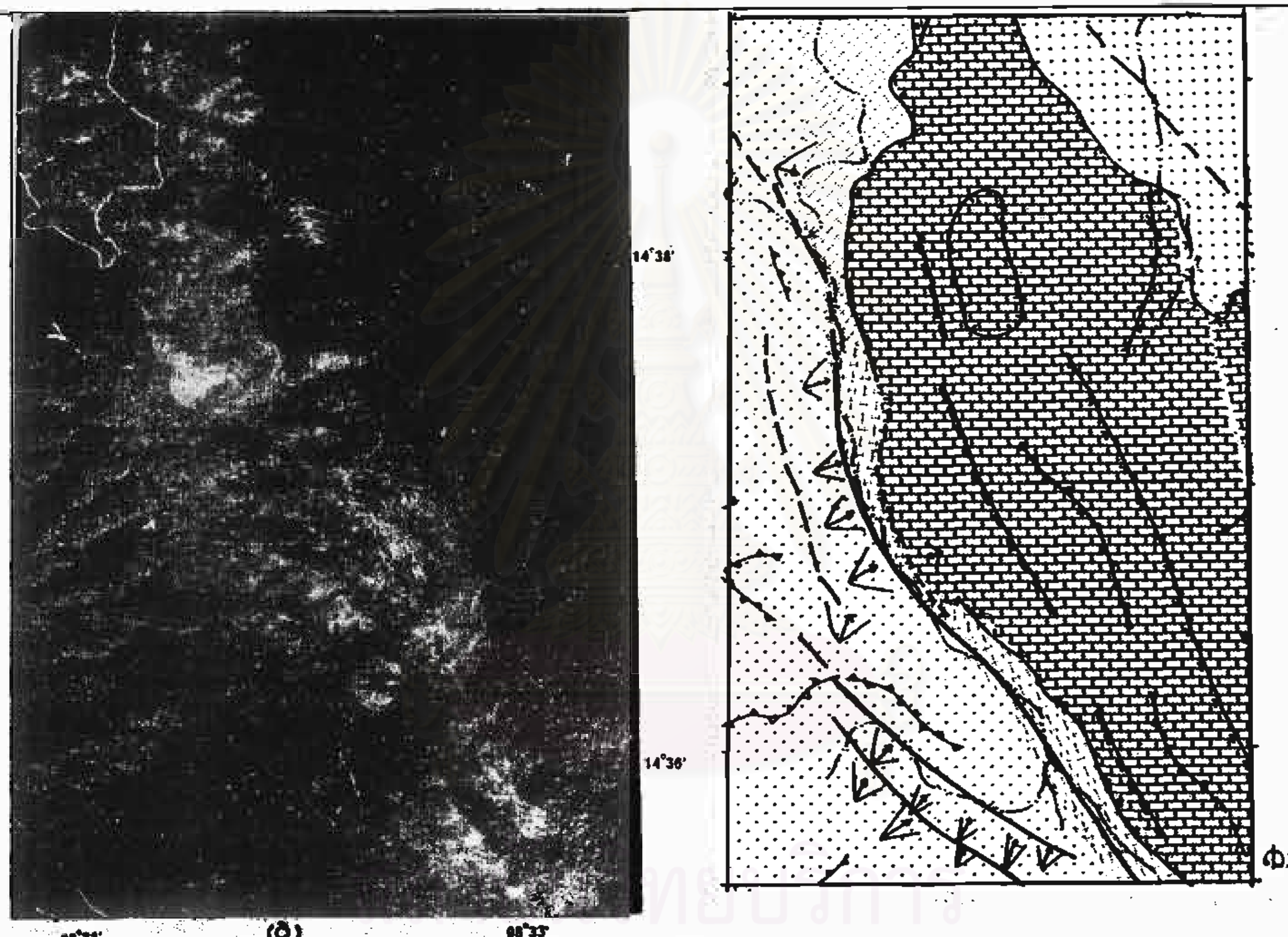


Figure 4.18 An area in Thong Pha Phum Segment selected for detailed morphologic analysis

a) aerial photographs of area S3-3 (Area 6 sheet 20 strip 75 no.15726).

b) morphotectonic interpretation of area S3-3 of map sheet 4639 II

c) location of area S3-3 in Kanchanaburi



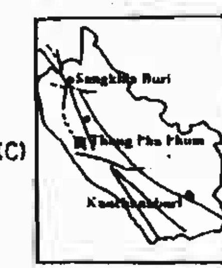


Figure 4.19 An area in Thong Pha Phum Segment selected for detailed morphologic analysis.
a) aerial photographs of area S3-4 (Area 6 sheet 22 strip 81 no. 16577).
b) morphotectonic interpretation of area S3-4 of map sheet 4738III.
c) location of area S3-4 in Kanchanaburi.

One fault step is found above the triangular facet. This fault step and a set of the triangular facet indicate two periods of fault movement. Based upon aerial photographs, it is possible that the fault trace in this area shows the dip-slip movement more prominent than the strike-slip movement.

S3-5 Area (Figure 4.20)

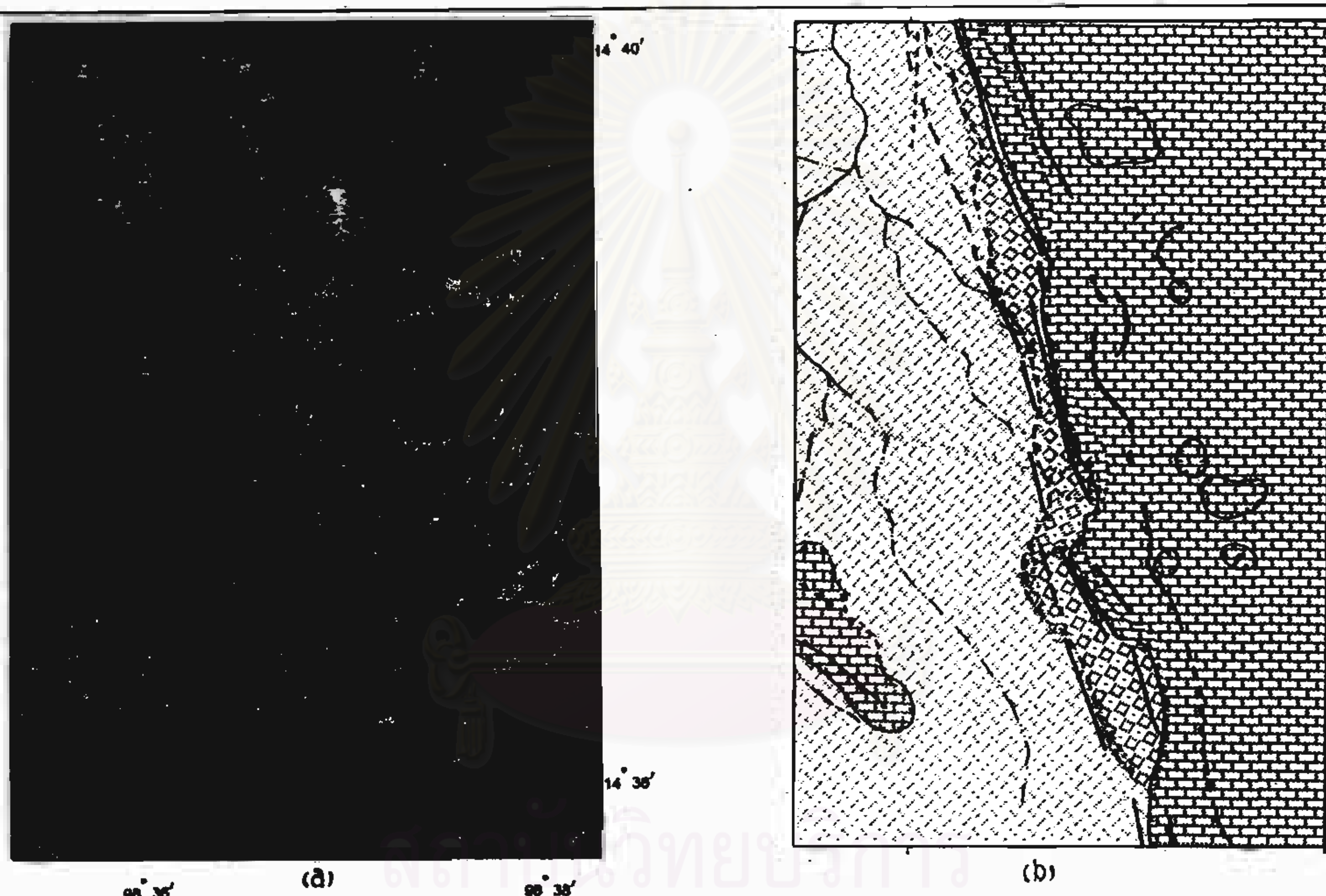
The study area is in the southern side of the Thong Pha Phum city. It is located to the southernmost end of the Thong Pha Phum Segment. Information gathered from satellite image data depicts that faults or lineaments can be traced continuously and runs parallel to the limestone rock immediately at the plain.

A detailed study on aerial photographs informs that the fault trace is in the N15W direction. It forms a prominent morphotectonic feature very similar to the so-called linear valley (see Slemmon and Depolo, 1986). Such a valley is a straight valley with the length of the long axis of about 4 km and the width of less than 150 m. To the south (about 7 km), this fault subsegment is interrupted by the other fault segment, which is herein called Mae Nam Noi Segment comprising Khao Aru and Huai Sai Yok Faults.

In this area, the outstandingly continuous fault scarp is also found in limestone. Each of its section is about 1.8 km long with the dip direction in the NNW direction.

The offset stream in this area is quite oblique to the main stream which flow to the south-southeast direction.

The fault trace in this area is likely to have the more notable dip-slip plane than the less prominent strike-slip one.



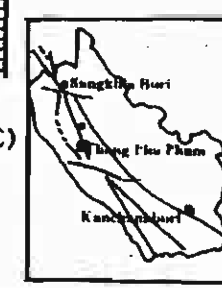


Figure 4.20 An area in Thong Pha Phum Segment selected for detailed morphologic analysis.
a) aerial photographs of area S3-5 (Area 6 sheet 22 strip 81 no. 16579).
b) morphotectonic interpretation of area S3-5 of map sheet 4738III.
c) location of area S3-5 in Kanchanaburi.

4.2.4 Mae Nam Noi Segment

There is one area selected for the interpretation of aerial photographs.

S4-1 Area (Figure 4.21)

This concerned area is in the middle part of the segment where the NW-trending Mae Nam Noi runs along the fault trace. The fault traces in this area are the faults that cut mostly through clastic rocks of Khao Mo Thi Mo and limestones of Khao Thi Pu. Information gathered from aerial photographs reveals that the fault trace posses its orientation in the N65W direction, corresponding to that interpreted from Landsat.

Two setss of the rather steep, continuously-aligning long triangular facets are found in the clastic rocks. The facets are about 0.1-0.2 km at base, and about 0.1-0.175 km high. The average total length of each set is about 3.2 km. The dip-directions of the triangular facet is estimated at N35E and S30W.

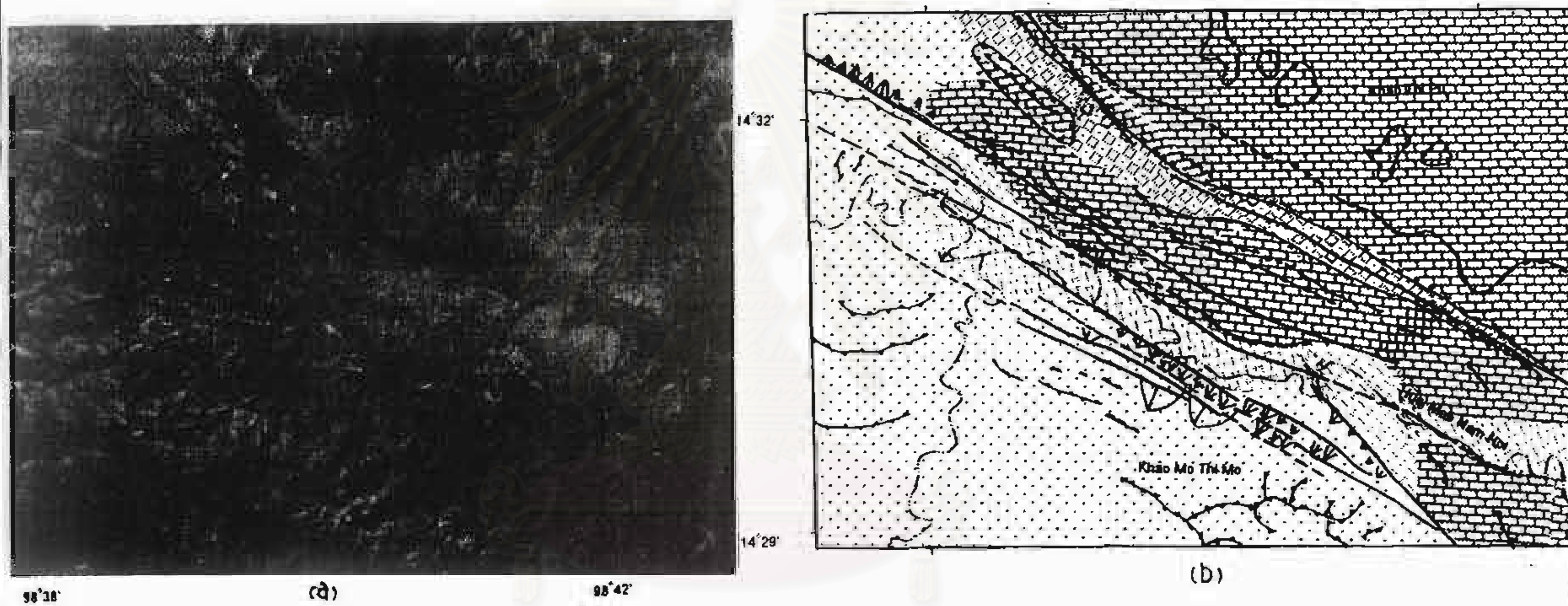
A fault scarp in this area is observed in the northern part of the limestone area and is consecutively long. The longest is approximately 7 km.

The offset streams in this area are rather oblique to the Huai Mae Nam Noi which is the permanent stream running to the southeast. Again there exists the linear valley and the feature called "parallel ridge" (of the clastic units) along the narrow stream valley.

There were about 3 trends of the fault steps found in this area. Each trend overlies the triangular facet, so it is anticipated that in this area fault movement possibly occurred approximately 4 times.

The interpretation using landform analysis indicate that the aspect of the limestone mountain with similar geographical features is likely to be the same rock. However, there is a fault cutting through between the both limestones area, so it is comprehended that this fault has moved sinistral in order to separate these both limestone.

Based upon all described data, the fault trace in limestone in this area is likely to be an oblique fault with the left lateral strike slip movement.



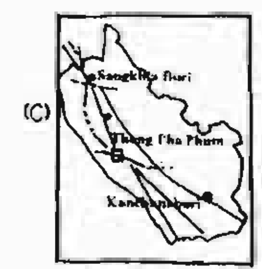


Figure 4.21 An area in Mae Nam Noi Segment selected for detailed morphologic analysis.
a) aerial photographs of area S4-1 (Area 6 sheet 22 strip 83 no. 16639).
b) morphotectonic interpretation of area S4-1 of map sheet 4737I.
c) location of area S4-1 in Kanchanaburi.

4.2.5 Khwae Noi Segment

There are two areas selected for detailed aerial photographic interpretation, as noted below.

S5-1 Area (Figure 4.22)

This area is in the middle part of the segment. Information collected from satellite images depicts that there is a fault passing between clastic rocks and alluvial plains. The fault run following the Khwae Noi River.

Based upon data deduced from the aerial photographs, it is found that the fault trace has its direction of N40W which is similar to that of satellite images. The NW fault trace is cut by the NE fault traces with the right lateral sense.

There are two set of the triangular facet which are roughly continuous. The average base width is about 0.375 km and the average height is about 0.35 km. The continuous overall of the facet set is averaged at length 1.75 km with the N35E to N45E dip directions. The triangular facets occur in the clastic rocks with prominent feature.

The offset stream of this fault trace in this area is not quite prominent.

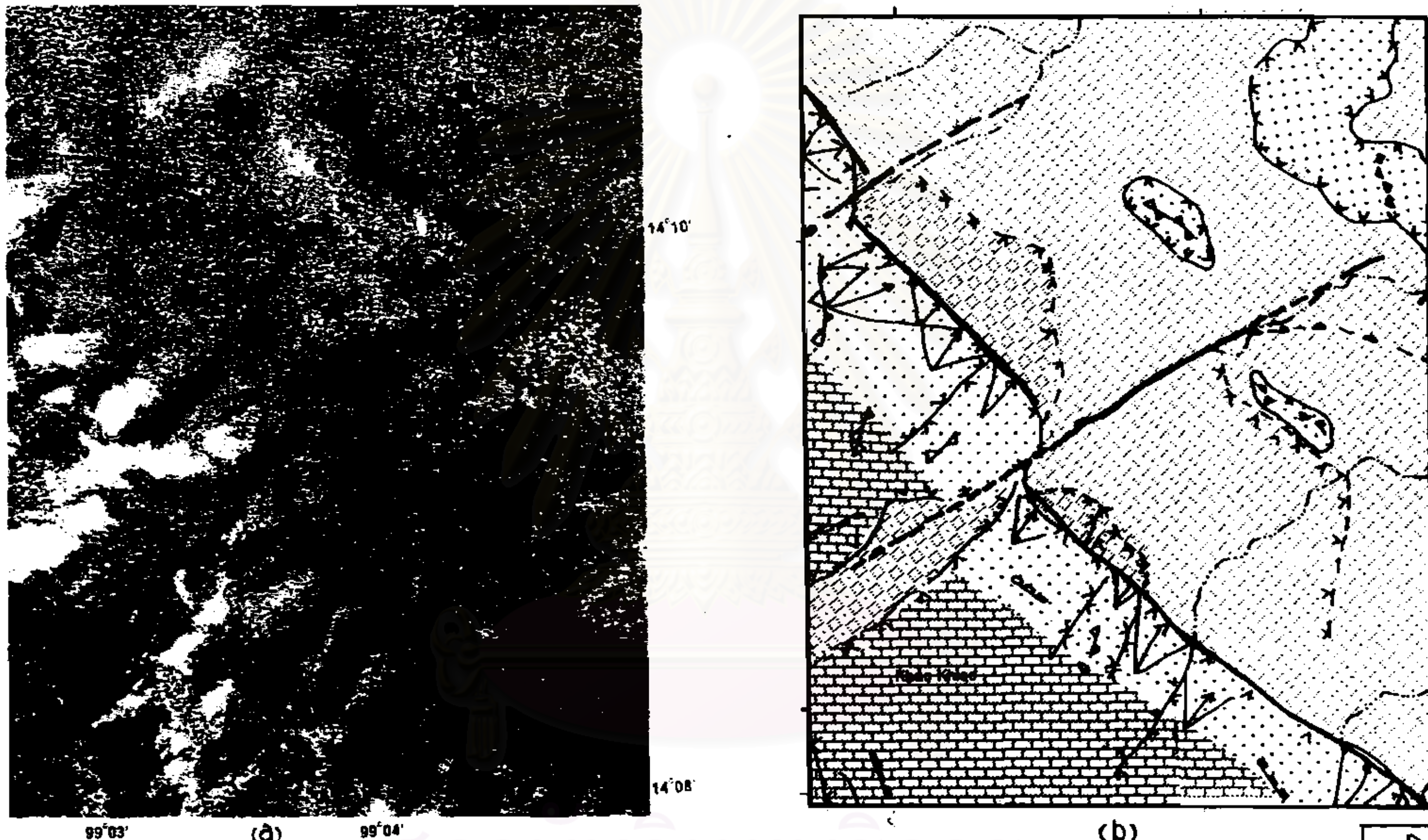
Two fault steps are observed in the upper part of triangular facet. So, it is believed that there were at least three fault movement occurred in this area.

And there is also the fault trace near Khwae Noi River as well which passes limestone and Cenozoic basin. Then it only passes the plain and cuts into the connection between limestone and plain and then it runs only the plain again. This fault trace passes limestone, so it makes the below fault scarp.

The fault scarp in limestone is very obvious and can be traced continuously at about 2.25 km in each section. The scarp orients with the S45W dip direction.

The offset streams are observed as well, the streams are mostly non-permanent and run from the hill in the NE direction. It then meets Khwae Noi River that has the SE flowing direction.

When the stream running out of the mountain meets the fault trace, it changes the direction from NE to SE and then again changes to NE. There are 5 offsets roughly running parallel to each other and finally they all run into Khwae Noi River. It is assumed that this offset is almost lateral and indicates the dextral movement.



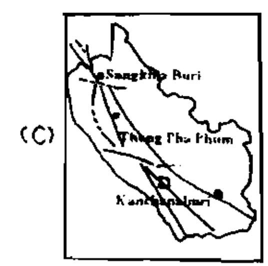
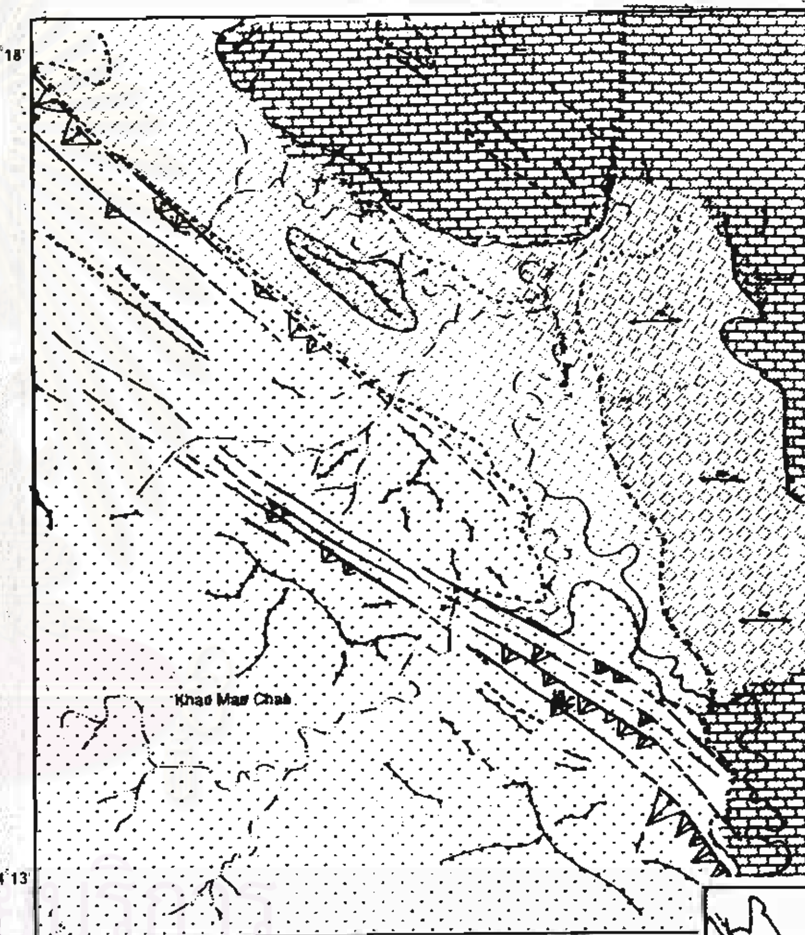


Figure 4.22 An area in Khwae Noi Segment selected for detailed morphologic analysis.
a) aerial photographs of area S5-1 (Area 1 sheet 3 strip 17 no. 1683).
b) morphotectonic interpretation of area S5-1 of map sheet 4837III.
c) location of area S5-1 in Kanchanaburi.

(a)



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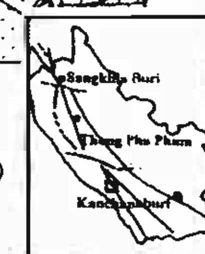


(c)

Figure 4.23 An area in Khwae Noi Segment selected for detailed morphologic analysis.
a) aerial photographs of area S5-2 (Area 1 sheet 3 strip 15 no. 1819).
b) morphotectonic interpretation of area S5-2 of map sheet 4737III.
c) location of area S5-2 in Kanchanaburi.

There are 3 lines of the fault step recognized in this area. Each line overlaps with the triangular facet, so it is comprehensive that in this area at least 4 times of fault movements occurred.

According to all obtained data, it is assumed that this fault is likely to be an oblique fault with the right lateral strike slip sense.

4.3 Field Evidences

In order to better clarify the result from remote-sensing investigation, field or ground- truth survey on geomorphology was conducted. A focus was made in area along the TPFZ, particularly those selected for aerial photographic interpretation.

4.3.1 Sangkhla Buri Segment

Area S1-1

The surveyed area is characterized by a long and continuous hilly terrain with steep slopes. Individual hills have the average width of about 250 m and the average height of 60-70 m. Triangular faults as recognized from aerial photographic interpretation is shown in the field (see Figure 4.24) as subdued and erosional-surface facets with the small temporary streamss parallel to one another. Top soil, with red to orange red colour and semi-consolidated nature, has the thickness of 1 m. The thin venire of this top soil developed overlying the sequence of siltstone and sandstone.

4.3.2 Kanchanaburi Segment

Area S2-1

The area as taken from aerial photographic investigation is a large alluvial plain adjacent to the mountain range. Fault scarps and triangular facets are well developed in granites. In the field, as observed at the Torchodoor school at Ban Radar (see Figure 4.25) (Grid reference 548-621), the area is occupied by the thick soil and regolith-covered hills with the height of 20-30 m above the flat plain and the average length of 200-300 m. These 5 hills, which run almost parallel to the higher-elevated NW-trending mountain, are interpreted to represent the parallel ridges occurring as a result of faultings which dissect the original physiography into smaller fragments.

Figure 4.24 A set of triangular-facet fracture with the SW-dipping face, right at the road from Sangkhla Buri to Pra Chedi Sam Ong, Amphoe Sangkhla Buri. Photo taken to NW (Sangkhla Buri Segment).

Figure 4.25 Panoramic view of the mountain range (background) with fault-scarp (arrowed, 1) and triangular facet (arrowed, 2) developed in the granite terrain. Photo taken to NE at the Tor Chodoor school (in the foreground). Thi Mong Tha Segment (Kanchanaburi Segment)

The alluvial deposit consists largely of un- to semi- consolidated materials of bad sorting (see Figure 4.26). The fragments or clasts range in size from 0.5 to 2 cm and are enclosed by silt and clay matrix.

At present, due to the impoundment of water in the Khao Laem reservoir, several distinct neotectonic features, such as fault scarps, were obliterated by such impoundment. At one surveyed gully, the valley is floored by gneissic rocks and the rocks are dissected by strike-slip fault movement (plane 320/75 NE) with the left lateral offset of about 10 cm (shown by displaced quartz veins).

Area S2-2

Data from aerial photographic interpretation reveal that this area is influenced by several fault sets of different directions. In the field, a large road-cut quarry (20x100 m) with the height of 6 m (at grid reference 652-412) is occupied by black calcareous shale with bedding attitude of 240/32 NW. This fine-grained clastic unit is disrupted and severely deformed by faults of several directions 0/20 E, 10/20 E, 320/30 NE, 130/70 SW, 150/60 SW, 310/50 NE, 350/60 E, 355/70 E and 172/40 W.

A fault-gouge material was collected in the 10/20 E fault- plane of this quarry for TL / ESR datings (see Table 4.3). The reason for selecting this fault plane for geochronological sampling is due to the fact that the fault of this direction represents the youngest faulting activity for this area.

Area S2-3

The area surveyed (Figure 4.27) is located in Ban Yot Ung Thi and Ban Kung Ka, Amphoe Thong Pha Phum. Evidences from aerial photographic analyses support the appearance of SW-dipping triangular facet immediately at the alluvial plain. The facet set was developed in NNW-trending Khao Ung Thi mountain range, suggesting a fault running parallel to the mountain front.

In the field, it is noteworthy that the alluvial deposit is observed data quarry front (10x50 m) and consists mainly of pale yellow to pale brown sediments with the clasts of 0.5-2 cm size range and silt/clay matrix. Gullies are strongly developed in the area which is now a corn field and presently obscure the offset streams.

For the triangular-facet feature, it is visualized in the field that the gully stream of about 1 m width developed onto the facets. These densely vegetated

Figure 4.26 A close-up view of semi-consolidated alluvial deposit at a man made quarry, clasts 0.5-2.0 cm. And silt and clay matrix. One-bath coil to scale. (Area S2-1 Grid ref. 546-821, Thi Mong Tha Subsegment).

Figure 4.27 A panorama of the NWW-trending Khao Ung Thi mountain range between Ban Yot Ung Thi and Ban Kung Ka villages, showing the SW-dipping Triangular facet covered mostly by dense vegetation. Photo taken to SW (Thi Mong Tha Subsegment of Kanchanaburi Segment).

facets are relatively large, with the average base width of about 250 m and the average height of 180 m. the facets tend to develop into a series. The area is mostly occupied by siltstone with inerbedded sandstone. Fault sets are well-recognized at this quarry and their attitudes of 30/65 SE, 25/45 SE, 30/45 SE, 340/60 NE, and 30/80 SE are recorded. A sample of fault-gouge material was collected within the fault plane of 30/80 SE which in inferred to represent the youngest fault movement in the study area.

Area 2-5

This area, located in Khwae Yai Subsegment, at Ban Lum Sum, is chiefly occupied by large limestone tower of Chong Krathing mountain with dominant fault scarp. A fault scarp as detected by aerial photographs runs following the NW-trending Khwae Yai River running southeast ward. Along the fault, there exist the beheaded stream (or superimposed-fault stream) developed in response to the sudden change in relief of the area surveyed. As shown in Figure 4.28, field investigation indicates clearly that the abrupt change is about 30°. Such feature strongly advocates the NW-trending fault running along this deflection plane.

4.3.3 Thong Pha Phum Segment

Area S3-1

This area is characterized by the long and continuous hills with gentle slopes at top and median parts. However, the hill bases form relatively steeper slopes (Figure 4.29). Evidences from field survey indicate the development of west-dipping triangular facets and fault steps in the upper parts of the hill next to the facets. The facets and fault steps are developed in clastic rocks of Khao Thiwa Khong as a long and continuous set.

Aerial-photographic investigation also indicates the occurrence of small shutter ridges, however they are completely obscured by the densely vegetated covers over the thick top soil (at least 1 m thick) which overlies strongly weathered siltstone. (grid reference 348-778).

Area S3-3

The area is manifested by a flat plain bounded to the east by the NW-trending mountain range (Khao Koeng Sada) with the straight flanks. The aerial photographic investigation reveals the occurrence of fault scarps along the mountain flanks. These subdued scarps (Figure 4.30) are considered to be gradually charged into triangular facet. These scarps are quite long (> 2 km)

Figure 4.28 A view at Ban Lam Sum showing Khao Chong Kra Ting limestone hills in the back ground, and a change in relief of the gentle loping plain in the fore ground, possibly suggesting the NW-fault (arrowhead) parallel to the mountain Khwae Yai Subsegment (Kanchanaburi Segment).

Figure 4.29 A panoramic view of NNW-trending clastic hill (Khao Thi Wa Khong) showing the west-dipping triangular facets (arrowhead, 1) and fault step(arrowed, 2). Thong Pha Phum Segment.

Figure 4.30 Subdued fault scarp (in the front arrowed) which gradually developed to triangular facets, close to the road to Sang Kha Buri and Three Pagoda Pass. The foreground is mostly gravel beds. (Thong Pha Phum Segment, photo to SE).

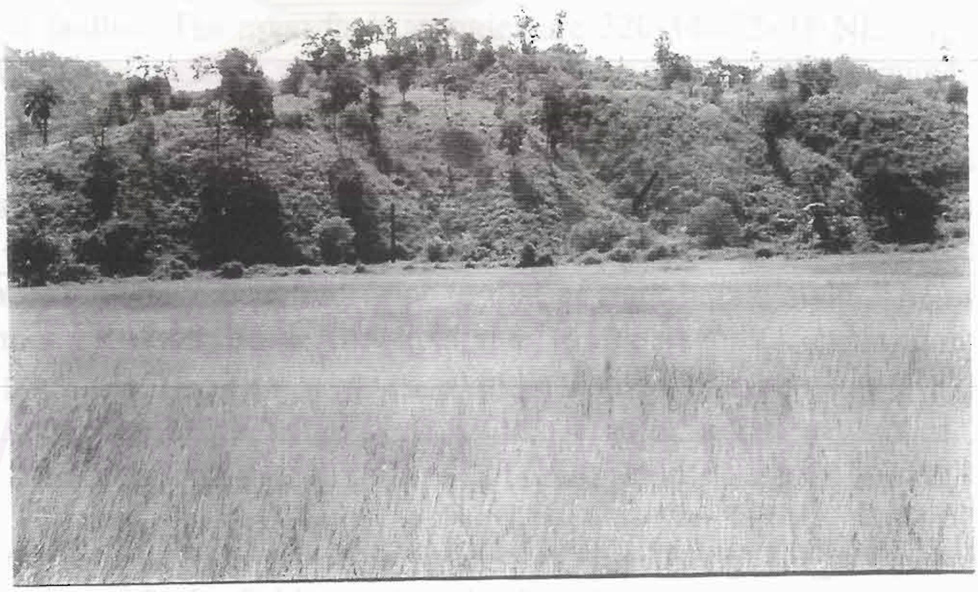


Figure 4.31 The density-vegetated subdued fault scarp which are gradually change to facet streams. Note that stream gullies (arrowhead) are developed (close-up of Figure 4.30). Photo to SE.

have very steep and high cliffs with small gullies (< 1 m wide). The hilly areas are mostly occupied by non-resistant siltstone overlain by 1-m thick top soil where as the flat-lying area is dominated by alluvial soil good for rice cultivation (Figure 4.31).

Area S3-5

The area, as viewed physicographically, is characterized by the limestone with karstic towers of Khao Phu Thong (700-800 m, msl) observed to the east of the large flat-lying plain (Figure 4.32). Scarps with sparse vegetation areas are clearly observed continuously for more than 32 km long in the field. The flat terrain (6x12 km) is manifested by maroon to pale reddish brown alluvium very close to Khao Laem reservoir.

4.3.4 Khwae Noi Segment

Area S5-1

Evidences obtained from aerial photographic and filed survey analyses indicate a set of large well-preserved triangular facets whose base width is about 750 m and height is 220 m from the flat area. Field data observed at grind reference 076-630 reveal exposuress of red sandstones (Figure 4.33) with average bedding attitude of 170/20 W. These red sandstones are severely deformed and faulted. The main fault attitudes are 320-340/25-35 NE and 185-190/55-80 W. The first fault set also shows obvious slicken side (Figure4.34). The sense of movement as evidence by offset quartz veins, is left lateral. However, evidence deduced from aerial photographic analyses as indicated by the offset stream, supports the right-lateral sense of movement. It is quite possible to conclude, therefore, that the left-lateral movement as visualized by triangular facet may have occurred prior to that of right-lateral style. The offset streams cannot be observed in the field due to the vigorous cultivation for agricultural purposes.

Area S5-2

The investigated area which is located at Huai Bong Ti (grid reference 932-748), as viewed in the field, consists chiefly of a long and continuous set of triangular facets with the previously-formed fault steps developed almost at the top of the hill. Geomorphological evidence taken from this field observation supports the existence of the triangular facets (see Figure 4.35) with the gullies of 2 m width and densely vegetative covers. The geology, particularly where fault steps are observed, is dominated by the appearance of red sandstone.

Figure 4.32 The straight NW-trending fault scarp developed in the limestone terrain of Khao Phu Thong (background). eastern side of Khao Laem (grid ref. 575-164, Thong Pha Phum Segment). Fault running immediately at foot of the mountain connecting the alluvial plain (foreground).

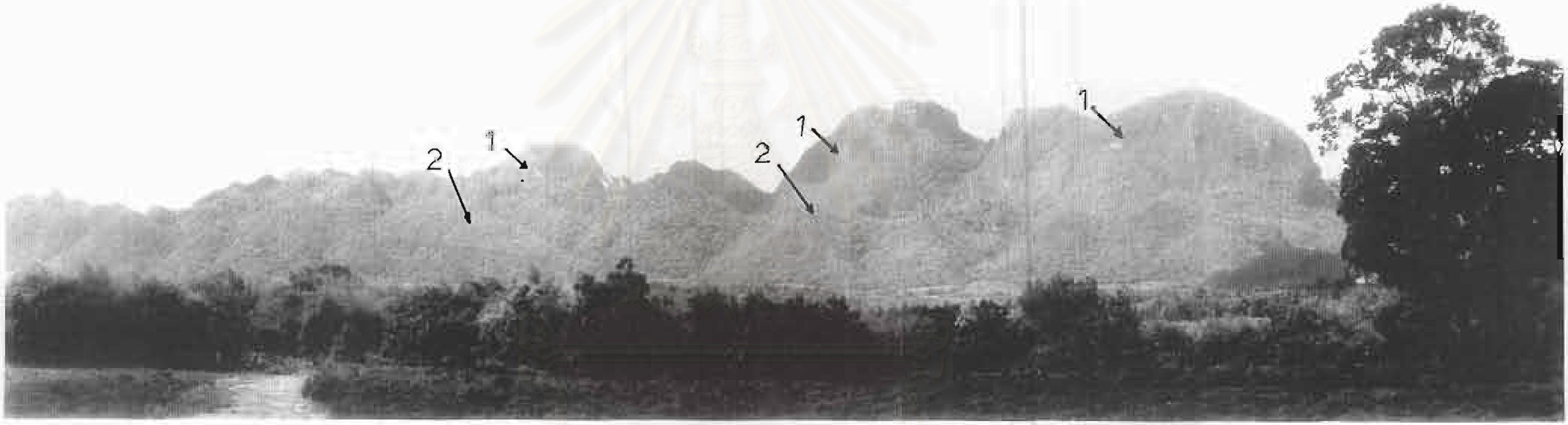


Figure 4.33 A panoramic view to SW showing the NW-trending high karstic limestone tower (arrowed,1) of Khao Khieo (background) with triangular facets (arrowed) developed at the eastern flanks of the mountain where the major rock is red sandstone (arrowed,2). The alluvial plain (in front) is mostly covered by dense vegetation (Khwae Noi Segment).

Figure 4.34 Outcrop of sandstone showing well-preserved slicken-side surface developed on the fault plane whose attitude is 320°/35° and pitch is 15°N40W (Photo taken to west, grid ref. 076-630).

Figure 4.35 View looking to the showing a set of SEE-trending subdued and densely-vegetation triangular facets (arrowhead) developed in the clastic rock (red sandstone) of Khao Mae Chae (background), Amphoe Sai Yok (Khwae Noi Segment). The foreground with the banana plantation is the area dominated by alluvial deposits..

4.4 Compilation of the results on tectonic geomorphology analysis

In this section, the most outstanding morphotectonic features as recognized from a large amount of remote-sensing information, are compiled together with the evidences deduced from the field (ground-truth) survey. Ten topics of morphotectonic evidences are compiled and explained below.

4.4.1 Fault scarp (Figure 4.36)

Fault scrap, a primary tectonic landform, is a fine evidence for indicating fault traces. It can tell both dip- and strike-slip components of displacement. The clearance of fault scarp depends on several factors, such as the freshness of fault cutting through the rock, the mineral ingredients in rocks and types of rocks.

The most distinctive scarp features (see Figure 4.37) are those occurring in the limestone terrain. However, those in the granitic and clastic-dominate areas are also prominent, such as granite fault scarp found in area S2-1 of the Thi Mong Tha subsegment (Kanchanaburi segment) and that observed in clastics rocks in area S3-3 of the Thong Pha Phum segment in Amphoe Sangkhla Buri.

The longest and distinctively continuous scarp is the one very close to Khao Laem Reservoir. The scarp belongs to Thong Pha Phum Segment and occurs in limestones. The total length of the scarp is estimated at 32 km.

The most outstanding scraps is the one situated at Ban Bong Ti, Khao Kwang (Figure 4.36), Amphoe Sai Yok and belonging to Sai Yok Noi Segment near Amphoe Sai Yok. The other well-preserved example is at Khao Chong Krathing in area S2-5 of the Sai Yok Yai subsegment.

4.4.2 Triangular facet (Figure 4.38)

Triangular facet is an inclined triangular erosional surface, commonly formed by erosion of a tectonically truncated ridge trending at a high angle to an active fault. Several are also formed by wave erosion of mountain fronts or by glacial truncation of spurs. It is widely accepted that the steeper the triangular facet is, the younger the age will be. The young distinct triangular facet as usually seen in clastic rocks becomes more obvious than that of other types of rocks.

The most outstanding feature of triangular facet, with very high and steep slope is that observed in area S1-1 of the Sangkhla Buri Segment, in Amphoe Sangkhla Buri. These NE-dipping facet which developed in clastic

Figure 4.36 Distinctive fault scrap of Khwae Noi Segment developed in the limestone terrain of Khao Khwang (grid reference 062-665), Ban Bong Ti, Amphoe Sai Yok.

Figure 4.37 Distinctive fault scrap of Thong Pha Pum Segment developed in the limestone terrain of Khao Phu Thong (grid reference 543-284), Amphoe Thong Pha Phum.

Figure 4.38 The density-vegetated subdued triangular facet (arrowhead) developed in the clastic rock (sandstone) of Khao Ung Thi (background), Ban Yot Ung Thi, Amphoe Thong Pha Phum (Thi Mong Tha Subsegment in Kanchanaburi Segment). The foreground with the crop is the area dominate by alluvial deposits.

units can also be seen as well in Myanmar, passing through the Three-Pagoda Pass road. This set of the facets is observed continuously with the total length of 4.5 km (see Figure 4.39, aerial photograph). The other interesting facet set is in area S3-1 at the beginning of the Thong Pha Phum Segment. This set of facets cant be traced with less continuous feature than that of the S1-1 area. The total length of the facet set is estimated at 3.5 km (Figure 4.40, aerial photograph).

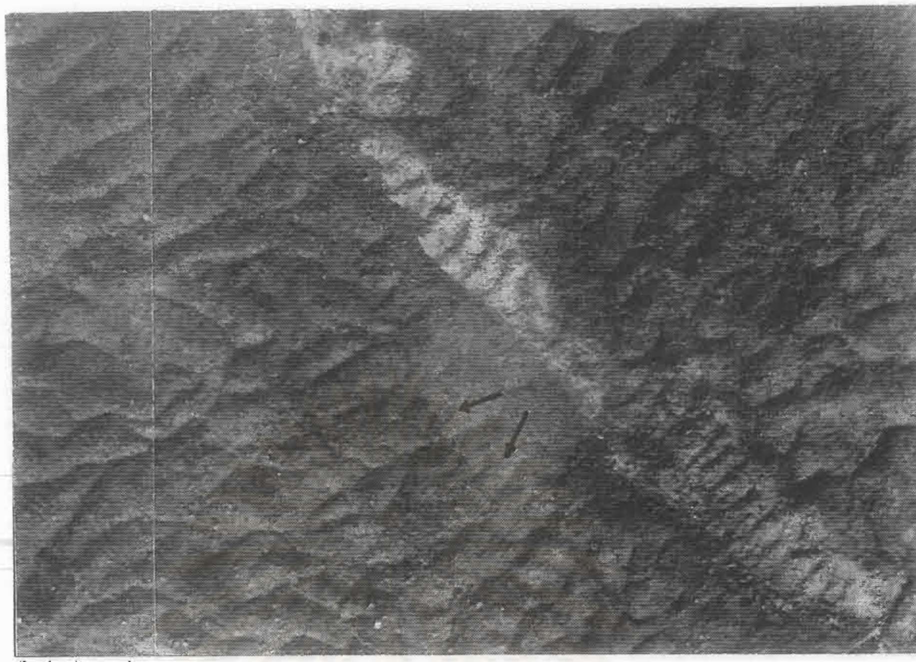
The largest triangular facet developed along the TPFS is the one at the S5-1 (Khwae Noi Segment) in the vicinity of Khao Khieo, Amphoe Sai Yok. The base width of the facet is about 750 m and the height is about 220 m. Slickenside is clearly observed on the fault plane of limestone indicating the sinistral sense of movement.

4.4.3 Offset Stream Channels (Figure 4.41)

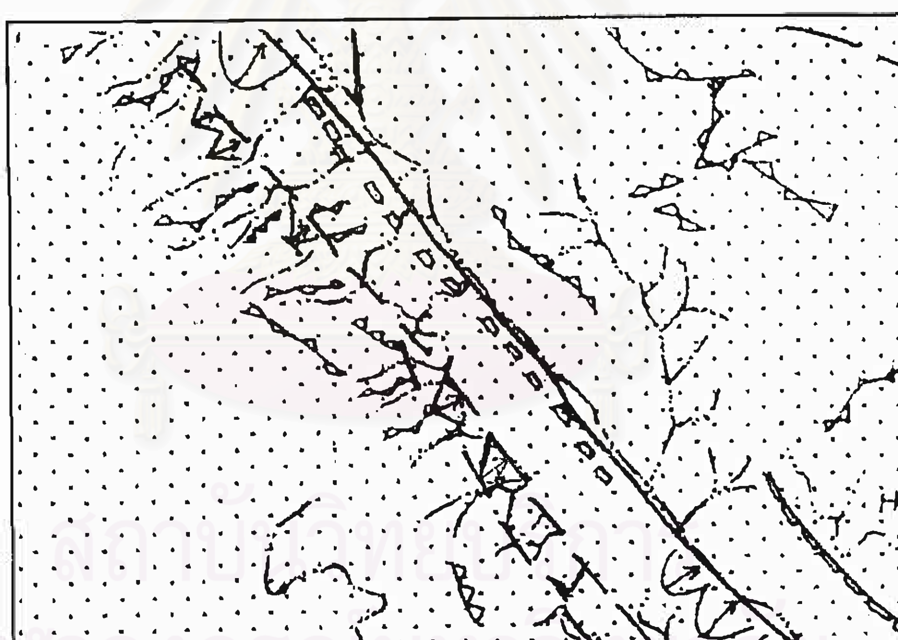
The occurrence of the offset stream channels is useful for recording displacement along strike-slip fault (see Barka, 1993), but generally provide only a minimum estimate of movement (Gaudermar et al., 1989) and can be ambiguous or misleading to reconstrut the precise form of paleochannel (e.g Wesnousky et al., 1990). The differential offset of linear landforms may delimit the timing and magnitude of discrete faulting events (Steward and Hancock, 1994). If there are many parallel offsets with almost the same offset direction, it can clearly indicate the direction of movement whether it is dextral or sinistral.

The parallel and most outstanding offset stream is observed in S1-1 Area and in the NW of the S1-1 Area. These offset streams are non-permanent running out of the hill in the direction of NE, and changes to SE. When passing fault trace, they flow back to the former NE direction and then run to meet the main river. There is also a sudden direction change of the stream to NW when passing the fault, they turn to flow back to NE as usual. It is apparent that the SE offset is more prominent than the NE one.

The area where the offset streams are most densely distributed and perhaps are most parallel to each other, is that observed in area S1-1 of the Sangkhla Buri Segment (Amphoe Sangkhla Buri). Such sets of angular-bending streams are also encountered in Myanmar. There are about 5 temporary streams developed in Mid-Paleozoic clastic unit (SD) that are found to have the deflection feature. The aerial photographic interpretation reveals the measured right-lateral offset of about 86.4 m. The other one is found in area S3-1 at the beginning of the Thong Pha Phum Segment. Five offset gullies are encountered in Mesozoic clastic unit (Tr-J). They show left-lateral movement with the total length of 83 m.



(a)



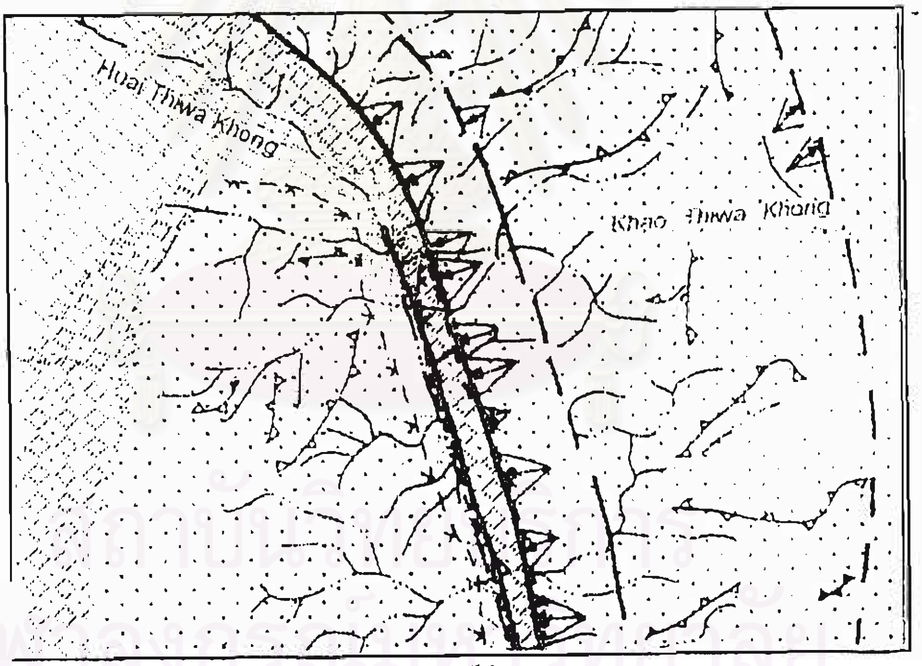
(b)

Figure 4.39 Fragment of aerial photograph (Area 6 sheet 20 strip 73 no. 15658) of S1-1 area, Amphoe Sangkhla Buri showing location of a set of Triangular facets aligned in the NW directions.

a) aerial photograph

b) triangular facet interpretation

(a)

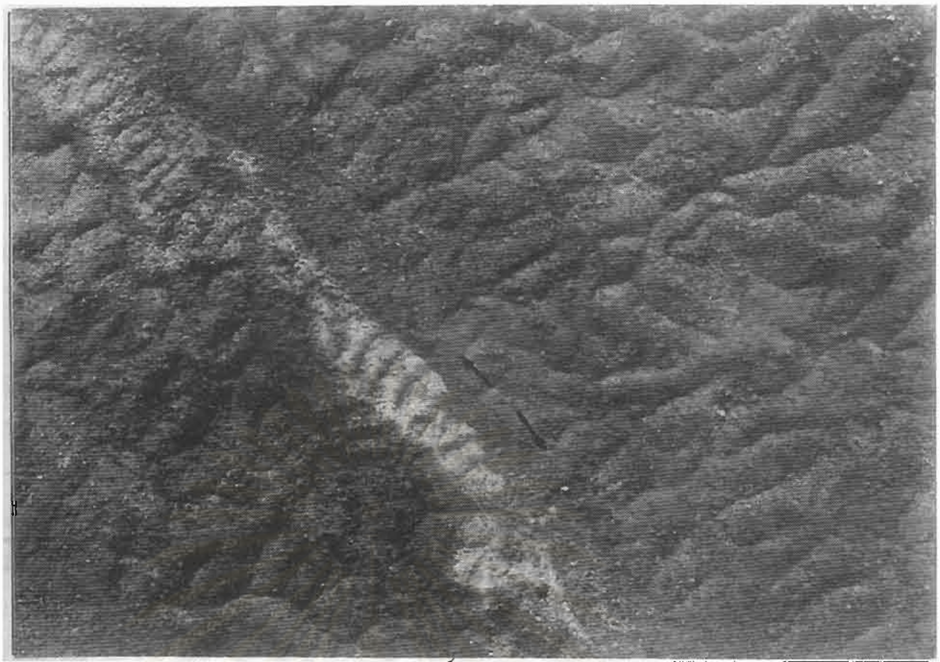


(b)

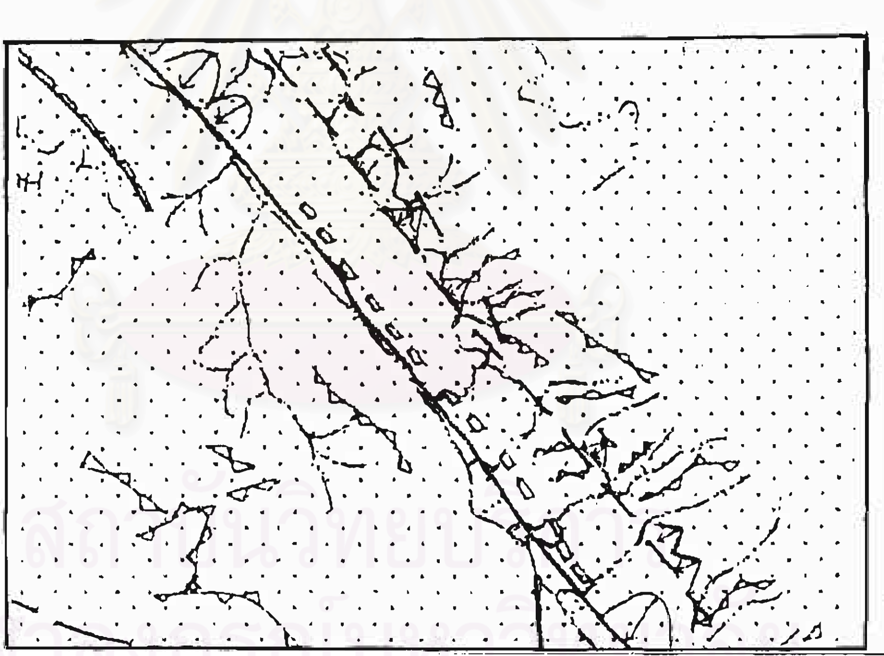
Figure 4.40 Fragment of aerial photograph of S3-1 area, (Area 6 sheet 20 strip 73 no. 15657) Amphoe Sangkhla Buri showing location of a set of Triangular facets aligned in the NNW directions.

a) aerial photograph

b) triangular facet interpretation



(a)



(b)

Figure 4.41 Fragment of aerial photograph of S1-1 area, (Area 6 sheet 20 strip 73 no.15658) Amphoe Sangkhla Buri showing location of a set of offset streams aligned in the NW directions.
a) aerial photograph
b) offset streams interpretation

The longest offset-stream feature observed along the TPF is that occurring in the area S2-4 in the Lin Thin Subsegment, at Huai Lin Thin (grid no.832-112). The offset is measured about 350 m, indicating right lateral sense of movement.

The well-defined left lateral offset stream feature is located in the area S1-1, to the west of Sangkhla Buri Segment. There are about 6 offsets found in the clastic rocks with the total deflection length of about 80 m.

It is quite important to note herein that in areas dominated by alluvial deposits, most of the offset-stream features show right-lateral sense of movement. Good examples are those encountered in area S1-1 the Sangkhla Buri Segment, where the stream course passes and alluvial plain, areas S2-1, S2-2, and S2-3 of the Thi Mong tha subsegment, area 2-4 of the Lin Thin subsegment, and S2-5 of the Khwae Yai subsegment. In addition, the less-clear offsets are also observed in area S3-2 and S3-3 in northern part of the Thong Pha Phum Segment and areas S5-1 and S5-2 of the Khwae Noi Segment.

4.4.4 Shutter ridges (Figure 4.42)

Shutter ridge is a linear hill or scarp sloping in a direction opposite to the overall local topographic gradient, formed by strike-slip or oblige slip offset of irregular topography. The ridge tends to block the flow of water and debris across the fault. The shutter ridge of various sizes are also well represented along the TPF fault. In some cases, small shutter ridges becomes invisible at the scale of the topographic map.

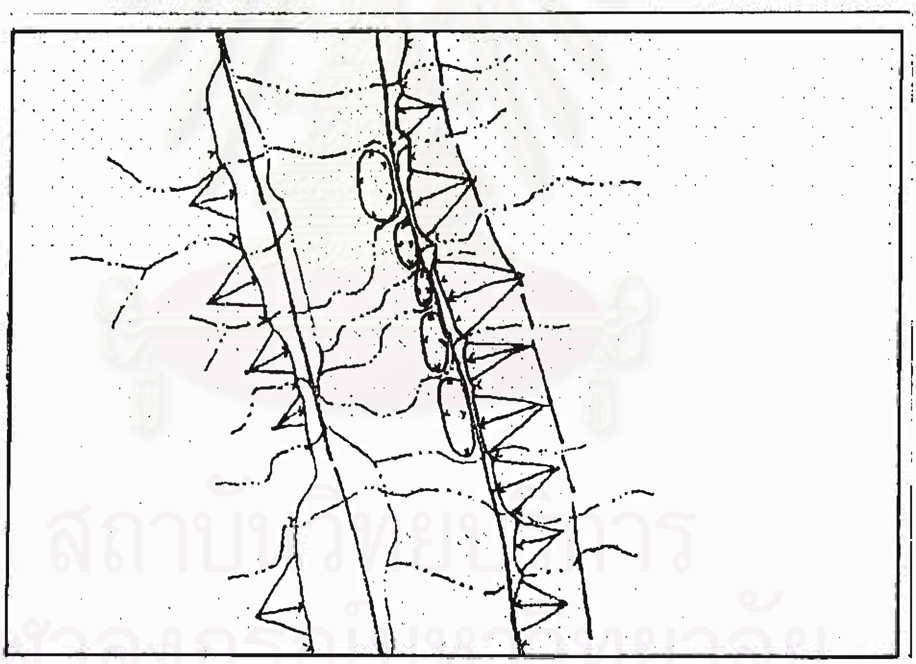
Based upon aerial photographic interpretation, the most outstanding shutter ridge is in area S2-1 of the Thi Mong Tha Subsegment (Kanchanaburi Segment) and area 3-1 of the Thong Pha Phum Segment. Both are almost equal in length which is estimated at about 50 m. The ridges orientated in the NW direction almost parallel to the main TPFZ.

4.4.5 Beheaded stream (Figure 4.43)

Beheaded stream is a portion of a channel downstream from a fault separated from its headwaters by strike-slip movement along the fault and therefore is another kind of tectonic geomorphology evidences. It can be mostly found both in the plain and basin.

The area that is nourished by alluvial deposit and shows the clearest and most prominent beheaded stream, is in the S5-1 Area and along the Mai Nam Khawae

(a)

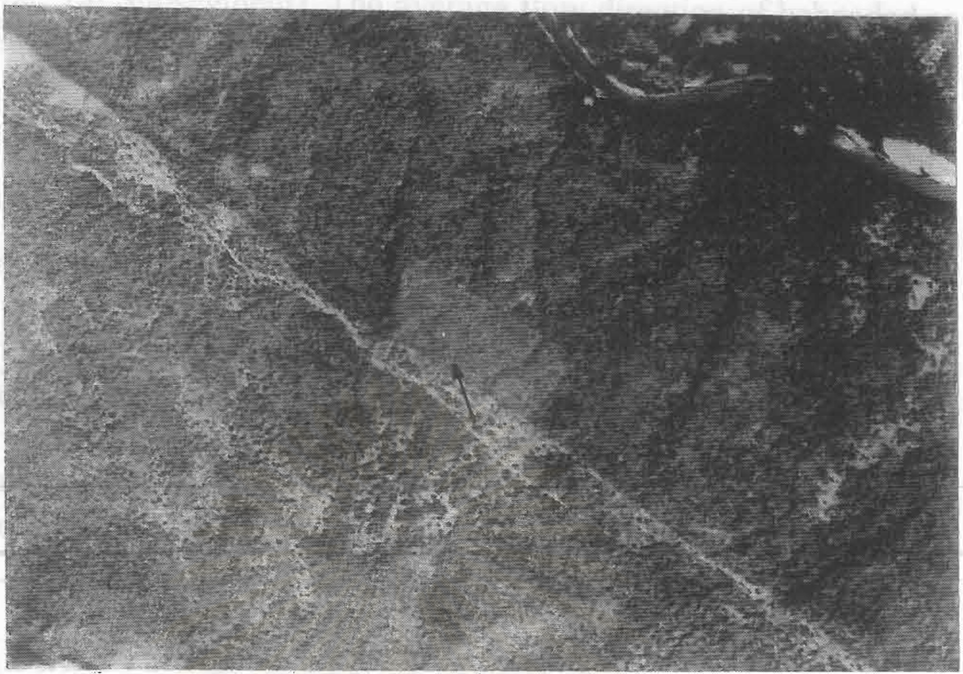


(b)

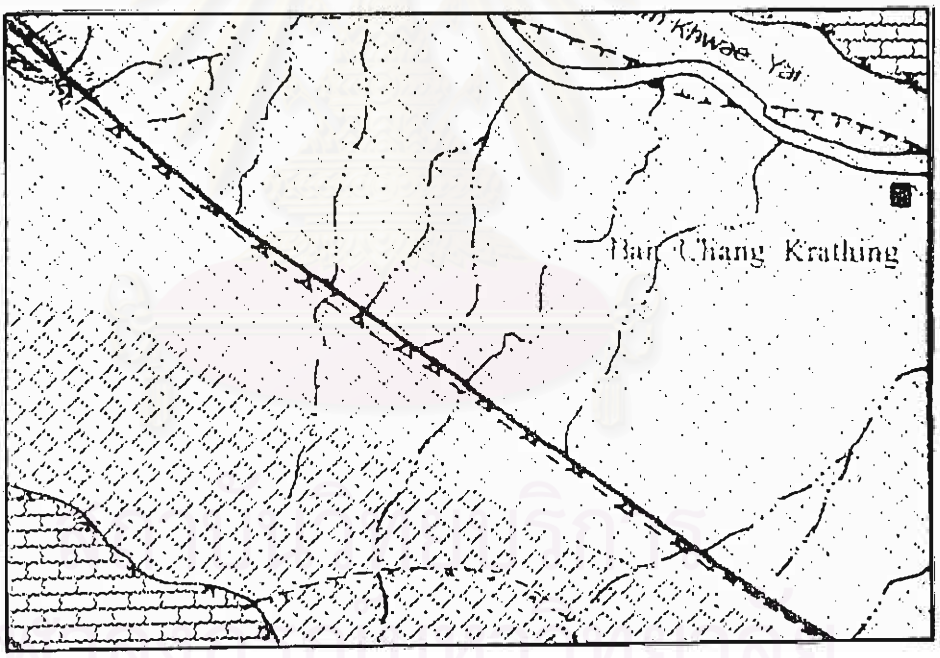
Figure 4.42 Fragment of aerial photograph of S3-1 area, (Area 6 sheet 20 strip 73 no.15657) Amphoe Sangkhla Buri showing location of shutter ridges aligned in the NNW directions.

a) aerial photograph

b) shutter ridges interpretation



(a)



(b)

Figure 4.43 Fragment of aerial photograph of S2-5 area, (Area 1 sheet 3 strip 16 no.1868) Amphoe Sai Yok showing location of beheaded stream aligned in the NW directions.

a) aerial photograph

b) beheaded streams interpretation

Yai (Khwae Yai Subsegment). The average flow direction of beheaded streams is in the NE direction.

4.4.6. Pressure ridges (Figure 4.44)

The other expression of fault scarp feature as denoted by a long ridge formed by compression stress and, in most cases, associated with the reverse fault.

In the study area, small amount of pressure ridges are recognized and they are not distinctive. This suggests that the tectonic activity of the Kanchanaburi study area is not dominated by the reverse fault movement. The most prominent pressure ridge is the one located at the northern part of the Sangkhla Buri segment of the TPF.

4.4.7 Fault trace cutting terraces (Figure 4.45)

Fault trace crossing the river or alluvial terrace is assumed that its age is not that much old. It is likely to be in the Neogene epoch (see also Thiramongkol, 1988).

The trace that is thought to possibly be the fault cutting by terrace is located in the northern out-of-area S5-1 Area which is parallel to the offset of Mai Nam Khwae Noi.

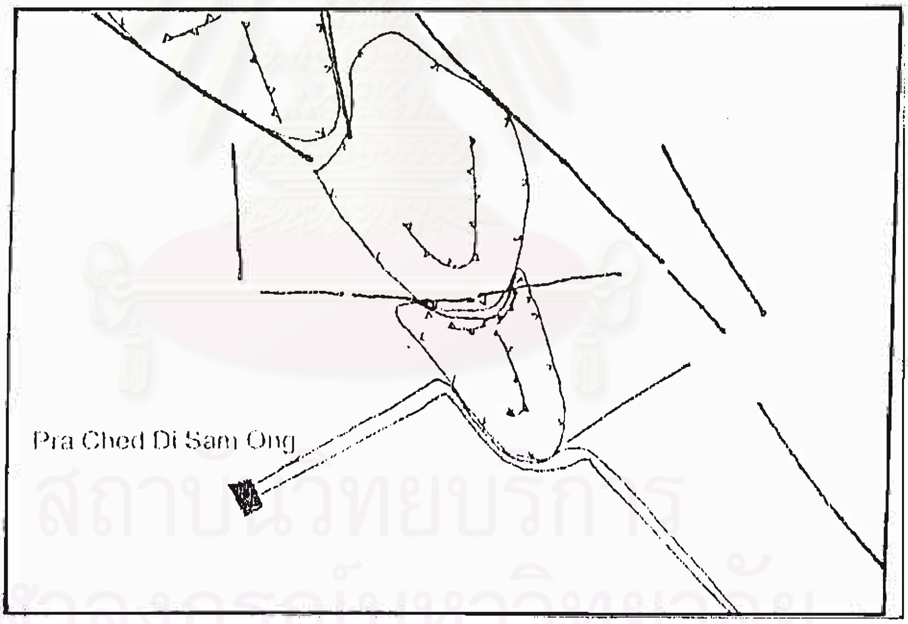
4.4.8 Basin development (Figure 4.46)

Two sedimentary basins are recognized in Khao Laem Basin (5x15 km^2) and Khawae Noi Basin (7x10 km^2). Both basins have the long axis in the direction of NNW-SSE approximately. The latter is bounded by fault traces of Thi Mong Tha subsegment.

In general, these two basins are also prominent and mainly bounded by the faults of the Thong Pha Phum Segment. When examining the age of the basins, it was found that the Khao Laem Basin is ranging from Tertiary till Quaternary and Khwae Noi Basin age is in Quaternary (see also Raksaskulwong, 1997).

Based upon the above information, the basin is likely to have formed probably during Middle Tertiary. It is because the influence of pull-apart-related tectonics causing the development of these two basins.

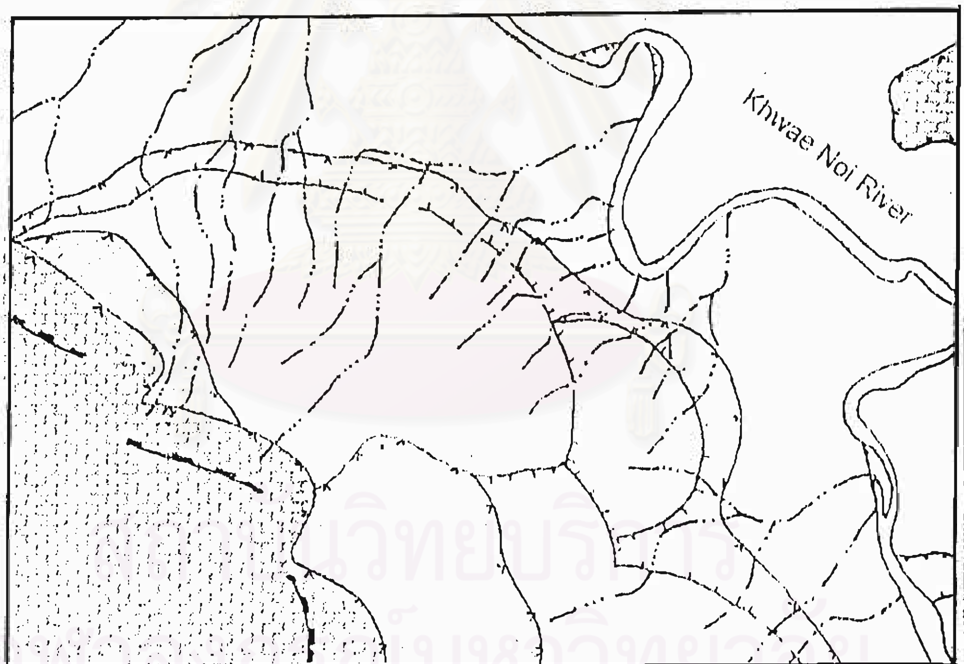
(a)



(b)

Figure 4.44 Landsat TM5 image of northern Sangkhla Buri segment near Pra Ched Di Sam Ong showing location of pressure ridge.
a) Landsat TM5 image
b) pressure ridge interpretation

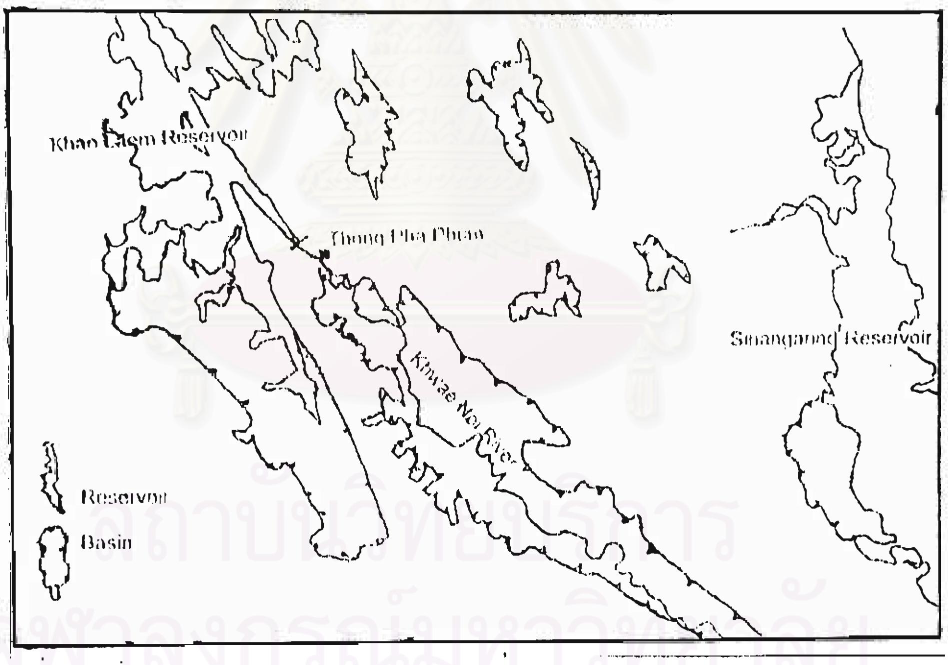
(a)



(b)

Figure 4.45 Fragment of aerial photograph (Area 1 sheet 3 strip 15 no. 1822), Ban Phu Thong, Amphoe Sai Yok showing location of terrace.
a) aerial photograph
b) terrace interpretation

(a)



(b)

Figure 4.46 Landsat TM5 image in the central area of Kanchanaburi showing the large basin in Thong Pha Phum and Khao Laem at Amphoe Thong Pha Phum.
a) Landsat TM5 image
b) basin interpretation

4.4.9 Parallel Ridge

Parallel ridge is the long and narrow ridge which on frequently found parallel to the strike-slip fault in the flat plain. Along the TPFZ, parallel ridge are not obvious, presumably due to the intense weathering and erosion activities mostly developed in the alluvial plain.

The poorly-preserved parallel ridge is that located in area S2-1 which belongs to Thi Mong Tha subsegment (Kanchanaburi Segment). It has the NW trend and is found in an alluvial deposit at grid no. 548-621, close to Ban Pom Pi Nai (about 2x3 km).

4.4.10 River Gravel Deposit (Figure 4.47)

Gravel deposit formed by active stream action and tectonically uplifted to the surface along the current river system, can indicate the probable young age of the neotectonic activity. The large, steep-sided exposed gravel deposit (200 x 100 m^2) in Amphoe Sangkhla Buri, is observed along the Song Kha Lia River at the altitude of 60 m above the river level. The gravel bed consists largely of variable-size round-shaped clasts (2 to 10 cm diameter) including quartzite, quartz and schist. The gravel beds an situated in the vicinity of limestone terrain. Therefore they have been removed southwestward to this area sometimes recently and subsequently uplifted tectonically.

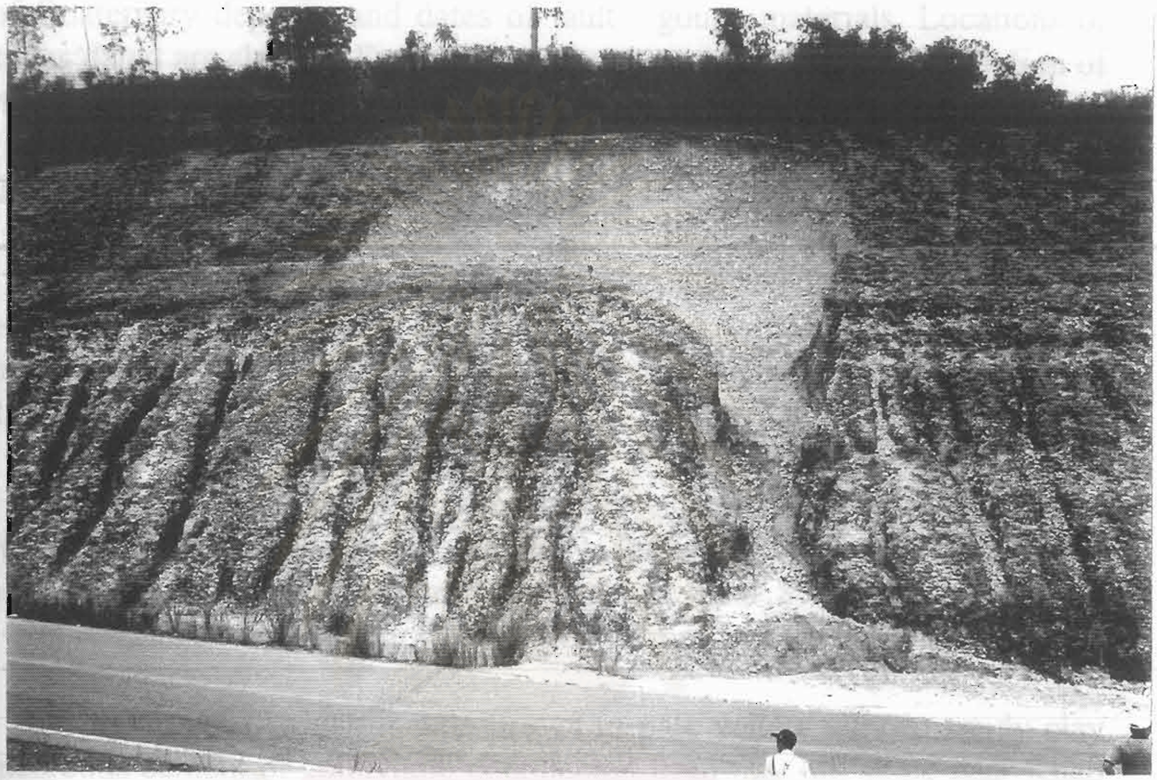


Figure 4.47 River gravel deposit, immediately at the road in Sangkhla Buri to the Three-Pagoda Pass, is about 60 m above the Song Khalia River. Note that most clasts are quite different from the bedrocks.

4.5 Dating Results

Table 4.2 displays the results of TL- and ESR - dating for Quaternary sediments and TL- dating for fault gouge materials collected at or near the TPFZ.

For convenience, the dating results are herein divisible into 2 groups - dates of Quaternary deposits and dates of fault - gouge materials. Locations of the samples dated are show in Figure 4.1, and summary of detailed description of individual samples are illustrated in Table 4.3.

4.5.1 Date of Quaternary Deposits

Six samples collected altogether from many places close to TPFZ reveal the TL-dates ranging from 142 to 1575 Ka and ESR - dates ranging from 183 to 228 Ka (see also Table 4.2). These dates correspond fairly well with Quaternary deposits.

A sample (TP10), which is pale orange to pale yellow silt of the river gravel deposit, represents the youngest sample. It is collected from gravel bed at the rim of Khwae Noi River in Ban Wang Krachae (near S5-1 area and closely Khwae Noi Segment). The sample yields a TL- date of 142 Ka.

A sample (TP3), which is pale brown to pale yellow silty to sandy clay with calcareous cement of colluvium, is collected from foot hill slope near Khao Wong limestone mountain near Sai Yole Noi Water fall (near S5-1 area this sample near Khwae Noi segment, Figure 4.49, 4.51). The sample render the ESR of 196 Ka.

Two samples (TP4-1 and TP4-2) which are creamy which-pale yellowish brown and reddish brown-creamy white travertine, respectively, are collected from the quarry which are beside the road in the Sai Yok Noi Water fall area (Near S5-1 and near Khwae Noi Segment, see Figure 4.50, 4.51). These two ssamples yield the rage of ESR - dates between 228 and 133 Ka.

Two other samples (TP8-1 and TP8-2), which are reddish brown silty to sandy clay of gravel bed, are collected from the rim of Song Kalia River at Sangkhla Buri (near Sangkhla Buri Segment and Song Kalia fault, see Figure 4.53). The samples render quite old age with the range of TL-dates between 920 and 1,575 Ka.

4.5.2 Fault Gouge Dates

Four samples from fault - gouge materials were selected from the road-cut quarries located immediately at Sangkhla Buri and Kanchanaburi segment (Thi Mong Tha subsegment). The results of the TL-dates seem to relate quite well the fault activity.

The youngest date obtained from a sample (TP2) consisting of greyish black silty clay with black and white tint fault - gouge material from S2-2 area (Kanchanaburi Segment, see Figure 4.48). This sample yields an unusually young TL-date at 2.2 Ka.

The sample (TP1) of pale arrange to white fault - gouge material collected from S1-1 area (Sangkhla Buri Segment). This sample gives the TL-date of 143.2 Ka.

Another sample (TP9) is characterized by the pale oragnish brown fault - gouge material, collected from Thi Mong Tha subsegment (Kanchanaburi Segment) in S2-3 area (see Figure 4.54), Amphoe Thong Pha Phum . This sample renders the TL-date of 468 Ka.

The last dated sample (TP6) is represented by the pale yellow fault - gouge material collected from S2-3 area (Figure 4.52) in Thi Mong Tha subsegment. Although collecting from the different location of TP9, the date obtained from this sample (TP6) yield the TL-date of about 578 Ka, similar to those of the TP9.

Table 4.2 The results of TL- and ESR- dating

No.	Sample No.	U (ppm)	Th (ppm)	K2O (%)	Water (%)	Annual dose (mGy/y)	Paleodose (Gy)	TL age (Ka)	Remarks
ESR measurement									
1	TP3	1.65	6.96	1.09	0	2.09	410	196	Cosmic = 0.25 mGy/a
2	TP4-1	0.66	0.5	0	0	0.64	145	228	Cosmic = 0.25 mGy/a, internal dose
3	TP4-2	0.5	0.5	0	0	0.55	100	183	Cosmic = 0.25 mGy/a, internal dose
TL measurement									
1	TP1	2.94	20.55	3.17	11.75	4.33	620	143.2	
2	TP2	6.07	24.12	4.32	19.65	5.54	123	22.2	
3	TP6	5.99	17.81	1.27	17.6	3.2	1850	578	
4	TP8-1	3.31	13.84	0.05	13.1	1.63	1500	920	
5	TP8-2	2.58	7.98	0.32	14.8	1.27	2000	1575	
6	TP9	3.96	9.58	0	18.9	1.39	650	468	
7	TP10	5.89	17.01	1.14	11.6	3.17	450	142	

Table 4.3 Summary of the description of samples collected for TL and ESR datings

Age (Ka)	Sample no.	Dating Method	Grid Reference	Location and description	Figure no.	Details of Samples	Sample materials
143.2	TP1	TL	390-845	Road-cut quarry (the route from Sangkhla Buri to Pra Chedi Sam Ong) at km no. 8, Amphoe Sangkhla Buri. The quarry - height 7 m and width 20 m. Outcrop - siltstone - in contact with calcareous black shale , fault plane 0/60E.	4.47	Pale orange to white silty to sandy clay, semi-consolidated.	Fault-gouge material
22.2	TP2	TL	652-412	Road-cut quarry (the route from Thong Pha Phum to Sangkhla Buri) at km no. 16, Ban Tha Madua (northern Kanchanaburi). The quarry is height 6 m and width 20 m. Outcrop - shear, strongly deformed calcareous black shale, fault plane 10/20 E.	4.48	Greyish black silty clay with black and white tint, semi-consolidated .	Fault-gouge material
196	TP3	ESR	058-744	Road-cut quarry at foot of Khao Wong limestone mountain (near Sai Yok water fall) Amphoe Sai Yok. Quarry - height 2 m width 100 m. Outcrop - travertine block (size 10-20 cm), with clay & silt matrix, poorly sorted, fault plane 320/75 NE.	4.49, 4.51	Pale brown to pale yellow silty to sandy clay with calcareous cement.	Colluvial deposit
228	TP4-1	ESR	062-740	Road -cut quarry near of banded travertines Khao Wong limestone mountain (near Sai Yok Noi water fall), Amphoe Sai Yok . The quarry – height 3 m and width 200 m. Outcrop two succeeding layers are recognized, the thinner overlying layer (1m thick) and the thicker underlying layer (2 m thick). TP4-1 was collected from the underlying layer, in the vicinity Khao Wong limestone terrain, outcrop is in contact with quartzite interbeded with mudstone, fault plane 210/80 W with right lateral.	4.50, 4.51	Stalactite with alternated layer of creamy white and pale yellowish brown colours (average individual layers 1-2 cm thick).	Travertine deposit
183	TP4-2	ESR	062-740	Sample very close to TP4-1 sample, extracted	4.50,	Stalactite with alternated bands of reddish brown to pale brown and	Travertine

				collected about 2 m above TP4-1	4.51	creamy white colour (average individual layers 1-2 cm thick).	deposit
578	TP6	TL	678-285	Road-cut steep - cliff quarry (close Huai Ong Thi reservoir), Amphoe Thong Pha Phum. The quarry - height 10 m and width 50 m. Outcrop - mainly deformed and sheared siltstone interbeded with sandstone, fault plane 30/80 SE.	4.52	Pale greenish yellow silt to clay, semi-consolidated.	Fault-gouge material
920	TP8-1	TL	407-740	Song Kalia river rim, Amphoe Sangkhla Buri. The quarry - height is 20 m and width 100 m. Outcrop - mostly gravel bed : clasts ; quartz, quartzite, and chert ; clast sizes are 0.5 - 5 cm, poorly sorted. The sample TP8-1 is located in the top bed (2 m thick).	4.53	Reddish brown silty to sandy clay, semi-consolidated to unconsolidated.	River gravel deposit
1575	TP8-2	TL	407-740	Lower gravel bed underlying TP8-1. Outcrop - mostly gravel bed (6 m thick) : clasts are chiefly quartz, quartzite, chert, and granite ; clast sizes are 2-20 cm, poorly sorted	4.53	Pale gray to white silty to sandy clay, unconsolidated.	River gravel deposit
468	TP9	TL	655-259	Road-cut quarry (close Huai Ong Thi reservoir), Amphoe Thong Pha Phum. The quarry - height 10 m and width 30 m. Outcrop are yellowish brown, thinly bedded siltstone interbeded with sandstone, bed attitude 330/38 NE, and fault plane 220/60 NW	4.54	Pale orange brown silt to clay, semi-consolidated to unconsolidated.	Fault-gouge material
142	TP10	TL	047-728	Khwae Noi rim at Ban Wang Krachae, Amphoe Sai Yok. Gravel quarry - height 8 m and width 50 m, gravel - bed clasts are quartz, quartzite, and chert. Clast sizes are 0.2-20 cm, poorly sorted.	4.55	Pale orange to pale yellow silt, unconsolidated to semi-consolidated	River gravel deposit

Figure 4.48 Road-cut exposure of siltstone (left) and black shale (right) to Pra Chedi Sam Ong) in SangKhla Buri district sample no. TP1 (fault-gouge) is collected from the siltstone.

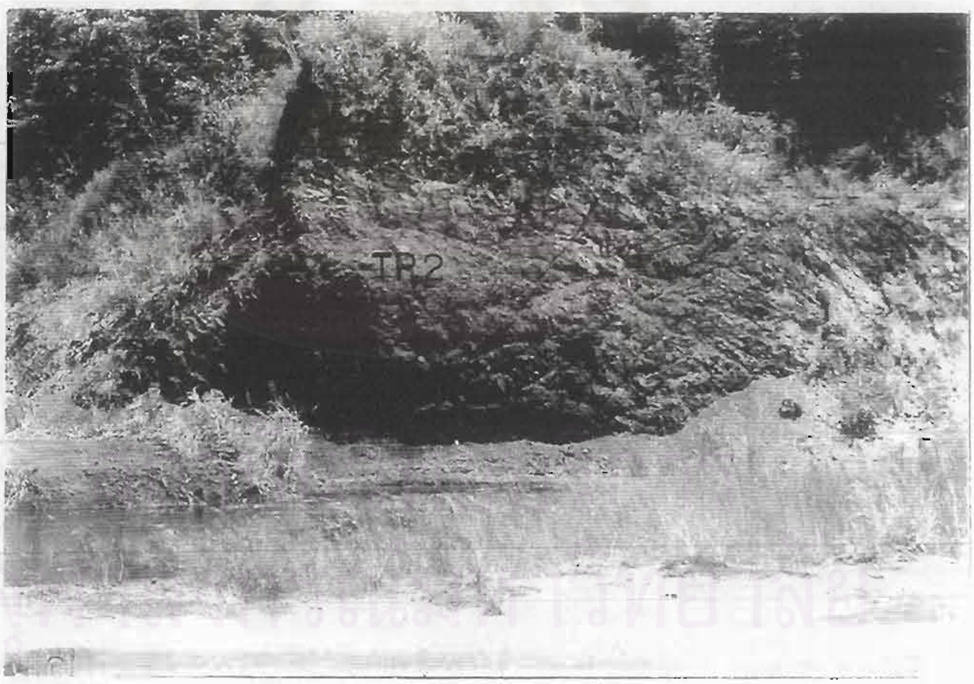


Figure 4.49 Road-cut exposure of weathered sheared and strongly deformed calcareous black shale on a road side from Thong Pha Phum to Sangkhla Buri, Ban Tha Madua, north Kanchanaburi. Sample no. TP2 is collected right at the arrowed mark.

Figure 4.50 Road-cut exposure at the foot of Khao Wong linestone showing poorly sorted angular fragments of travertine with clay and silt matrix. Note that sample TP3 is collected for ESR dating.

Figure 4.51 Road-cut exposure of banded travertine near Khao Wong mountain when TP4-1 and TP4-2 samples are located.

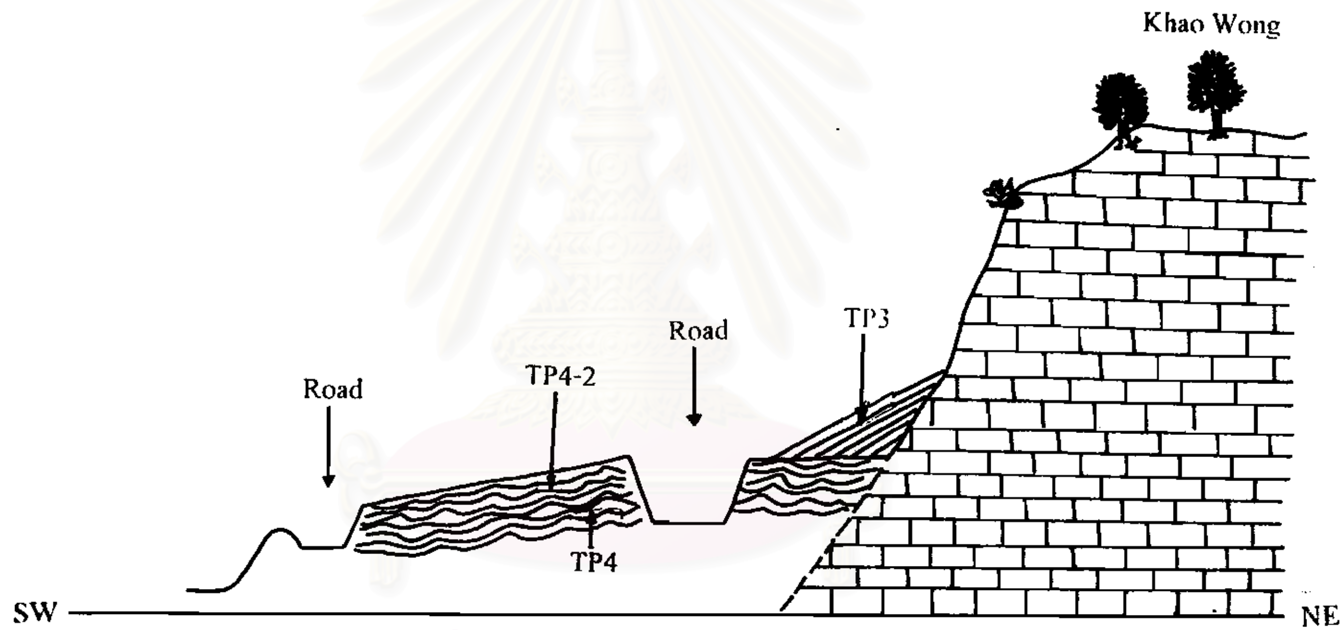


Figure 4.52 Sketched cross-section map along the SW-NE direction showing location of TP3, TP4-1, and TP4-2.

Figure 4.53 Road-cut, steep-cliff exposure of sheared and deformed siltstone interbedded with sandstone. Fault-gouge material (TP6) was collected from as semi-consolidated pale greenish yellow silt to clayey silt material.

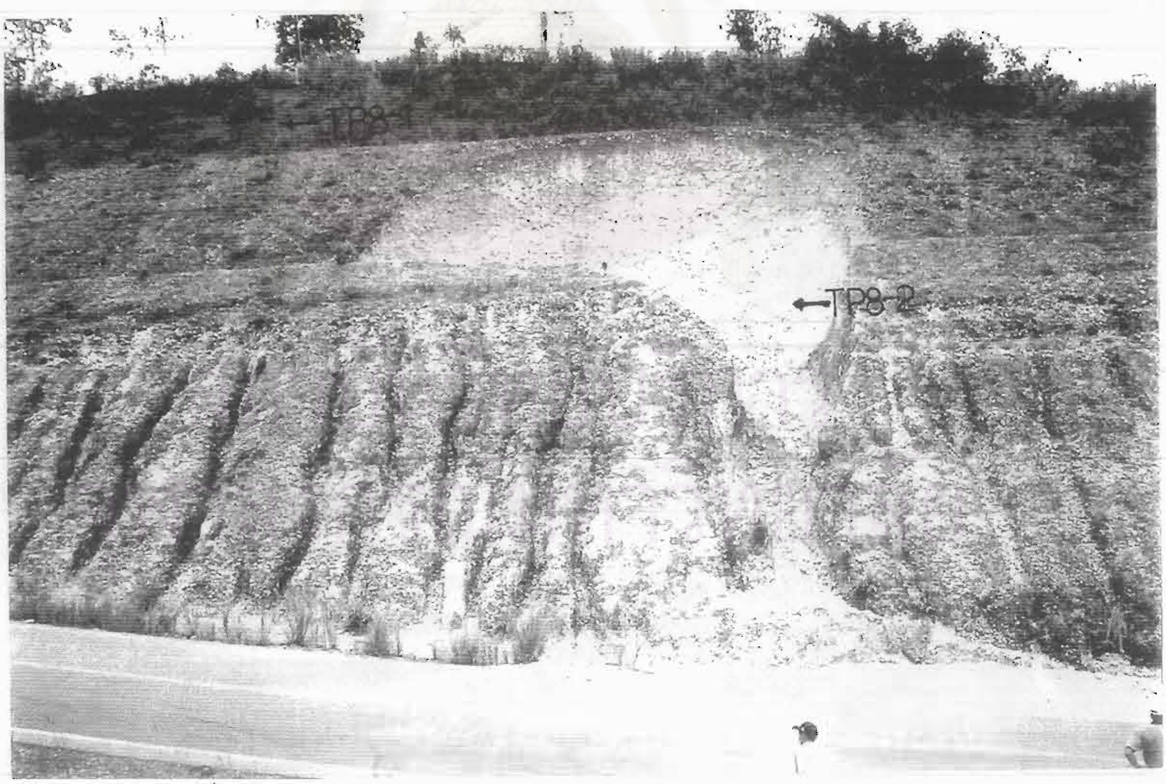


Figure 4.54 Road-cut exposure of gravel beds immediately at the Song Ka Lia River. Samples TP8-1 and TP8-2 were collected from the river gravel bed.

Figure 4.55 Road-cut exposure of weathered yellowish brown to brown, thinly bedded siltstone interbedded with sandstone. Sample no. TP9 was collected from the fault gouge.

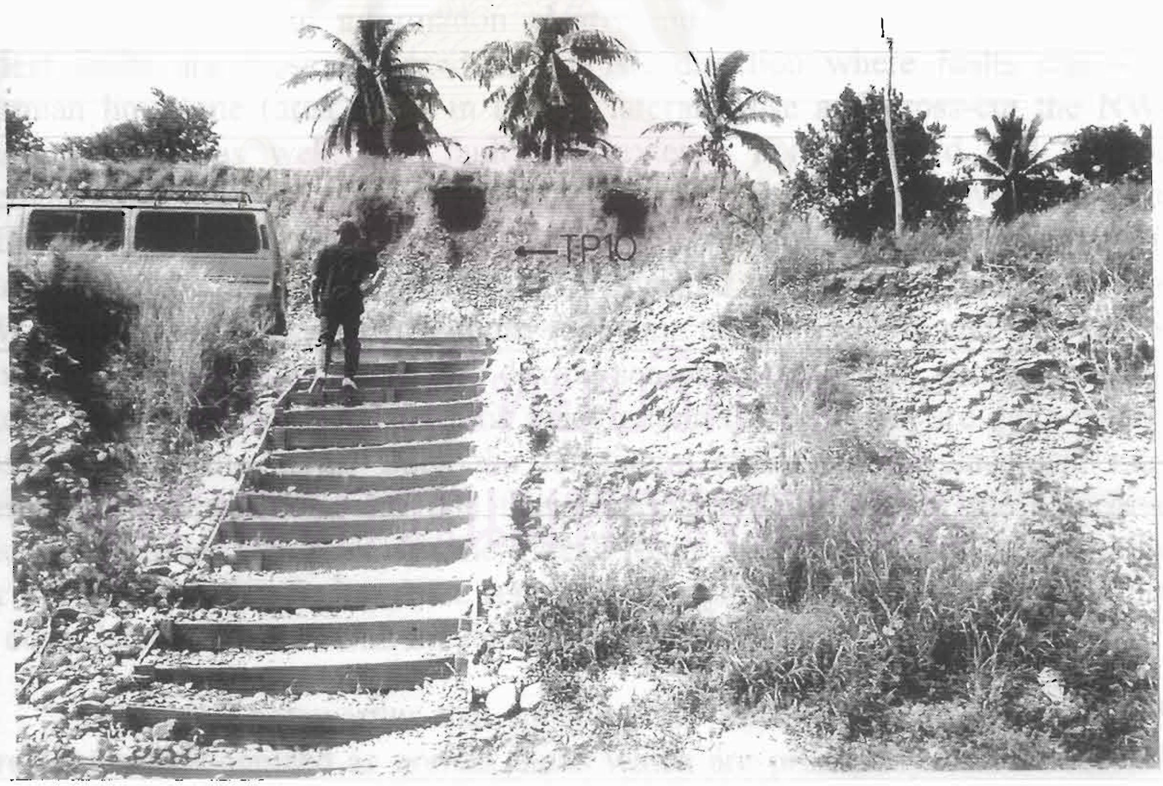


Figure 4.56 Location when sample no. TP10 was collected, also shown is the river-gravel beds with layer clasts in the bottom layers and smaller ones in the upper.