CHAPTER III

THE PHRAE FAULT SYSTEM

At present, although many documents of geological researches had mentioned the faults that are located within or bounded the Phrae basin, many papers had used different names to refer these basin-bounded faults. The problem of terminological confusion may rise among many geologists. This subsequent study is an attempt to characterize past tectonic movement of the fault bounded in southeastern portion of the Phrae basin. In the first priority, it is important to make an understanding of such a fault definition.

Three sections involve in the definition and characterization of the Phrae fault. The first section cites on previous definitions of the Phrae fault from various authors. Additionally, the author's definition of the Phrae fault system is included in this section. The second section focuses on fault characteristics in cross-section using seismic profiles to illustrate useful subsurface geological features. Ultimately, the last section provides a briefly information focussing on characteristics of the southeastern segment of the Phrae fault system.

3.1 Definition of the Phrae Fault System

3.1.1 Definition of Previous Study

Nutalaya et al.(1985) stated that the Phrae basin is flanked by the NE-SW trending faults, namely the Thoen fault zone on the west and the Phrae fault zone on the east (Figure 3.1). Moreover the Phrae fault is probably active but most evidences on both seismicity and geology are needed before conclusion is made definitely.

Chuaviroj et al.(1992) published the geologic map of Phrae, sheet 5045 III at a scale of 1:50,000. There exists a trace of fault delineated between basin and mountain range in southeastern margin of the Phrae basin. The fault lies in NE-trending with approximately 10-km-long. Note that, the fault trace shown in the map is found split in several small branches.

Charoenprawat et al.(1995) proposed geologic map of Lampang quadrant, with scale 1:250,000. Trace of basin-bounded fault has shown in the eastern margin of the Phrae basin. This trace is delineated in the NE trend and splits into small branches. The trace is composed of two

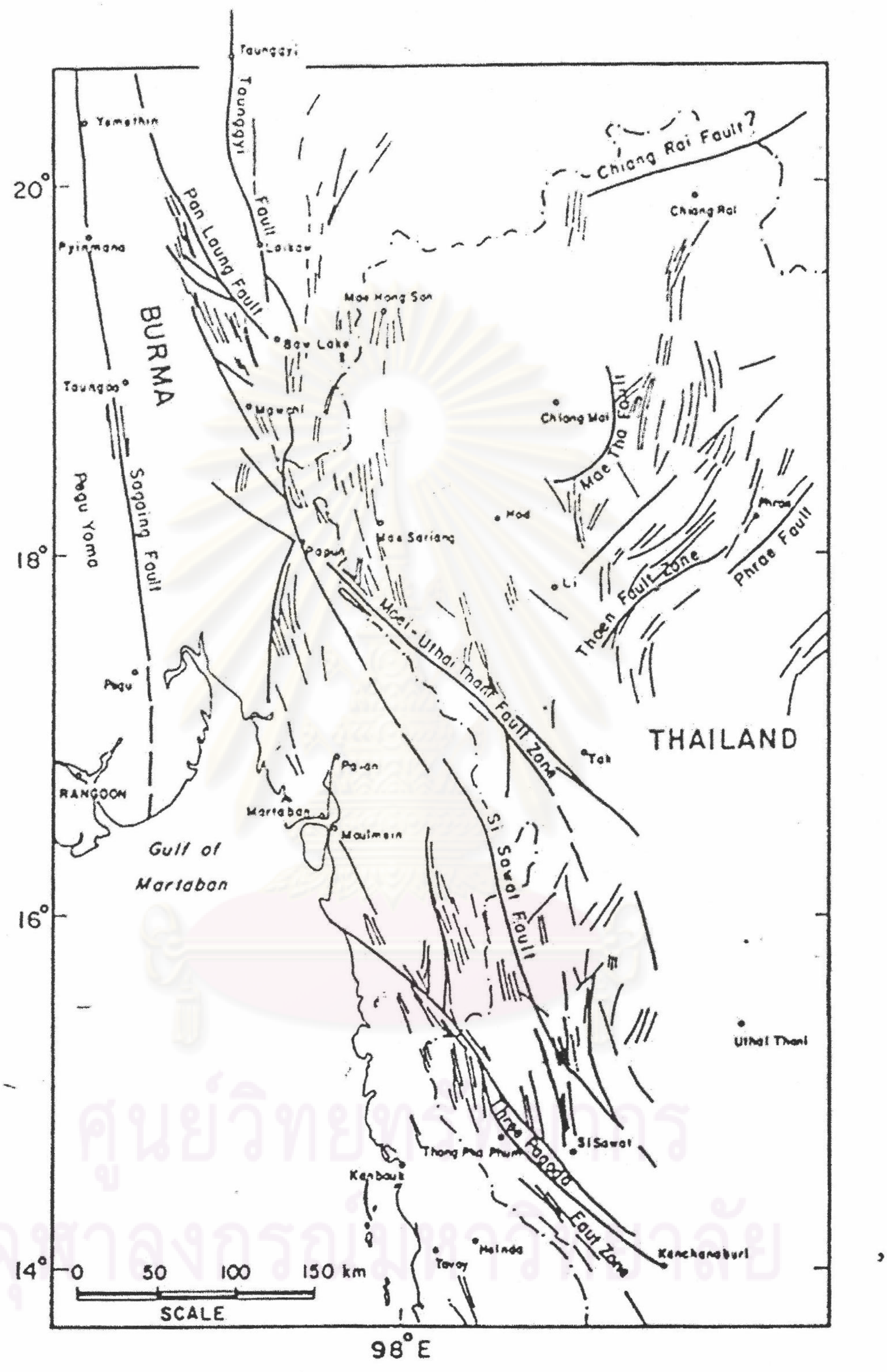

Figure 3.1 Major faults in the Tenasserim Ranges, eastern Myanmar (Burma)and northern Thailand (after Nutalaya, 1985).

segments; the southeastern and the eastern with total length about 20 km.

Chauviroj (1995) recognized 13 fault zones in Thailand (Figure 3.2), included The Phrae fault zone as the NE- trending Thoen fault. This zone can be delineated from Thoen basin in southwest to Phrae basin in northeast with approximately 250-km-long. Its also regarded this fault zone related to Dien Bien Phu fault zone in Chaiburi and Laung Phra Bang of Loas PDR with a dextral displacement fault.

Hinthong (1995) mentioned that the Phrae fault zone is classified as potentially active fault zone (Figure 3.3). This result had classified based upon various types of existing data, for example seismotectonic map scale 1:1,000,000 compiled by Nutalaya and Sodsri (1985), the geological map of Thailand compiled by Lumjuan and Lovacharasupapun (1982) scale 1:1,000,000,various geological maps at scale 1:250,000, airborne geophysical maps at scale 1:250,000 and 1:1,000,000, and thermoluminescence dating results for some faults.

Bott et al.(1997) cited that earthquake swarms in 1980 and 1983 at south and southwest of the Phrae basin, respectively, may be occurred either on the Phrae fault located the western basin edge or on blind faults beneath the basin. Earthquake epicenters indicate that the southern portion of the Phrae basin and nearby is tectonically active with E-W to NW-SE extension on N to NE-trending of normal or normal-oblique faults.

Fenton et al.(1997) revealed that the Phrae basin comprises of the Phrae fault and the Phrae basin fault (Figure 3.4). The former is located at the western margin of the basin, lying in NNE-trending, and characterized by normal movement with east dipping. In addition, the fault has shown closely related to the Thoen fault in the south. The Phrae basin fault is NE-trending, located closely to the southeastern margin of the basin with east dipping. Both faults have the same maximum credible earthquake of Mw 7.

Charusiri et al.(2001) quoted that the Phrae fault is a set of NE-trending Thoen-Long-Phrae fault zone (Figure 3.5). Based on thermoluminescence dating of fault-related sediments, age of faulting events in this fault zone is found at 0.16, 0.21 and 0.49 Ma. Consequently, the Phrae fault is intended to be still active.

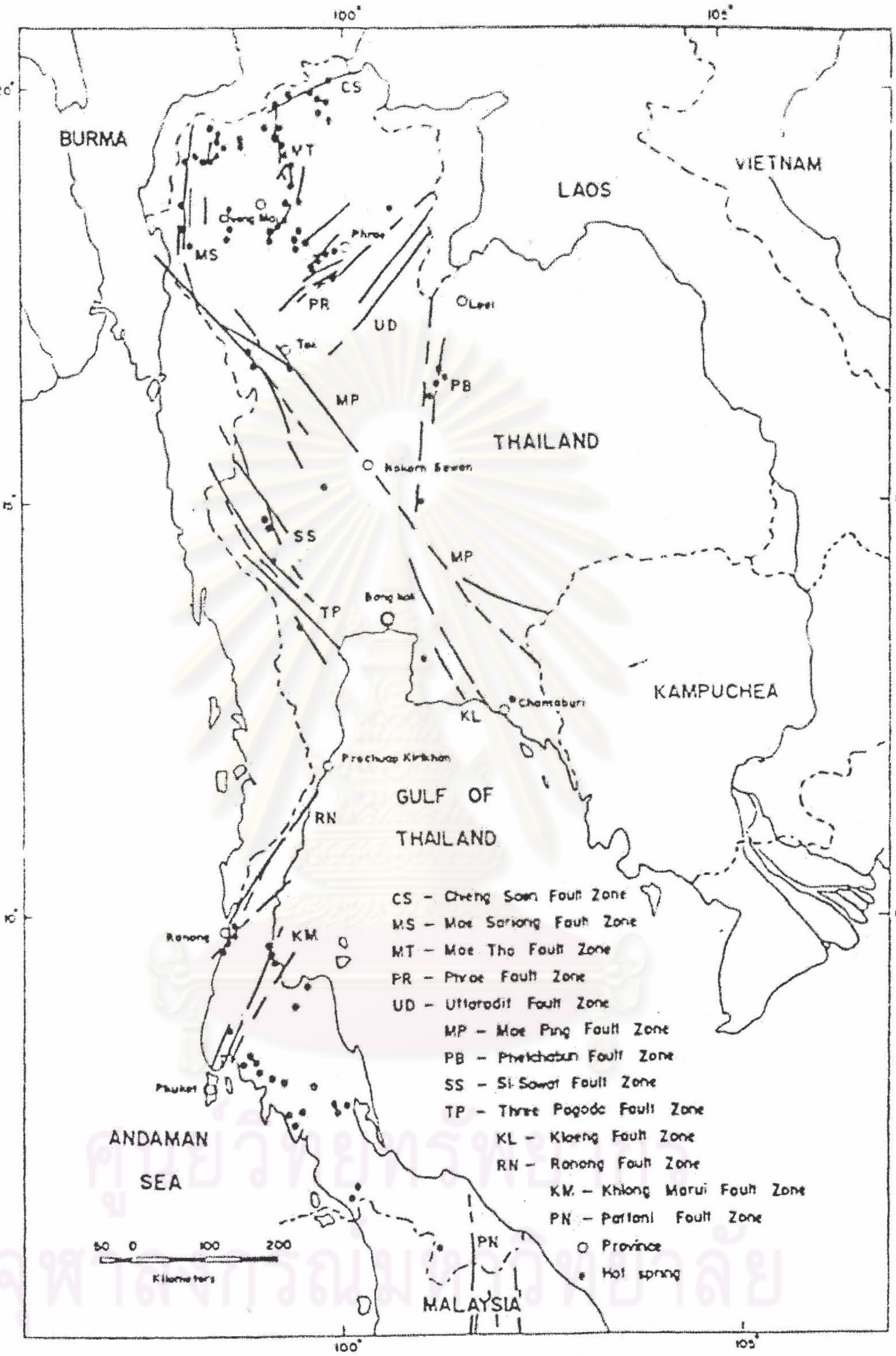

Figure 3.2 Fault zones and hot spring locations in Thailand (after Chauviroj, 1995).

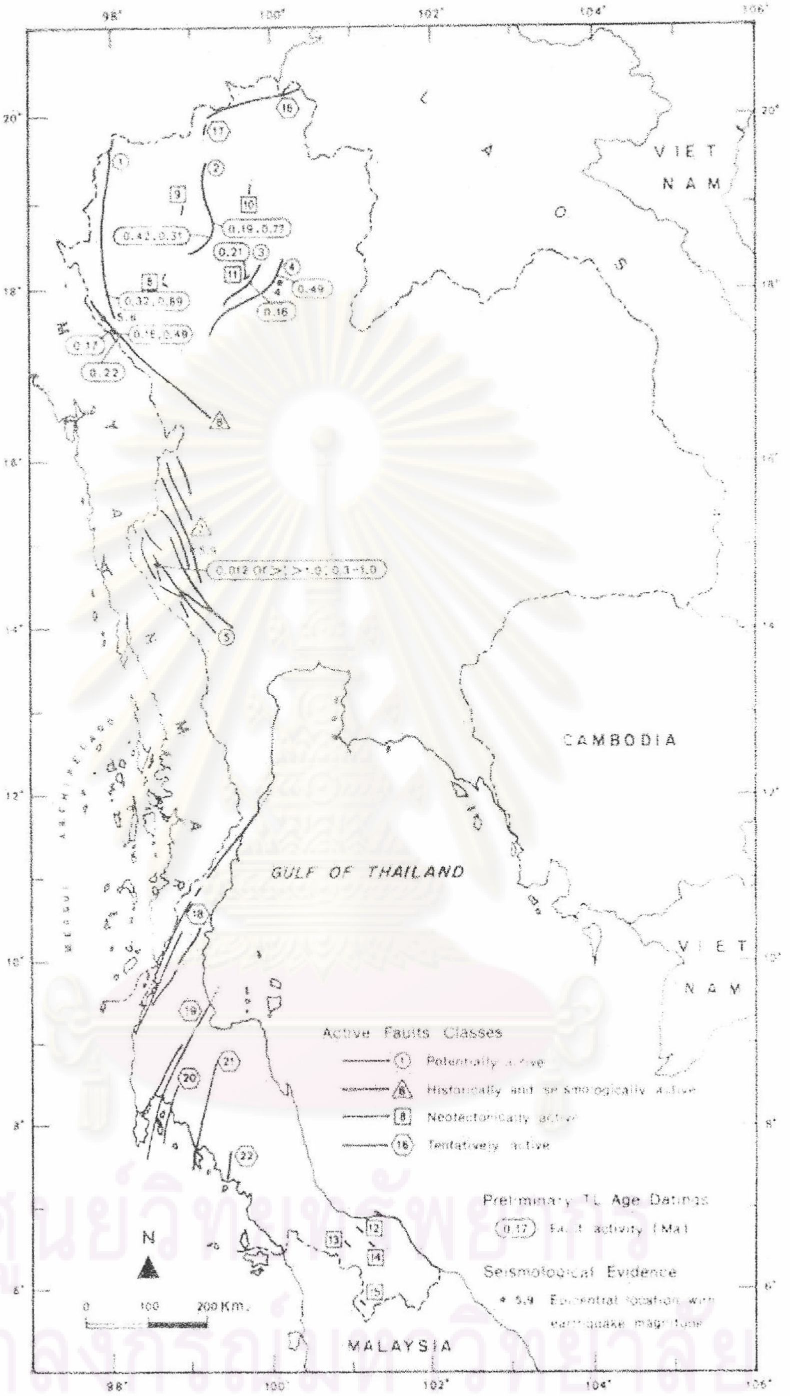

Figure 3.3 Map of Thailand showing distributions of major classified active faults and fault zones in Thailand (after Hinthong, 1995).

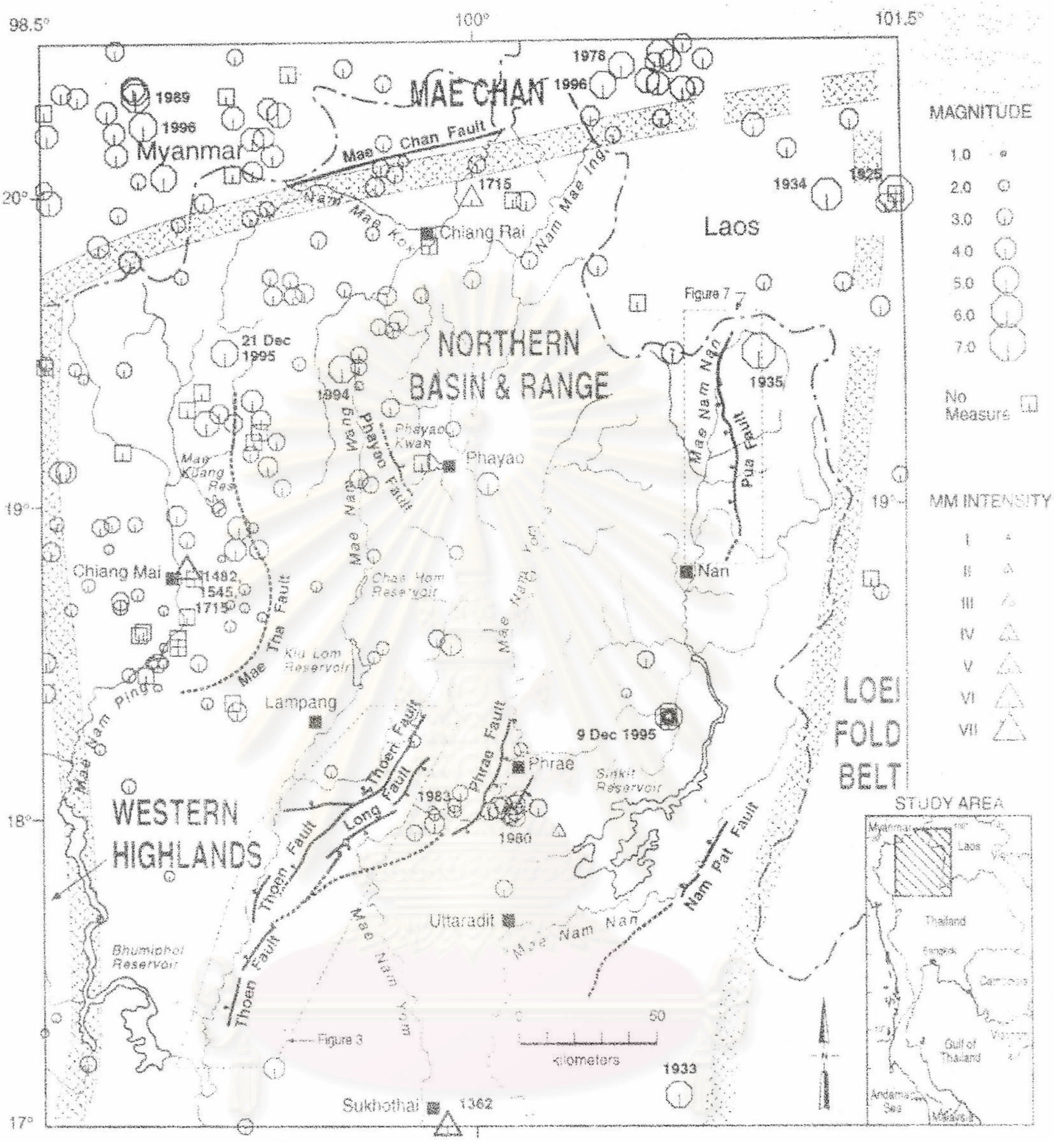

Figure 3.4 Late Cenozoic faults and historical seismicity (1362 to 1996) of the northern Thailand. The Phrae fault and the Phrae basin fault are located close to western and eastern margin of the Phrae basin, respectively, and both are east-dipping faults(after Fenton et al, 1997).

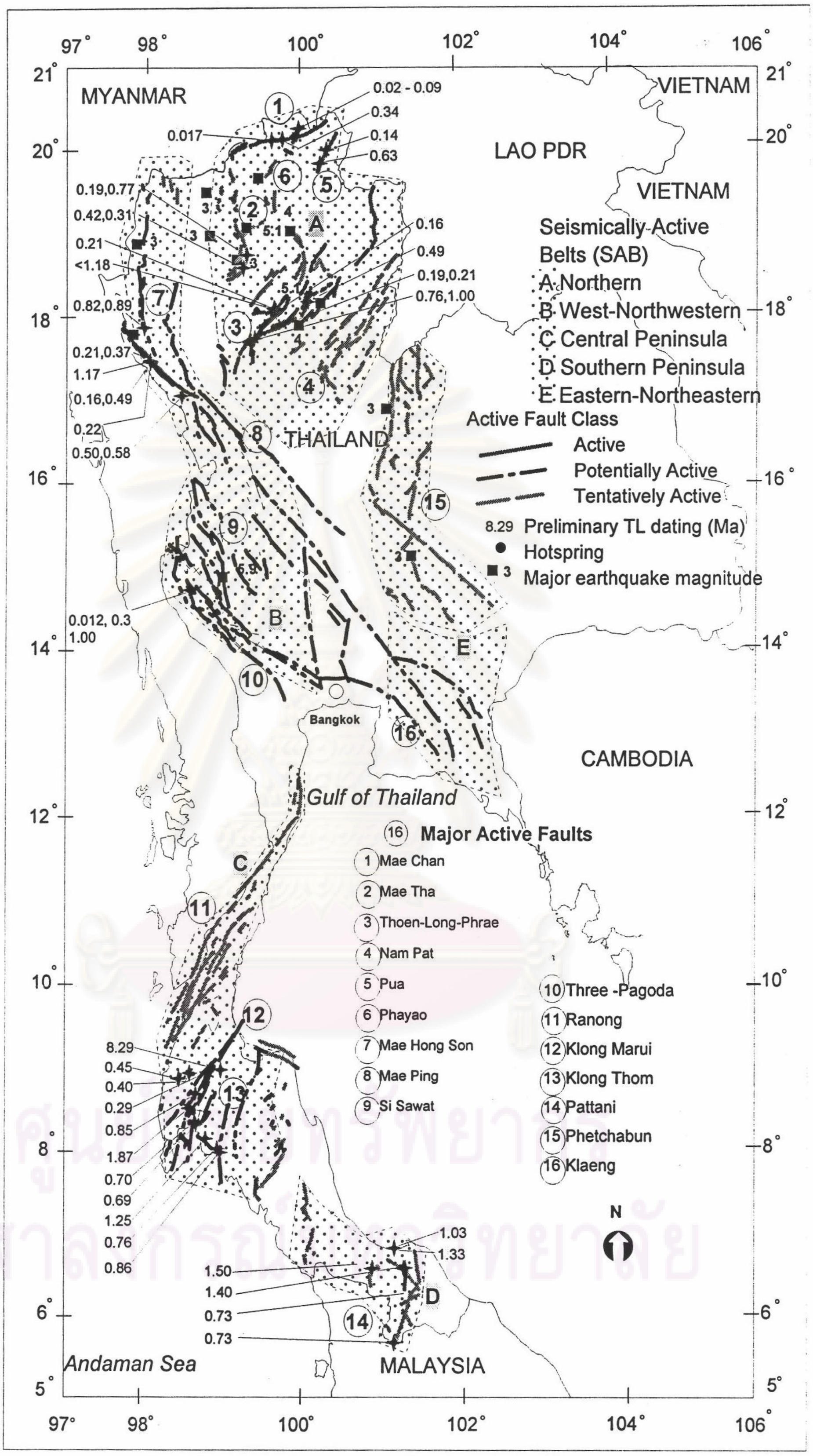

Figure 3.5 Seismic active belt of Thailand
(after Charusiri et al., 2001)

Srisuwan et al.(2000) implied that the Phrae-Thoen fault zone has a strong influenced to the development of the Phrae basin and the Thoen basin. The main trace of this fault zone lied in the NE trend and is characterized by sinistral motion with east-west extension. Figure 3.6 is a model of Phrae-Thoen fault zone, showing four major faults governed in the Phrae basin. Three faults on the left characterized with east- dipping, except the last one bounded on the far right showing west-dipping nature conjugated to the previous faults.

3.1.2 The Phrae Fault Segment of This Study

Due to structural complexity expressed in the Phrae fault zone, the term of the Phrae fault system is used herein instead of the Phrae fault zone. The Phrae fault system in this thesis is composed of several fault domains, which is once mentioned by the previous authors. For instance, the Phrae fault zone (Nutalaya et al., 1985),the Phrae fault and the Phrae basin fault (Fenton et al., 1997, and Bott et al., 1997), the Thoen-Long-Phrae fault zone (Charusiri et al.,2001), the Phrae-Thoen fault zone (Srisuwan et al., 2000). All of these definitions are referred to or contained in the Phare fault system.

In this study, based on remote-sensing seismicity and field data, there are at least four fault segments contained in the Phrae fault system; namely, the Southwestern, Western, Southeastern, and Northeastern segments (see detail in section 4.2).

The Southwestern segment can be delineated in the south of the Thoen basin with NE-trending trace. The fault has been observed passing the mountainous area in the south before reaching the Phrae basin. However, at this locality, the fault trace is not prominent.

In the Phrae basin, the fault is found split into at least two major segments bounded on the western and southeastern margins of the basin and herein named as the Western and Southeastern segments, respectively(Figure 3.7).

To the north, the prominent NE-trending fault has found located in mountainous area in the northeastern part outside the Phrae basin. This fault is also referred to be the segments of the Phrae fault system and is designated as the Northeastern segment. Seemingly, this fault segment shows a linkage between faults in the Phrae and the Nan basins since the southern and northern tips

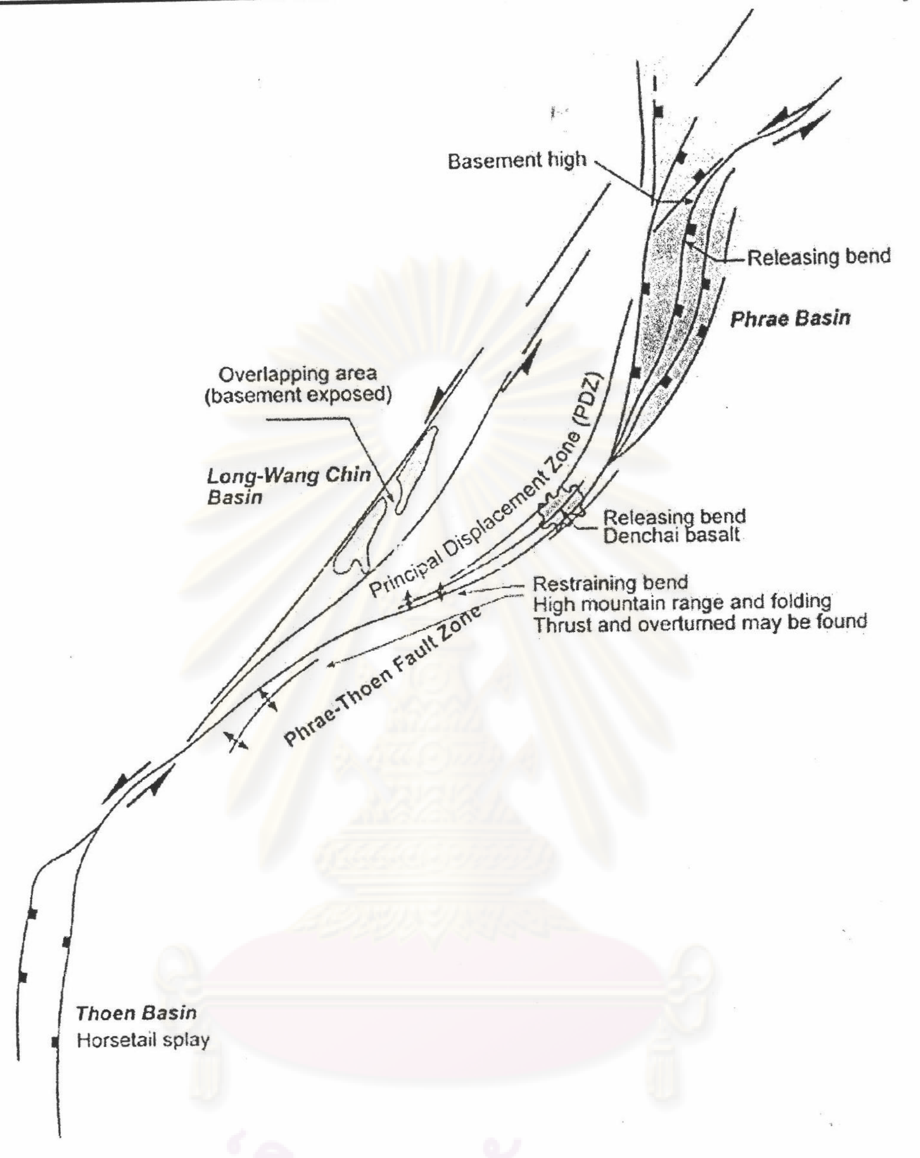

Figure 3.6 The model of basins associated with the strike-slip fault zone applied to the Phrae-Thoen areas, including the Long and Wang Chin Basins (after Srisuwan et al., 2000).

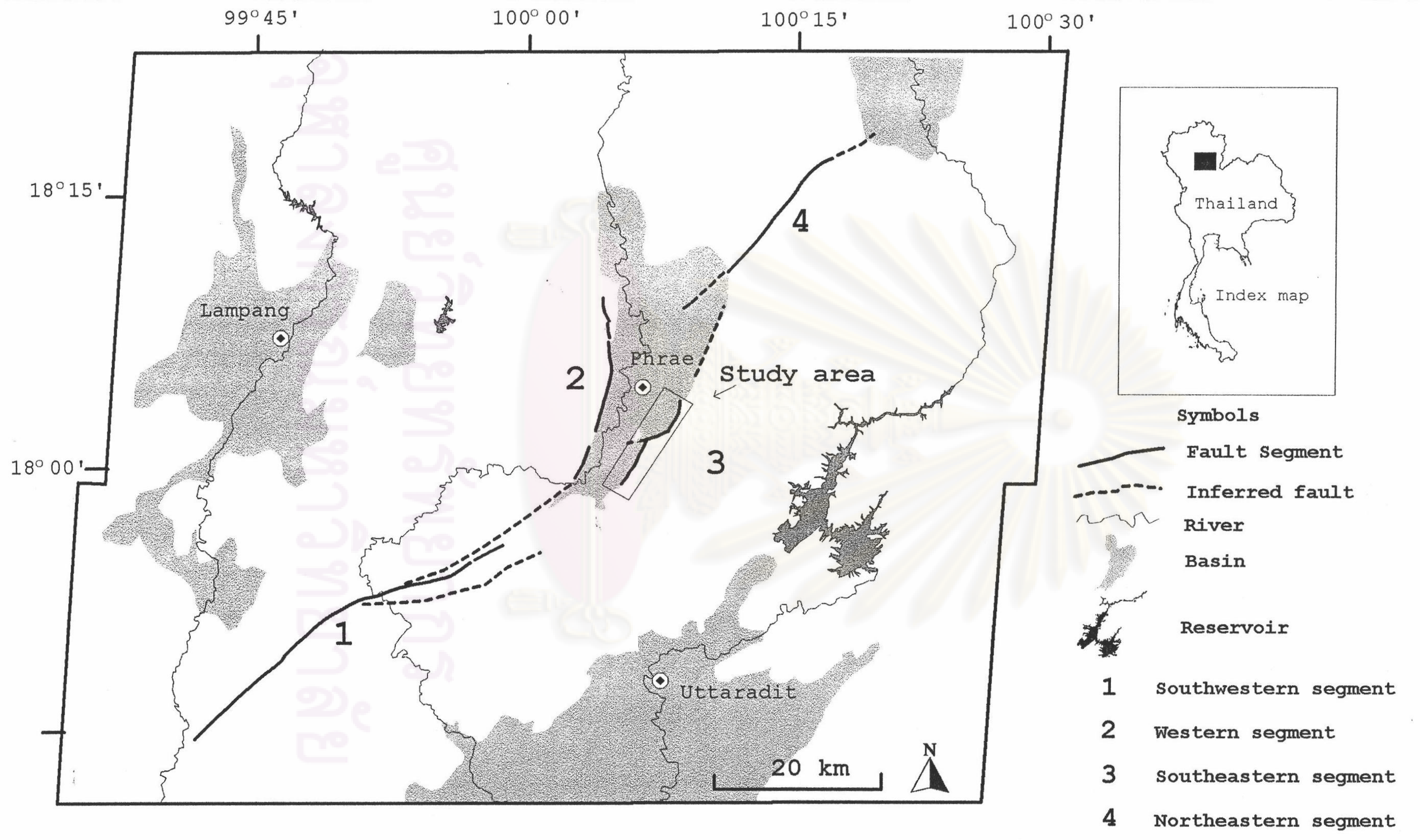

Figure 3.7 Fault segments of the Phrae fault system based on Landsat TM5 image data. The study area is shown in a box.

of this segment are terminated at those basins. Furthermore, it is herein regarded that this fault may extend northeastward to join the Dien Bien Phu fault zone in Chaiburi and Laung Pha Bang of Laos PDR (Chauviroj, 1995).

3.2 Seismic Profiles

In 1994, PTT EP company had launched nine lines of seismic survey for coal exploration in the Phrae basin. These seismic lines were run to cover the basin with the total length of 180 km. Three lines were operated within the study area, viz. line nos. P94-220, P94-240 and P94-260 (Figure 3.8 & Figure 3.9).

GMT (1996a), Srisuwan et al. (2000), and Khrauthao (2001) reported the results of these seismic interpretation. However, their interpretation results are quite different from one another. GMT (1996a) reported no fault traces cutting across the eastern margin of the Phrae basin (Figure 3.10) whereas Srisuwan et al. (2000) and Khrauthao (2001) reported that they axist. On the other hand, some controversies on the delineation of the eastern border fault of the Phrae basin had been risen.

On the report of Srisuwan et al. (2000) and Khrauthao (2001), however, there are some differences in the location of the observed fault traces (Figure.3.11 & Figure 3.12). Nevertheless, both of these results have illustrated the existence of the fault in southeastern portion of the Phrae basin. This fault is, in this thesis study, referred as the southeastern segment of the Phrae fault system. Based on both results, the so-called main border fault in the eastern boundary of the basin is dip-to-the west with approximately 45 degree of dip angle. Hanging wall of the fault is contained the formations of basin-filled sediments and the footwall is mostly occupied by marine deposited rocks. Additionally, this fault is found cut across the basin downward until reaching the basement rocks.

Besides, depending on seismic interpretation of this thesis study (Figure 3.13), in structural geology underneath the Phrae basin, especially fault architecture on the southeastern portion of the basin is of interest. Thus seismic interpretation in this thesis is mainly concentrated on fault traces. Consequently, the same three lines of seismic profiles previously stated have been reinterpreted by the author.

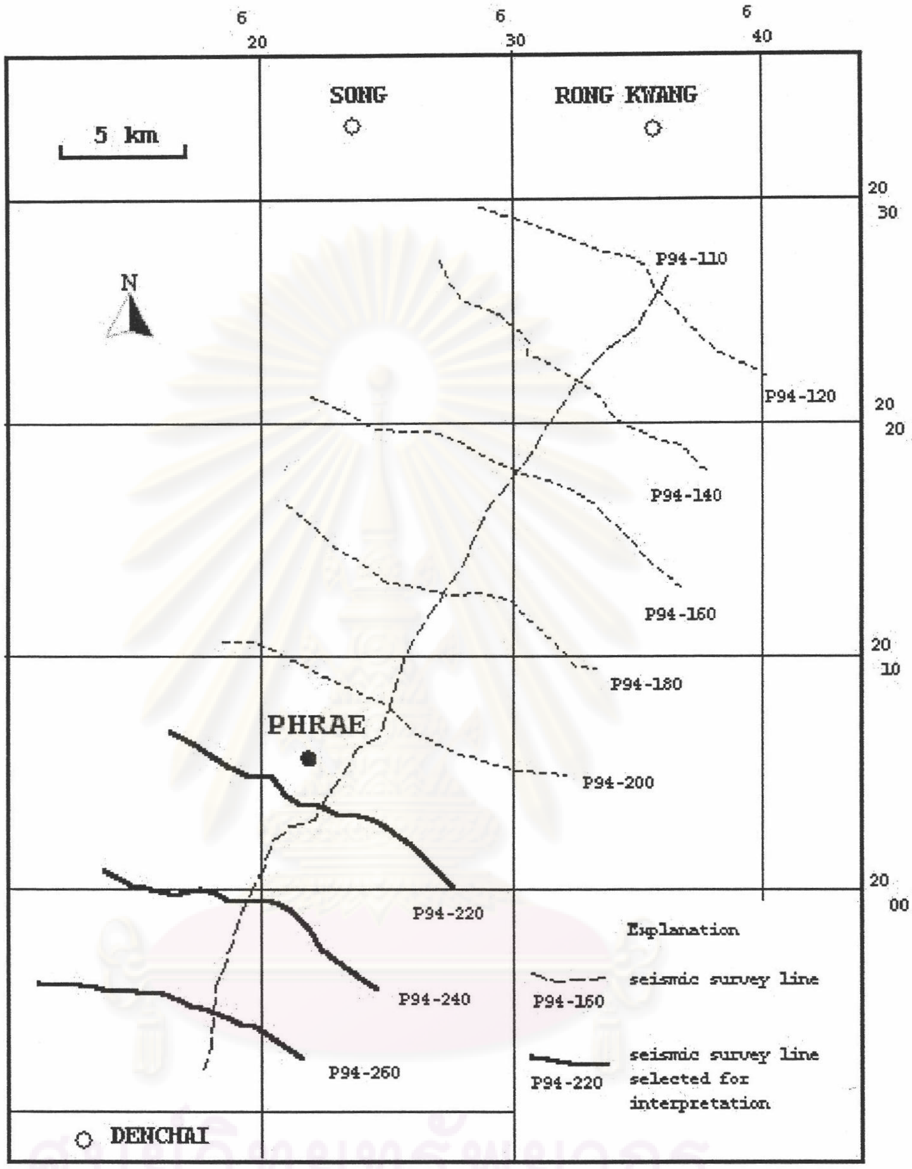

Figure 3.8 Seismic survey lines in the Phrae basin. Line nos. P94-220, P94-240, and P94-260 run across this thesis study area (after GMT, 1996a).

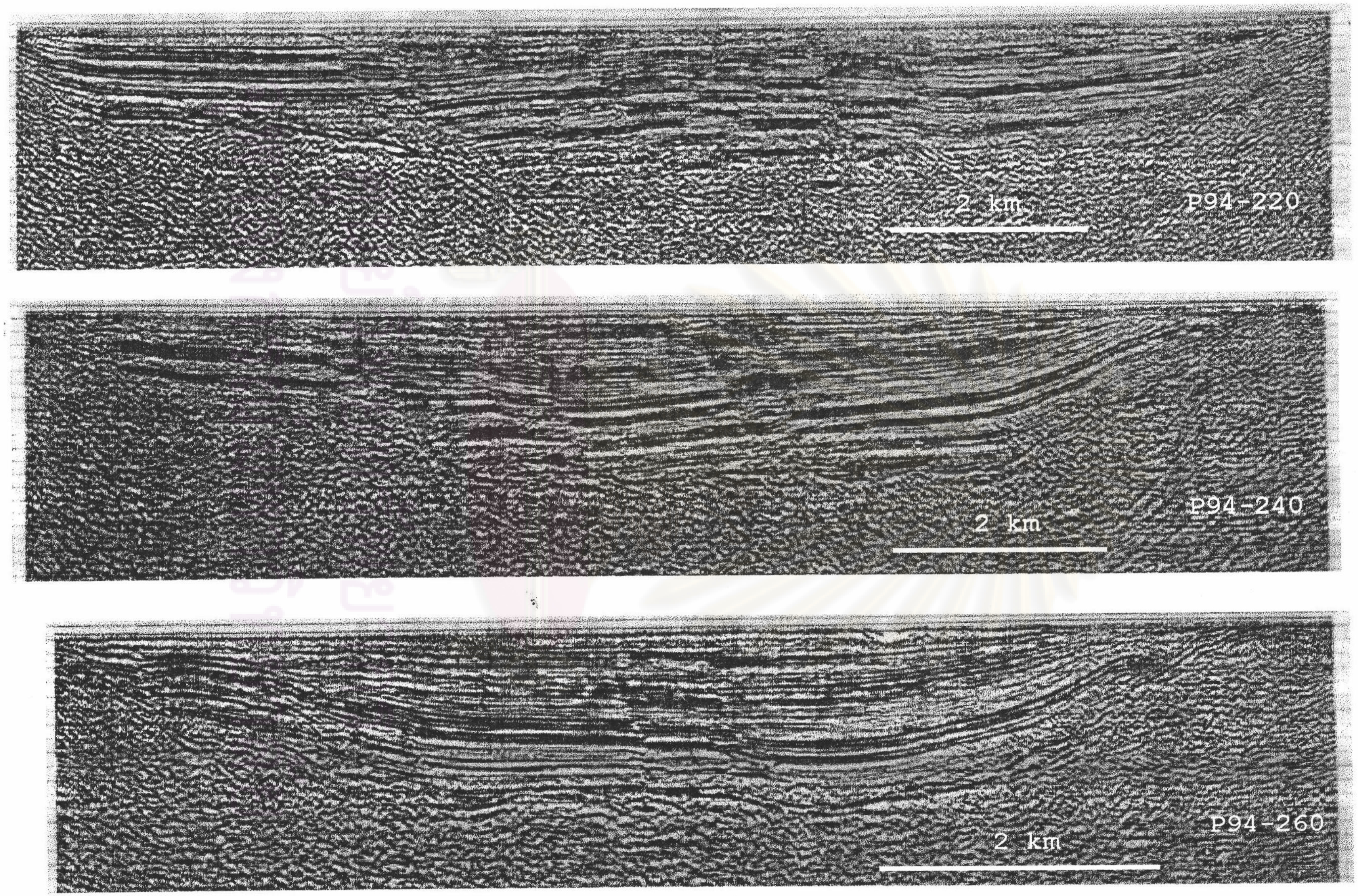

Figure 3.9 Seismic reflection profiles, line nos. P94-220, P94-240 and P94-260 (after GMT, 1996a).

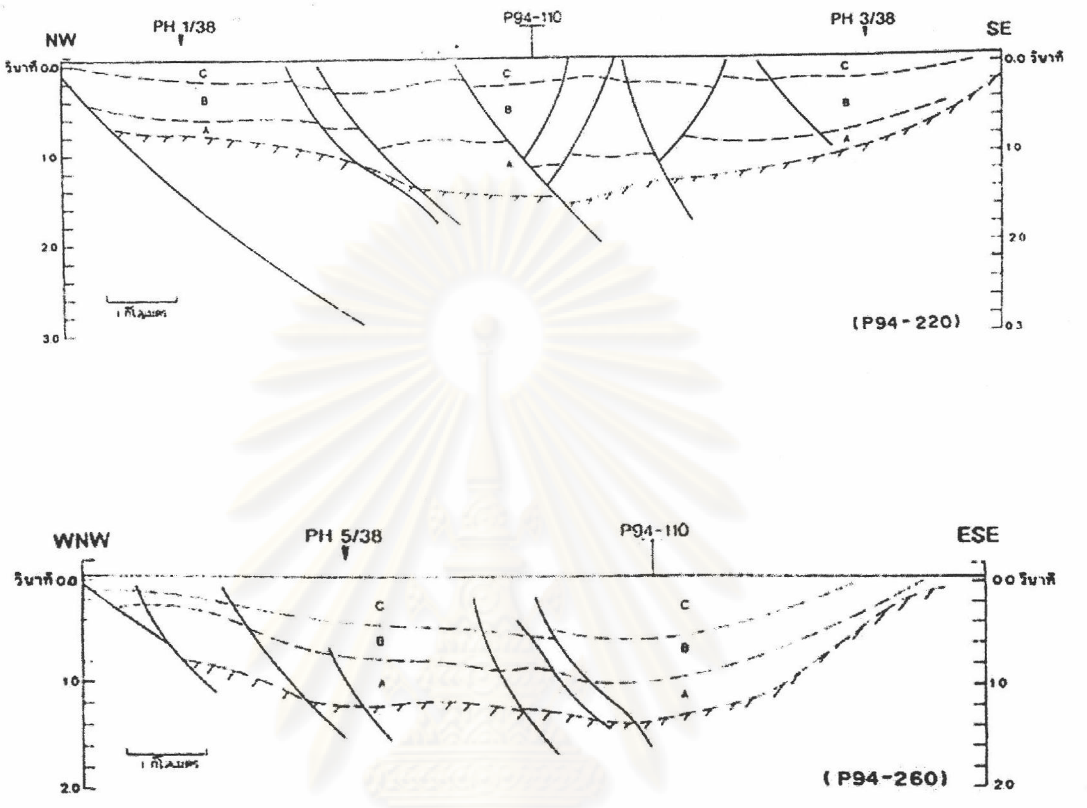

Figure 3.10 Seismic interpretation profiles of line nos. P94-220 and P94-260 (after GMT, 1996a).

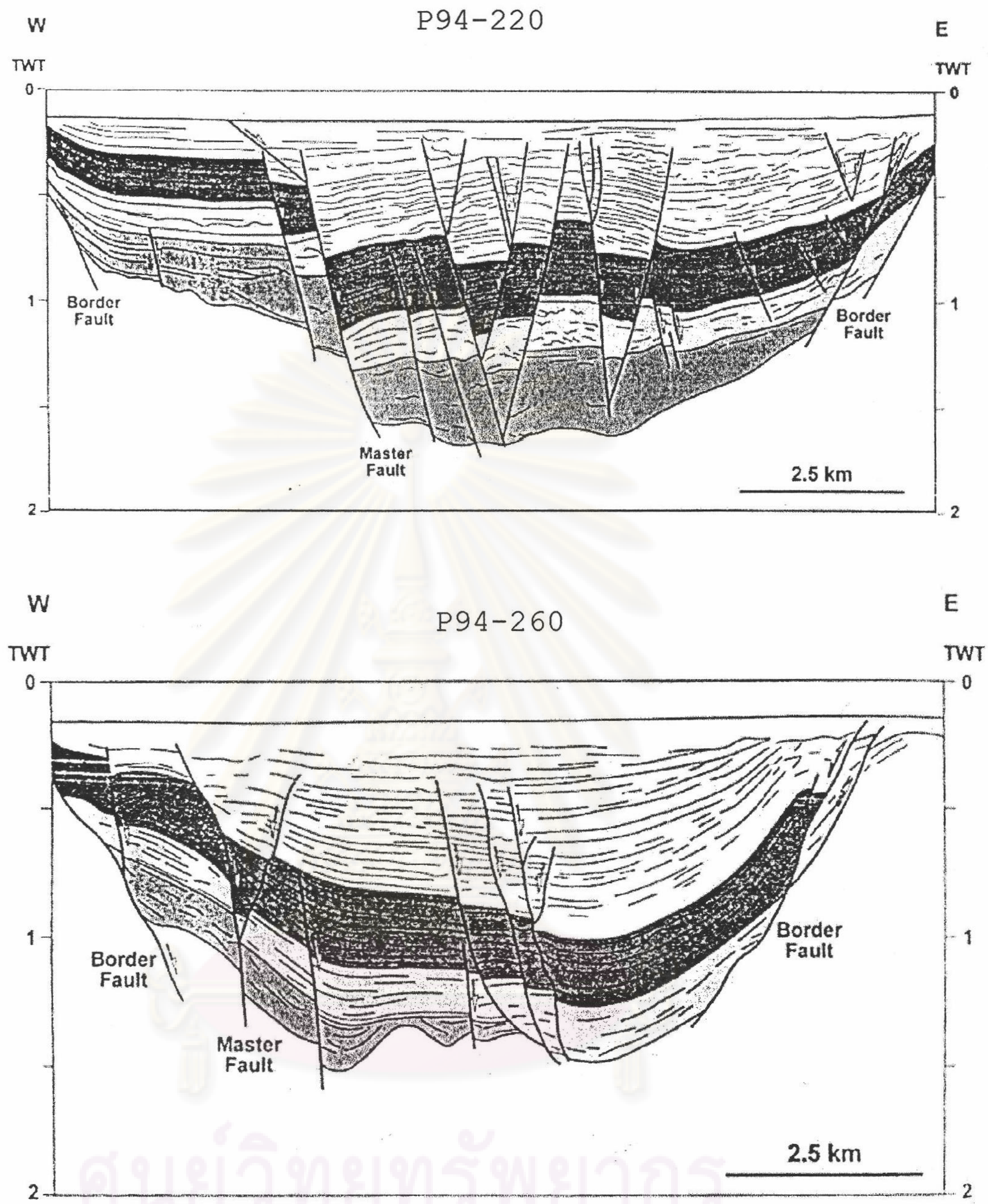

Figure 3.11 Seismic interpretation result of the southern part of the Phrae basin, line nos. P94-220 and P94-260, interpreted by Srisuwan et al.(2000) showing trace of eastern border fault on both seismic profiles (after Srisuwan et al., 2000).

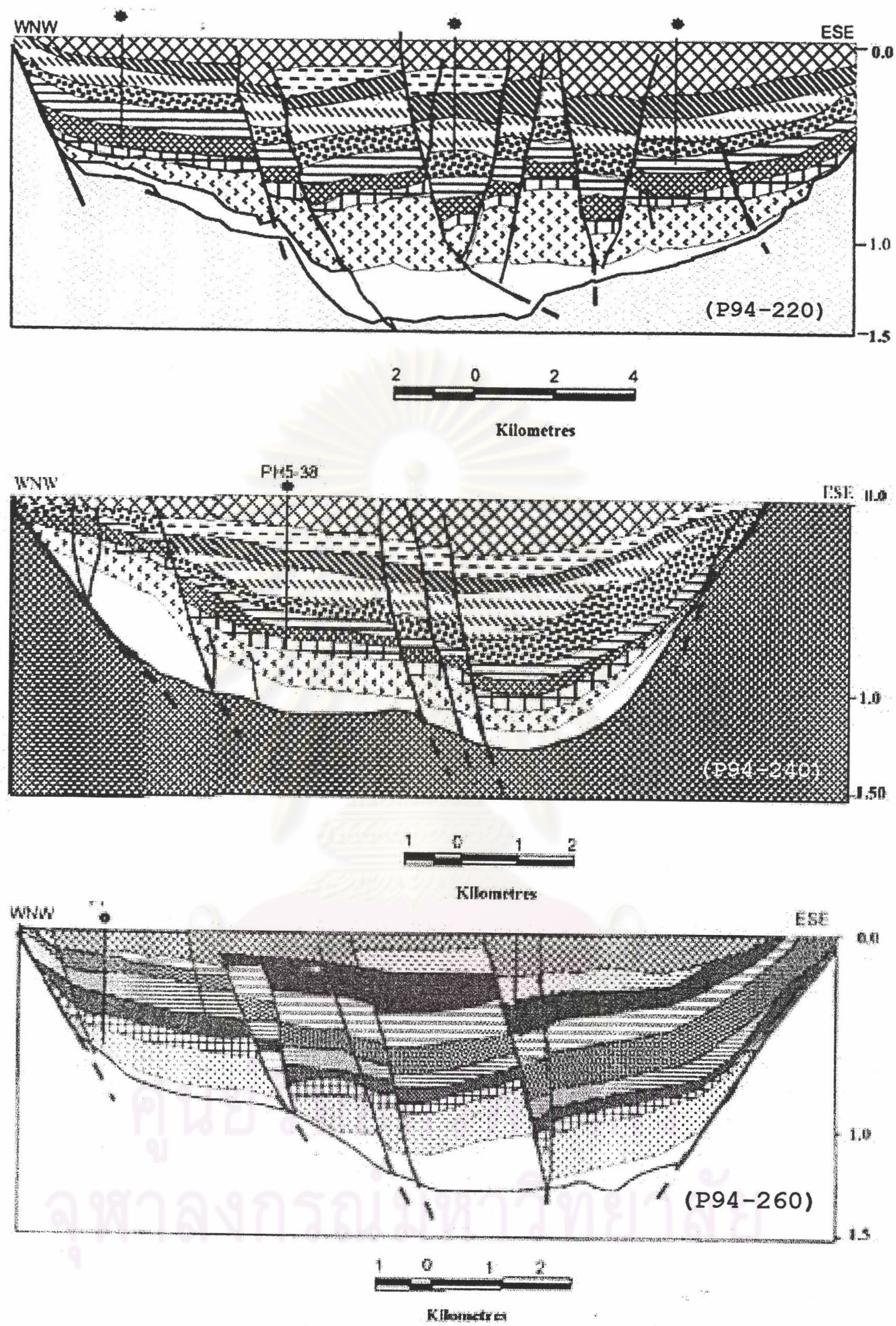

Figure 3.12 Seismic interpretation results of the southern part of the Phrae basin, line nos. P94-220, P94-240, and P94-260, showing trace of eastern border fault on seimic line nos. P94-240 and P94-260 (after Kruathao, 2001).

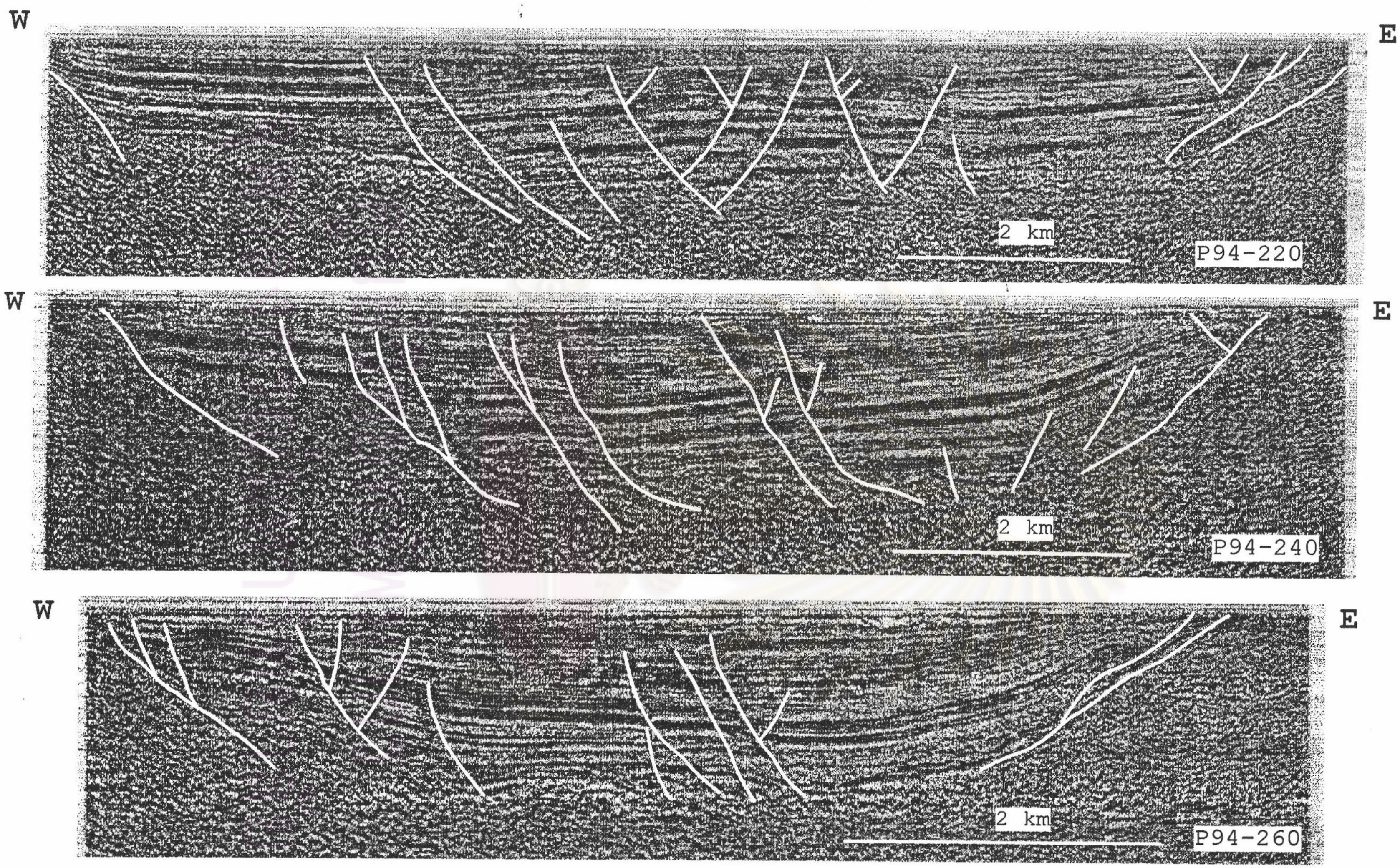

Figure 3.13 Seismic interpretation results showing eastern border fault on each seismic profiles. This fault is referred to the southeastern segment of the Phrae fault system. Line P94-240 shows antithetic fault on eastern border.

As the result, the Phrae basin is influenced by sets of normal faults, which mainly located on the western border, the central, and the eastern border. The major trend of the western border fault displays east-dipping with approximately 45 degrees. Noteworthy, the western border in line no. P94-260 of profile characterizes as splay fault. In the central, there is the most structural complexity in the basin. Due to negative flower structure and fault splay, they are mainly illustrated in the center of the basin. Finally, on the eastern border of the basin, there is the location of the southeastern segment of the Phrae fault system trace situated. All seismic profiles have indicated the eastern border of the Phrae basin dip approximately 45 degrees to the west.

In as much as interesting fault in this thesis study is located on the eastern margin of the Phrae basin, eastern border fault characteristics are extensively clarified as below.

According to seismic profile line no. P94-220, the eastern border fault is located on the right end of the profile showing normal displacement. In addition, on the hanging wall of the border fault, there is the other normal fault characterized as splay fault and showing synthetic to the border fault. Small conjugate fault is also found situated closed to the hanging wall of the splay fault. Note that the lower end of the border and the splay fault traces are delineated to the bottom of the basin, and the upper tip of the splay fault is closed to the present ground surface. However, the upper tip of the border fault can not be delineated because seismic survey line is end up. Seismic profile line no. P94-240 shows eastern border fault illustrated as normal fault with west dipping about 45 degrees. At the upper part of this fault, there is a small fault showing conjugate to the border fault. The upper tip of the border fault is found closed to the present ground surface, and the lower end of the fault is reached to the bottom of the basin. Additionally, at the hanging wall of the border fault, there are two small blind faults showing synthetic to the the border fault. Finally, Seismic profile line no. P94-260 also shows eastern border fault as a normal fault with west dipping of about 45 degrees. This fault is characterized as splay fault. The tips of both splays are closed to the present ground surface and the lowest trace of the fault is found reached to the bottom of the basin.

3.3 The Southeastern Segment of the Phrae Fault System

Based on lineament interpretation and fault segmentation using Landsat TM and JERS imageries (see detail in sections 4.1 and 4.2) and seismic profiles, the southeastern segment of the Phrae fault system is located at the southeastern portion of the Phrae basin(see Figure 3.7). The major trend of the fault segment is in the NNE direction. It has regarded as the basin-bounded fault, with approximately 20-km-long, located at Ban Phae Mai in the south to Ban Pa Deang in the north, dipping to the west about 45 degrees.