CHAPTER II

TECTONICS AND SEISMICITY

2.1 Tectonics

2.1.1 General Background

Basically, knowledge of earth's interior has been provided by geophysical studies of earth's gravity and magnetic fields and from earthquake seismology. Furthermore, seismology has played an important role in this concept. Technically speaking, seismic wave properties can be applied to understand the earth's interior (Figure 2.1). As a result, earth's interior has been divided into three main parts; the crust, the mantle, and the core. The boundary between crust and mantle is marked by P-wave velocity increased suddenly. This zone is called "Mohorovicic discontinuity". Additionally, the boundary between mantle and core is marked by zone of shear waves disappearance and a sharp reduction in velocity of P-waves. This zone is called "Gutenberg discontinuity". According to the core, it can be divided into two parts; the outer and the inner which the inner has higher P-wave velocities (Lehmann, 1936), and is displayed by the boundary of "Lehmann discontinuity".

Tectonically, the earth is the most dynamic planet in the solar system. The earth's crust is composed of individual plates but all of these are related altogether. In addition, these dynamic plates can be produced and destroyed by earth's tectonism. Such tectonic processes of the earth can be well-explained by plate tectonic theory.

Tectonics is the study of the forces within the earth that give rise to continents, ocean basins, mountain ranges, earthquake belt, and other large-scale features of the earth's surface (Cox & Hart, 1986).

The cause of plate movement can be briefly explained that the convection cell of magma in astenosphare has risen, and magma is released out to the crust. This magma-risen process is commonly observed at the zone of spreading center or mid oceanic ridge, which is located between plates (Figure 2.2).

According to plate tectonics, there are two important terms related in this context; lithosphere and

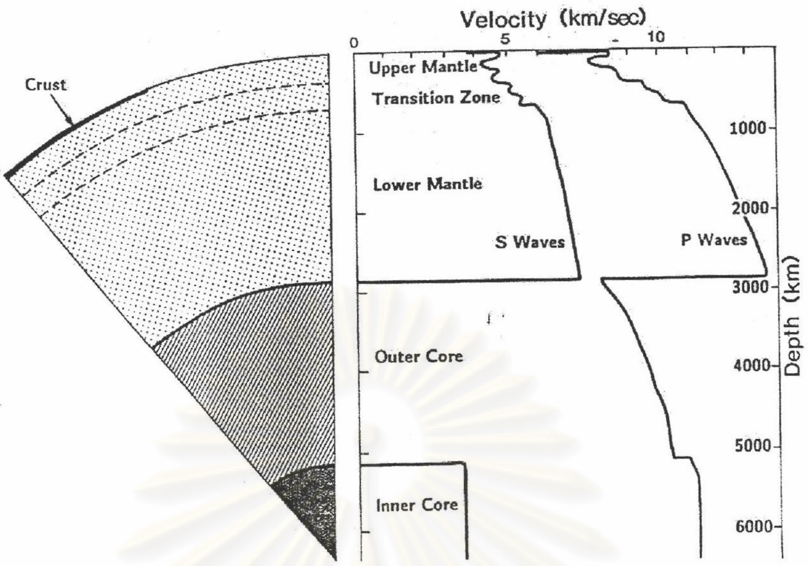


Figure 2.1 Model of the earth's interior. Summary of the physical model of the earth's crust. Left, representation of major subdivisions of the earth's interior. Right, the variation of seismic wave (P and S) velocity plotted against depth (after Hart et al., 1977).

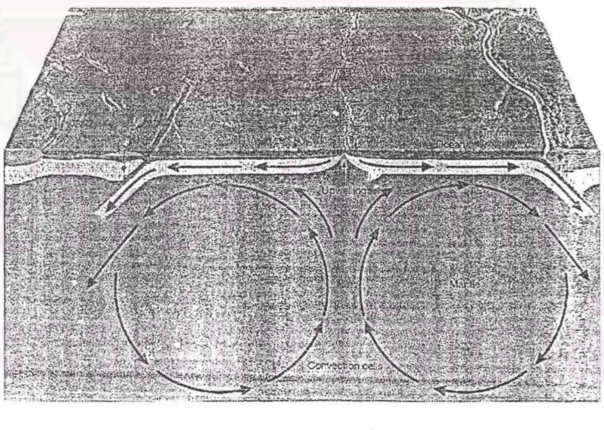


Figure 2.2 Seafloor spreading. The convective motion of the mantle material carreis the seafloor in a conveyor-belt fashion to the deep-ocean trenches, where the seafloor descends into the mantle(after Tarbuck & Lutgens., 1999).

astenosphere. Lithospere is rigid material composed of the crust and the uppermost portion of mantle. This sphere is override asthenosphere and the zone between two spheres is marked by low velocity zone, commonly found in the mantle at depths of 50-150 km.

There are three main categories of plate boundaries; divergent, convergent, and transform fault (Figure 2.3). Firstly, convergent boundaries consist of zones of plate convergence which are the location where oceanic lithosphere is subducted and absorbed into the mantle. When plate convergence occurs, the leading edge of one plate is bent downward, allowing it to descend beneath the other. The region where an oceanic plate descends into the asthenosphere is called a "subduction zone".

In addition, convergent boundaries can be subdivided into there types; oceanic-continental, oceanic-oceanic and continental-continental zones (Figure 2.4). These zones are controlled by the type of crustal material involved and the tectonic setting. The example of oceanic-continental lithosphere zone is Andean arc that runs along the western part of the South American Plate, when the Nasca oceanic plate descents beneath the South American Plate. A good example of oceanic-oceanic types is the subduction zone of the Atlantic beneath the Caribbean plate. Finally, continental-continental convergent boundary type is the most well-known as a collision between Indian and Eurasian plates producing the Himalayas, the most spectacular mountain range on Earth.

Secondly, a divergent boundary occurred along the crests of oceanic ridges. In this area, plates move away from each other or from the ridge axis. As a result, molten rocks that come up from the hot asthenosphere below have been filled up at the space between the plates. This hot material cools to hard rocks, then, producing new slivers of seafloor. In a continuous manner, plate spreading and upwelling of magma add new oceanic crust (lithosphere) between the diverging plates.

The most well know divergent boundary is Mid-Atlantic Ridge where is the zone divided North and South American from Eurasian and African plates.

Finally, transform fault is characterized by strike-slip faulting where plates grind past one another without production and destruction of lithosphere. Horizontal displacement on these faults causes offset of an oceanic

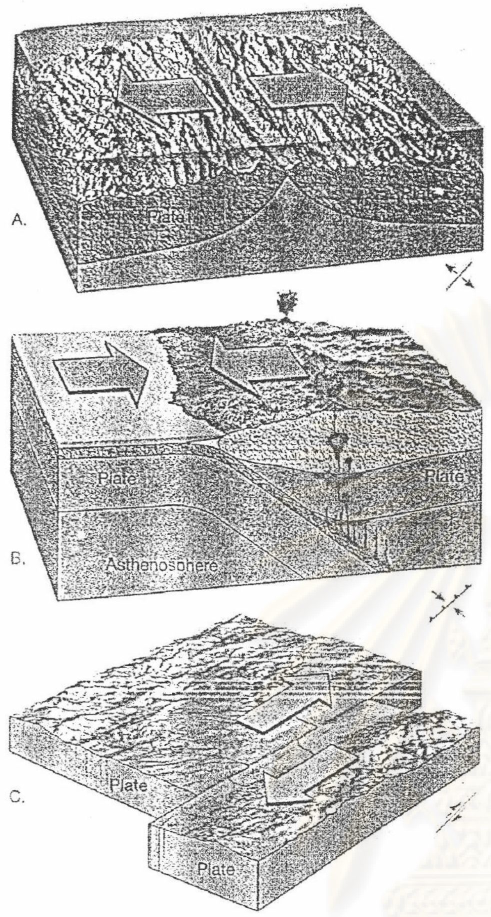


Figure 2.3 Schematic diagram of plate boundaries showing the relative motion of plates.
A. Divergent boundary.
B. Convergent boundary.
C. Transform fault boundary
(after Tarbuck & Lutgens, 1999).

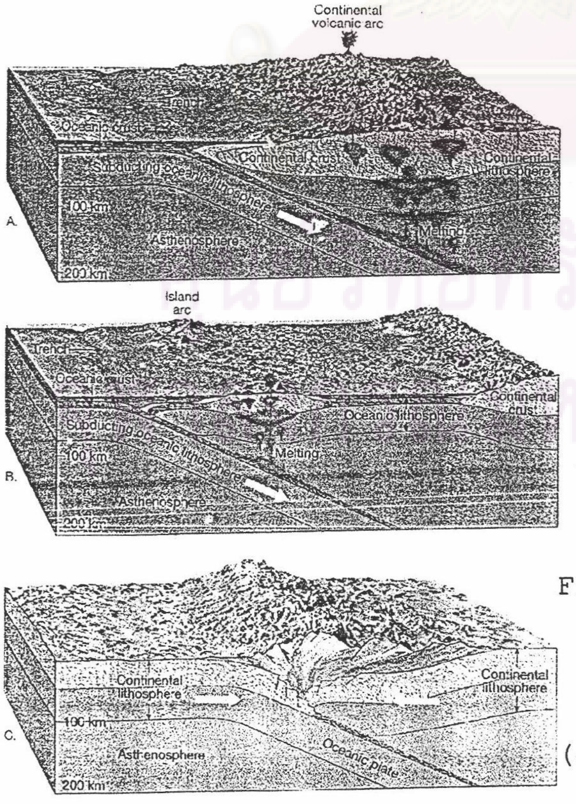


Figure 2.4 Zones of plate convergence.
A. Oceanic-continental.
B. Oceanic-oceanic.
C. Continental-continent
(after Tarbuck & Lutgens,1999).

ridge, However, movement along these faults was found to be in the exact opposite direction required to produce the offset ridge segment. Displacements along the Mid-Oceanic Ridge are of the examples of this type of plate movements (Tarbuck & Lutgens, 1999).

2.1.2 Regional Tectonic Setting

Tectonic feature of Southeast Asia is associated to collision between Indian and Eurasian plates (Tapponnier et al., 1977; Pollachan & Sattayarak, 1989; Charusiri et al., 2001). Several evidences are as the result of this collision. All of the recent tectonics of China are, to some extent, related to Indian and Eurasian convergent which have collided at rate of about 5 cm/year since Cenozoic time (Figure 2.5). In central China, there are three major E-W trending fault systems with characteristic sinistral strike-slip motion. This movement appears to dislocate China eastward (Tapponnier & Molnar, 1977). However, McCaffrey (1996) stated that Australia is moving northward (along a vector of 010° to 020°), toward southeast Asia, with a convergence rate of 65 to 75 mm/yr. According to the faults in southwest to south China, particularly in mountainous areas such as the Kan-Ting, the Red River fault, there are dominantly strike-slip. In addition, strike-slip fault in eastern Tibet and south China are believed to be the result of Indian plate moving east to southeast beneath Eurasian plate (Verma et al., 1980).

Tectonic evidences around active subduction zones in western Burma are quite useful for tectonic study in this region. In this area, where Indian plate subducts beneath the Indoburman ranges. This process has continued until recently. However, nowadays, Indian plate has move easterly, not northerly direction in this zone similar to southernmost Burma and the Andaman-Nicobar ridge (Curray et al., 1974, and Curray et al., 1982). However, Tapponnier, et al.(1986) suggested that strike-slip motion along the Sagiang fault at the east and more widespread conjugate strike-slip motion farther east of Indoburma range are the results of northward translation of Indian plate. Indoburma range, as a result, has not only move north but also apparently rotated several tens of degree clockwise and move west which may be respected to Indian. Present day tectonics of Burma and surrounding region seem to be part of changing pattern from convergent and subduction to strike-slip displacements and conjugate shears on vertical planes (Le Dain et al., 1984). The subduction zone can be traced southwards in the approximately N-S trend and passes southernmost

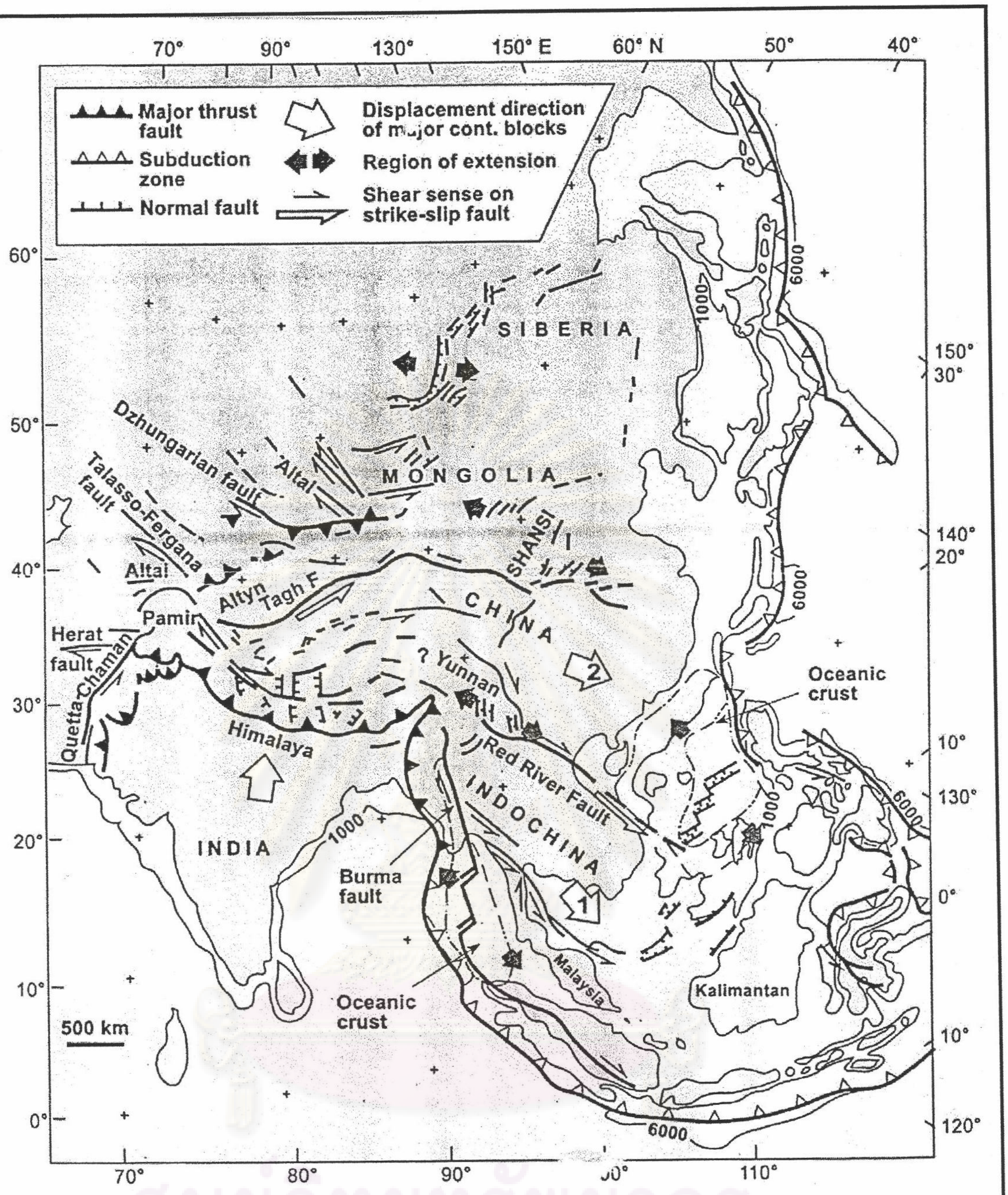


Figure 2.5 Tectonic map of central-east Asia illustrating 'extension' model and its relationship with Cenozoic structures in the region. Numbers in white arrows indicate the relative order in which certain continental blocks were extruded toward the southeast (after Tapponnier et al., 1982).

Myanmar to Andaman Sea. Ridge trench collision zone in Andaman Sea has migrated northward along the east of the Ninetyeast Ridge. There is the cause of much compressional stress released from this zone. This stress has applied to the back-arc region and causing the opening of Andaman Sea. However, this zone is not a common subduction zone related to back-arc basin, but probably a basin formed by oblique extension and rifting related to both ridge subduction and deformation of the back-arc region caused by a nearby continental collision (Eguchi et al., 1979). Spreading center found in the back-arc basin east of subduction zone is the evidence of this complexity. This spreading center relates to Sagiang fault in the north and connects to Sumatra fault in the south. The extentional stress of the spreading center may be associated with sense of movement of both faults, which are undergoing right lateral strike-slip movement.

Thailand is composed of two microcontinents; Indochina on the right and Shan-Thai on the left. These continents have collided to each other as continent-continent type of convergent plate boundary. The event occurred since late Triassic period (Bunopas, 1994 and Charusiri, 1997). Shan-Thai continent is composed of western half of Thiland, eastern Burma, and north-west Malay peninsular. Besides, Indochina consists of eastern half of Thailand, Loas, Cambodia, South Vietnam and eastern Malay Peninsula. Boundary of these two continents is determined as an ophiolite belt. This belt is called the Nan Suture (Bunopas, 1994 and Mantajit, 1997) and lies in approximately NE-SW trending found abut against the Red River fault in the north and is traced south pass through the north and central Thailand with subsequently bend to the eastern part. The trace seemingly continues and lies across the Gulf of Thailand. Moreover, this geosuture can subdivide Malay peninsular into two tectonic provinces eastern and western belts (Figure 2.6) (Bunopas, 1994).

At present, although the majority of deformation takes place on the Red River and other faults to the north (e.g., Kun Lun, and Altyn Tagh faults) but persistent moderate earthquake activity across mainland southeast Asia indicates contemporary deformation in this region (Fenton et al.,1997). Integration of the geometrical relationship of strike-slip and extentional faults with the evidence of clockwise rotation of crustal block and earthquake analyses are related to the strain ellipsoid of dextral simple shear. The NW-SE trending faults, the Red River, Mae Ping, Three-Pagoda, and Sumatra represent the master dextral faults, and the NNE-

SSW trending faults, the northern Thailand, Uttaradit, Ranong and Klong Marui are sinistral. It is considered that these sets of faults also characterized as conjugate set (Figure 2.7)(Pollachan & Sattayarak, 1989).

2.1.3 Active Faults in Thailand

According to Charusiri et al. (2001), Thailand active faults were classified into five seismic active belts (SABs) which were defined as linear or elongate zones of seismicity. These SABs were commonly classified based upon neotectonic movements and coincident with major tectonic structures (Figure 2.8). They are Northern, Western-Northwestern, Central peninsular, Southern peninsular, and Eastern-Northeastern SABs. The Northern SAB is composed of six major fault zones with difference classifications of their activeness. As a result, Mae Chan fault zone was classified as the active fault. Mae Tha fault zone was believed to be a tentatively active fault. Thoen-Long-Phrae fault zone was designed as the active fault, Nam Pat fault zone was considered to be a potentially active fault. Pua fault zone was regarded as the active fault, and Phayao fault zone was inferred to be a tentatively active fault. The Western-Northwestern SAB has four major fault zones. Ranging from the north to the south, Mae Hong Son fault zone was interpreted as the potentially active fault. Mae Ping fault zone was considered as the potentially active fault. Sri Sawat fault zone also was inferred as the potentially active fault, however, Three-Pagoda fault zone inferred to be the active fault. Thirdly, the Central Peninsular SAB includes Ranong, Klong Marui, and Klong Thom fault zones. The Ranong fault zone was suggested as a tentatively active fault. The Klong Marui was inferred as the potentially active fault, and the Klong Thom fault zone was regarded as the tentatively active fault. Fourthly, the Southern Peninsular SAB consists of several sets of discontinuous, isolated, and relatively short faults with sparse distribution hot springs. Pattani fault zone is mostly clarified in this area which was inferred as tentatively active fault. Lastly, the Eastern-Northeastern SAB consists of two major fault zones; Pethchabun and Klaeng fault zones. Both fault zones were assigned as the tentatively active faults.

2.2 Seismicity

Earthquake is caused by sudden release of stored elastic energy along a fault inside the earth. The main source of that energy is from plate tectonics. It is

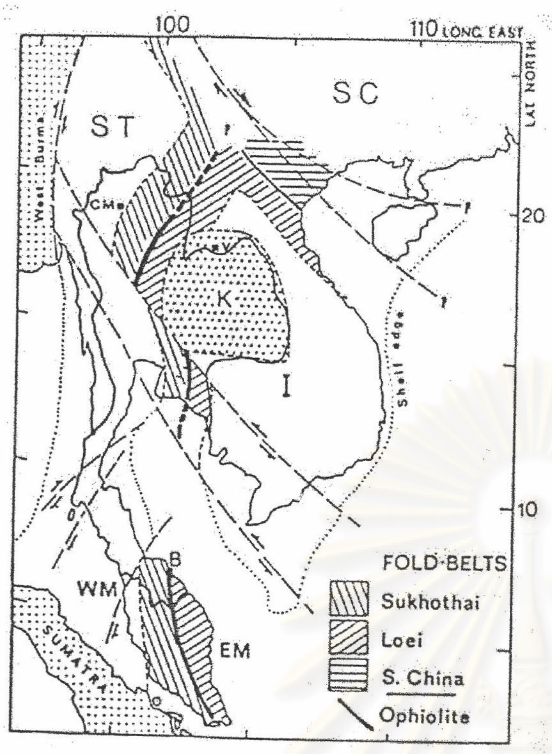


Figure 2.6 The map of Thailand and nearby areas showing two ancient microcontinents: Shan-Thai Terrane (including Sukhothai Fold belts) and Indochina Terrane (including Loei fold belts). I, Indochina (including eastern Thailand); SC, south China and ST, Shan-Thai. K, Khorat Basin; CM, Chiang Mai; V, Vientiane; WM, West Malaysia Peninsular; EM, East Malay Peninsular; B, Bentong (after Bunopas, 1994).

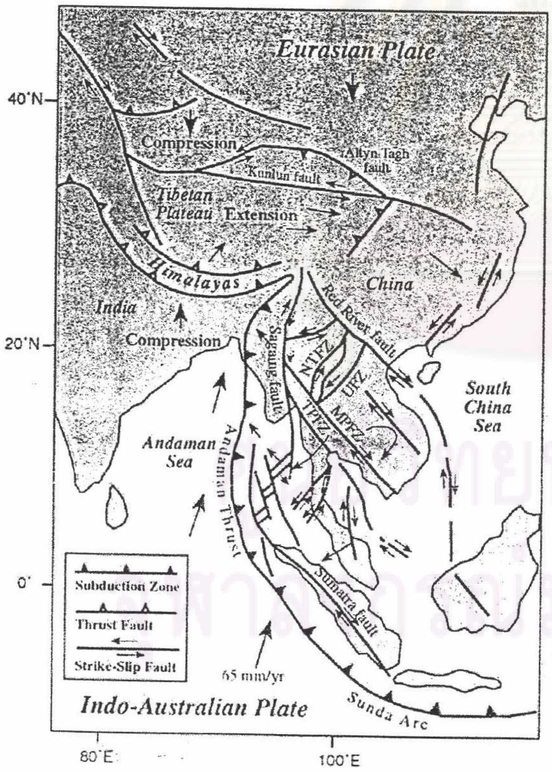


Figure 2.7 Major tectonic elements in southeast Asia and southern China. Arrows indicate relative directions of motion of crustal blocks during the late Cenozoic. MPFZ: Mae Ping fault zone; NTFZ: Northern Thailand fault zone; TPFZ: Three-Pagoda fault zone; UTFZ: Uttaradit fault zone(after Pollachan et al., 1991).

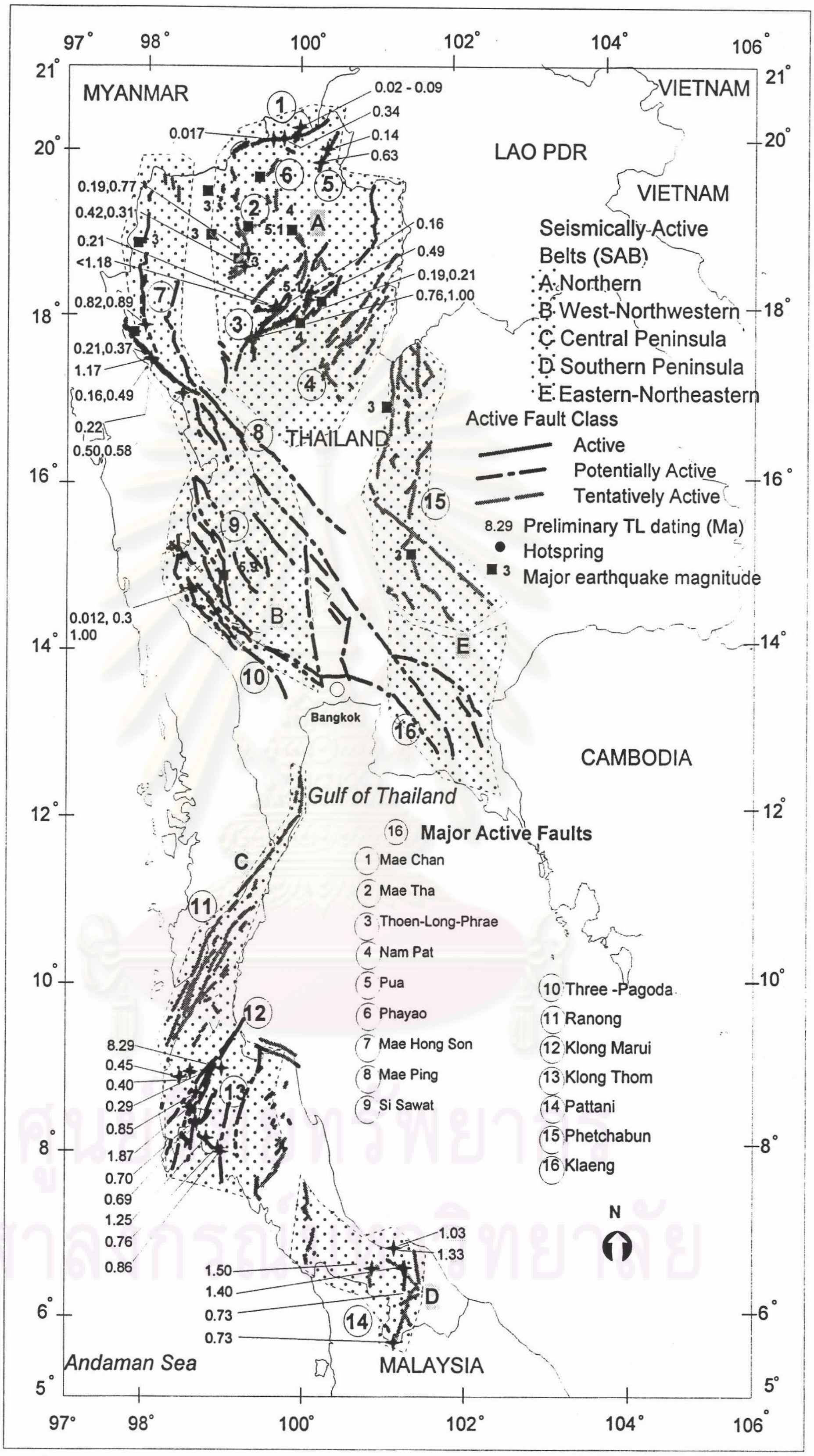


Figure 2.8 Seismic active belt of Thailand
(after Charusiri et al., 2001)

acceptable among scientists that elastic rebound theory can provide information about the cause of earthquake. This theory is explained that if fault surfaces have been locked rather than slipped easily passing one another. Rocks on either side of the fault will bend while store elastic energy. Consequently, when the fault ultimately does slip and the bent rocks rebound to their original in a huge earthquake (Skinner & Porter, 1995). Release energy from the rock is formed partly as heat and partly as elastic waves or seismic waves (Bolt., 1999). Seismic waves can be divided into two main types; body waves and surface waves. The body waves can travel outward in all directions from the focus and have the capacity to travel through the earth's interior. There are two types of body waves; P-waves and S-waves. P-waves or primary waves can deform materials by change of volume. This change is performed by alternating pulse of compression and expansion. S-waves or secondary waves, on the other hand, deform materials by change of shape which are called shear waves. Surface waves, however, travel around but not throughout the earth's interior. Figure 2.9 shows propagation of waves in different manner. These waves can be recorded by a seismogram after a few seconds depended on distance between epicenter and seismograph station. P-wave is recorded firstly followed by S-wave and surface waves (Figure 2.10).

2.2.1 Seismicity in Thailand

Although small to moderate earthquakes in Thailand have long been recognized since the past historical period. However, past tremendous earthquakes in this country had not been occurred. Besides, most of strong earthquakes have been reported frequency in Myanmar and Andaman-Sumatra belt.

Generally, Thailand has two major seismic provinces; the west and the north (Figure 2.11). In the west, for example, four moderate earthquake swarms were reported in the upper part of the reservoir of Srinagarin dam since 1983. This earthquake occurred with main shock of M_L 5.9 in April 22, 1983. Swarm earthquakes also were reported located around Khao Laem dam since portable seismographs were installed in 1982. The larger event occurred in Jan 22, 1985 with magnitude 4.5. However, these two earthquake events in the west were interpreted as reservoir induced seismicity phenomena (Klaipongpan et al., 1991. and Hetrakul et al., 1991).In the north, according to Bott et al.(1997), both historical and instrumental earthquake data in Thailand and adjacent areas had been revised. These data were gathered from

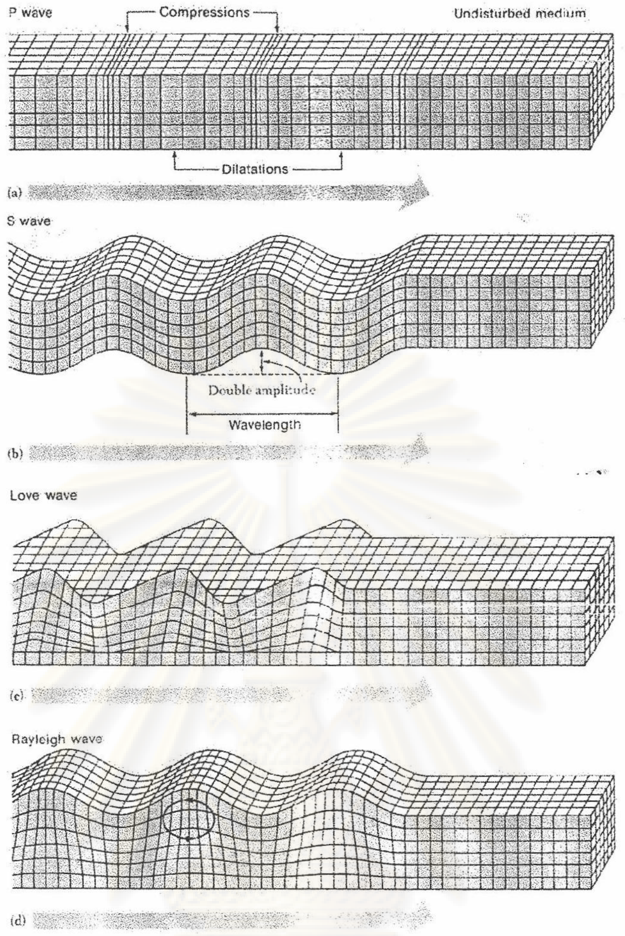


Figure 2.9 Diagram illustrating the form of ground motion near the ground surface in four types of earthquake waves (after Bolt, 1999).

various agencies, including; (1) a catalogue for Thailand and adjacent areas compiled by Nutalaya et al.(1985) for the period 624 B.C. to 1984; (2) the International Seismological Center (ISC) catalogue and the International Seismological Summaries (ISS); (3) Gutenberg and Richter (1954); (4) the National Geophysical Data Center, USA; (5) the Thai Meteorological Department (TMD) catalogue, 1983-1996; (6) seismic located by the Electricity Generating Authority of Thailand (EGAT) in a geothermal study from 1976-1978 (Ramingwong et al., 1980); and (7) the U.S. National Earthquake Information Service (NEIS) Preliminaty Determination of Epicenters (PDEs) from 1985 to date. There are 17 significant historical earthquakes of maximum intensity MM VI or M_L5 and greater have been reported in the north since 1362 (Figure 2.12). For instance, the first documentary report was Sukhothai event in 1362 with assigned maximum intensity MM VI. Subsequently, three events in Chiang Mai were reported in 1482, 1545, and 1715 with maximum intensity MM VI, VII, and VI, respectively. The 1545 event had damaged Great Pagoda in this province and the 1715 event occurring near Chiang Saen district had destroyed temples and pagodas in four districts.

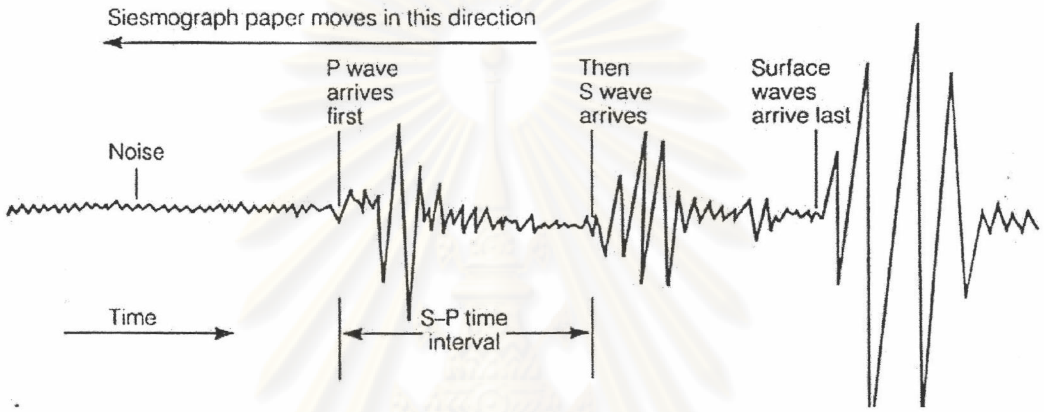


Figure 2.10 Travel times of P, S, and surface waves. Typical record made by a seismograph. All three types of wave leave the earthquake focus at the same instant. The fast-moving P waves reach the seismograph first, and later by S waves arrive. The surface waves travel slower than either P or S waves (after Skinner & Porter, 1995).

Gutenberg and Richter (1954) stated that in Febuary 12, 1934, earthquake with M 6 was experienced in Laos and also felt reported in Thailand. In September 28 and 30, 1989, two earthquakes were occurred in Myanmar approximately 100 km west-northwest of Chiang Rai province, with same M_W 5.8, caused damages in northern Thailand. September 11, 1994 earthquake event had reported with epicenter closed to Mae Suai, Chiang Rai province with m_b 5.1. Felt report was found across Chiang Rai province and Phan district was influenced the largest damage. The damage were included a community hospital building, 21 schools and 30 temples. Landslide in Doi Mok was also reported in response to this event. In December 21, 1995, earthquake with M_L 5.2 was located near Phrao district of Chiang Mai province. Felt report was also

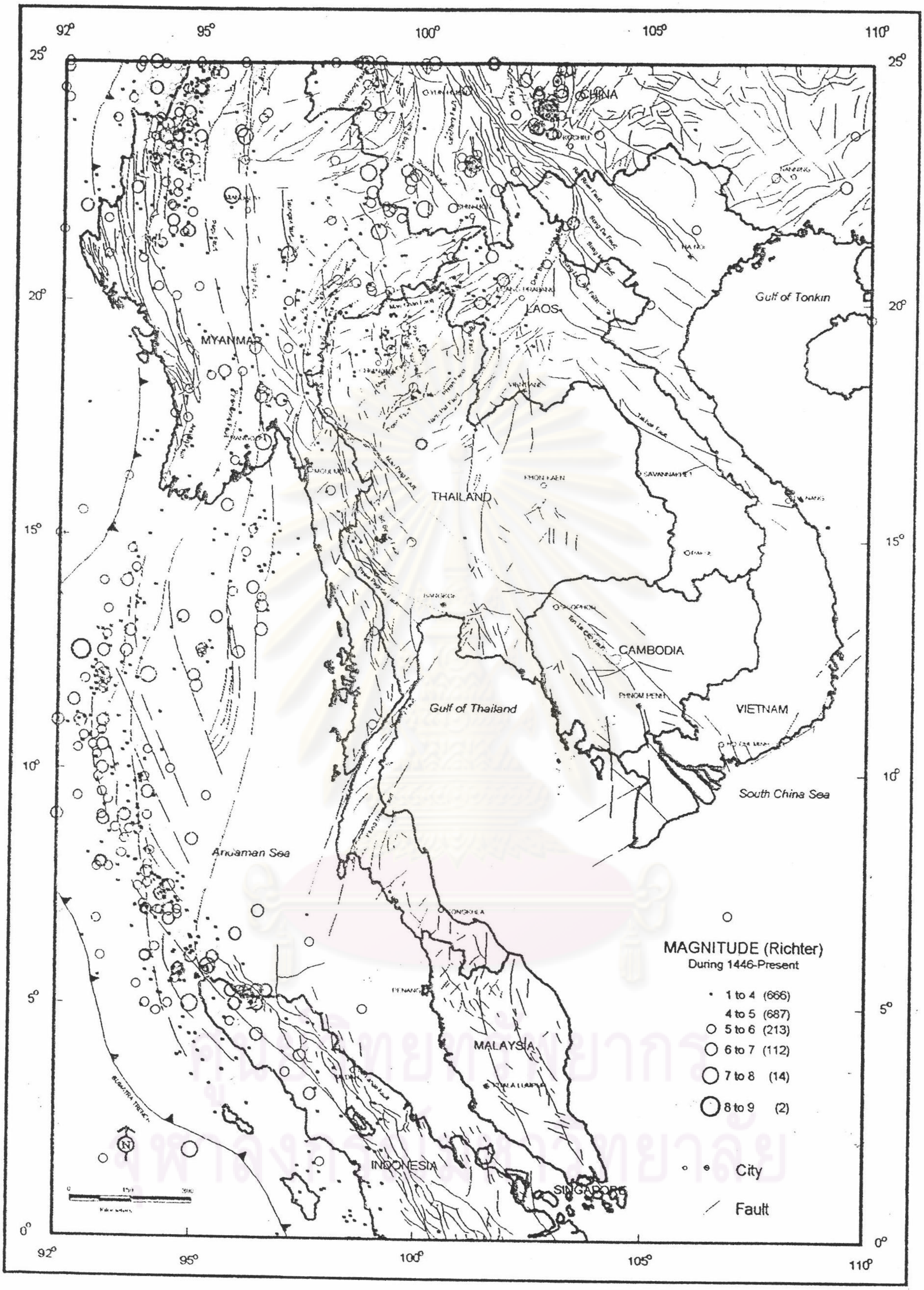


Figure 2.11 Faults and earthquake epicenters in Thailand and mainland southeast Asia(after Charusiri et al., 2001).

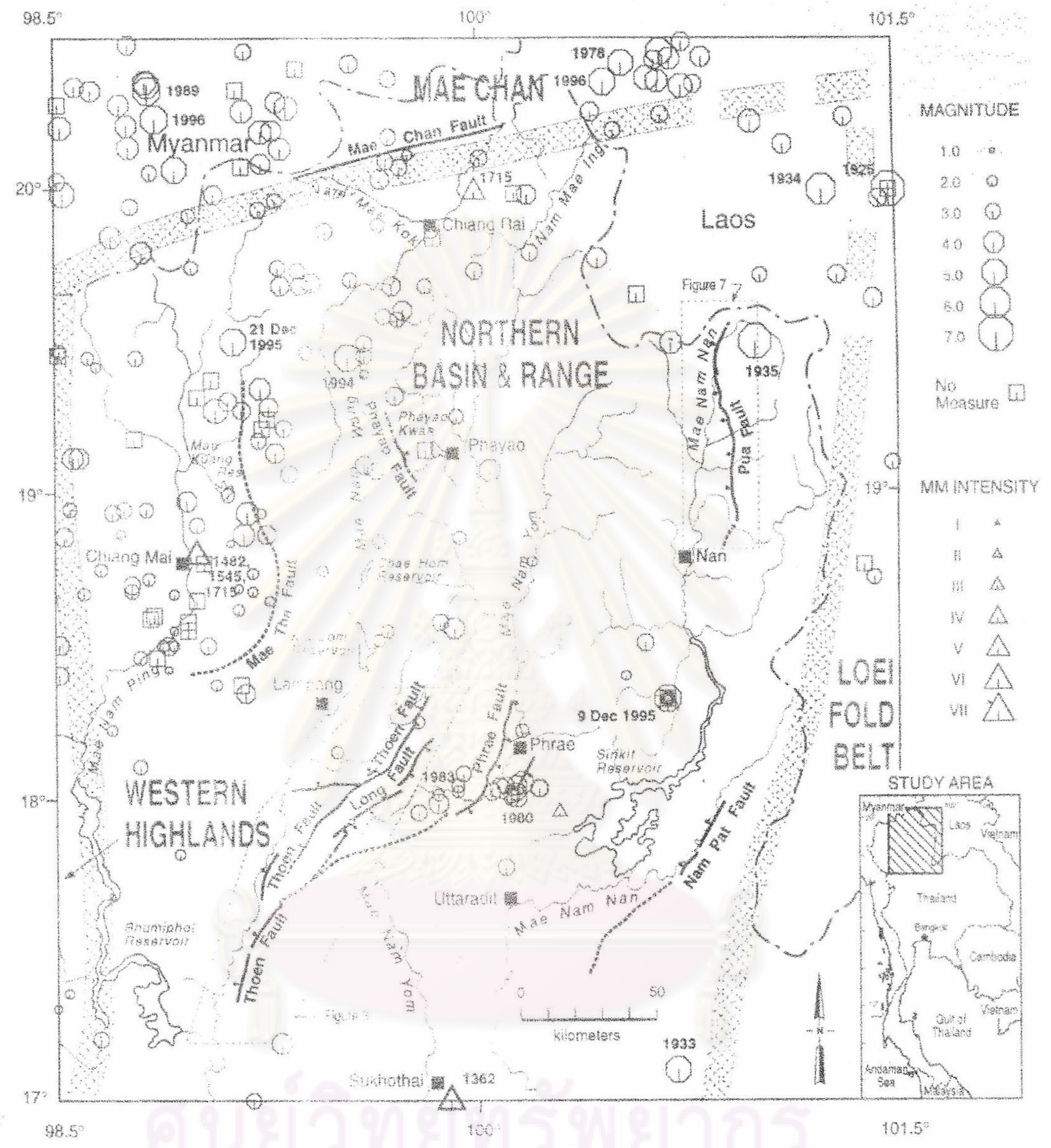


Figure 2.12 Late Cenozoic faults and historical seismicity (1362 to 1996) of northern Thailand (after Fenton et al., 1997).

found in Chiang Rai, Phayao, Lamphun, Lampang, and Mae Hong Son provinces with minor damage in Chiang Mai.

2.2.2 Seismicity in the Phrae Basin and Nearby Areas

Based on earthquake instrumental records from Chiang Mai Seismograph Station, 106 small to moderate earthquakes with magnitudes ranging from M_L 1.3 to 5.1, had occurred within and nearby the Phrae basin between December 1993 to January 2000. Interested event was December 9, 1995, near Rong Kwang earthquake with M_L 5.1 was found located near Rong Kwang district of Phrae province. This event occurred with felt report in Chiang Rai, Chiang Mai, Lamphun, Lampang, Phayao, Uttaradit, and Nan provinces and minor damage found in Phrae province.

Additionally, Gutenburg & Richter (1954) mentioned that in May 13, 1935 earthquake event with M_L 6.5 occurred in Nan province near Thai-Laos border. Between 1980 and 1983 the Phrae earthquake swarms was reported that the swarms began in December 19, 1980 with M_L 3.5. The largest events were found on December 22, 1981 and December 23,1981 with M_L 4.0 and 4.2, respectively. These earthquake swarms were reported locating in the south of the Phrae basin. All of these earthquakes were detected by seismograph station. Earthquakes occurred between 1980 and 1983 had no report of both man-made structural damages and human feeling.

It can be calculated that distribution of earthquake frequency in the Phrae basin and nearby areas is approximately 16 times per year of small to moderate sizes. Figure 2.13 shows epicentral distribution in the Phrae basin and nearby areas using the record mentioned above and additional records of earthquake during 1980 and 1983. Earthquake epicenters are found scattered throughout the basin and some of these epicenters were located in mountainous area outside the basin.

2.3 Tectonics and Seismicity Relationship

2.3.1 General

Plate tectonics has provided the fundamental geological theory needed to understand both global and regional seismicity. It has long been well known that many earthquakes occurred along the edges of interacting plates (interplate earthquakes) than within the plate boundaries (intraplate earthquakes). More than 90 percent of earthquakes are located in convergence plate boundaries with shallow earthquakes, as well as

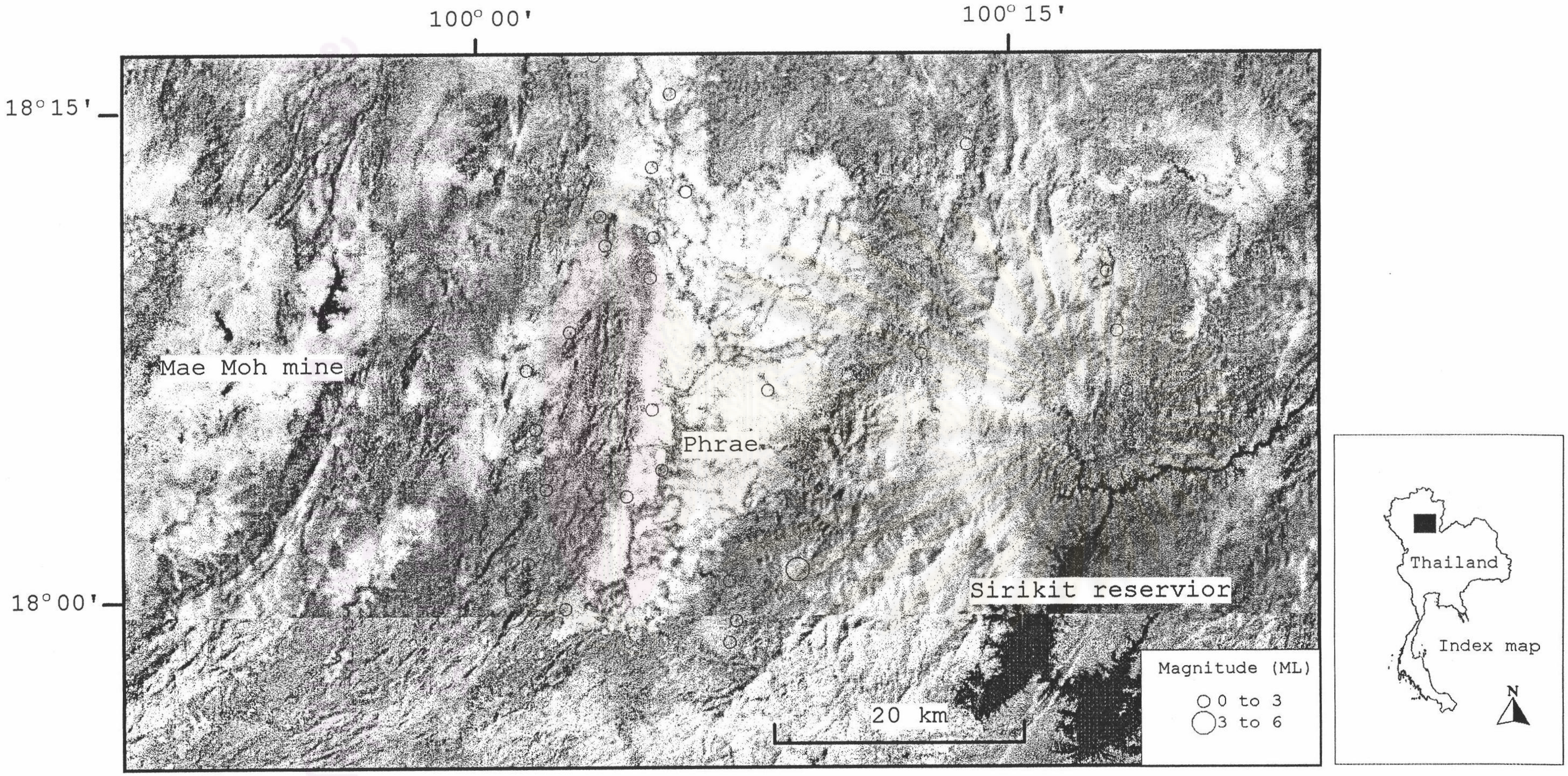


Figure 2.13. Earthquake epicentral distribution in the Phrae basin and nearby areas during 1996-2000, overlain on Landsat TM5 image. (data source: Chiang Mai Seismic Station)

intermediate and deep-focus earthquakes. For example, the 1960 and 1985 Chile earthquakes, the 1964 Alaska earthquake, and the 1985 Maxico earthquake, have originated in the subduction regions as a result of trusting mechanism. In addition, most of earthquake distributions along the Ring of Fires of the Pacific margins are the result of subduction tectonism. Besides, intraplate earthquakes must arise from localized system of forces in the crust, perhaps associated with ancient geological structural complexities with anomalies in temperatures and strength of the lithosphere. For instance, the 1811 and 1812 large earthquakes in New Madrid area of Missouri were generated by buried faults in the upper part of the North American plate (Bolt, 1999).

Thailand, which is located in intraplate region, lies immediately east of the Andaman-Sumatra earthquake belt. Many of earthquakes occur in this belt usually felt in Thailand (Hinthong, 1991). In addition, earthquakes in Thailand and adjacent areas may be related to extentional regime. This regime is caused by associated tectonism related to the subduction zone and spreading ridge in Andaman Sea (Siribhakdi, 1986).

According to the studies by Makert (1979), EGAT (1980), and Ramingwong et al.(1980) for small earthquake epicentral distribution, the result had shown that epicenters were located within or nearby the edges of the Tertiary basin both in the west and the north of Thailand. Although some of these epicenters are scattered outside the basin, they might be related to the opening activities of the Tertiary basin system (Siribhakdi, 1986).

2.3.2 Focal Mechanisms

Fault plane analysis or focal mechanism solution has played an important role in explaining the relationship between tectonism and earthquake. The main objective of focal mechanism study is to identify seismic faults from seismological observation. Since the mechanism of both oceanic earthquakes and earthquakes with no evidence of ground surface rupture are doubtful for understanding, therefore, the study of earthquake focal mechanism is needed to explain the identification of the seismic faults.

2.3.2.1 Basic Concept

The concept of focal mechanism rises from the assumption that seismic wave behavior is due to forces acting on a focal point (point force). This assumption is related to the radiation pattern of P-waves, and distance between the hypocenter and stations. The double couple force system acting on the hypocenters can explain the polarity of P-waves of most natural earthquakes. Besides, some earthquakes resulting of volcanic activity and all artificial events such as nuclear test, cannot be explained by the double couple model.

Configuration of the double couple force system can be explained by two pairs of forces (Figure 2.14). Each pair containing forces with equal magnitude and opposite directions, then the total force is equal to zero. The double couple force system has an equivalent force system in which two pairs of forces, tension and compression, are of equal magnitude and perpendicular to each other. The direction of the pair of tension is called tension axis (T-axis) and that of compression is compression axis (P-axis).

The equivalence of the double couple force system can be briefly explained that the double couple force system produces the same seismic wave far from the source as that due to shear faulting (Figure 2.15). According to the orientations of double couple force system, one of these two orientations is the orientation of the fault or fault plane and another one is the auxiliary plane. Therefore, if double couple force system is determined to be responsible for an earthquake, then two possible orientations of the seismic fault can be revealed.

Radiation pattern of seismic P-wave is normally used for earthquake focal mechanism analysis. The P-wave radiation is composed of four-lobed pattern (Figure 2.16). The P-wave first motion is large and positive around T-axis and large and negative around P-axis. The pattern of the polarity and amplitude is symmetric to the hypocenter. The amplitudes are zero along two planes separating the areas of different polarities. These two planes are called "nodal planes" (fault plane and auxiliary plane) and have the same orientations as those of the double couple force system (the two plane are orthogonal to each other, since the two couple forces are perpendicular to each other). Therefore, it is suggested that two possible orientation of seismic faults can be determined from the two P-wave nodal planes of P-wave polarity information (Suetsugu, 1995).

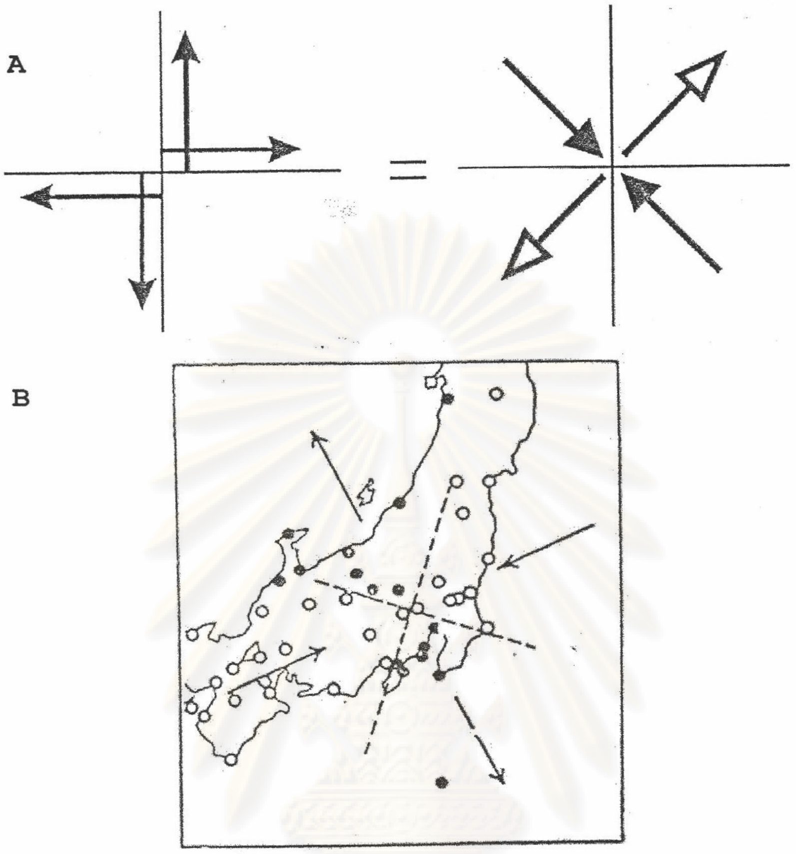


Figure 2.14 A. Double couple force system. Solid-head arrows indicate compression, open-head arrows represent tension, cross lines refer to fault and auxiliary traces. B. Simplified earthquake mechanism, open circles denote dilatation P-wave and closed circles indicate compression (after Suetsugu, 1995).

2.3.2.2 Focal Mechanism Study in Thailand

According to Bott et al.(1997), previous study on focal mechanisms from 10 earthquake events in Thailand had been integrated together with the two new events (Figure 2.17). The previous studies are those of Chung and Lui (1992), Klaipongpan et al.(1991), Hetrakul et al. (1991), and National Earthquake Center USA. Additionally, the new solutions are from those of December 9, 1995 and December 21, 1995 of the near Rong Kwang and Phrao events, respectively.

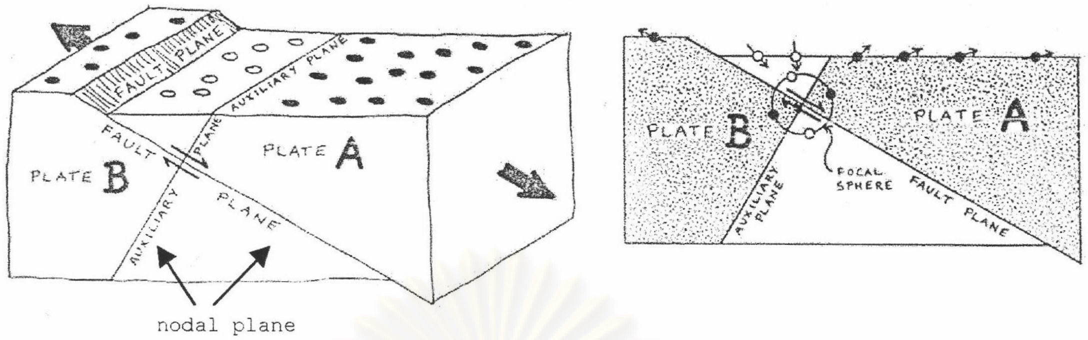


Figure 2.15 Nonvertical normal fault model. Seismograph stations recording pushes (solid circles) can seperated from those recording pulls (open circles) by lines of intersection at the earth's surface of fault plane and auxiliary plane (after Cox & Hart, 1986).

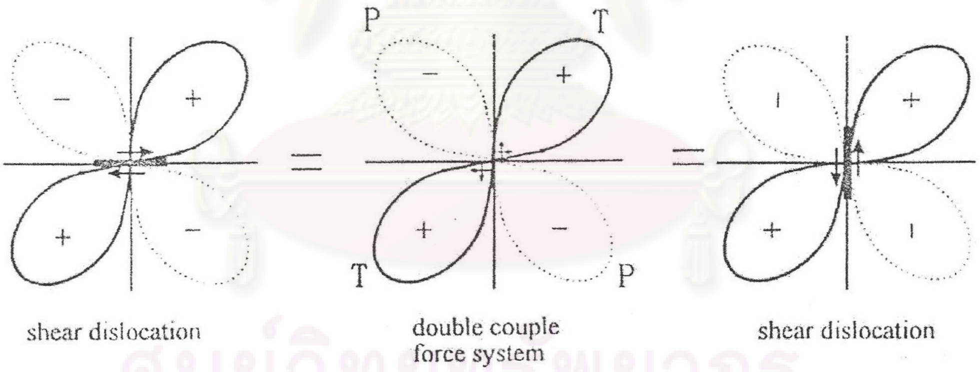


Figure 2.16 Equivalence of double couple and shear faulting and ambiguity of fault plane and its auxiliary plane. P, compression at hypocenter with negative on seismographs since first motion down; T, tension with positive at earthquake focus and upward first motion (after Suetsugu, 1995).

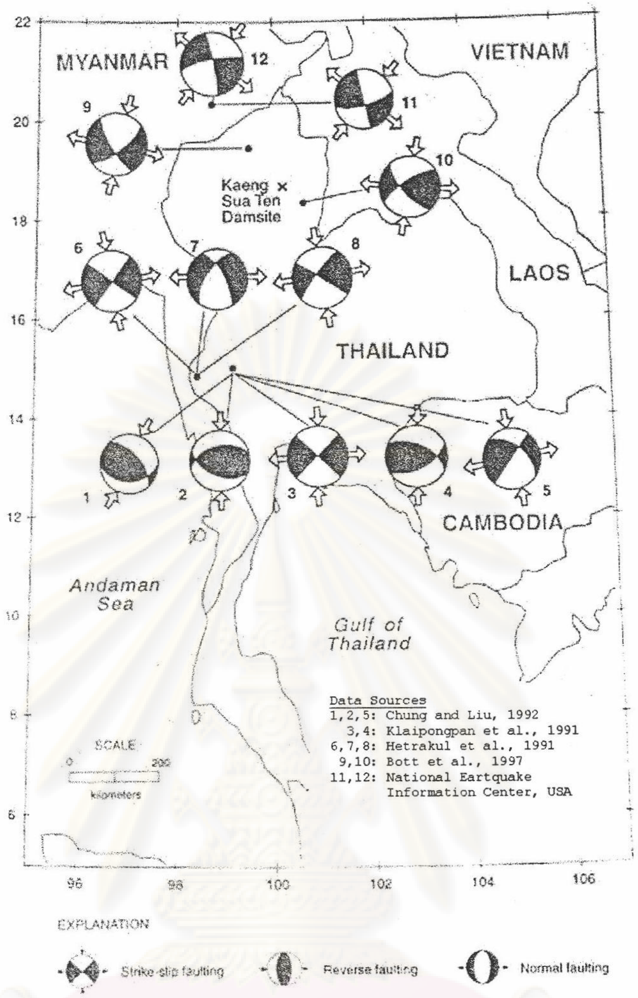
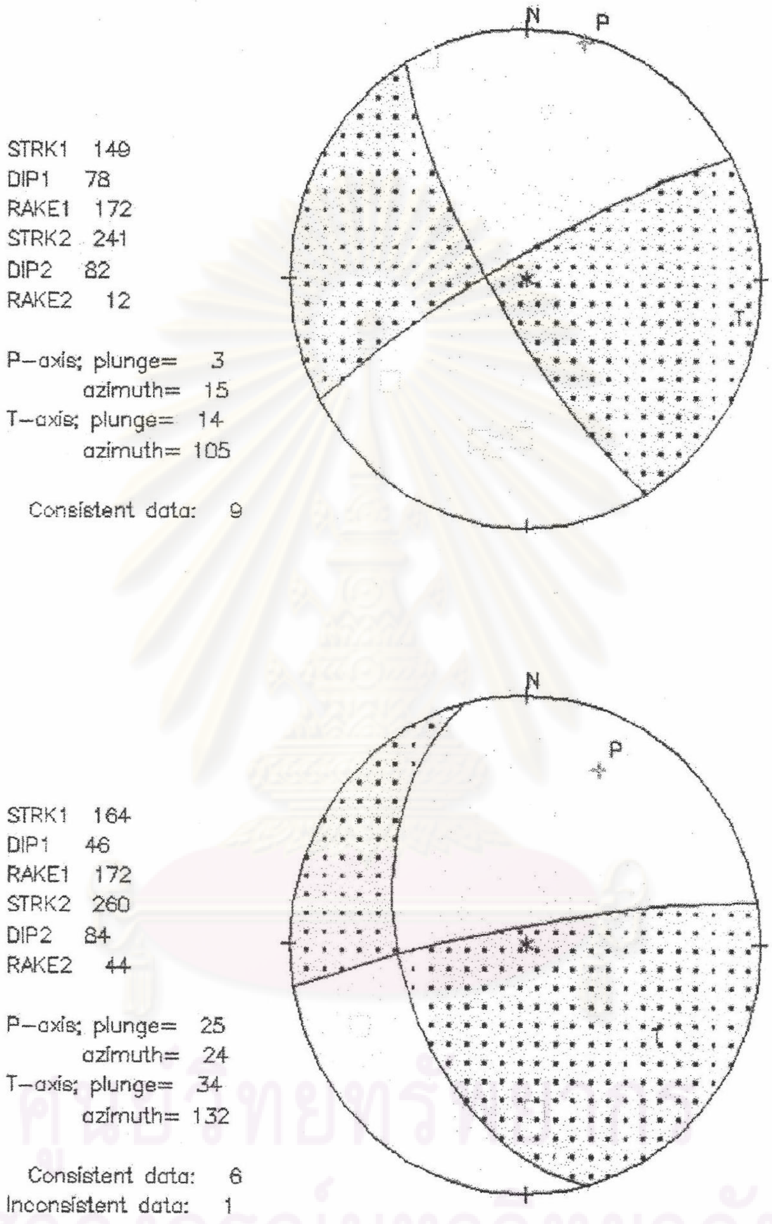


Figure 2.17 Schematic focal mechanisms of Thailand and adjacent regions. Compresional axis is located approximately north-west trending whereas tensional axis is lied about east-west trending (after Bott et al., 1997).

Regarding to these focal mechanisms, the maximum principal stress appears to rotate from north-northwest to a northeast orientation from south to north. On the other hand, these mechanisms suggested that Thailand is being subjected to approximately west-east to northwest-southeast tectonic extension (Fenton et al., 1997).

Based on focal mechanism solutions of this thesis study, the two new events earlier performed by Bott et al.(1997) had been reconstructed. The objective is to construct new focal mechanism diagrams using different computer program for yielding additional data compared to the previous study. The computer program used in this thesis study is MOHAMED. Primary earthquake data used in this study were provided by Thai Meteorological Department (TMD) from seismic station across Thailand. As a result, focal mechanism diagrams from this study are shown in Figure 2.18.

According to the result of the December 9, 1995 event, which primary data collected from 9 seismographs, it can be interpreted that seismic fault should be displaced by strike-slip movement with small normal component. The P-axis is in NNE-SSW with 3° plunge, and T-axis is in SE-NW with 14° plunge. Two nodal planes have stricken in 149° and 241° with high-angle dipping. For the December 21, 1995 event, the result from 7 seismograph stations indicates strike-slip displacement with normal component. P-axis lies in NNE-SSW, inclined 24 degrees and T-axis is in the SE-NW trend with 34° plunge. Two nodal planes are in 164° and 260° striking with moderate and high degrees of dipping, respectively.



STRK1 149
DIP1 78
RAKE1 172
STRK2 241
DIP2 82
RAKE2 12

P–axis; plunge= 3
azimuth= 15
T–axis; plunge= 14
azimuth= 105

Consistent data: 9

STRK1 164
DIP1 46
RAKE1 172
STRK2 260
DIP2 84
RAKE2 44

P–axis; plunge= 25
azimuth= 24
T–axis; plunge= 34
azimuth= 132

Consistent data: 6
Inconsistent data: 1

Figure 2.18 Focal mechanism solution diagrams of near Rong Kwang event(above, equivalent to no. 10 of Figure 2.17) and Phrao event (below, equivalent to no. 9 of Figure 2.17) using Mohamed program for construction. P represents compressional axis and T indicates tensional axis.