

CHAPTER II

REGIONAL GEOLOGICAL SETTING

Physiography

Generally, the northern part of Thailand consists of numerous Cenozoic intermontane basins covering almost all the low-lying areas whereas the pre-Cenozoic rocks including igneous rocks are exposed in mountainous areas (Fig. 2.1). In the central part of northern Thailand, the Cenozoic basins are oriented in an approximately NNE-SSW direction parallel to the structural trends of the mountains (Figs. 2.1 and 2.2). Among these main intermontane Cenozoic basins, there are Chiang Mai basin located to the west, Lampang-Mae Moh basins located in the central part and Phrae-Long basins located to the east. The Mae Than area is a small sub-basin situated on the southern part of the Lampang basin (Fig. 2.2).

There are three main perennial river systems in the central part of northern Thailand, namely, the Ping river in the Chiang Mai basin, the Wang river in the Lampang basin and the Yom river in the Phrae basin (Fig. 2.1).

Regional geology

The regional geology of the area is illustrated in Figure 2.3. They are modified from those of Piyasin (1971 and 1974), Bunopas and Vella (1983), and Bunopas (1992 and 1994). The general geology of the regional area are mainly composed of Silurian-Devonian meta-sedimentary rocks of Don Chai Group, Permian-Carboniferous undifferentiated rocks, Permian rocks of Ratburi Group (i.e., Pha Huat, and Huai Thak Formations), Triassic sedimentary rocks of Lampang Group (Phra That, Pha Kan and Hong Hoi Formations). Tertiary, and Recent sediments cover almost all the intermontane basins. Igneous rocks including Permo-Triassic volcanics, Mesozoic

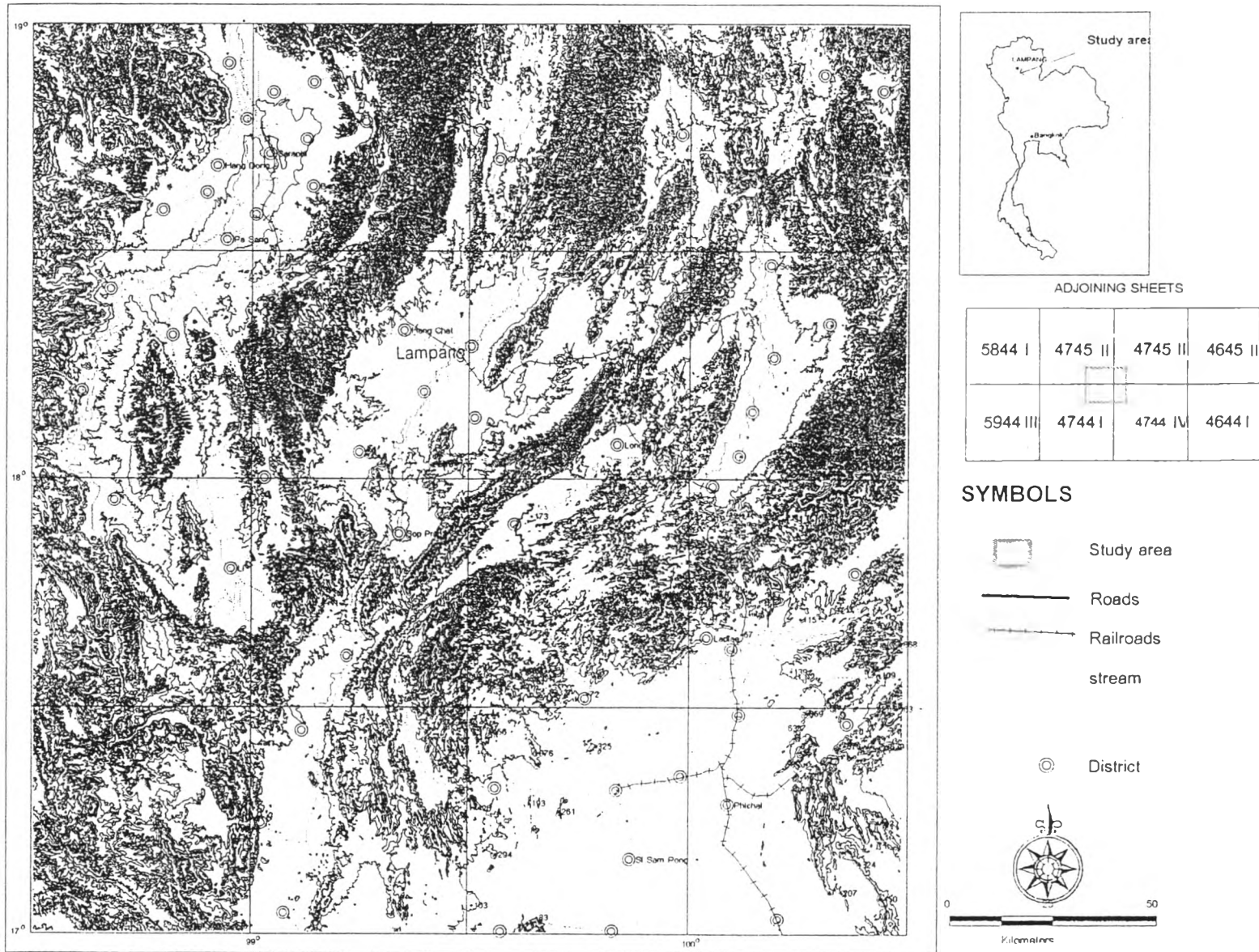


Fig. 2.1 Regional topographic map showing the structural trends of the mountains in NNE-SSW direction, the intermontane basins and the main river systems.

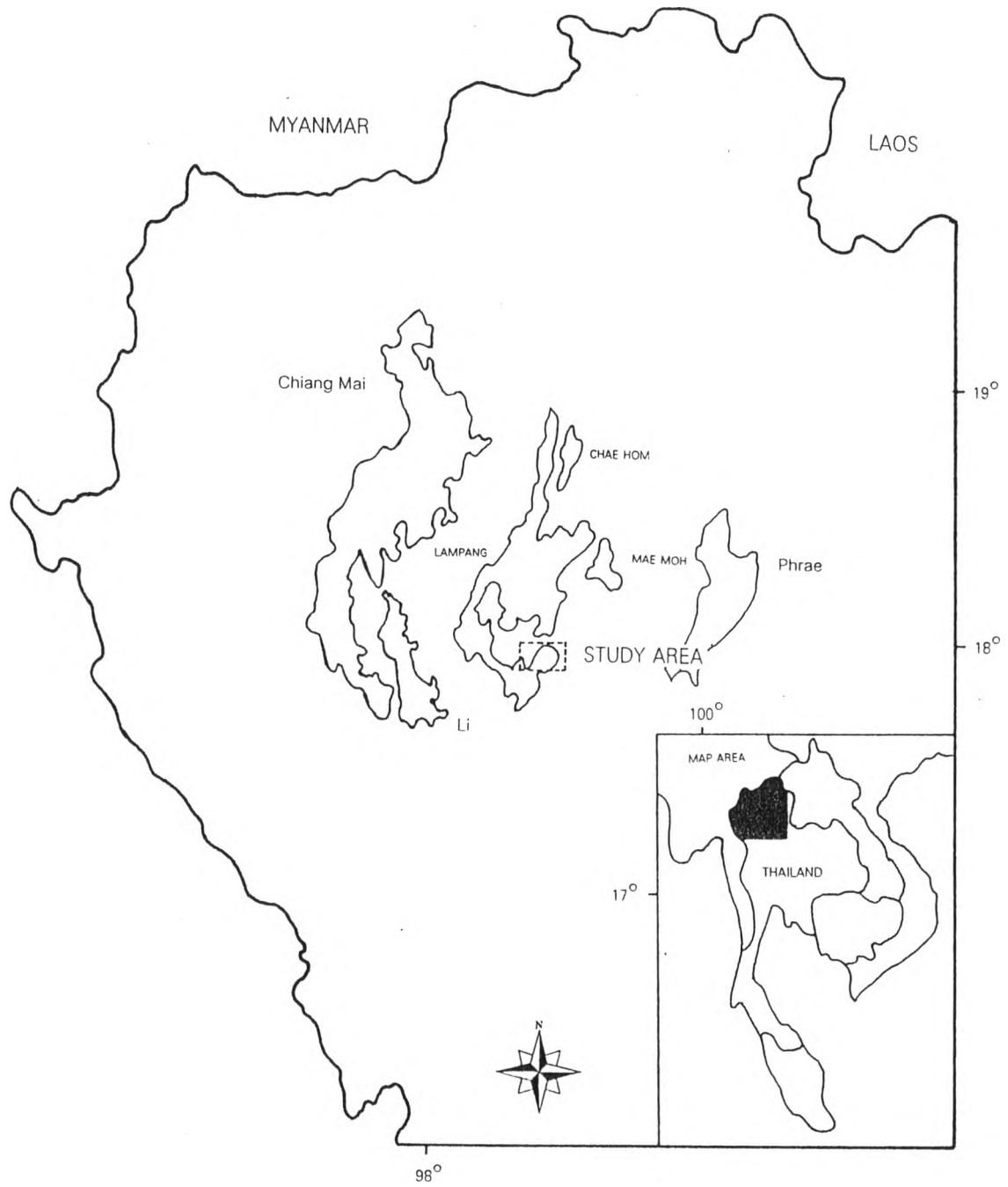


Fig. 2.2 Main Cenozoic intermontane basins in northern part of Thailand oriented in NNE-SSW direction.

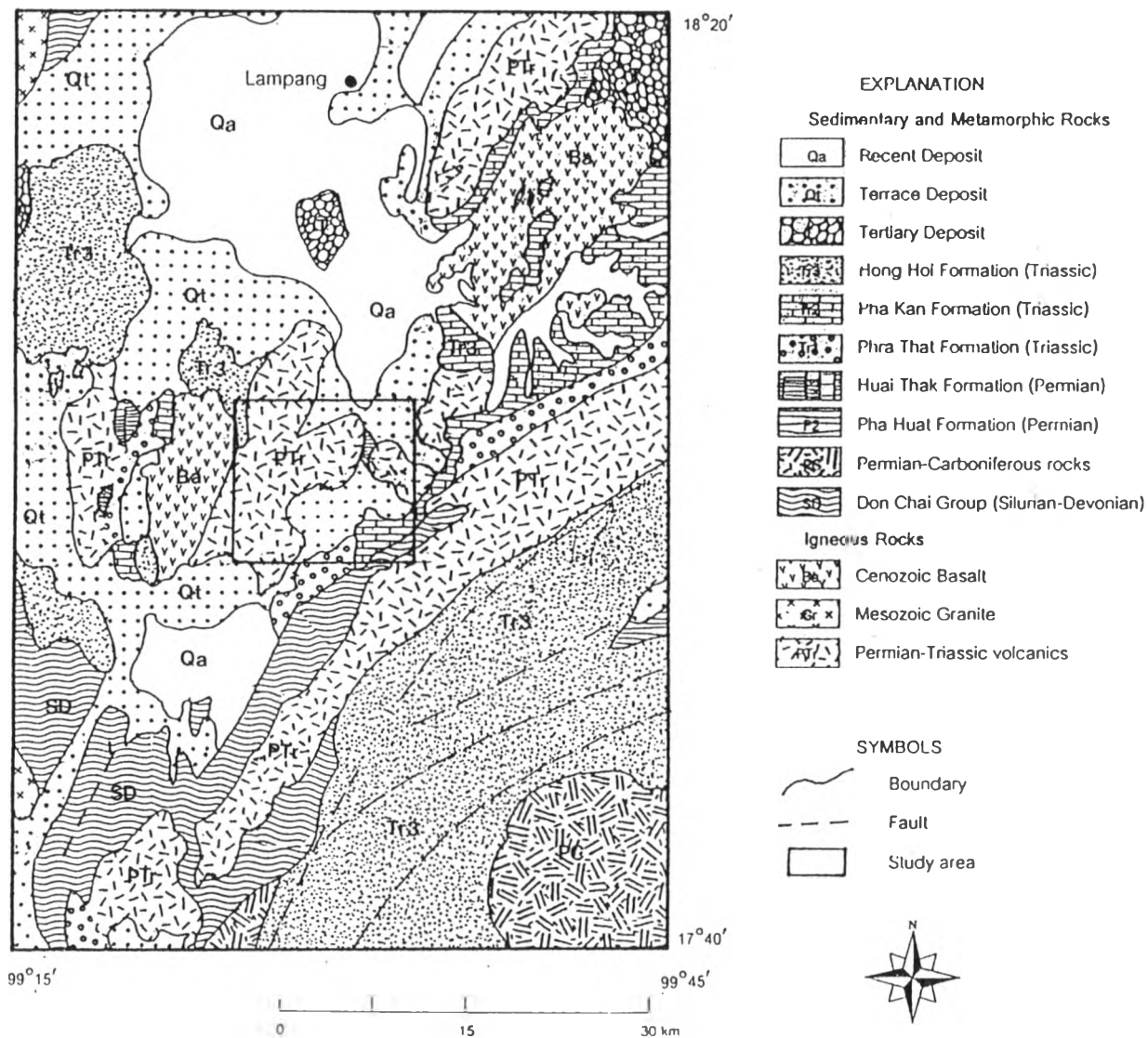


Fig. 2.3 Regional geological map of the Lampang-Sop Prab area (after Piyasin, 1971 and 1974).

granites and Cenozoic basalts are also exposed in this area. Brief reviews of these rocks are described herein from the oldest to the youngest.

Silurian-Devonian meta-sedimentary rocks

The rocks of Silurian-Devonian age are exposed on the southwestern part of the area (Fig. 2.3). Quartzite, quartzo-feldspathic schist, phyllite, chloritic phyllite, calc-silicate phyllite and chert characterize them. Piyasin (1971) has mapped these rocks as Don Chai Group. The type section is located at Nam Mae Bon stream near Ban Don Chai, Amphoe Mae Tha, east of Changwat Lamphun. Bunopas (1981) to be more than 1,500 metres estimated the thickness of these rocks.

From the designated rock names, these rocks were undergone low-grade metamorphism. Their beds are mesoscopically folded. Part of this rock unit is exposed in the study area. The megascopic and microscopic characteristics will be described in the next chapter.

Permian-Carboniferous undifferentiated rocks

The rocks of Permian-Carboniferous age are exposed on the southeast corner of the area. They are characterized by thickly bedded sandstone, and laminated shale intercalated with siltstone. No fossil records in this rock unit.

Permian rocks

The Permian rocks are sedimentary rocks of the Ratburi Group (Piyasin, 1971). This group consists of three formations, namely, Kiu Lom Formation, Pha Huat Formation, and Huai Thak Formation, in ascending order, respectively. However, only the upper two formations. (the Pha Huat and the Huai Thak Formations) are exposed as small outcrops in the west-central part and eastern part of the regional map (Fig. 2.3). A brief description of each formation is outlined below

Kiu Lom Formation

The Kiu Lom Formation consists mainly of sandstone, shale, calcareous shale and thin limestone with fusulinids. The total thickness of this formation is 500-600 metres at the type section at Kiu Lom Dam, Amphoe Muang, Changwat Lampang, but much thinner at other places.

Pha Huat Formation

The Pha Huat Formation consists mainly of massive to well-bedded crystalline limestone, locally fossiliferous, of at least 600 metres thick (Bunopas, 1992). The lower 100 metres of this formation is a limestone thinly-interbedded with feldspathic sandstone containing fossils of brachiopods and bryozoans. The top 300-400 metres of this formation are massive limestone with chert nodules and bedded cherts, silicified brachiopods, corals and fusulinids.

Huai Thak Formation

The Huai Thak Formation comprises mainly of fossiliferous shale and thin intercalations of sandstone, limestone and intraformational conglomerate. The thickness of this formation was estimated to be at least 760 metres and possibly up to 1,500 metres thick. This rock unit is also exposed in the study area and will be described in detailed in the next chapter.

Permo-Triassic rocks

The Permo-Triassic rocks are dominantly exposed in the central, southwestern and northeastern parts of the map. They comprise of rhyolite, andesite, tuff and agglomerate (Piyasin, 1971, 1974). They are collectively named as Mae Man volcanics by Charusiri et al. (1994). These rocks are unconformably underlain by clastics of the

Huai Thak Formation. Jungyusuk and Khositantont (1992) have grouped the Mae Man rocks into Phrae-Lampang volcanic province of the northern highland volcanic rocks.

This rock unit is also exposed in the study area. Their megascopic and microscopic features will be described in the next chapter.

Triassic rocks

The Triassic rocks are dominated by marine sedimentary rocks and have been grouped into Lampang Group by Piyasin (1971). This marine Triassic sequence conformably or disconformably overlies the Permo-Triassic volcanics and Permian rocks. The Lampang Group consists of five formations, however, only three formations are shown in the regional map and only one formation is exposed in the study area. Brief descriptions of the five formations in an ascending order are given as follows:

Phra That Formation

The Phra That Formation consists chiefly of epiclastic rocks including sandstones, siltstones, conglomerates, breccias, and minor limestones. These rocks are generally coarse-grained and red in colour at the base, and gradually become finer-grained and green to grey in colour-upwardly. They are believed to have been deposited in near-shore and partly continental environments (Chonglakmani, 1983) with source materials mainly from Permo-Triassic Mae Man Group (Charusiri et al. 1994). This formation is from 100 to 840 metres thick and contains bivalves, ammonoids, and brachiopods which indicate an age ranging from Upper Griesbachian (Early Triassic) to Middle Karnian (early Late Triassic). This rock unit is also exposed in the study area and will be described in detail in the next chapter.

Pha Kan Formation

This formation overlies the Phra That Formation and comprises predominantly of grey limestones with minor grey to green shales and sandstone. The formation is 80 to 500 metres thick and conformably underlies the Hong Hoi Formation. It contains characteristics fauna of ammonoids, bivalves, and gastropods, indicative of an age range from Upper Anisian to Upper Karnian (Chonglakmani, 1983).

Hong Hoi Formation

The Hong Hoi Formation overlies the Pha Kan Formation and is the upper formation of the Lampang Group in this regional map. It consists of flysch sequence with predominantly grey to greenish-grey shales, sandstones, siltstones, and conglomerates, and minor interbedded argillaceous limestones. This formation, based on the macrofauna, ranges in age from Scythian (Early Triassic) to Lower Norian (Late Triassic) (Chonglakmani, 1983).

Doi Long Formation

This formation is not exposed in this regional area. The Doi Long Formation is 230 metres thick comprising of grey to light grey finely crystalline limestones, which lies between the Pha Daeng Formation and the Hong Hoi Formation. The unit contains an indeterminate fauna of bivalves, serpulid worms, brachiopods, and gastropods, however, the formation is considered to be Middle Karnian (Chonglakmani, 1983).

Pha Daeng Formation

The Pha Daeng Formation is the uppermost unit of the Lampang Group with thickness of about 500 to 600 metres. This formation was not exposed in this

area. It is composed of well-bedded red micaceous siltstones, sandstones, shale and thin coguina limestones; the basal part is a calcareous conglomerates with clasts of grey limestones, rare rhyolite and less common quartzite and slaty shales. Siltstones above the basal conglomerates contains the fossil of Hettangia (Bunopas, 1992).

Tertiary

Tertiary deposits expose only in few parts of the Lampang basin (Fig. 2.3). However, they are well exposed in the mine pits of the Mae Than basin. They are characterized by conglomerates, sandstones, shales, limestones, carbonaceous shales, and coal (Piyasin, 1974). Tertiary deposits in northern Thailand always develop in intermontane basins. They frequently serve as major sources of coal and industrial clay. Details of a part of Tertiary sequences in the Mae Than basin will be described in the next chapter.

Quaternary

Quaternary sediments are well developed in the low-lying area of the Lampang basin (Fig. 2.3). They comprise of gravels, sands, silts, muds and clays. They always occur as terraces and floodplains including Mae Nam Wang floodplain. Basaltic rocks in some places cover Quaternary deposits.

Igneous rocks

Igneous rocks of both extrusive and intrusive affinities are found in the regional area and its adjacency. These include granitic and volcanic rocks. The granitic rocks occur as small and scattered stocks and are characterized by biotite-hornblende granite, leucogranite, porphyritic granite, and pegmatite. They are inferred to be Mesozoic in age. Mostly these felsic plutonic are found in the northwestern corner of this regional map.

The volcanic rocks are composed mainly of felsic and mafic rocks. The more felsic volcanic rocks have been grouped into Permo-Triassic volcanic rocks, which are described earlier. Mafic volcanic rocks are characterized by basalts. They occur mostly on the west of the study area and the northeastern of regional area. The basalts are dark grey, vesicular and fine-grained. Chemical compositions of the Lampang basalts denote basanites and hawaiite (Barr and McDonald, 1981). K/Ar ages of 0.8 ± 0.3 and 0.6 ± 0.2 Ma are reported by Sasada et al. (1987), whereas Ar/Ar age of 0.59 ± 0.05 Ma is published recently by Sutthirat et al. (1994). Paleomagnetic studies and fission-track dating (Barr and Macdonald, 1981) have indicated the age of the Mae Tha basalt at about 0.69 and 0.95 Ma.

Sop Prab-Ko Kha basalt can be divided into five flows covering an area of approximately 55 square kilometres between Amphoe Ko Kha and Amphoe Sop Prab. These five basaltic flows are similarly characterized by vesicular, or massive, microporphyritic-porphyritic, fine-grained to aphanitic rocks. Phenocrysts of olivine frequently occur in most flows. These basaltic flows similarly contain plagioclase, pyroxene, olivine, opaque minerals and other accessories.

Geological structures

Generally, the major structural trend of the region lies approximately in the NE-SW to NNE-SSW directions (Figs. 2.2 and 2.3). This structural feature is a part of the regional trend in northern Thailand with swing in a curved- or S-shape concaving northwesterly toward Chiang Mai. As a consequence, the shape of the intermontane Cenozoic basin in the north is slightly conformable to this regional trend.

The major faults in this area are generally oriented in the NE-SW and NNE-SSW directions conformable with the orientation of the mountain range. Almost all of these faults are normal type with only a few reverse faults.