CHAPTER II

REGIONAL GEOLOGY

The following discussion on the regional geology is focusing upon Changwat Saraburi and neighbouring area in order to serve as a background for future detailed study under the present investigation. This includes the geomorphology, stratigraphy and distribution of rock types, geological structures, and the geological evolution. The target area concerned envelops approximately between the latitudes of 14°00' N. to 15°00' N. and longitudes of 100°30' E. to 102° 00' E., covering approximately 18,000 square kilometres.

2.1 Geomorphology

The topographic expression of the regional area, Changwat Saraburi and neighbouring area, can be broadly divided into two main features, lowlands area, and highlands area (Figure 2.1). The lowland area consists of alluvial plains, terraces, and peneplain. Alluvial plains and terraces occupy almost half of the area under the present assessment mainly along the western and southern part with some extension to the southern and southeastern part, covering some parts of Lopburi river, Pa Sak river, Chao Phra Ya river, Nakhon Nayok river, and Prachin Buri river. The average elevation is approximately 50 metres above the mean sea level. The highlands area consists of plateau and mountain range occupying mainly eastern and northeastern part with some extension to the north. The mountain range can be distinguished into four different features, notably, volcanic mountain range, the karst topography, isolated hills and knolls, and cuesta. The volcanic mountain range shows a complex plateau and conical-shaped hills in the area of Khao Yai. The karst topography shows typical features of the mountain consisting of carbonate rocks, sharp crest, sink-holes, and lapies with terra rossa. Isolated hills and knolls are features present in the area underlain

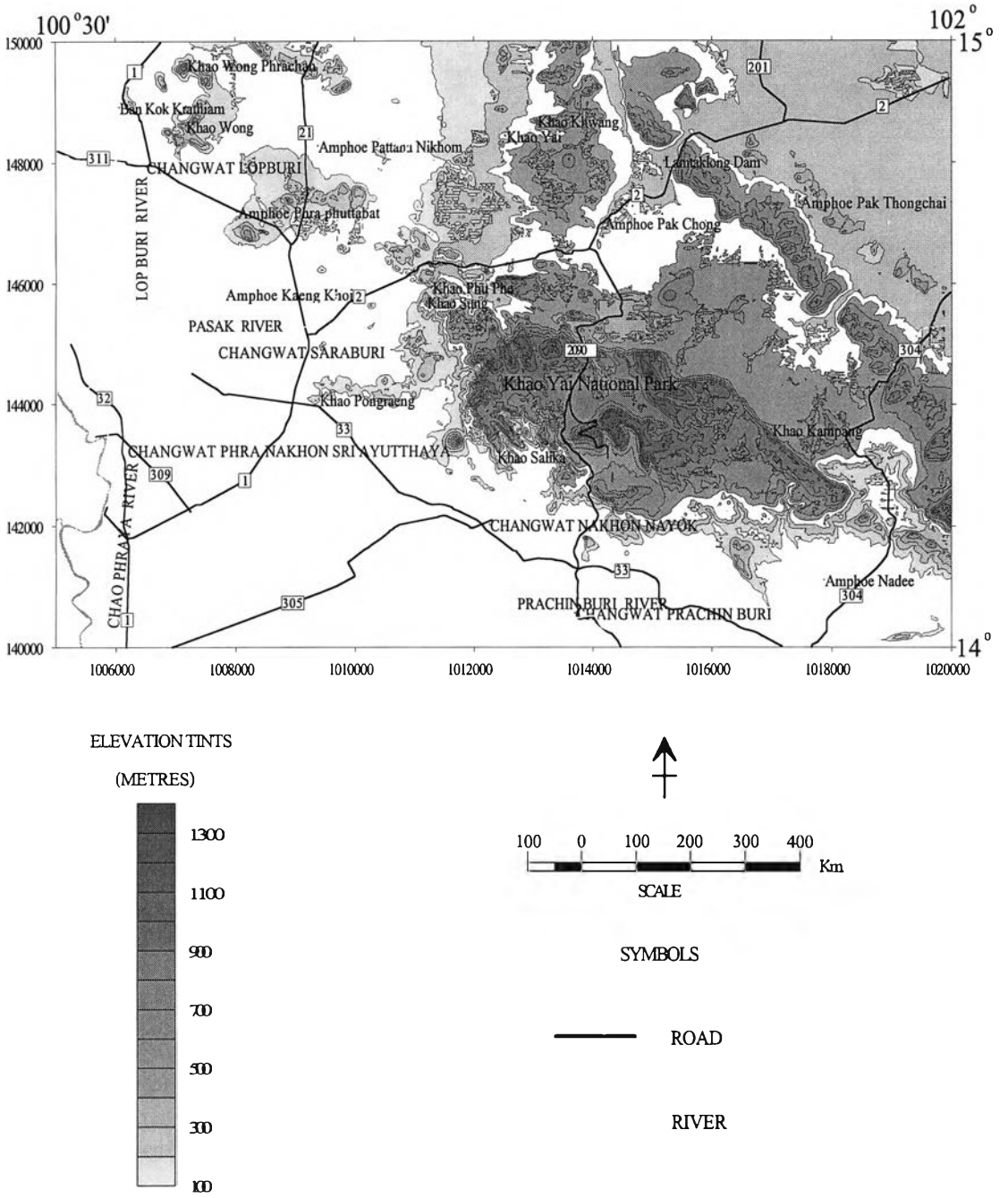

Figure 2.1 Hypsographic map of Changwat Saraburi and neighbouring area.

(modified after Geological Map of Thailand sheet Changwat Phranakhon Si Ayuthaya, ND 47-8, DMR, 1985)

by shales, sandstone, siltstone, and plutonic rocks. The cuesta features are present in the area underlain by the extensive clastic sediment. Sedimentary sequences dipping northeastwardly marking the western margin of the Khorat plateau.

The drainage pattern in the area can be distinguished into four patterns, namely, braided pattern, dendritic pattern, annular pattern, and centripetal pattern (Figure 2.2). The braided pattern is restricted in the lowlands area of Lopburi, Pa Sak, and Chao Phra Ya rivers, in the western part of the area. The dendritic pattern, mostly abundant, is scattered in the plateau, mountain range as well as the alluvial plain. The annular pattern is recognised in the area underlain by plutonic rocks in the eastern part of Amphoe Pak Chong. The centripetal pattern is restrictedly present in the northeastern and eastern parts of Changwat Lopburi.

2.2 Stratigraphy and distribution of rock types

The region of Changwat Saraburi and neighbouring area compose of the rocks deposited since Lower Permian through Quaternary ages. They are consisting of sedimentary rocks, igneous rocks, and unconsolidated sediments. The sedimentary rocks and igneous rocks are, mainly, distributed in the highland of the region located in the central throughout the northern and eastern parts of the area whereas the unconsolidated sediments exist in the southern and western parts of the area (Figure 2.3). Since the former time, various geological works have been conducted in the region by the many workers and the rock sequences have been established as summarized in Table 2.1.

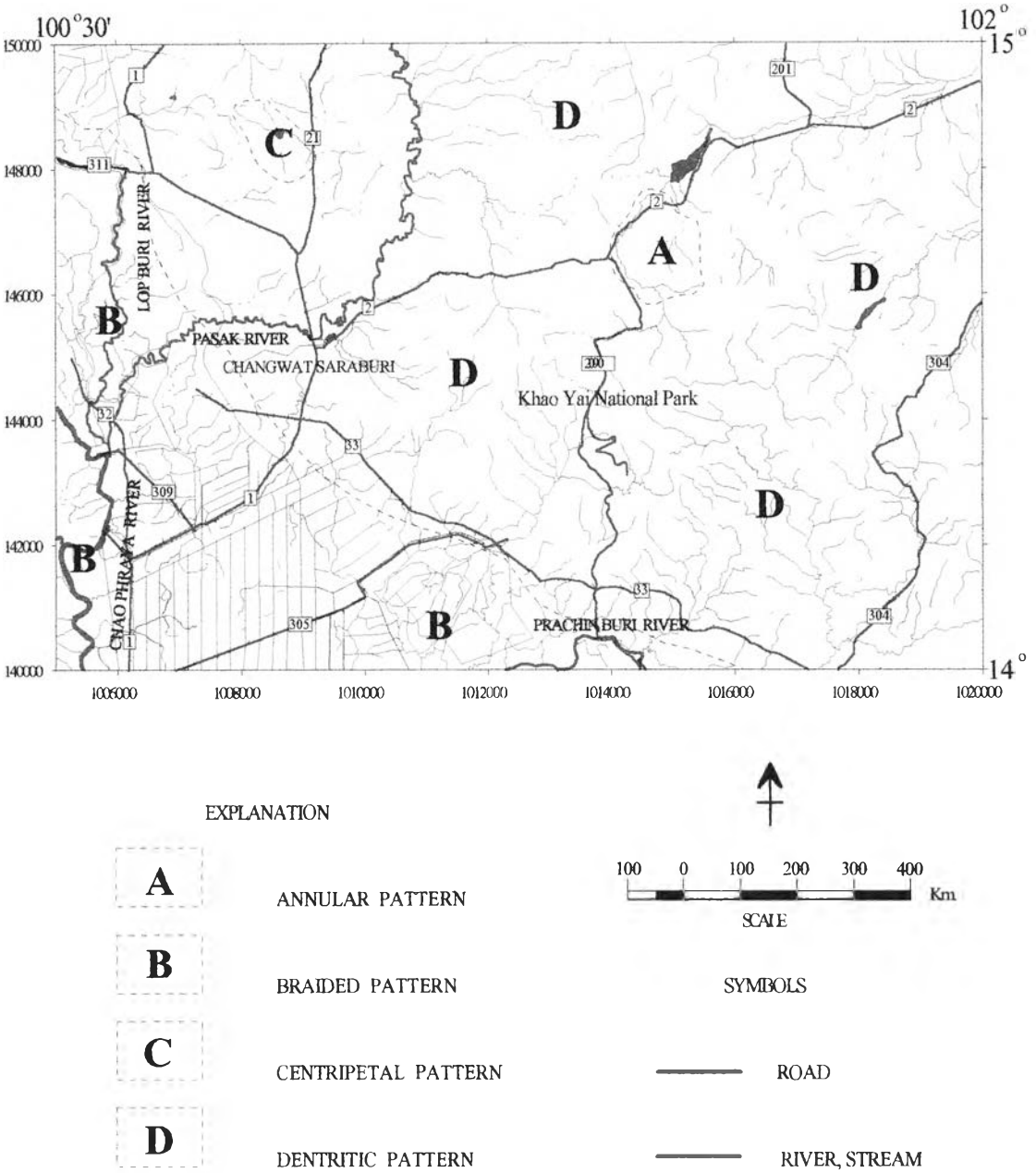

Figure 2.2 The drainage pattern map of Changwat Saraburi and neighbouring area (modified after Geological Map of Thailand sheet Changwat Phranakhon Si Ayuthaya, ND 47-8, DMR, 1985)

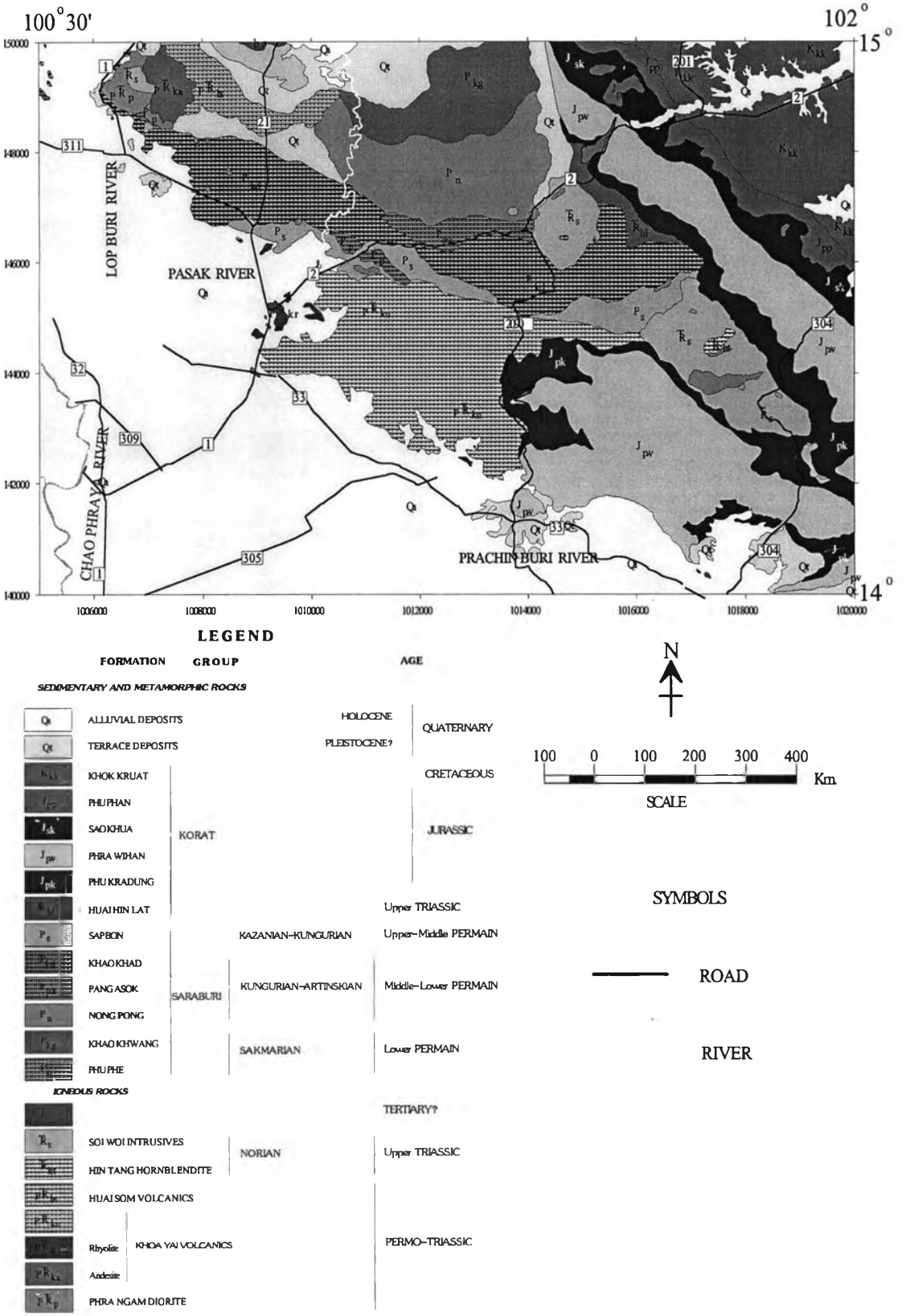

Figure 2.3 Geological map of Changwat Saraburi and neighbouring area (modified after Geological Map of Thailand sheet Changwat Phranakhon Si Ayuthaya, ND 47-8, DMR, 1985)

Table 2.1 Stratigraphic classification and nomenclature of Changwat Saraburi and neighbouring area.

Age	Brown et al. (1951)	Jalichan and Bunnag (1954)		Ward and Bunnag (1964)		Iwai et al. (1966)		Chonglakmani and Sattayarak (1978)	Bunopas (1981)	Hinthong (1985)
Mesozoic	Khorat Series	Khorat Series	Phu Phan member Phra Wihan member Phu Kradung member	Khorat Group	Khok Kruat Formation Phu Phan Formation Sao Khua Formation Phra Wihan Formation Phu Kradung Formation Nam Phong Formation	Khorat Group	Khok Kruat Formation Phu Phan Formation Sao Khua Formation Phra Wihan Formation Phu Kradung Formation Nam Phong Formation Huai Hin Lat Formation	I Mo member Phu Hi member Dat Fa member Sam Khaen member Phu Hai member		
Permian	Ratburi Limestone								Saraburi Group	Sab Bon formation Khao Khad Formation Pang Asok Formation Nong Pong Formation Khao Khwang Formation Phu Phe Formation

2.2.1 Saraburi Group

The lowest lithostratigraphic units of Changwat Saraburi and neighbouring area had been studied by many workers, namely, Brown et al. (1951, 1953), Bunopas (1981), and Hinthong (1985). Up to the present moment, the Saraburi Group of Permian age (Bunopas, 1981) has been generally accepted. The Saraburi Group is further subdivided in to six Formations (Hinthong, 1985), namely, Phu Phe Formation, Khao Khwang Formation, Nong Pong Formation, Pang Asok Formation, Khao Khad Formation, and Sab Bon Formation, respectively in ascending order. The overall thickness of the Saraburi Group is 4,486 metres (DMR, 1992). The detailed descriptions of the Saraburi Group are as follows:

a) Phu Phe Formation

The lithology of this formation is mainly characterised as well-bedded grey to very dark grey limestone. The upper part of the formation is essentially thick to very thick bedded limestone, whereas the lower part displays the interbedding of light brown to brownish-grey shales, slaty shales with brownish-grey to dark grey lenticular and nodular cherts. The type section is at Khao Phu Phe, east of Km. 131-132, Friendship Highway with the thickness of 593 metres. The formation is mainly distributed along Phetchabun ranges and in the area northwest of the Khorat plateau. The age of the Phu Phe Formation is Lower Permian (Sakmarian).

b) Khao Khwang Formation

The lithology of this formation is mainly characterised as grey to dark grey, thick-bedded limestones dolomitic limestones and dolomites. Brownish grey chert nodules are scattered in the lower part, middle part, and more abundant in upper part of the sequence. Rarely shales, sandstones, tuffaceous sandstones and volcanic rocks are

intercalated in some beds. The type section is designated at Khao Khwang, Changwat Saraburi, with the thickness of 490 metres. The formation exclusively exposes in the northern part of the area under present assessment, Khao Khwang, Phetchabun ranges, and northwest of the Khorat plateau. The age of Khao Khwang formation is Lower Permian (Sakmarian).

c) Nong Pong Formation

The lithology of this formation is characterised by interbedded shales and limestones. Shales are mostly brownish grey, greyish brown to light grey, and bluish grey, occasionally silty, sandy, or siliceous. Limestone are medium to dark grey; bedded, banded to well laminated and argillaceous in some beds. Occasionally the limestones are lenses and lenticular beds especially in the upper part. Bedded cherts are generally intercalated in the upper part of the sequence. The type section is located at the east of Khao Khwang with the thickness of 673 metres. The formation is also distributed along the Phetchabun ranges, and northwest of the Khorat plateau. The age of Nong Pong Formation is Lower Permian (Artinskian-Kungurian).

d) Pang Asok Formation

The lithology of this formation is mainly shales, and slaty shales intercalated with sandstones. The lowermost part of this formation is prominently light greenish grey to pale reddish brown sandstones intercalated with shales. Overlying the lowermost unit is pale reddish brown shale interbedded with light greenish grey arkosic sandstone and pale reddish brown shale interbedded with brownish grey limestone. The middle part of the sequence is mostly grey to greyish brown shale. The upper part is brown to dark grey shale, slaty shale intercalated with greenish grey lenticular arkosic sandstone. The type section is located in the vicinity of the Pang Asok village close to the Pang Asok railway station with the thickness of 366 metres. The formation is distributed along the

Phetchabun ranges, and northwest of the Khorat plateau. The age of this formation is Lower Permian (Artinskian-Kungurian).

e) Khao Khad Formation

The lithology of this formation is dominantly grey to dark grey limestone, argillaceous limestone, and dolomites. Nodular and bedded cherts are common intercalated. Shale and sandstone are frequently interbedded with limestone. Locally, marble, calcsilicate hornfels, and volcanic rocks are present. The type section is designated at Khao Khad, Amphoe Phra Phuttabat, Changwat Saraburi, with the total thickness of 1,812 metres. The formation exposes in many areas of Changwat Lopburi and Changwat Saraburi, the Phetchabun ranges, and northwest of the Khorat plateau with east-west trending. The age of Khao Khad Formation is Lower Permian (Artinskian-Kungurian).

f) Sap Bon Formation

The lithology of this formation is mainly grey to brown tuffaceous sandstone, shale, and cherts intercalated with grey limestone. The upper part of this sequence is mainly light grey to dark grey, thin-bedded limestone interbedded with light brown to rusty brown shale, and siltstone. The type section is located at Ban Sap Bon teak plantation, Ban Sok Luk and Huai Sap Tai, Amphoe Muak Lek, Changwat Saraburi with the thickness of 1,103 metres. The formation exposes in many areas along Ban Phu Kae, Ban Nong Chan, and Ban Sap Bon, northwest of the Khorat plateau. The age of this formation is Middle Permian (Kungurian-Kazanian).

2.2.2 Khorat Group

Overlying the lowest lithostratigraphic units of Changwat Saraburi and neighbouring area is very thick clastic sequence of Mesozoic rocks, namely, the Khorat Group (Ward and Bunnag, 1964). The Khorat Group had been studied by many workers, namely, Lee (1923), Brown (1951), Jalichan and Bunnag (1954), La Moreaux et al. (1959), Ward and Bunnag (1964), Iwai et al. (1966), Gardner et al. (1967), Chonglakmani and Sattayarak (1978, 1984), Maranate (1982), Bunopas (1970, 1981), Hahn (1982), and Sattayarak (1983, 1985). Finally, six out of seven formal formations of the Khorat Group (DMR, 1992) are present in the eastern and northeastern parts of area consisting of Huai Hin Lat Formation, Phu Kradung Formation, Phra Wihan Formation, Sao Khau Formation, Phu Phan Formation, and Khok Kruat Formation, respectively in ascending order.

Detailed descriptions of the Khorat Group exposed in the area are as follows:

(a) Huai Hin Lat Formation

The Huai Hin Lat Formation was first proposed by Iwai (1966) to represent the basal conglomerate of the Khorat Group lies unconformably on the Permian rocks. The basal conglomerate consists of pebbles of Permian limestone, rhyolite and other rock fragments. The overlying sequence is grey to dark grey sandstone, siltstone, shale, and limestone conglomerate. Later on, Chonglakmani and Sattayarak (1978) further subdivided the Huai Hin Lat Formation into 5 member in ascending as follows:

(i) Phu Hai member consists mainly of volcanic rocks; tuff agglomerate, rhyolite, and andesite including some intercalation of sandstone and conglomerate. The thickness is 210 metres at type location.

(ii) Sam Khaen member consists of basal conglomerate intercalated with red siltstone, shale, and locally limestone beds.

(iii) Dat Fa member consists of grey to black, carbon-rich calcareous, well bedded shale with numerous argillaceous limestone layers.

(iv) Phu Hi member consists of grey sandstone, shale and argillaceous limestone with some intercalation of conglomerate beds.

(v) I Mo member consists of diorite and its associated volcanic facies intercalated with the well-bedded grey shale, sandstone and limestone.

The type section of this formation is located at Huai Hin Lat, Km. 108 Khon Kaen - Loei Highway with the thickness of 140 metres. The formation exposes in the vicinity of Ban Sab Phu, Amphoe Pak Chong, and in the southern part of Lamtaklong dam/reservoir. The age of this formation is Triassic (Carnian-Norian).

(b) Phu Kradung Formation

The Phu Kradung member was first proposed by Jalichan and Bunnag (1954) without the stratigraphic section. Later on, Ward and Bunnag (1964) conducted a more detailed study and establishing the measured type section of the Phu Kradung Formation consisting mainly of interbedded pink sandstone, red siltstone, and red shale with occasional thin fine conglomerate, greenish grey calcareous conglomerate. The type section of this formation is located at the eastern slope of the Phu Kradung mountain, Amphoe Phu Kradung, Changwat Loei, with the thickness of 1,001 metres. The formation widely exposes along the edge of the Khorat plateau, including part of Khao Yai, encircling of Khao Kampang range, Ban Thung Pho, and the southeastern of the area under the present assessment. The age of this formation is Lower Jurassic.

(c) Phra Wihan Formation

The Phra Wihan member was first proposed as informal member by Jalichan and Bunnag (1954). Later on the Phra Wihan Formation was established (Ward and Bunnag, 1964) consisting predominantly of white to pink thick bedded, well sorted, medium grained quartz sandstone with some thin lamination of red siltstone. The type locality of the formation is located at the southern slope of Khao Phra Wihan with the thicknesses of five measured sections varies from 56 to 136 metres. The formation exposes along the edge of the Khorat plateau, represented by the ridges, escarpments, above the top of the Phu Kradung Formation, including some areas of Changwat Nakhon Nayok and Changwat Prachin Buri, Khao Kampang range, Khao Rom, Khao Lam, and some parts of Khao Yai. The age of this formation is Middle Jurassic.

(d) Sao Khua Formation

The Sao Khua Formation (Ward and Bunnag, 1964) is consisting of a thick sequence of non-resistant, and conglomeratic sandstone, interbedded red to pink quartz sandstone, and red to purplish shales. The type section of this formation is located at Huai Sao Khua, Km. 35.2-41.5, Udon Thani-Nong Bua Lamphu road with the thickness varies from 404 to 702 metres. The formation covers the inner rim of the Khorat plateau. The age of this formation is Upper Jurassic.

(e) Phu Phan Formation

The Phu Phan Formation was formerly proposed by Jalichan and Bunnag (1954) as in formal member. Later on, Ward and Bunnag (1964) proposed the Phu Phan Formation to represent thick-bedded, and cross-bedded conglomeratic sandstone, yellowish grey to pinkish grey sandstone interbedded with siltstone and shale. The type section of this formation is located at Phu Pha Phung of the Phu Phan range with the

thickness of 183 metres. The formation cxposes along the northeastern part of the area under the present assessment, around the Khorat Plateau, and along the Phu Phan range. The age of this formation is lower Cretaceous.

(f) Khok Kruat Formation

The Khok Kruat Formation was first proposed by Ward and Bunnag (1964) to represent the sequence of interbedded, moderately consolidated, red siltstone, and red to white quartz sandstone, fine conglomerate and caliche conglomerate. The type location is between Km 207 and Km 209, Friendship Highway, with the thickness of 709 metres. The outcrops of this formation are rather poorly exposed in the Khorat plateau, the northeastern part of the area under the present assessment. The age of this formation is Upper Cretaceous.

2.2.3 The Cenozoic Deposits

The upper most lithostratigraphic units of Changwat Saraburi and neighbouring area are clastic sequences of Cenozoic deposits consisting of terrace deposits, and alluvial deposits. The Cenozoic deposits in the area had been studied by Hinthong(1985).

(a) Terrace deposits

The terrace deposits are mainly associations of unconsolidated gravel, sand, and silt. However, in some areas the Cenozoic sediments are consolidated by calcareous or furrugeneous cementation, laterites, calcrete or caliche, calcareous tufa or travertine. The terrace deposits cover the northern and locally, the southern parts, along the foothills higher than the alluvial plains. In the northern part, they cover the eastern areas of Amphoe Pak Chong, and Ban Lam Phraya Klang. In the southern part, they cover the

areas of Ban Dong Lakorn of Changwat Nakhon Nayok, Amphoe Nadee, and the northern part of Changwat Prachin Buri. In addition, the terrace deposits also cover the area of Ban Kok Krateum of Changwat Lopburi, and Amphoe Phra Phuttabat of Changwat Saraburi. The thickness of the terrace deposits are unknown, and the age is Pleistocene.

(b) Alluvial deposits

The alluvial deposits are mainly unconsolidated gravel, sand, silt, and clay underlying the recent flood plains. The alluvial deposits cover nearly half part of the area under the present assessment in western, southwestern, and southern parts, along the flood plains of Lopburi river, Pasak river, Chao Phraya river, Nakhon Nayok river, and Prachin Buri river. The age of these deposits is assumed as Holocene.

2.2.4 Igneous Rocks

The igneous rocks exposed in Changwat Saraburi and neighbouring area are both intrusive and extrusive in origin. The igneous rocks in the area had been studied by Hinthong (1985), and Charusiri et al. (1991). Hinthong (1985) divided intrusive igneous rocks in the area into three groups consisting of Phra Ngam diorite, Soi Woi intrusives, and Hin Tang hornblendite. For the extrusive igneous rocks, he also divided into three groups consisting of Khao Yai volcanics, HuaiSom volcanics, and basalt.

a) Phra Ngam diorite

The Phra Ngam diorite is characterised by greenish grey, green to black, granular texture, medium to fine grain. The essential minerals of Phra Ngam diorite are plagioclase, hornblende, diopsite, and augite. The composition of plagioclase varies from andesine to labradorite, mostly alterated to be sericite. Quartz is frequently present

as inclusion in hornblende. The accessory minerals are sphene, apatite, epidote, biotite, muscovite, calcite, and magnetite. The Phra Ngam diorite occurs as stocks and dikes in the areas of the eastern part of the Khok Kateum railway station, Khao Pu Ka, and Khao Phra Bat Noi in Changwat Lopburi; Khao Than Tongdang in Amphoe Phra Phuttabat, Khao Man in Amphoe Kaeng Khoi of Changwat Saraburi; and in the vicinity of Khao Hin Tang in Amphoe Pak Thongchai of Changwat Nakorn Rachasima. The relative age of the Phra Ngam diorite is Late Permian to Early Triassic.

b) Soi Woi intrusives

The Soi Woi intrusives are diverse association of granodiorite, granite, quartz monzonite, quartz diorite, and syenodiorite. These intrusions exposed in two major areas notably the southeastern part close to Amphoe Pak Chong covering a nearly circular area with diameter of 12 - 18 kilometres, and further southeastern part of Amphoe Pak Chong as a belt of approximately 15 kilometres by 45 kilometres along the northeastern margin of Khao Kampang range. In addition, the Soi Woi intrusives also exposed as stocks in numerous small areas of the northwestern part of the area under the present assessment, Amphoe Khok Samlong, and Amphoe Muang of Changwat Lopburi; the western part of Amphoe Pak Chong; the eastern part of the road from Kabinburi to Nakornrachasima between Km 31 to Km 40. The relative age of the Soi Woi intrusives is Late Triassic, Norian. Detailed lithological characteristics of these intrusives are as follows:

i) Granodiorite

The granodiorite is characterised as grey, greenish grey, dark green, medium to coarse grain with granular hypidiomorphic and allotriomorphic texture. The essential minerals are quartz, orthoclase, microcline, microperthite, plagioclase, hornblende, and biotite. The composition of plagioclase varies from oligoclase to andesine. The accessory minerals are apatite, calcite, chlorite, sericite, epidote, sphene, magnetite,

hematite, and muscovite. Quartz and plagioclase sometimes show the myrmekitic texture.

ii) The granites

The granites are of both types, namely, hornblende-granite, and biotite-granite characterised by whitish grey and pinkish colour, fine to medium grain with mainly granular and some porphyritic texture. The essential minerals are quartz, hornblende, biotite, orthoclase, microcline, and muscovite. The accessory minerals are apatite, zircon, rutile, and magnetite.

iii) Quartz monzonite

The quartz monzonite is characterised by grey and greenish, medium grain, hypidiomorphic granular texture. The essential minerals are quartz, orthoclase, microcline, perthite, microperthite, oligoclase, pyroxene, and biotite. The accessory minerals are epidote, chlorite, sericite, calcite, clay-minerals, magnetite, and zircon.

iv) Quartz diorite

The Quartz diorite is characterised by grey to dark green, medium grain, allotriomorphic granular texture. The essential mineral are quartz, orthoclase, microcline, and calcic oligoclase to medium andesine. The accessory minerals are apatite, chlorite, epidote, sericite, and sphene.

v) Syenodiorite

The syenodiorite is characterised by greenish grey to grey, fine to coarse grain, hypidiomorphic granular texture to porphyritic texture. The essential minerals are quartz, orthoclase, microcline, calcic-sodic andesine, biotite, hornblende, and pyroxene. The accessory minerals are apatite, calcite, sericite, epidote, sphene, and magnetite.

The Soi Woi intrusives exhibit the thermal metamorphic phenomena with the carbonate-clastic sequences of the Saraburi Group in almost all areas where the intrusives are present, whereas the extrusives apparently overlying the Saraburi Group in many areas.

c) Hin Tang hornblendite

The Hin Tang hornblendite is characterised by black, coarse grain, hypidiomorphic granular texture. The essential minerals are mostly hornblende, with few quartz, orthoclase, and sodic plagioclase. The Hin Tang hornblendite occurs as stocks in the vicinity of Khao Hin Tang, the border of Amphoe Pak Chong and Amphoe Pak Thongchai. The relative age of the Hin Tang hornblendite is approximately Triassic.

d) Khao Yai volcanics

The Khao Yai volcanics are associations of rhyolite, andesite, rhyolite and andesite porphyries, volcanic breccia, agglomerate, and tuff, mostly, difficult to distinguish to individual rock type. They occur as flows, dikes, and sills, cover a large area of the central part of the area under the present assessment, especially, the Khao Yai national park covering some parts of Changwat Saraburi, Changwat Nakornrachasima.

The rhyolite is characterised by yellowish brown to light brown and reddish brown, fine grain, locally with porphyritic texture. In some areas, the flow structures can be recognised. The rhyolite covers the area of the Khao Pongraeng, Khao Nom Nang,

Khao Phra Buddha Chaay, Khao Sung, Khao Salika, eastern part of Amphoe Kaeng Khoi, and the Khao Yai national park.

The andesite is characterised by greenish, violet, and violetish brown, fine grain, locally porphyritic texture. The andesite exclusively associates with rhyolite, covering scattered area of Khao Wong and Khao Wong Phrachan in Changwat Lopburi, eastern part of Khao Phu Ka and Khao Phu Lon in Changwat Saraburi, along the Pasak river in Amphoe Kaeng Khoi, Huai Wang Takai in Changwat Nakorn Kayok, and is commonly present as dike in carbonate rocks.

The volcanic breccia is characterised by brown, consisting of various types of volcanic pebble, angular shape, cemented by volcanic rocks, mostly, rhyolite. In some areas the volcanic breccia was formed as thick layer, the orientation of pebbles may be recognised as layers. The volcanic breccia covers scattered area of Khao Phra Buddha Chaay, Khao Yai, Nang Rong water-falls, and Wang Muang water-falls.

The agglomerate is characterised by white and light brown, consisting of rounded pebble of igneous rocks and volcanic bombs, fine grain, cemented by volcanic materials. The agglomerate covers some areas of Changwat Nakorn Nayok, Salika water-falls. The relative age of the Khao Yai volcanics is Permo-Triassic.

e) Huai Som volcanics

The Huai Som volcanics are volcanic complex similar to the Khao Yai volcanics consisting of mostly undifferentiated rhyolite and andesite porphyries; rhyolitic and andesitic vitric tuffs, and less abundant andesitic basalt. They are characterised by pinkish brown, green to dark green, fine grain, porphyritic texture with phenocrysts of white and pinkish feldspar. The Huai Som volcanics cover area in the vicinity of

Amphoe Phattana NiKhom, Ban Di Lang, Ban Nong Bua, and Ban Khok Salung, of Changwat Lopburi. The relative age of Huai Som volcanics is Permo-Triassic.

f) Basalts

The basalts are mostly olivine basalts characterised by black to dark green, fine grain. They are restricted to the northeastern part of area under the present assessment along Khao Phra Yajon, Khao Salad Di, and Khao Phraya Dernthong. They overlie shale, schist and fine sandstone. The relative age of basalts is approximately Tertiary.

2.3 Geological structures

The regional strike of the Saraburi Group is approximately oriented in the east-west direction with the variation ± 25 degrees, dipping approximately 30 to 54 degrees northwardly and southwardly. Various types of fold both anticline and syncline, namely, isoclinal overfold, zig-zag fold or chevron fold are commonly present in the clastic sequences with the fold axes parallel to the regional strike (Figure 2.4). The symmetrical curvilinear fold is commonly present in the limestone sequences. The sedimentary sequences of the Khorat Group exhibit the northwest-southeast regional strike direction, dipping approximately 5 to 25 degrees eastwardly with relatively gentle folding in some parts. The board major anticlinal structure is present in the eastern part of the area in the vicinity of Khao Kampang range.

Faults are commonly recognised in Permian rocks (Figure 2.5). There are two major fault zones oriented in the northwest-southeast direction, and the southwest - northeast direction consisting of various type of faults, namely, normal faults, thrust faults, strike-slip faults, and strike faults. The normal faults are mostly found in the carbonate rocks. There are three zones of left-lateral strike-slip fault oriented in

northwest-southeast direction, namely, Pa Sak fault, Pang Asok fault, and Pak Chong fault. The thrust faults are recognised at the Khao Nam Tok, and Khao Phu Phe.

It is noted that there is an angular unconformity between the carbonate-clastic sequences of Saraburi Group striking in the east-west direction and the clastic sequences of the Khorat Group striking in the northwest-southeast direction.

2.4 The geological evolution

Formerly, the area under the present assessment was a part of the western old Indosinian land-mass (Klompe, 1962) or Indosinia (Workman, 1972), which submerged as a shelf sea since Middle Carboniferous Period. A Thick sequence of mixed clastic-carbonate sediments of the Saraburi Group were deposited under the marine shelf environment. During Late Permian, a spreading ridge development in the ocean floor between Shan-Thai and Indochaina and a pair of subduction zones was formed, one dipping relatively westward beneath the Shan-Thai, whereas the other dipping relatively eastward beneath Indosinian, or Indochaina (Bunopas, 1981). Indosinian orogeny probably started since Late Permian where the convergence of the Shan-Thai and Indochaina were eventually collided in Early Triassic (Figure 2.6). This caused the emergence of the former shelf sea followed by strong foldings in such area, the Phetchabun fold belts. The post-collision igneous activities were mostly taken place during Late Triassic to Early Jurassic.

Consequently, the region became once a part of an enlarged stable Indochaina land-mass. This large areas were deposited by continental sediments of fluvio-lacustrine and aeolian origins occasionally covered by inland sea during Late Triassic to Late Cretaceous of the Khorat Group (Hinthong, 1985). The final shaping of the present-day land form has been mainly achieved by the Himalayan orogenic movements in Late Cretaceous to Early Tertiary. The effects of this orogeny on this area were in the form of

board regional foldings and block-faultings, or epeirogeny. Such an epeirogenic movements might cause eruptions of the Cenozoic basalts probably through the new-created faults and the ones development along the pre-existing faults in Tertiary (Hinthong, 1985).

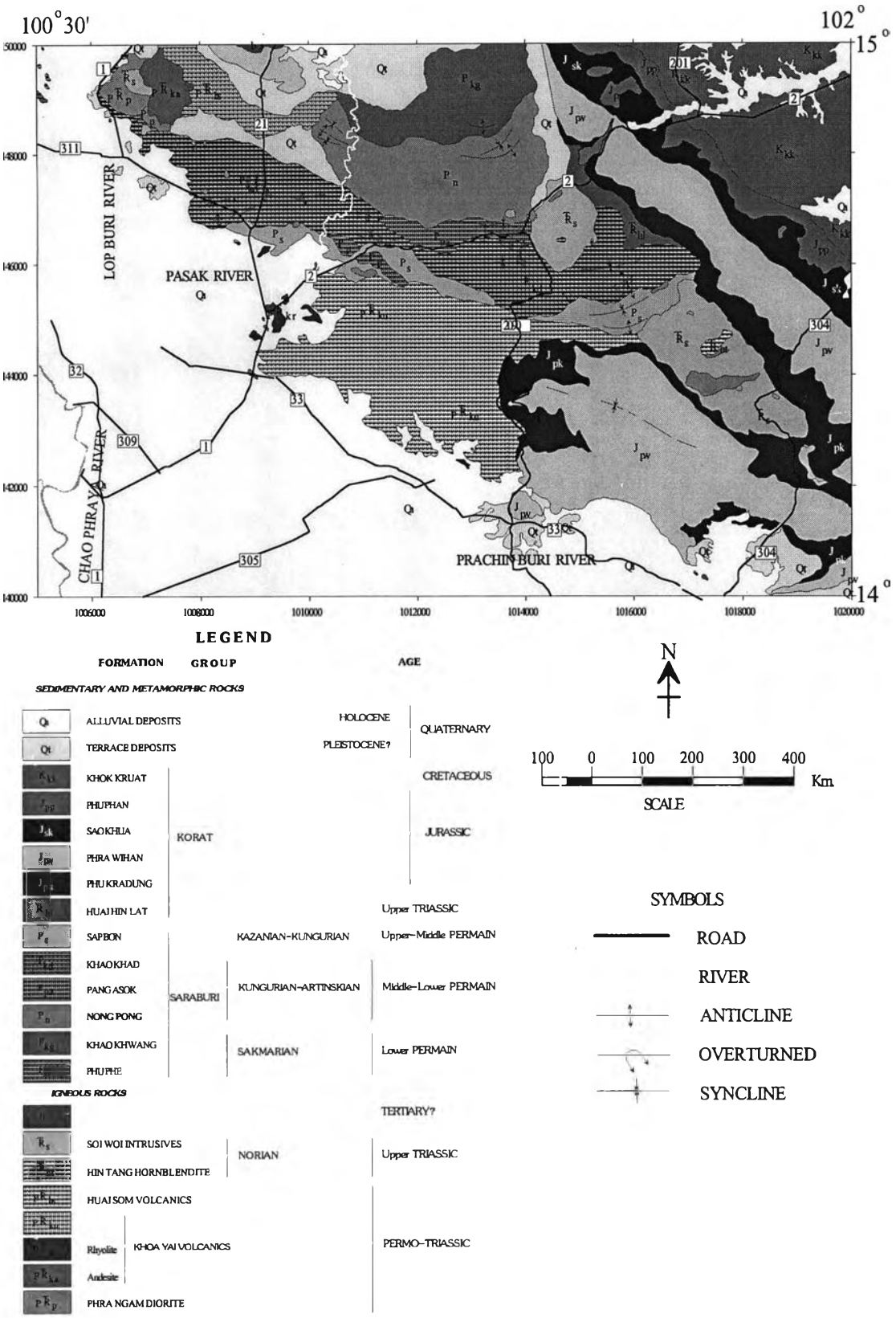

Figure 2.4 Map of fold axes in Changwat Saraburi and neighbouring area. (modified after Geological Map of Thailand sheet Changwat Phranakhon Si Ayuthaya ,ND 47-8, DMR, 1985)

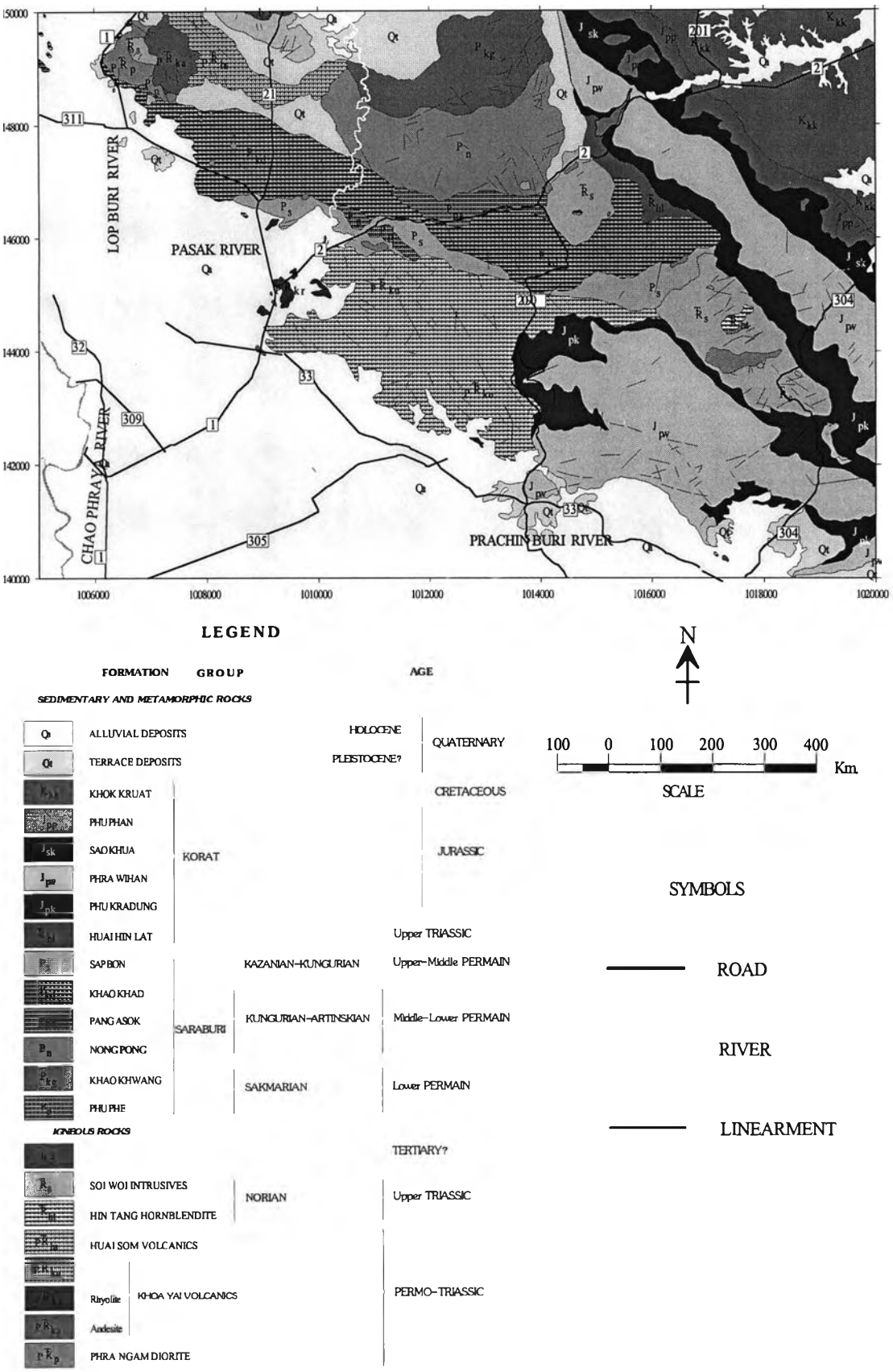

Figure 2.5 Lineament map of Changwat Saraburi and neighbouring area (modified after Geological Map of Thailand sheet Changwat Phranakhon Si Ayuthaya ,ND 47-8, DMR, 1985)

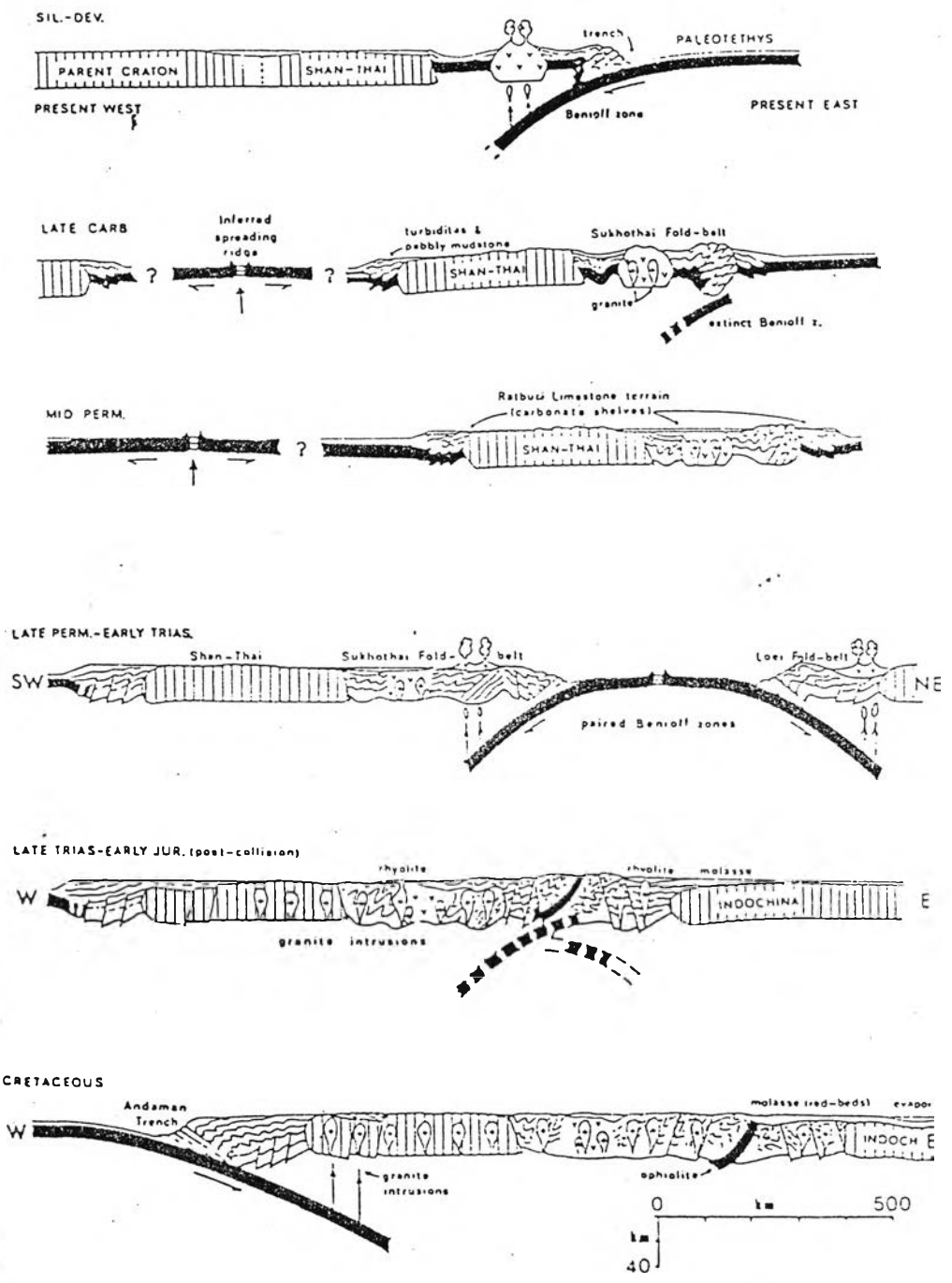

Figure 2.6 Schematic diagram of plate tectonic model of Thailand during Middle Carboniferous to Cretaceous. (Bunopas 1981)