



CHAPTER II

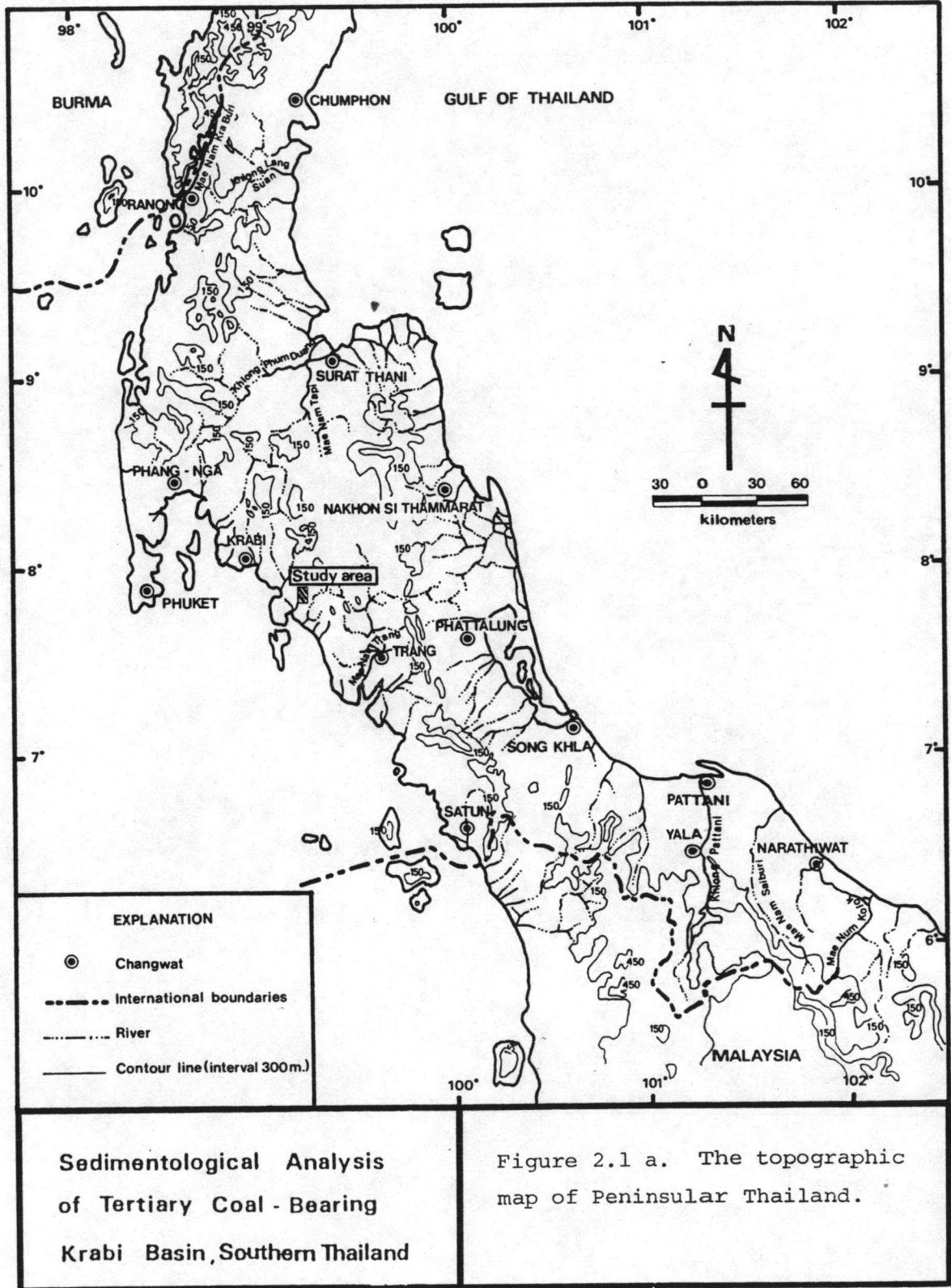
GEOLOGY

2.1 Physiographic and Geological Settings of Peninsular Thailand

Most parts of peninsular Thailand have the tropical monsoon climate except an area along the eastern coast from Nakorn Si Thammarat which have the tropical rainfall climate. The temperature is fairly uniform within the range of 26° - 28°C , and there is a cold season with temperature down to just below 20°C during November to mid-February. The average annual rainfall of the region is very high of approximately 2,500 mm. with heavy rainfall throughout most of the year with no distinct dry season. There are two peak periods of rainfall during the monsoon; the first is in May to September (south-west monsoon), and the second is in October to January (north-east monsoon).

The high mountain range in this region can be subdivided into three zones, namely, central, western, and eastern mountain ranges. The central mountain range of mainly granitic rocks of Khao Luang and Khao Ban That extending from Surat Thani to Satun, the western mountain range of mainly igneous and sedimentary rocks of Khao Thanaosi lying closed to Thai-Burmese border extending from Ranong to Phuket, and the eastern mountain range of granitic rocks extending from Yala and Narathiwat. The highest peaks of central, western and eastern mountain ranges are Khao Luang, Khao Lang Kha Tuk and Ula Tit Basar with approximate elevations of 1,835, 1,395, and 1,538 m. above the mean sea level, respectively. The area between central and western mountain range have the elevation range of 0 - 200 m. above the mean sea level, whereas the area between the central and eastern mountain ranges have

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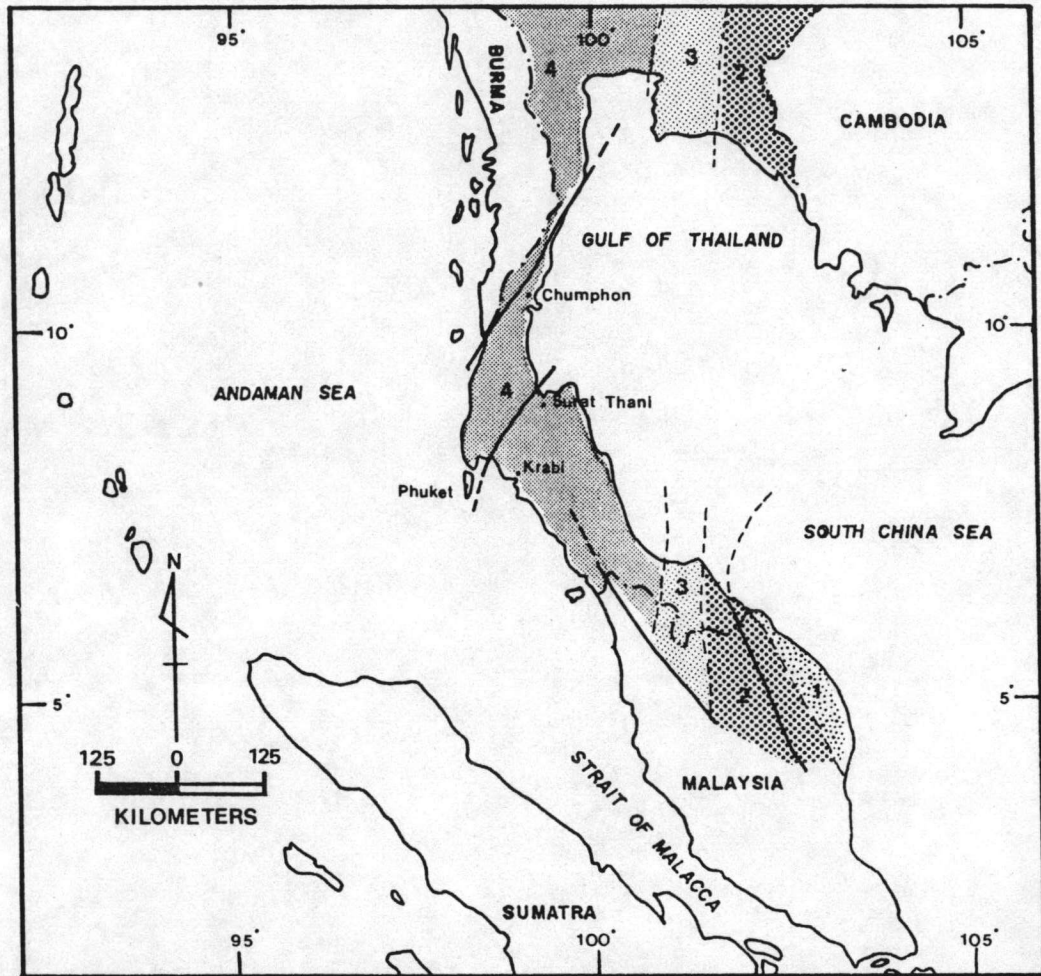
the elevation range between 0-100 m. above the mean sea level.

Monadnocks or isolated hills form peculiar topographic features on the flat terrains or other low relief of Surat Thani, Phangnga, Krabi, Trang and Phatthalung. Beach sand deposits of Quaternary age are confined along the eastern coast extending from Surat Thani to Nara - Thiwat. Old beach deposits extending about 1-35 km. further in-land from the present shoreline indicate the emergent shoreline.

Most of the major drainage systems flow approximately in the north and northeast directions towards the Gulf of Thailand except Mae Nam Trang and Mae Nam Kra Buri which flow southwardly into the Andaman Sea. The main rivers are Khlong Lang Suan, Khlong Phum Duang and Mae Nam Kolok drain to the northeast whilst Mae Nam Tapi, Mae Nam Saiburi, Khlong Thepa and Khlong Pattani flow northwardly. Mae Nam Kra Buri and Mae Nam Kolok are international boundary between Thailand-Burma and Thailand-Malaysia, respectively (Fig 2.1 a).

The geology of peninsular Thailand can be generally subdivided into four major zones from east to west as; (a) Internal Positive zone of Paleozoic rocks intruded by granite; (b) Eugeosynclinal zone in which a Paleozoic/Mesozoic series with volcanic have been strongly folded and overlain by later Mesozoic rocks; (c) Miogeanticlinal zone of mildly metamorphosed Paleozoic geosynclinal rocks only; and (d) Miogeosynclinal zone, fronting the Indian Ocean, with deformed Paleozoic overlain by thin Mesozoic rocks (Burton, 1974). These four major zones are shown in Figure 2.1 b.

Bunopas (1982) subdivided the geology of peninsular Thailand into two parts, namely, middle peninsula and southern peninsula. The middle peninsula is a rhomb-shaped segment of the isthmus roughly



| EXPLANATION | |
|-------------|------------------------|
| | INTERNAL POSITIVE ZONE |
| | EUGEOSYNCLINAL ZONE |
| | MIOGEANTICLINAL ZONE |
| | MIOGEOSYNCLINAL ZONE |

Figure 2.1 b Simplified map of four major zones of Peninsular Thailand (modified after Burton, 1974).

| Age | Middle Peninsula | South Peninsular Thailand | | |
|---------------------|---------------------------------------|--|---|--|
| | | west | Middle | East |
| CENOZOIC | Coastal and alluvium Krabi lignite | Coastal and alluvium Sadao lignite | Coastal and alluvium not known | Coastal and alluvium not known |
| Cretaceous | — | — | — | — |
| Jurassic | Chumphon Red-beds | White quartz sandst. and red shale near Thung Song | Chian Yai red-beds | — |
| Triassic | — | — | Na Thawi shale | — |
| Permian | Ratburi Limestone | Ratburi Limestone? | Ratburi Limestone? | — |
| Carboniferous | Phuket Group ? ? ? ? ? | Sandstone & shale at Trang | Ko Yo shale and chert | Mayo red-beds. |
| Devonian-Silurian | | Khuan Din So and Thung Wa shale, chert and limestone | Satun shale | Yala, Narathiwat phyllite, metatuff |
| Ordovician-Cambrian | | — | Thung Song Limestone Tarutao Formation | — |
| PRECAMBRIAN | | — | Khanom gneiss | — |



Figure 2.1 c Lithostratigraphic units of Peninsular Thailand (After Bunopas, 1980).

defined by the towns Prachuap Kiri Khan, Chumphon, Surat Thani, Krabi and Ranong at its four corners, the northwest edge being the border with the southernmost part of Burma. The southern peninsula extends southward from Krabi and Surat Thani to the Malaysian border south of Songkhla and Nara Thiwat (Fig 2.1 c).

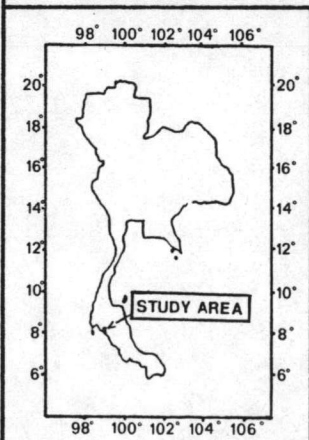
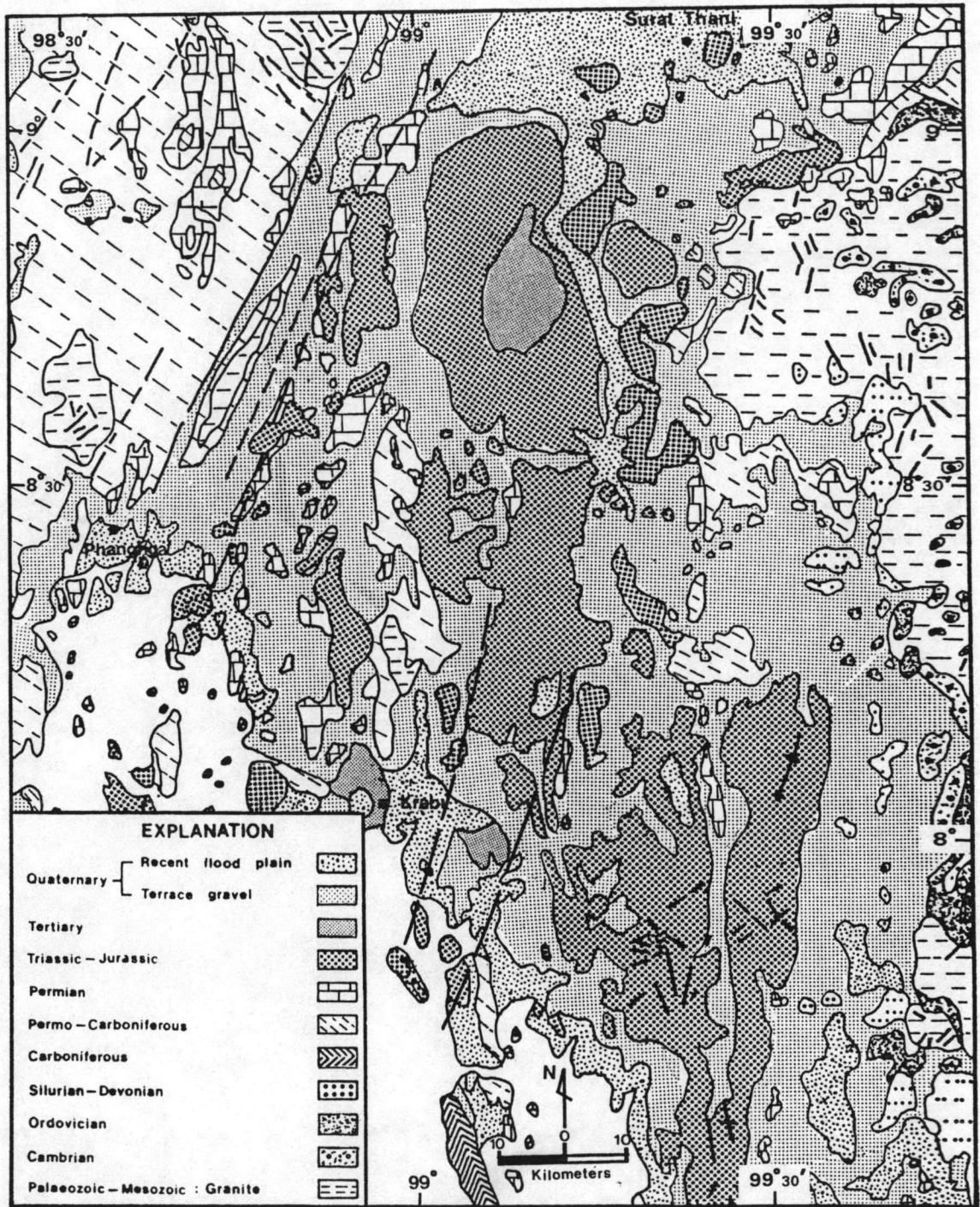
In the middle peninsula areas, the oldest known rocks are the thick, strongly deformed, Permo-Carboniferous pebbly mudstone bearing facies, known as the Phuket Groups but not differing much in lithology and structure from the Kaeng Krachan Group to the north or the Mergui Formation in adjacent Burma. The dominant lithologies in Phuket Group are grey laminated mudstones and alternating grading sandstones and mudstones interpreted as turbidites. Locally, the top of Permo-Carboniferous rocks is found overlain by Ratburi Limestone (Middle Permian) which occur in many north-south trending belt in the middle peninsula. The Mesozoic is represented in the middle peninsula by the Chumphon red beds extending in the north-south trend from Chumphon to Trang.

The Tertiary deposits are limited as isolated basin in Surat Thani - Krabi - Trang belt. Many Triassic and Cretaceous granitoid stocks are intruded into the Phuket Group strata and are surrounded by narrow metamorphic aureoles.

2.2 Distribution of pre-Tertiary and Tertiary rocks

Krabi Tertiary basin is generally surrounded by only a few rock formations ranging in age from Late Paleozoic to Mesozoic. The basin itself is mainly covered by Quaternary deposits with only few localities where Tertiary deposits are exposed (Fig 2.2 a).

To the north, the basin is bounded mainly by undifferentiated Mesozoic rocks which are characterized by sandstone, siltstone, shale



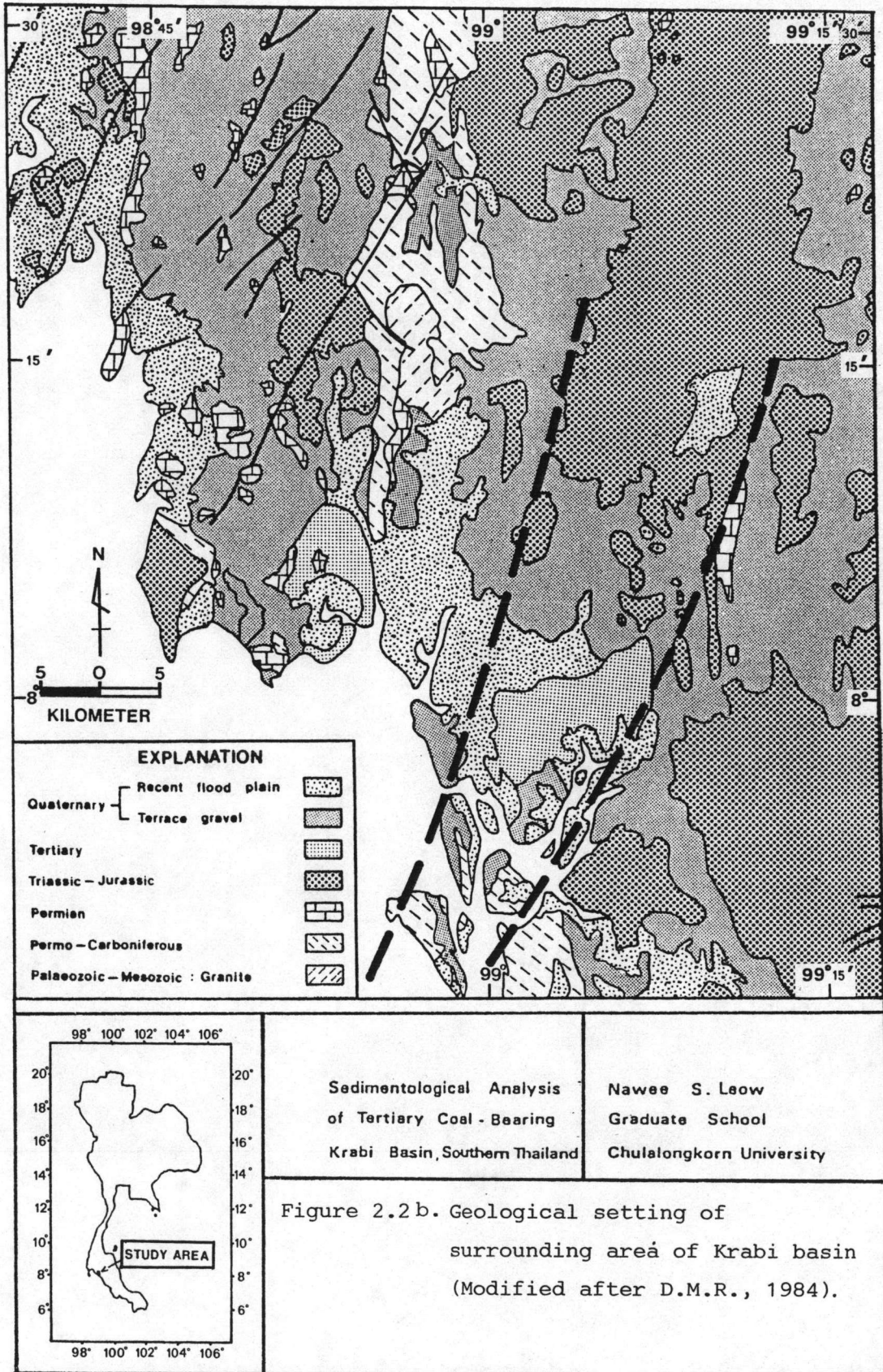
Sedimentological Analysis
of Tertiary Coal-Bearing
Krabi Basin, Southern Thailand

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Figure 2.2 a Geological structural map of Peninsular Thailand (Modified after D.M.R., 1984).

and conglomerate of dark red, red, reddish brown or brown, with cross-bedding, ripple mark and micaceous in some parts. The nearest exposure of these Mesozoic rocks are at Khao Khaun (245 m. high). Further in the northeastern part, there is the north-south trending of Permian limestone, whereas the area farther in the northwestern part is underlain by Paleozoic-Mesozoic granite, granodiorite, and diorite, as well as Carboniferous-Permian rocks. The Carboniferous-Permian rocks are characterized by sandstone, shale, chert, pebbly shale, pebbly sandstone of grey to dark grey, greenish grey, brown, laminated to thick bedded, conglomerate and tuff. The western part of the basin is marked by the presence of Carboniferous-Permian rocks. The basin is bounded by the present coastline with many offshore islands of Mesozoic rocks, namely, Ko Hang , Ko Nok Khaum and Ko Pu. The eastern part of the basin is characterized by mountain range of Mesozoic rocks and Permian limestone (Fig. 2.2 b.).

The Tertiary deposits in southern Thailand was first reported by Lee (1923). Altogether there are five limited basins of Tertiary rocks consisting of conglomerate, soft red and grey sandstone, sandy-shale, clay, limestone and coal which lie unconformably on the pre-Tertiary rocks in these regions. Brown, et al (1951) proposed Mae Sot Series for the lower unit and Krabi Series for the upper unit. Later on, Javanaphet (1969) reconsidered all Tertiary deposits under Krabi Group represented by semiconsolidated and consolidated conglomerate, sandstone, shale, limestone, coal bed with non-marine fossils of Lower Tertiary up to Upper Tertiary or Lower Pleistocene. Garson, et al. (1975) renamed the Krabi Formation for Tertiary rocks within Phuket, Phang-nga, Takua Pa, and Krabi areas. The Krabi Formation is well exposed at Krabi and occurs throughout the area in small outcrop about



thirteen localities resting unconformably on the older sediments.

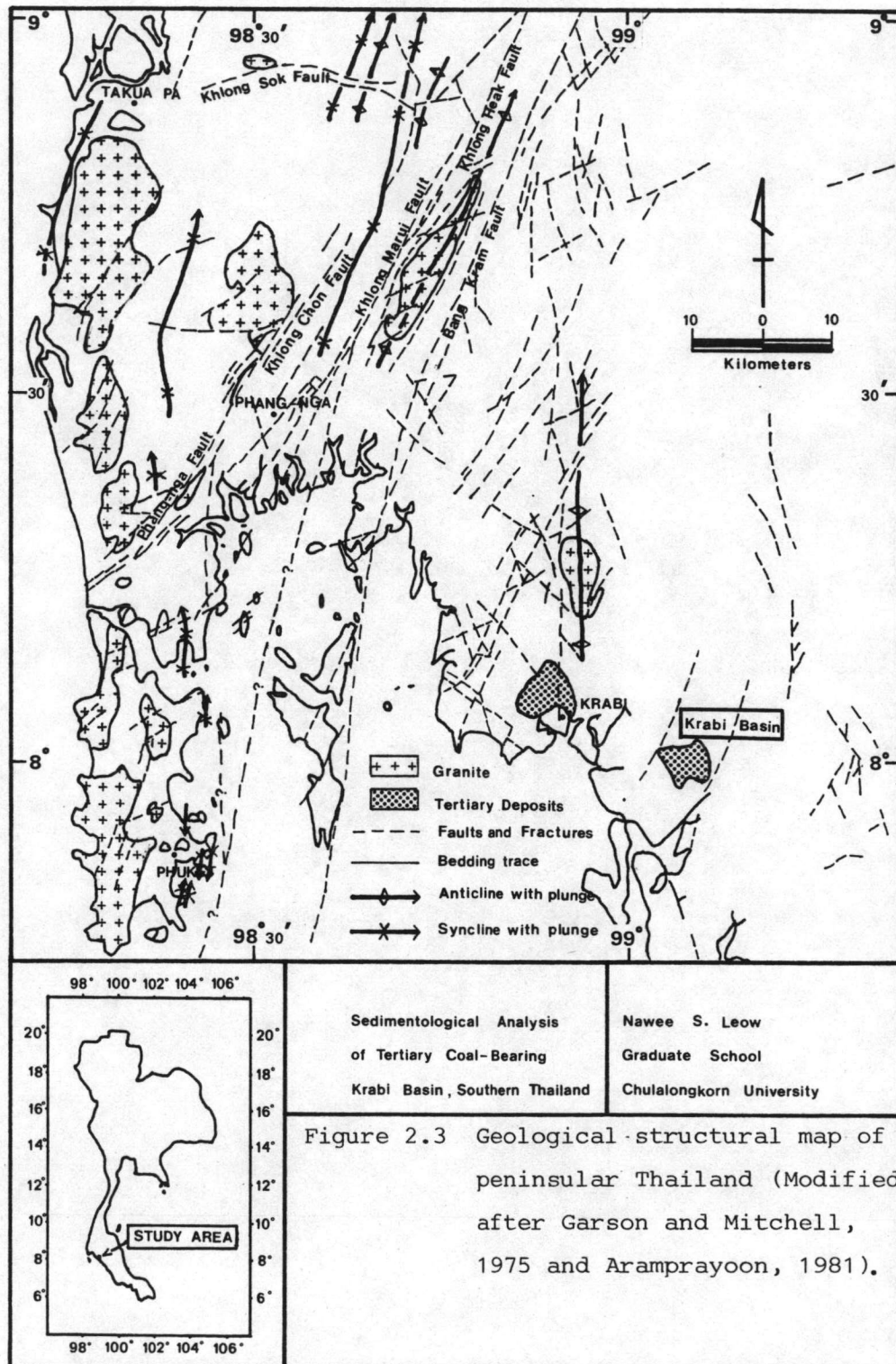
At Ban Pu Dam, these rocks consist of coarse-grained sandstone, oil shale, limestone, and lignite with gastropods, fossil plants and gypsum. At Laem Pho, there are alternating of shelly limestone, marl, and lignite with fossils of Viviparus sp., Hydrobia sp., and Territella sp. indicated Tertiary age.

The Quaternary deposits in the middle part of the Thai peninsula are valley floor and coastal plain deposits of insignificant thickness. In the southern part of study area, the Quaternary sediments are essentially estuarine deposit, mangrove, mudflat, Recent-flood plain, and swamp deposits.

2.3 Geological Structures

Considering the main structural features of the area around Krabi basin, most of the longer faults have a north-easterly trend and these are a number of minor faults with a north-westerly trend. Grabens are present throughout these fault-zones. Four major north-easterly faults in the western part of the basin are Bang Kram, Khlong Marui, Khlong Chon and Phang-nga Faults. It is noted that there is apparent evidence of vertical movements of at least a few hundred meters along the faults bordering the graben, and lateral sinistral movement of up to 250 kilometers have been explained (Emery and Niino, 1963; Rodolfo, 1969).

North of Krabi basin, there is an anticline plunging north oriented in the north-south direction. Farther to the northwest of the study area in the fault-zone, a series of anticline and syncline with plunging are oriented in the north-northeast direction (Fig.2.3).



The area of Krabi basin under the present study is also bounded on the northwest and southeast by the northeast-southwest faults, located approximately at the margin of the basin.

2.4 Geological Evolution

During or before Devonian times, there was the deposition of marine sediments of Phuket Group. The lower formation of Phuket Group is characterized by turbidite, pebbly mudstone, mudstone and slump units which are believed to be accumulated on submarine fan bordering a continent which lay to the east. Laminated mudstone deposited on the continental slope, and shallow water sediments were deposited in deltaic environment near the source area. However, the end of deposition of the Phuket Group there was a rather abrupt change in facies from shallow-water clastics and deltaic sediments of the upper formation to marine limestone of Ratburi Limestone Formation. It is evident that carbonate sedimentation began over the wide area in Lower or Middle Permian. Carbonate sedimentation accompanying the relative rise in sea level which continued to Upper Permian. The limestone succession is more than 800 m. thick. It is also assumed that there is an angular unconformity between the two lithostratigraphic units, namely, Phuket Group and Ratburi Limestone Formation.

The deposition of Ratburi Limestone most succeeded by major tectonic events, with uplift accompanied by faulting and folding as well as local erosion.

After that there was a marine transgression and deposition of arenaceous Ko Yao Formation in shallow marine and fluviatile environments. The main episode of folding took place in Late Triassic time after the deposition of Ko Yao Formation. Folding was most intense in the west (Bunopas, 1982).

The sinistral movement of at least 250 km. occurred along the northeast trending Khlong Marui fault in Late Jurassic to Cretaceous time. Emplacement of the fine-grained two-mica granite, which are commonly cut by minor northeast trending faults, may have happened in the late Cretaceous. Vertical movements along the earlier sinistral faults formed a narrow graben extending from Phang-nga Bay to beyond the north-east margin of the region. The Khao Phanom granite and surrounding hornfelsed sediments of Phuket Group were elevated in a narrow horst within the graben. Uplift along the Khlong Marui fault, forming the western wall of the graben, resulted in erosion of the Ko Yao Formation, which now occurs only in and to the east of the graben.

Minor fault movements and erosion toward the close of the Mesozoic and probably in Early Tertiary times were succeeded by deposition of the sediments of the Krabi Group, mainly in shallow marine or lacustrine basins located in structural depressions within the older rocks. A minor phase of deformation and uplift, probably due to continued movement along faults, exposed the Krabi Group to erosion. Local steep dips in the Group probably resulted from faulting and from downslope gravity movements (Longworth CMPS Engineers, 1980).

Erosion during the Quaternary and possibly during the Late Tertiary led to the accumulation of alluvial deposits, and deep weathering has produced a mantle of colluvium. A relative rise in sea level drowned river valleys on the west coast and submerged the erosional remnants of the Ratburi limestone, which now island in Phang-nga Bay; it also resulted in very thick deposits of alluvium. Small area of marine sediments and local erosion surfaces on Phuket Island, and west of Takua Pa where mollusc shells are present, probably accumulated during high eustatic sea level in the Quaternary (Bunopas, 1982).