CHAPTER I

INTRODUCTION

Cenozoic sediments are very important targets for the petroleum exploration. Almost all petroleum produced in Thailand are from Cenozoic basins scattering throughout the country both in the onshore and offshore areas. Six basins have already been proved to contain commercial petroleum deposits (Chinbunchorn, Pradidtan and Sattayarak, 1989). Besides, other types of geological resources, namely, coal, diatomite, ball clay, groundwater, etc. have been exploited from Cenozoic sediments. The state of the art on Cenozoic geology of Thailand is very limited and poorly defined because the lack of information. Almost all Tertiary sediments deposited in the Central plain, scattered in the intermontane basins in the Northern part, and in the Gulf of Thailand are covered in most parts by younger deposits of Quaternary age (Fig.1.a).

The geological studies of Cenozoic sediments must be essentially undertaken from subsurface data and information obtained from drilling and subsurface geophysical explorations. The subsurface study of Cenozoic deposits in Thailand are mainly motivated by the geological resource exploration programmes. During 1921-1923, Prince Kamphaengbej engaged Wallace M. Lee, an American geologist, to investigate the mineral fuels in Thailand. However, in those day exploration activities were very limited due to the lack of incentives and technical know-how.

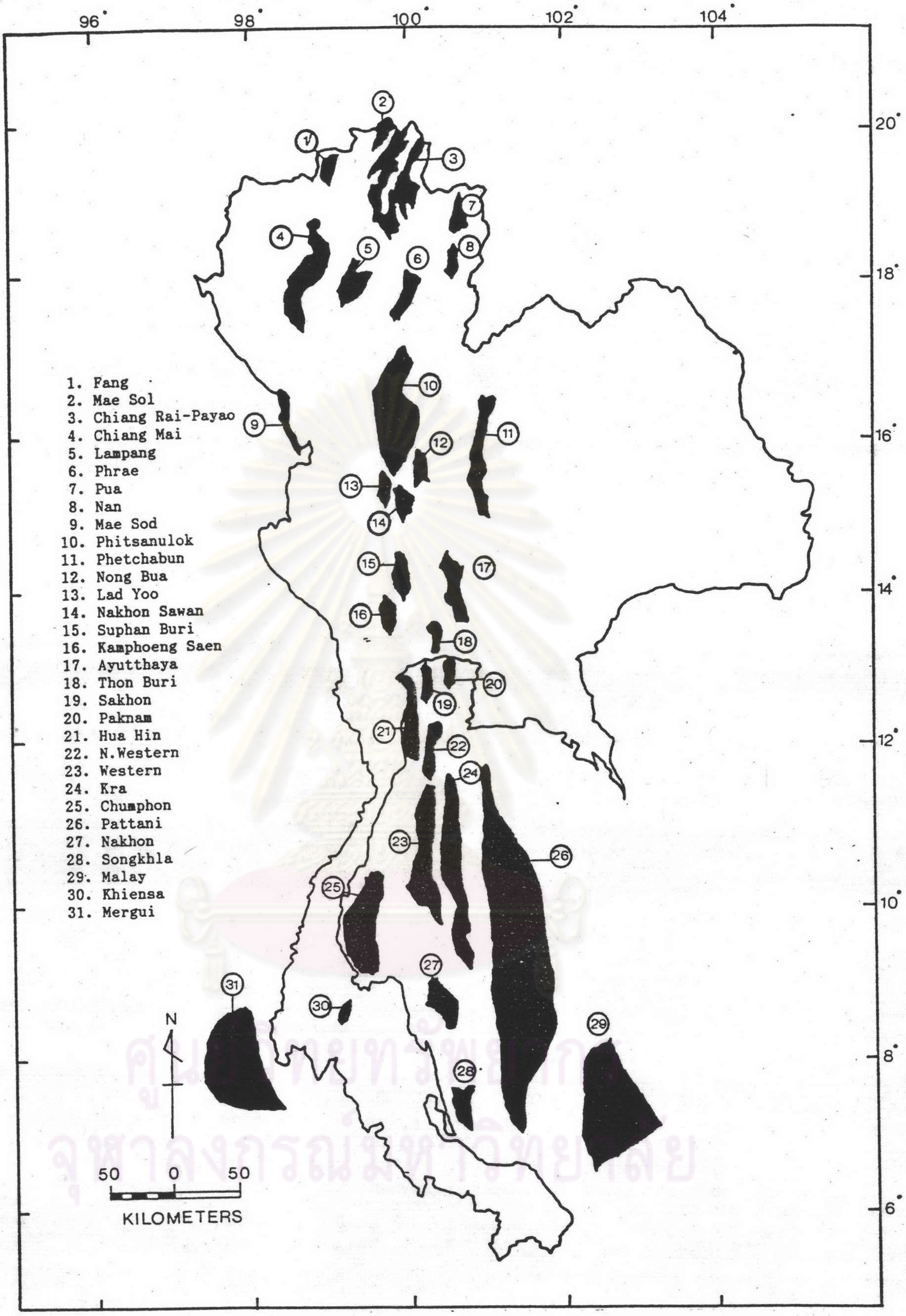

Figure 1 a Significant Cenozoic basins in Thailand.

(after Chinbunchorn, Pradidtan and Sattayarak 1989.)

Petroleum exploration in the Gulf of Thailand has begun since early 1968 with geophysical surveys over prospective Cenozoic basins and exploratory drilling has started since 1971. During 1971-1982, 58 exploratory wells have been drilled; 49 wells concentrated in the two major Tertiary basins, namely, Pattani and Malay basins; 9 wells scattered in the western graben basins (Fig.1.b). Exploration activities in the Gulf have continued until present over relatively unexplored Cenozoic basins. Most of the gas and condensate are accumulated in Pattani and Malay basins. The reserves of gas and condensate are estimated as 11.42 trillion cubic feet of gas and 141.42 million barrels of condensate (Polahan, 1986). Besides, oil has been discovered in Chumphon basin with estimated reserve of 16 million barrels in 1987 (Nakornthap and Chinbunchorn, 1988).

Significant oil and oil shale reserves were discovered in few onshore Cenozoic basins. The Central Plain is the major onshore Cenozoic oil field. In the north Central Plain, the Phitsanulok basin, oil has been discovered with reserve of about 870-1750 million barrels and the production of oil from Sirikit oil field has continued to the present. The South Central Plain, the Chao Phraya basin, consists of some small basins extending southwardly to the Upper Gulf of Thailand. Oil has been discovered in these small basin, notably, Kamphaengsaen and Suphan Buri basins in the eastern part of the Chao Phraya basin, with total estimated reserves of 5-30 million barrels.

Some small Cenozoic basins in the Upper Gulf of Thailand are considered to have a high potential for petroleum because of the discoveries of oil in small basins such as Kamphaengsaen and Suphan

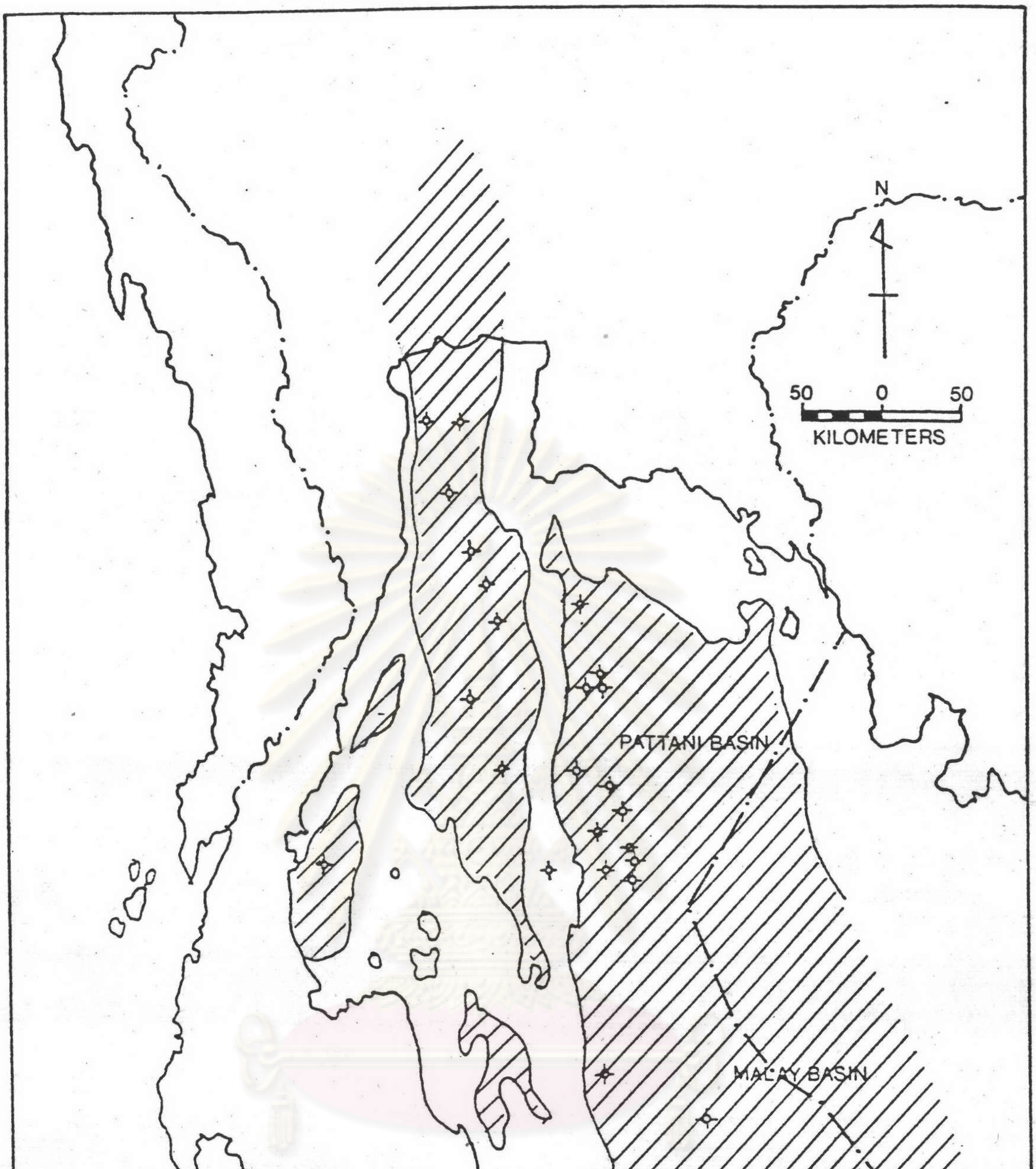

Figure 1 b The exploratory wells in the Gulf of Thailand have been drilled during 1971-1982. (after O'Leary and Hill 1989.)

Buri basins in the Central Plain and Chumphon basin in the Gulf of Thailand.

The geology of Hua Hin basin and adjacent areas is considered to be very important in the petroleum exploration for the full understanding of the region can serve to bridge the missing link between the geological configurations of the Central plain and the Gulf of Thailand. However, it is necessary to study the geophysical and geological data in order to understand the evolution of the Hua Hin basin. Besides, the findings from this study may benefit further understanding of the development of other Cenozoic basins which have similar geological setting.

1.1 Study Area

The study area covers the Hua Hin basin in the Upper Gulf of Thailand between latitudes 12 00'N to 13 18'N and longitude 100 00'E to 101 00'E. This basin is elongated in the N-S direction and parallel with coast of Phetchaburi and Phrachuap Khirikhan provinces. The area is approximately 900 square kilometres which is covered by the offshore petroleum concession blocks nos. 1, 2 and 3 (Fig.1.1.a). These blocks lie in the water ranging in depth from 20 to 48 metres.

The climate of the Upper Gulf is closely related with the lower Central plain and near-by coastal areas. The total annual precipitration is 1,492 millimetres. The rainy season is from May to November with maximum precipitration of 288 millimetres in October, whereas the rest of the year has a minimum precipitation of 8 millimetres in February. The minimum air temperatures is about 16 °C in October, whereas the maximum of about 36°C is in April. These data

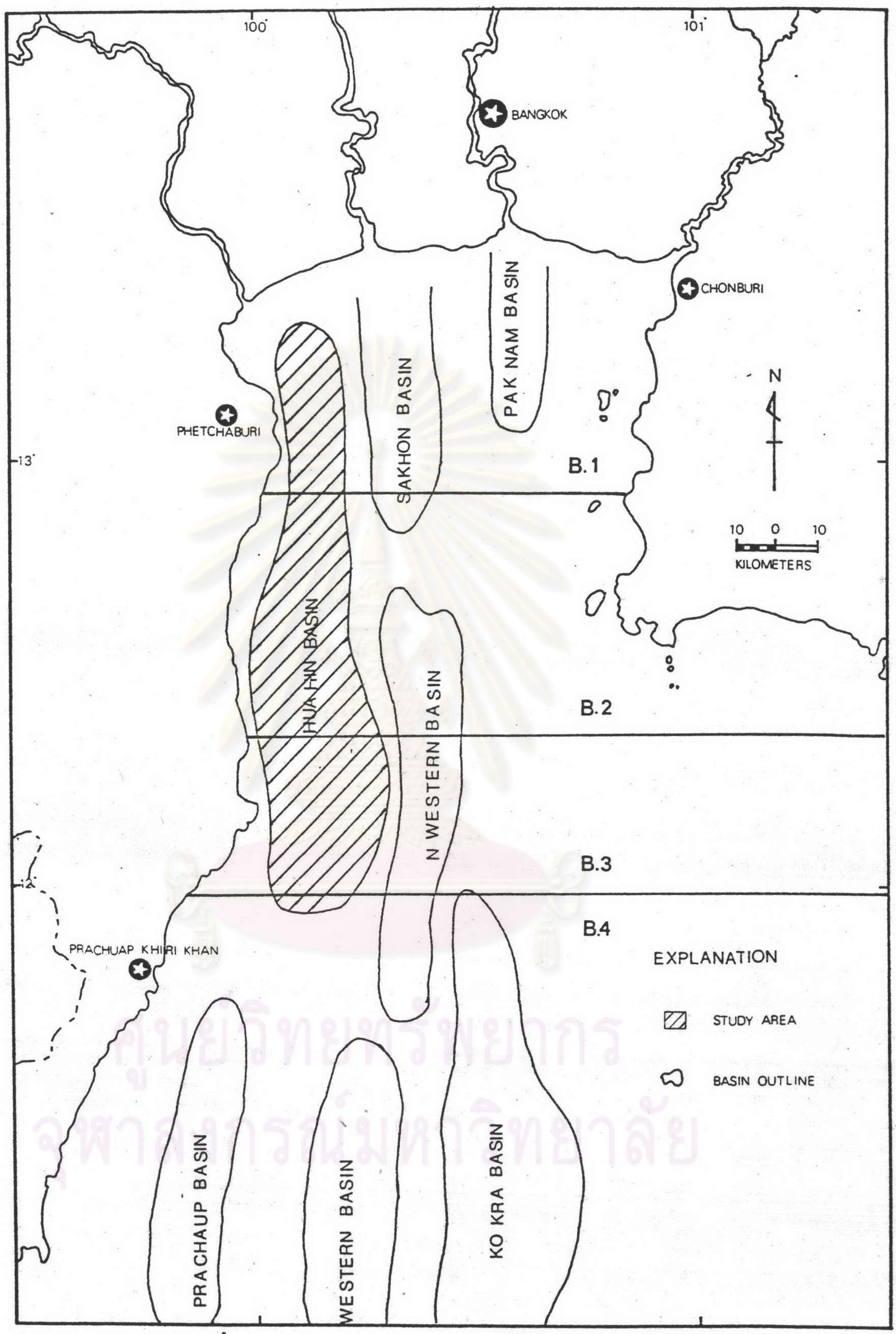

Figure 1.1 a The study area.

are evaluated from the meteorological stations in Bangkok, Chonburi, Phetchaburi, Phrachuap Khirikhan and Chumporn Provinces during 1985-1987 (Fig.1.1.b & 1.1.c).

1.2 Exploration History of the Hua Hin Basin

The Hua Hin basin has been covered by the petroleum concession block nos. 1, 2 and 3 (Fig.1.2.a). In 1968, the concession block nos.1, 2, 14 and 15 were awarded to the Tenneco Company and the concession block nos. 3, 4, 16 and 17 were awarded to the BP Petroleum Development of Thailand Limited. Magnetic survey and minor seismic survey were carried out and the results reveal that the concession block nos. 1, 2 and 3 consist of a few small Cenozoic basins. Hua Hin basin is the largest Cenozoic basin in the Upper Gulf of Thailand. Subsequently, the oil companies relinquished their concessions without any exploration drilling in the basin area.

In 1981, the concession block nos. 1, 2 and 3 were awarded to the Pecten International Company. Extensive seismic surveys of totally 2,627 line-kilometres were conducted. Four exploratory wells were drilled, they are, Phetchaburi-1 with total depth of 11,007 feet, Krabang-1 with total depth of 3,622 feet, Nong Kae-1 with total depth of 4,211 feet, and Sattakut-1 with total depth of 4,353 feet (Fig.1.2.b & 1.2.c). Only Phetchaburi-1 wells was drilled in the Hua Hin basin, whereas others were drilled in adjacent areas with high basement. Noncommercial hydrocarbon was presented and Pecten International Company relinquished its concessions in 1985.

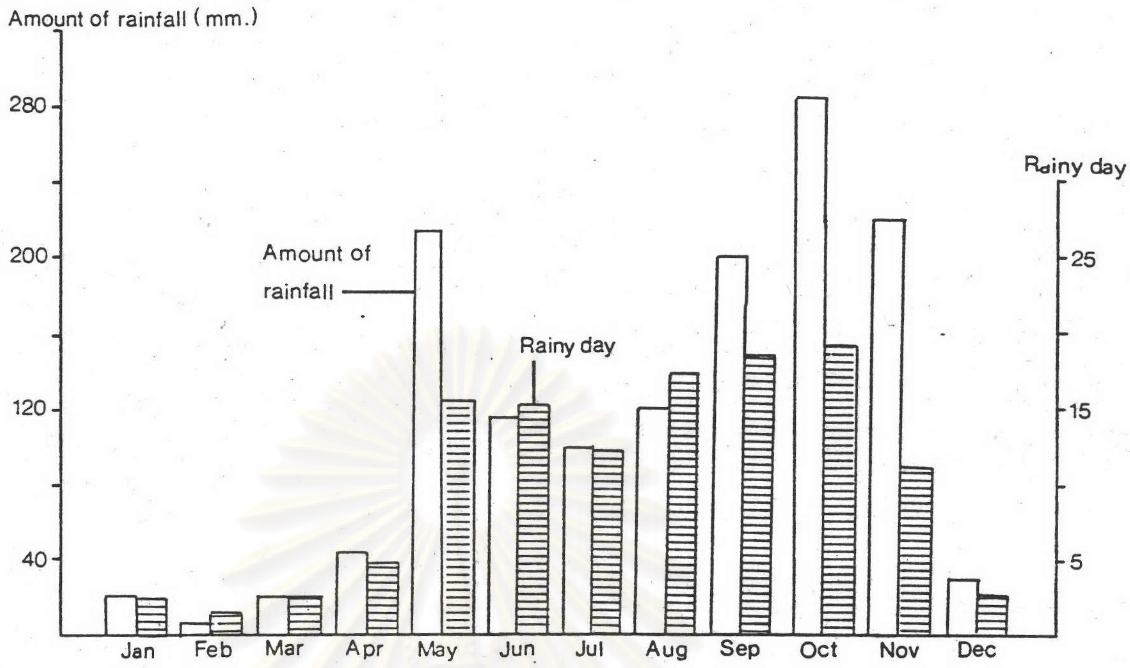

Figure 1.1 b Chart shows rainfall around the Gulf of Thailand during 1985-1987.

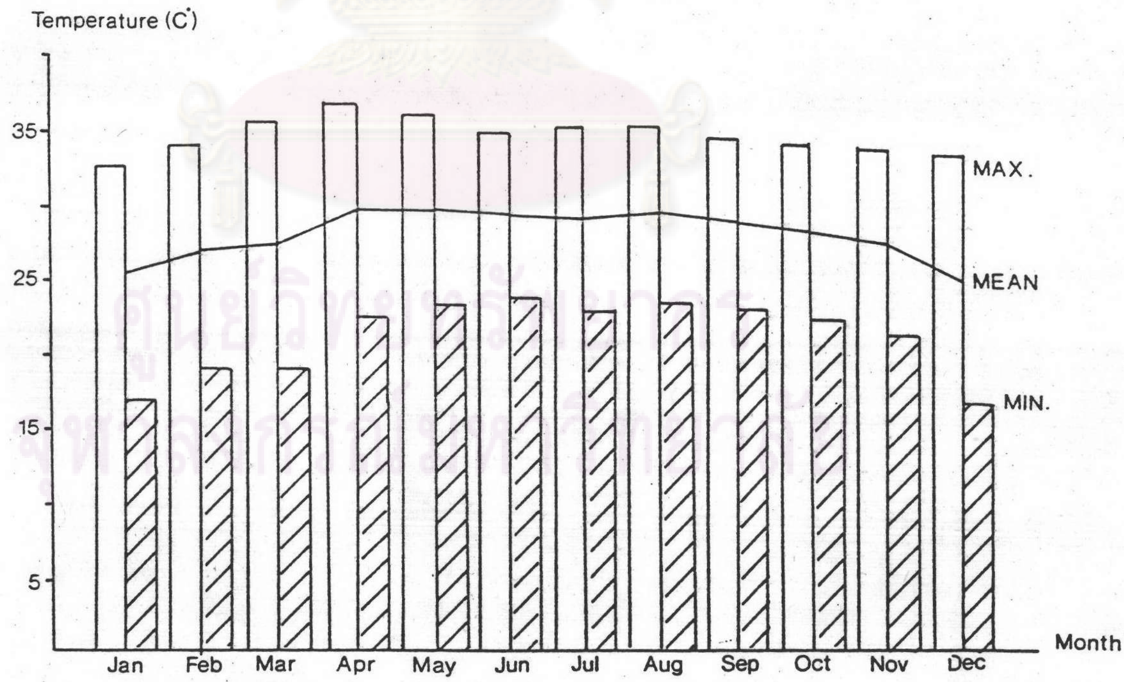

Figure 1.1 c Chart shows the temperature around the Gulf of Thailand during 1985-1987.

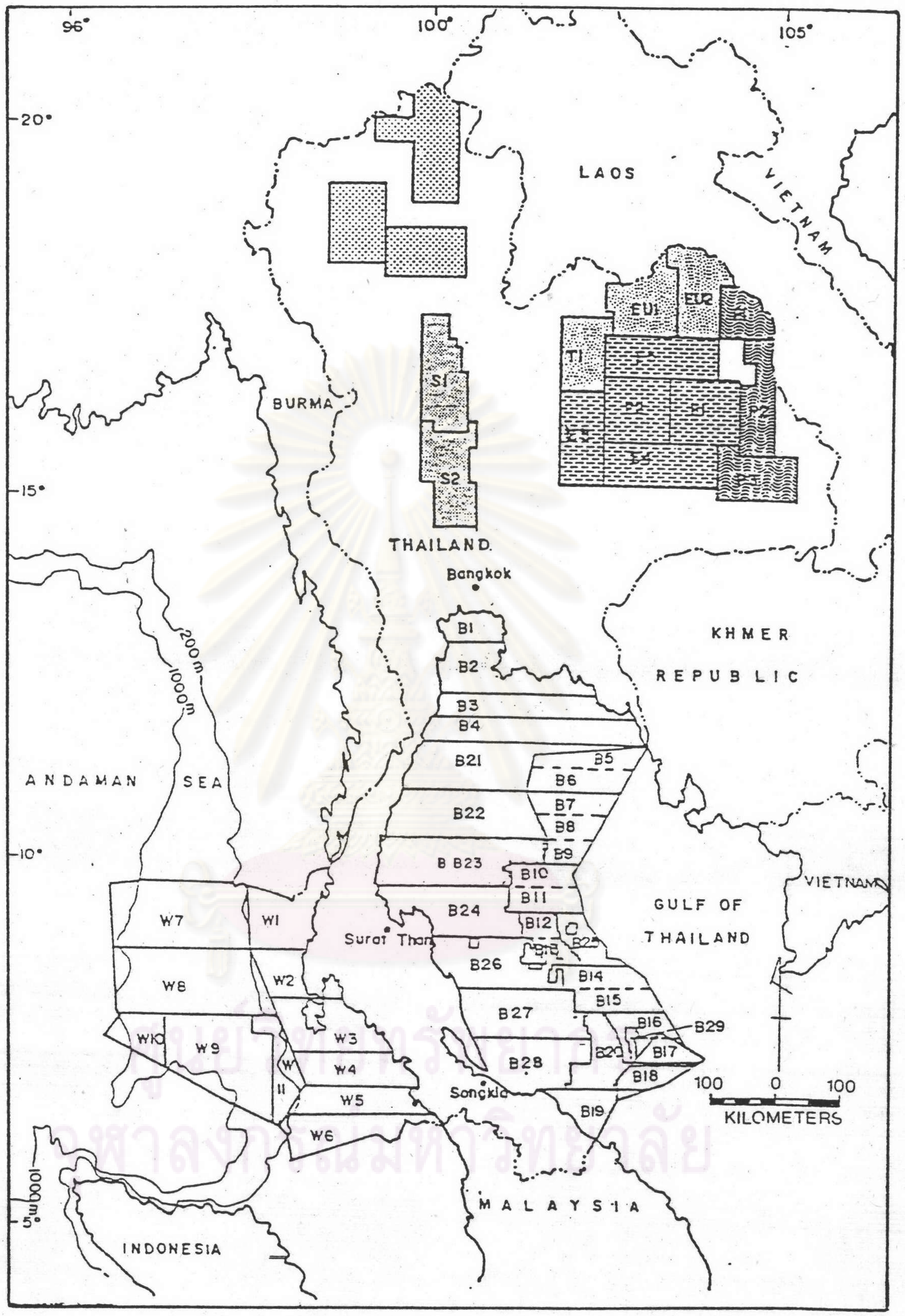

Figure 1.2 a Shows the petroleum concession blocks in Thailand.

(after Nakornthap 1984.)

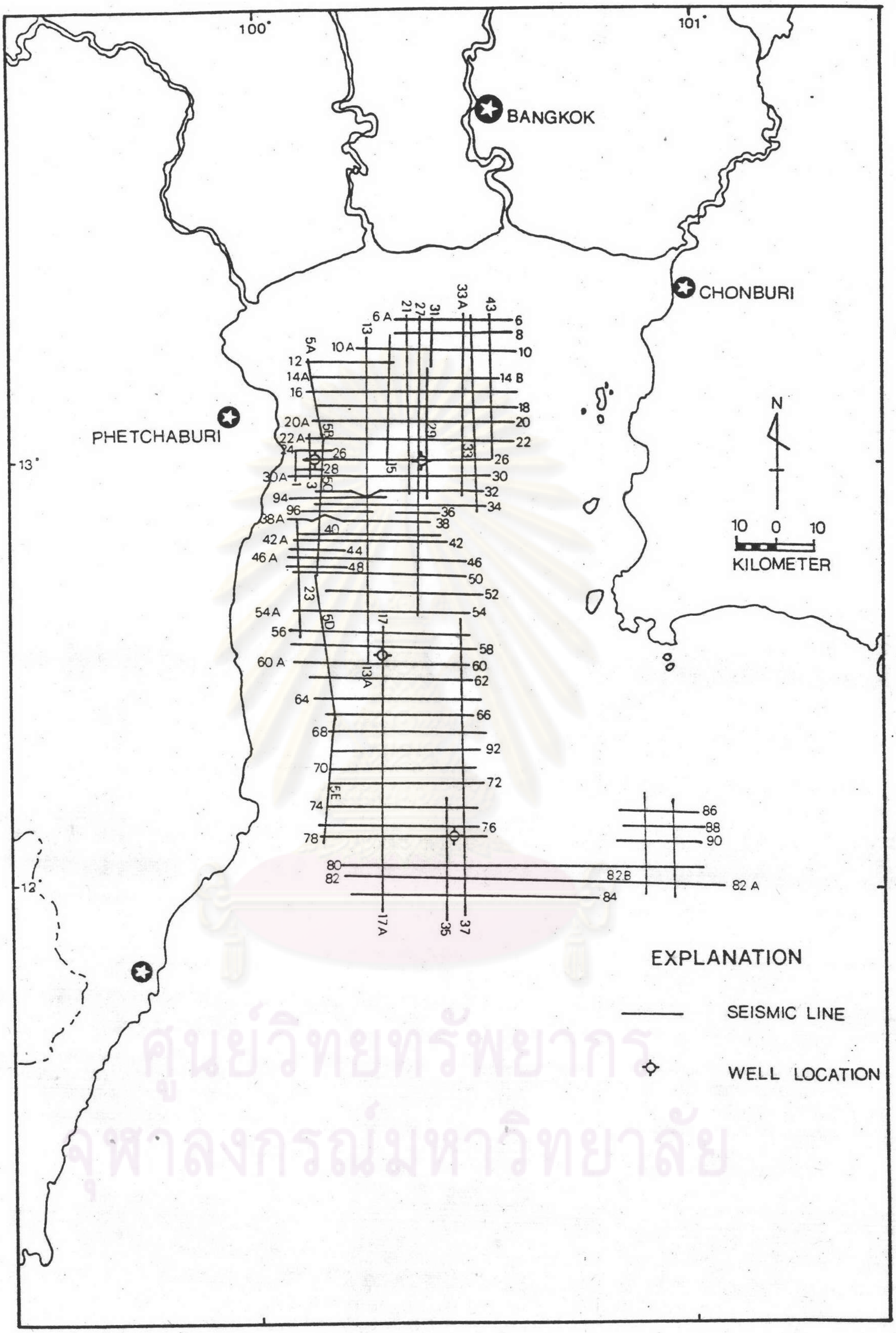

Figure 1.2 b The extensive seismic survey of totally 2,627 line-kilometres conducted by Pecten International Company in 1981 and well locations.

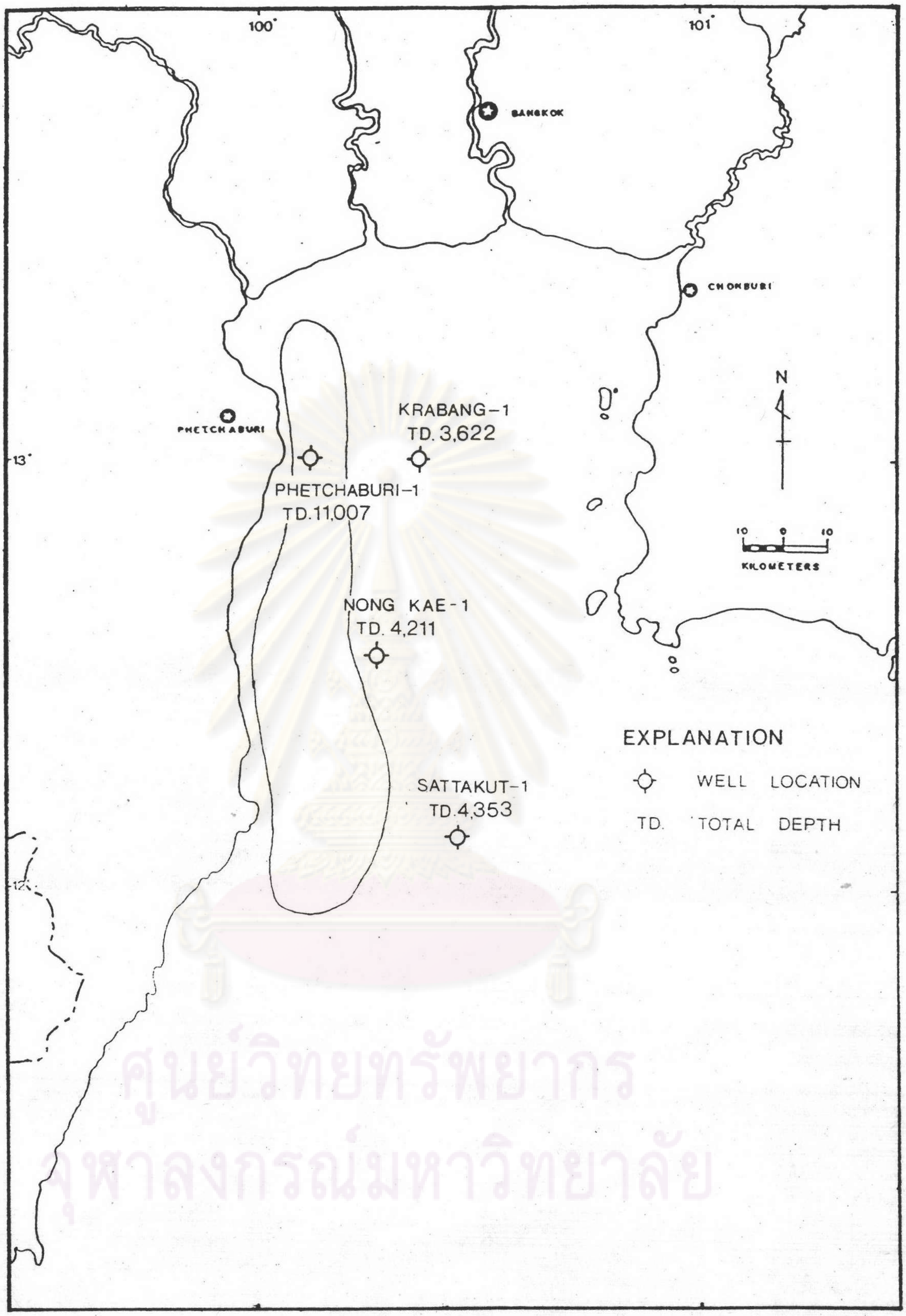

Figure 1.2 c The exploration wells in the upper Gulf of Thailand.

1.3 Objectives of the Study

The purpose of this research is to assess the geological setting, geological structures and stratigraphic framework of Cenozoic sediments in the Upper Gulf of Thailand with special reference to the Hua Hin basin. Additional attempt is to study the geological evolution of the basin.

1.4 Data Sources

The data employed in the present study were provided by the Department of Mineral Resources (DMR), Thailand. Under the Petroleum Act of Thailand (1971), exploration data were given to DMR will be releasable after 2 year of relinquish most. The data consist of seismic sections, cutting samples, descriptions of sidewall core, wireline geophysical logs and general geological data. Reflection seismic sections are approximately 1,000 line-kilometres. Forty-eight-fold stacked seismic sections have a vertical scale of 5 centimetres/second, shot point interval of 25 metres and 5 seconds record length. The total number of cutting samples are 350. Wire-line geophysical logs of 4 wells are available in term of caliper, gamma ray, spontaneous potential (SP), resistivity logs (MSFL,LLS,LLD), compensated neutron logs (CNL), formation density compensated (FDC), dip meter and sonic log. In addition, sidewall core descriptions, paleontological and geochemical analyze data are also available.

1.5 Study Methodology

Basically, the existing information on regional geology of the Gulf of Thailand are reviewed to serve as a background of the present study. Later on, the study is focusing upon the geological setting of the Hua Hin basin and Upper Gulf of Thailand in order to fully understand the geological history, sedimentation pattern as well as tectonic evolution. The data were collected and prepared to serve the objectives of the study programme. Seismic data were selected and analyzed to search the boundary of depositional sequence and important geological structures. At the same time, the wire-line geophysical logs data from 4 drill holes have been studied together with geological logs and cutting samples to determine lithology, sedimentary structure, paleontology and others. The classification of bedding thickness of Mckee&Weir (1953) and the rock colour chart of Goddard&et.al. (1948) are used to descripe the characteristics of the sediments in this study. The results of these study were compared and correlated to establish the sedimentary units. Various sedimentary units were classified, defined and described. Vertical sedimentary successions, which have been stratigraphically defined, are correlated in order to illustrate their horizontal distribution using Walther's law (1884) of the correlation of facies. Moore (1949), defined the sedimentary facies as "A sedimentary facies is defined as an areally restricted part of a designated stratigraphic unit which exhibits characters significantly different from those of other parts of the unit". Afterthat, under the present study the sedimentary sequences are analyzed in terms of sedimentary facies (Selley,1978; Reading,1979; Middleton,1973; Davis,1983; Miall,1984; Anderton,1985; Walker,1984). The sedimentary facies were interpreted for depositional environments of the study area. Finally, the sedimentary basin is reconstructed within the framework of regional geological setting of the study area including the configuration of the basin and geological evolution (Fig.1.5.a & 1.5.b).

1.6 Previous Investigations

The earliest study of the Gulf of Thailand was carried out by Emery and Niino (1963), covering the bottom and dispersal patterns of surficial deposits and subsea topography.

From geophysical surveys, Parke (1971) gave the first comprehensive account showing the extent and approximate depth of the main Tertiary basins of the Gulf of Thailand.

Achalabhuti (1974) summited the first paper dealing with the offshore oil industry's drilling results in Thailand. In 1980, he reported the geological history and hydrocarbon potential in the Gulf of Thailand, particularly the gas and condensate fields of the concession block no.23 which is one of potential area of the Union Oil Company. Afterthat, he described the natural gas deposit of two gas-condensate field belonging to Union Oil and Texas Pacific companies in 1981.

Paul and Lian (1975) described the specific well data and seismic data from Union Oil concession block and presented the basement structural map of the northern Sunda shelf.

Woollands and Haw (1976) published a paper on Tertiary stratigraphy and sedimentation in the Gulf of Thailand in more detail. They used the results of the three wells drilled in three different sub-basins in the Gulf. These wells were drilled by the BP Petroleum Development of Thailand Limited.

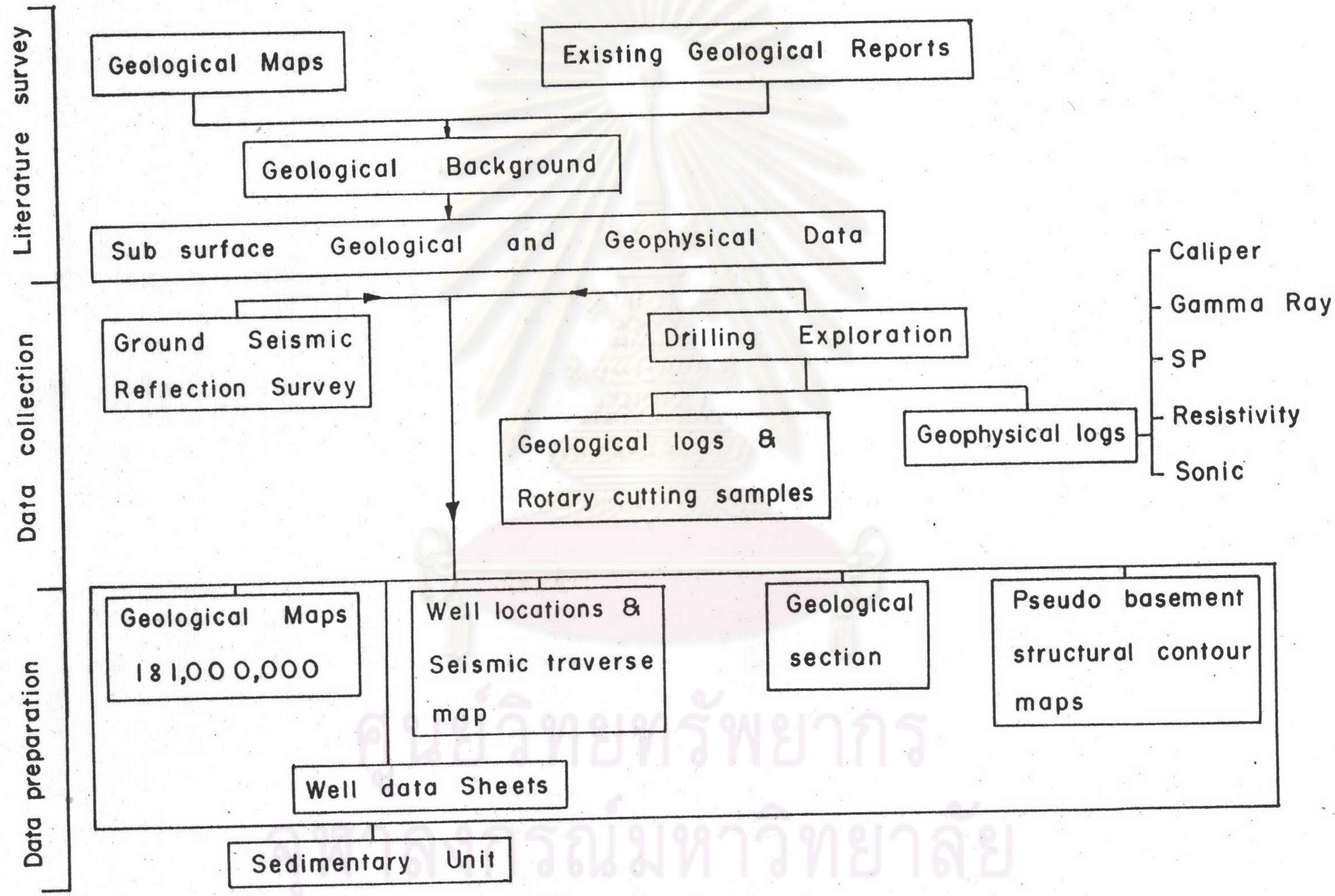

Figure 1.5 a The summarized flow chart illustrating the study methodology for literature survey, data collection and preparation.

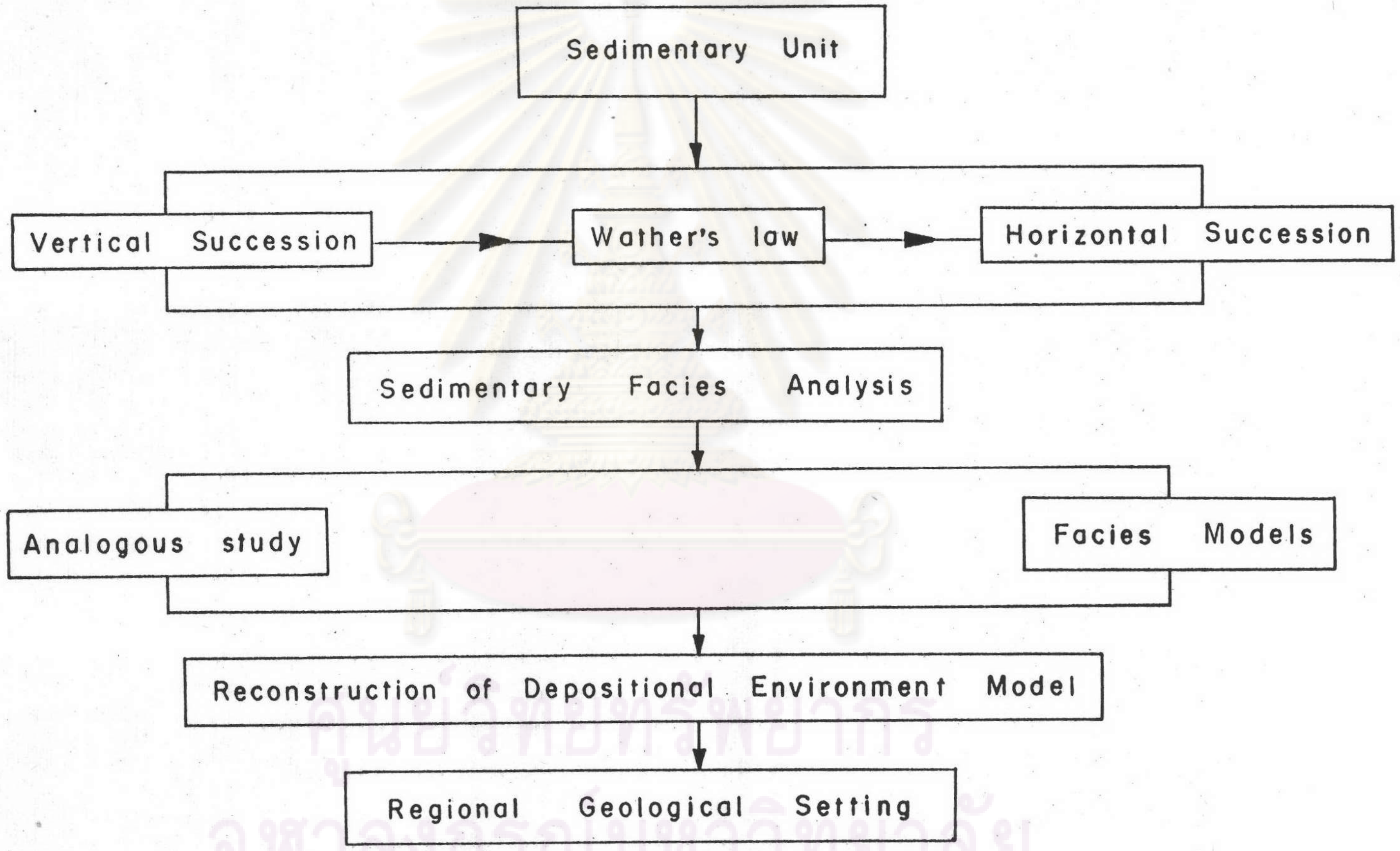

Figure 1.5 b The summarized flow chart illustrating the study methodology for interpretation and reconstruction of depositional environments.

Bunopas and Vella (1983) proposed that the opening of the Gulf of Thailand is the results of the rifting of Sunda shelf and a brief period of spreading during Late Cretaceous- Early Tertiary using the evidences from geological and geophysical data.

Khantaprab and Sarapirome(1983) reviewed the geology of the Gulf of Thailand and Andaman sea.

Lek-u-Thai, Sangsuwan and Thongpenyai (1984) utilized the exploration drilling data in Chumporn basin, to analyze the petroleum potential in terms of source rocks, and geothermal gradient.

Lian and Bradley (1986) described the geology of the gas fields in Pattani basin, and proposed that the 3-D seismic techniques could solve the complex structural and stratigraphic problems. Besides, they identified the source rocks and determine the gas composition as well as the heat value in different gas fields.

Prадidtan (1987) proposed the chance to find the petroleum in the upper Gulf of Thailand through the study of the geological evolution of the Hua Hin basin. In 1989, he suggested the characteristics and control of lacustrine deposits of some Tertiary basins in Thailand using the data from Chumphon and Fang basins.

Pradidtan, et. al., 1990, study the sedimentary sequences of the Western, Chumphon, Pattani and Malay basins and concluded the stratigraphy of Tertiary basins in the Gulf of Thailand.

Nakornthap and Chinbunchon (1988) proposed that the petroleum may be trapped in the pre- Tertiary sediments using data from Chumporn basin at Nang Nuan oil field of the Thai-Shell Exploration and Production Co.,Ltd.

In 1989, Chinbunchorn, Pradidtan and Sattayarak assessed the petroleum potential of Tertiary intermontane basins in Thailand. They suggested, that these basins were developed during Tertiary time under nonmarine depositional system, and sequences of Lower to Middle Miocene lacustrine deposits are the petroleum source rocks.

Burri (1989) proposed that most of basins in SE Asia were originated during Early Tertiary as a result of extensional rifting associated with collision of India with Asia.

Palachan and Sattayarak (1989) suggested, the development of N to S trending Tertiary basins in Thailand were related to complex movement of NW to SE and N-NW to S-SE trending strike-slip faults as evidenced of the clockwise rotation of SE Asia and recent earthquake in this region. The NW to SE trending faults are the Red River, Mae Ping, Three Pagodas and Sumatra while N-NE to S-SW trending faults are Uttarradit, Ranong and khlong Marui. The collision of Indian craton with southern Asia caused clockwise rotation of SE Asia, that subsequently led to movements on the strike-slip faults.