CHAPTER 1

INTRODUCTION

General

Cenozoic sediments are very important targets for petroleum exploration. In Thailand most Cenozoic basins are located in an old suture zone (Uttaradit-Nan Suture) between Indochina in the east and Shan-Thai block in the west. This suture is a mobile area of repeated orogenic movements since the Palaeozoic (Burri.,1989). Regarding the geology of the a Cenozoic basins in Thailand, approximately 30 basins are expected to have petroleum potential, of which 19 basins are in the onshore area, and 11 basins are in the offshore area. (Fig.1.1 a).

The petroleum exploration in Thailand began in 1921 with the aim to find alternative fuels for locomotive instead of timber logs. Early petroleum exploration was conducted by the government in the Fang Basin in Northern Thailand where oil seeps were earlier found.The aeromagnetic and gravity surveys were carried out over Chao Phraya basin in Central Thailand in 1954. Four wells were drilled in Ayutthaya province where a prospect was identified, but unfortunately no hydrocarbon was found.

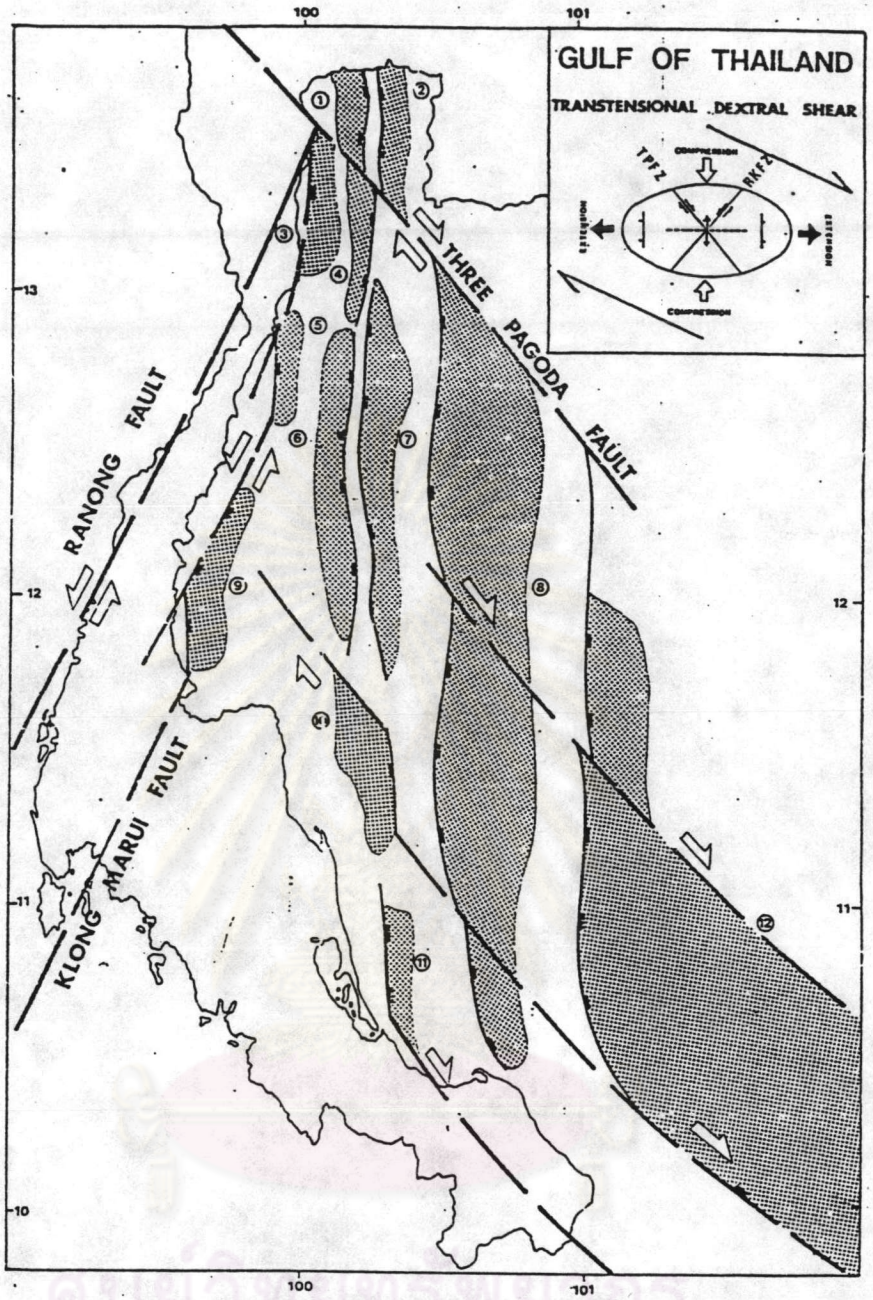

Figure 1.2 a Strutural map of the Gulf of Thailand, showing relationship between conjugate strike-slip faults and the development of N-S trending pull-apart basins. (1) Sakhon, (2) Paknam, (3) Hua Hin, (4) N.Western, (5) Prachuap, (6) Western, (7) Kra, (8) Pattani, (9) Chumphon, (10) Nakhon, (11) Songkhla (12) Malay (after Polachan and Sattayarak, 1989)

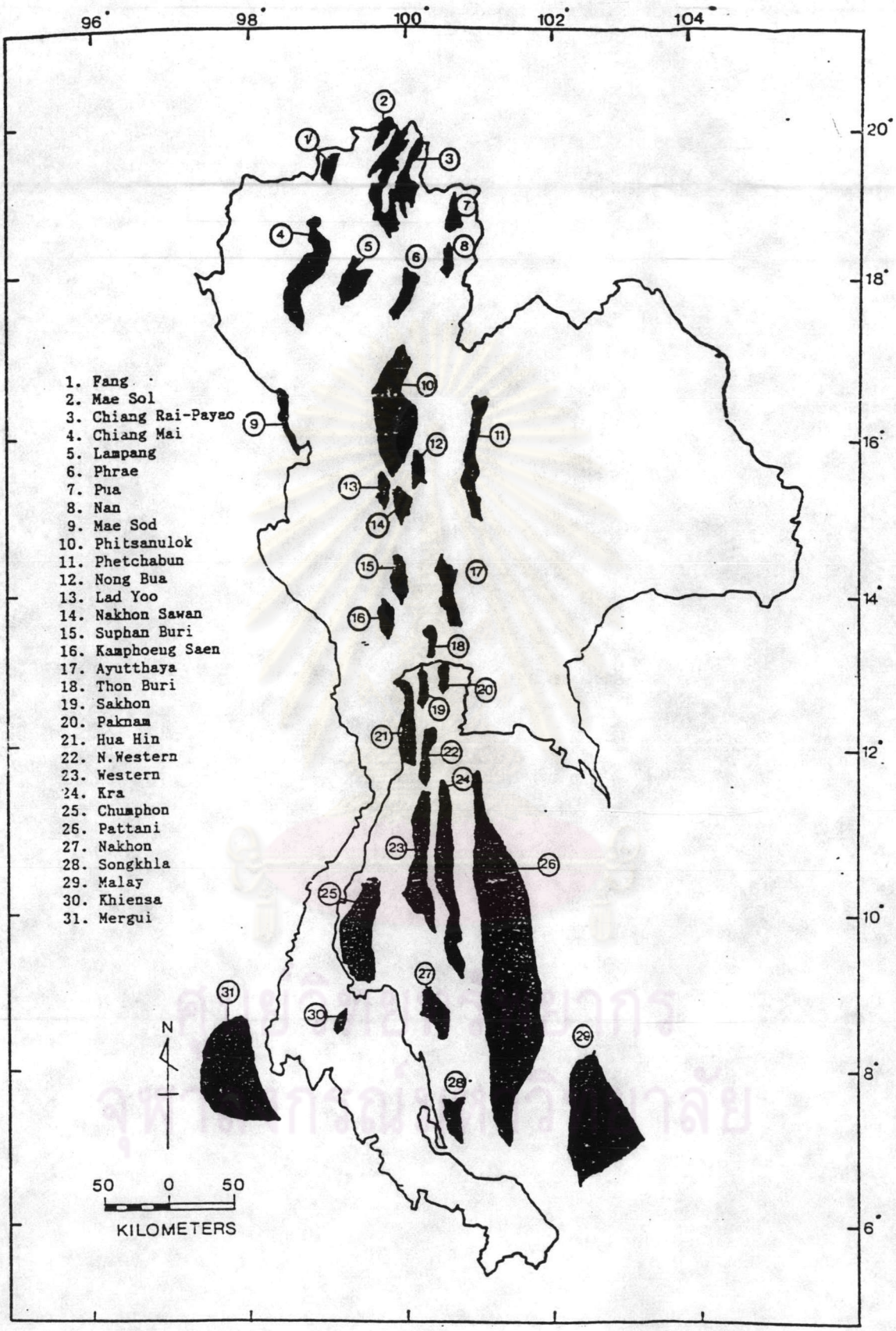

Figure 1.1 a Significant Cenozoic Basins in Thailand;

(after Chinbunchorn et.al., 1989)

In 1954 Thailand changed her attitude by allowing private sectors to engage in the petroleum exploration and production. A few foreign companies were granted the exploration permits in the onshore area. After drawing up the rules for petroleum exploration and production application, six companies were granted permissions to explore in the Gulf of Thailand in 1968.

The first exploration well was drilled in the offshore area in 1971, and plugged as a dry hole. But geological evidences were encountered which proved to have petroleum accumulation in the Gulf of Thailand. Two years later, natural gas and condensate were found in the Erawan Field. At present, more than 650 wells were drilled, and 19 gas and oil fields were founded in the Gulf.

Most of the producing strata of Thailand are in Tertiary age most important reservoirs of Miocene age. During 1981-1991, Thailand's productive areas have the accumulative production of 1.57 trillion cubic feet of gas, 52 million barrels of condensate, and 60 million of oil (Trangcotchasan et al.,1992).

Exploration in the Western basin, one of Cenozoic basins in the Gulf of Thailand,is still at a relatively early stage. However, at present some geological information from the sub-surface in this area is available, as the concessionaire BG Thailand Limited,

relinquished the concession of B5/27 to the Thai Government two years ago.

Exploration in the Western basin which is located in blocks 5 and 6 was undertaken by the AMOCO Thailand Petroleum Co. In 1971, the well 6-1-C was drilled in the northern part of the Western basin which is my study area (Fig.1.1 b). The trace of petroleum was discovered.

Structural framework

The northern part of the Gulf of Thailand appears to lie near the intersection of two major strike slip fault systems (Fig.1.2 a). The NW-SE trending Three Pagoda Fault runs from the Myanma border and appears to extend into the northern part of the Gulf. The NE-SW trending Ranong Fault cuts across the peninsular Thailand and may extend into the north-western part of the Gulf (Achalabuti,1974; Polachan and Sattayarak,1989). Both sinistral and dextral movements along both faults have been reported by various authors.

Pre-Triassic structural elements in Thailand and the peninsula are generally oriented in the North-South trend. These structural grains are likely to be present in the northern part of the Gulf.

Macabe et al. (1987) described dextral movement of the NW-SE trending Three Pagodas Fault during the

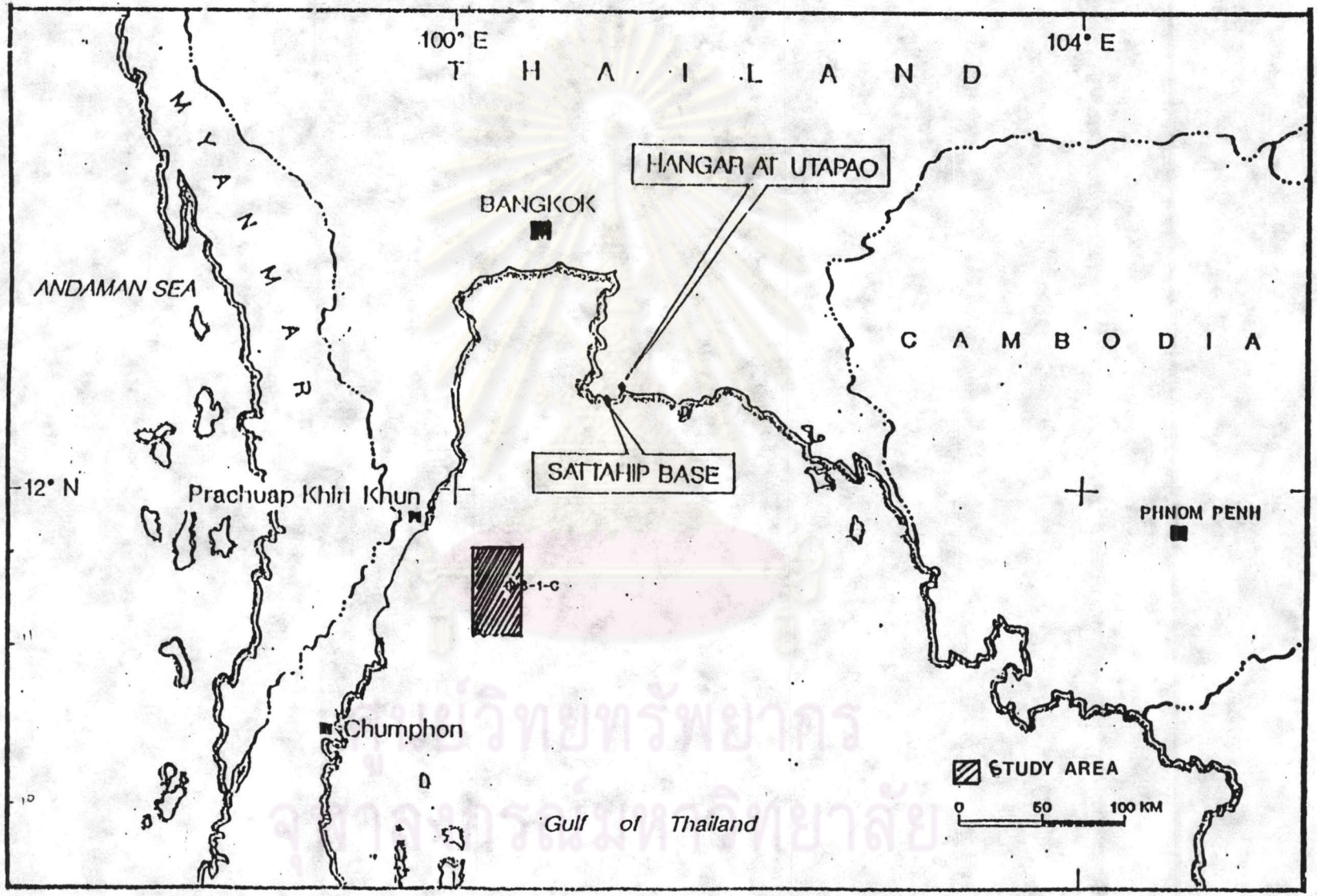

Figure 1.1 b The study area illustrating the location of the AMOCO 6-1-C well.

Neogene time.

Polachan (1988) suggested that the dextral movement of the NW-SE strike-slip faults and the sinistral movement of the NE-SW strike-slip conjugate faults, probably had occurred initially in the Oligocene.

Pradidtan et.al.,(1991) proposed a Pre-Tertiary basement map (Fig.1.2 b) and regional cross- section (Fig.1.2 c), respectively. The geometry and distributiom of the basins in the northern part of the Gulf of Thailand are therefore revealed.

In Southeast Asia Tertiary tectonics have largely been caused by the interaction of Indian and Eurasian plates. The Indian plate separated from Africa during Late Cretaceous time and through the northward movement, eventually collided with the Eurasian plate in the Eocene. With continued penetration to the north, Southeast Asia was slowly pushed out to the southeast and progressively rotated clockwise, with the angle of subduction changing from perpendicular to oblique. Progressively increasing oblique subduction accelerated dextral movement of the NW-SE strike-slip fault, including the Three Pagodas and Mae Ping Faults (Tapponier.,1986).

The Gulf of Thailand can be divided by the N-S trending Ko Kra ridge into two areas, the West and the

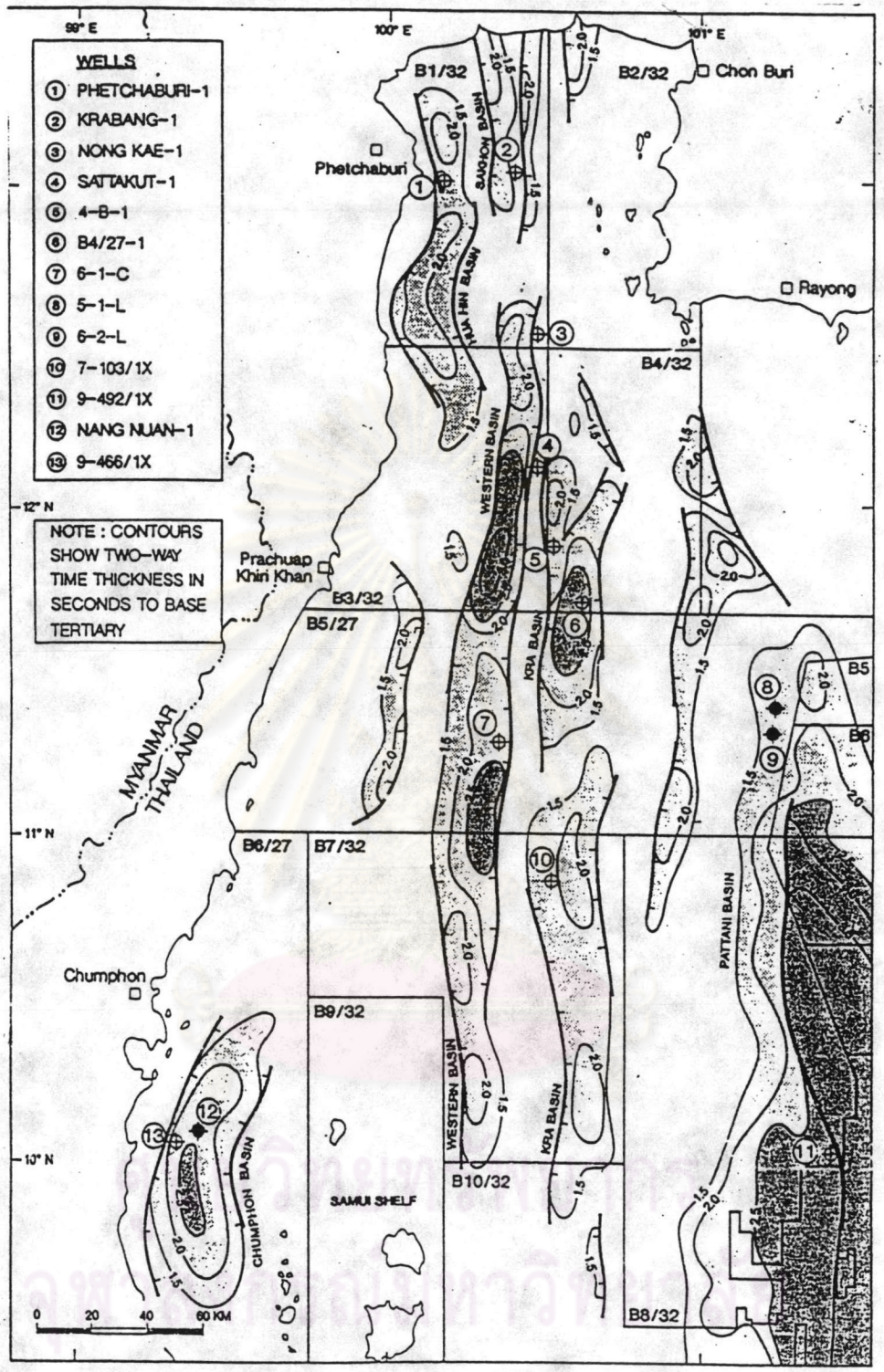

Figure 1.2 b Tertiary basins in the northern part of the Gulf of Thailand. (after Pradidtan et.al.,1991)

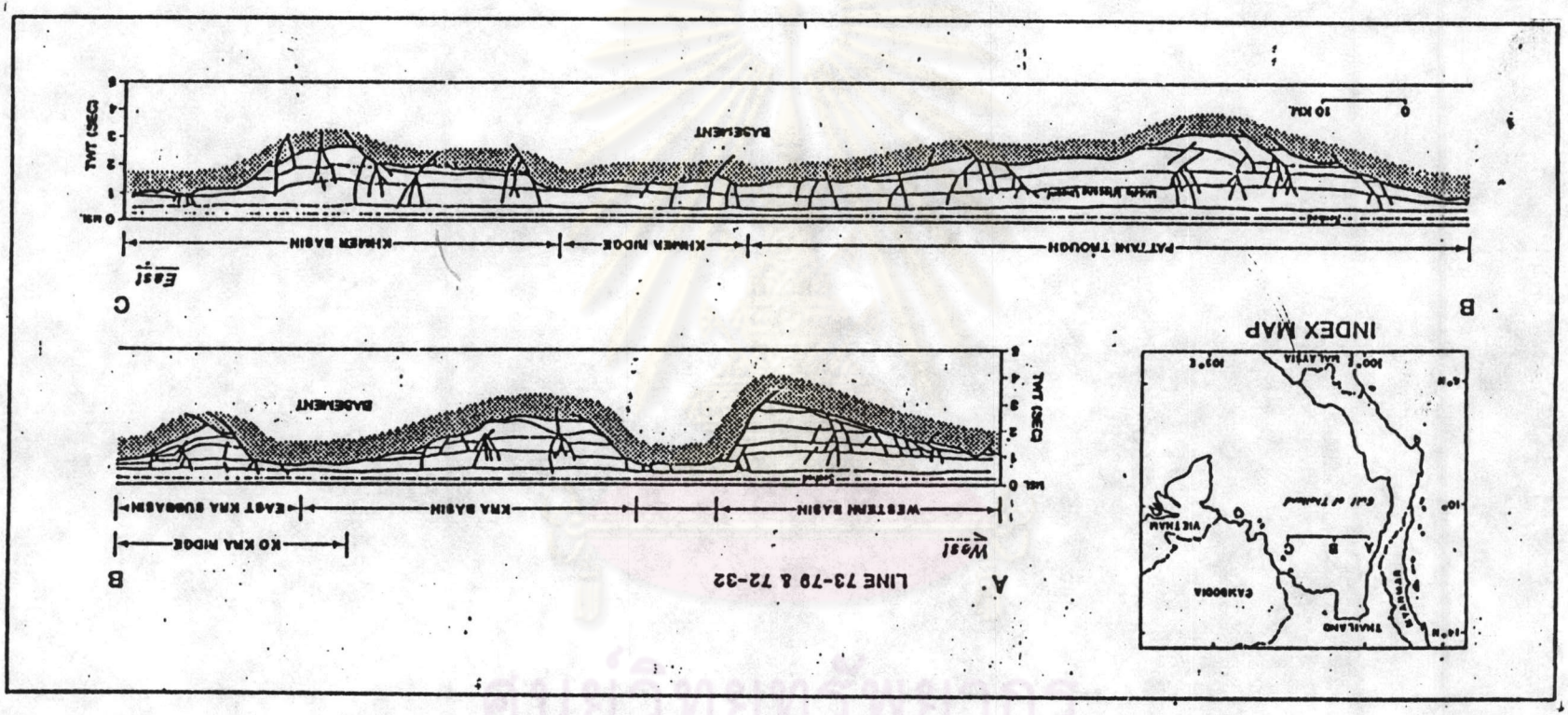

Figure 1.2 c Section across the northern part of the Gulf of Thailand (after Pradidtan et.al.,1991)

East. According to Bunopas (1981), the west area, where numerous narrow and small Tertiary basins are located, appears to be situated in the Shan-Thai block. The East area, where the Pattani and Malay basins are located, appears to be part of the Indochina block.

Geological setting

The Gulf of Thailand is bordered on the east by the Indochina peninsula, and on the west by Thai-Malay peninsular (Fig.1.3 a). The northern part of the Western basin is one of Cenozoic basins in the Gulf of Thailand which is rested on the left side of Kra basin. This basin resulted from the Eocene to Oligocene collision of the Indian plate with Eurasia and the subsequent extrusion and rotation of Indochina.The bathytmetric features and sea floor configurations of the Gulf, are shallow and flat basin (Achalabhuti,1980). The area in the northern part of the Western Basin is very shallow with average depth of about 25 metres (Fig.1.3 b). Along the northern side of the upper Gulf, there are four rivers, namely, Meklong, Tha Chin, Chao Phraya and Bang Pakong debouch into the Gulf. In 1990, Pradidtan et al., analyzed the sedimentary sequences and described the stratigraphy of this area. They suggested that the sequence above the Late Middle unconformity is named as Chao Phraya Group. Then the sequences below the unconformity in each basin is defined as the basin group name (Fig.1.3 c), notably, Western Group, Chumporn Group,

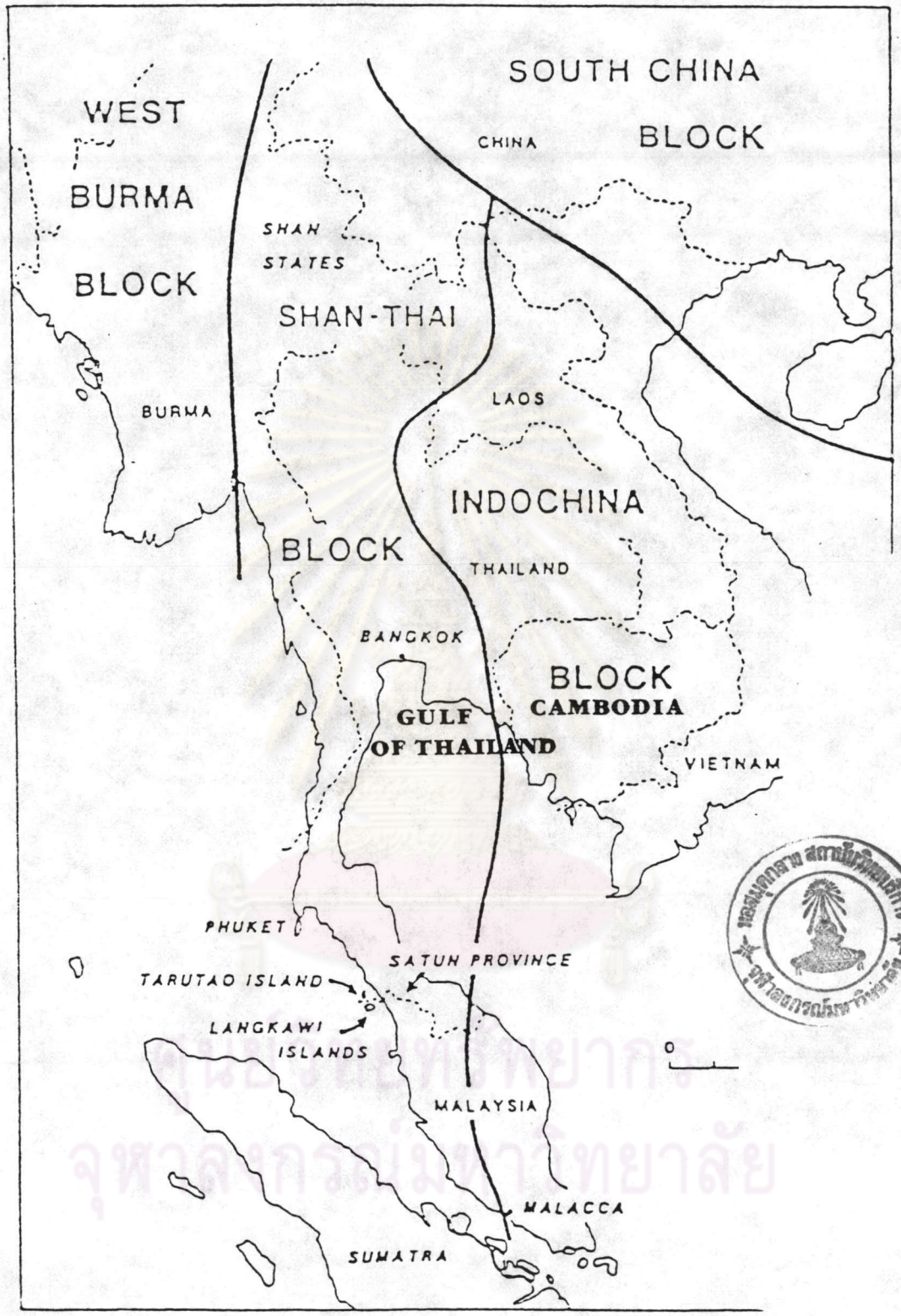

Figure 1.3 a The Gulf of Thailand and adjacent areas.

(after Bunopas and Vella, 1983)

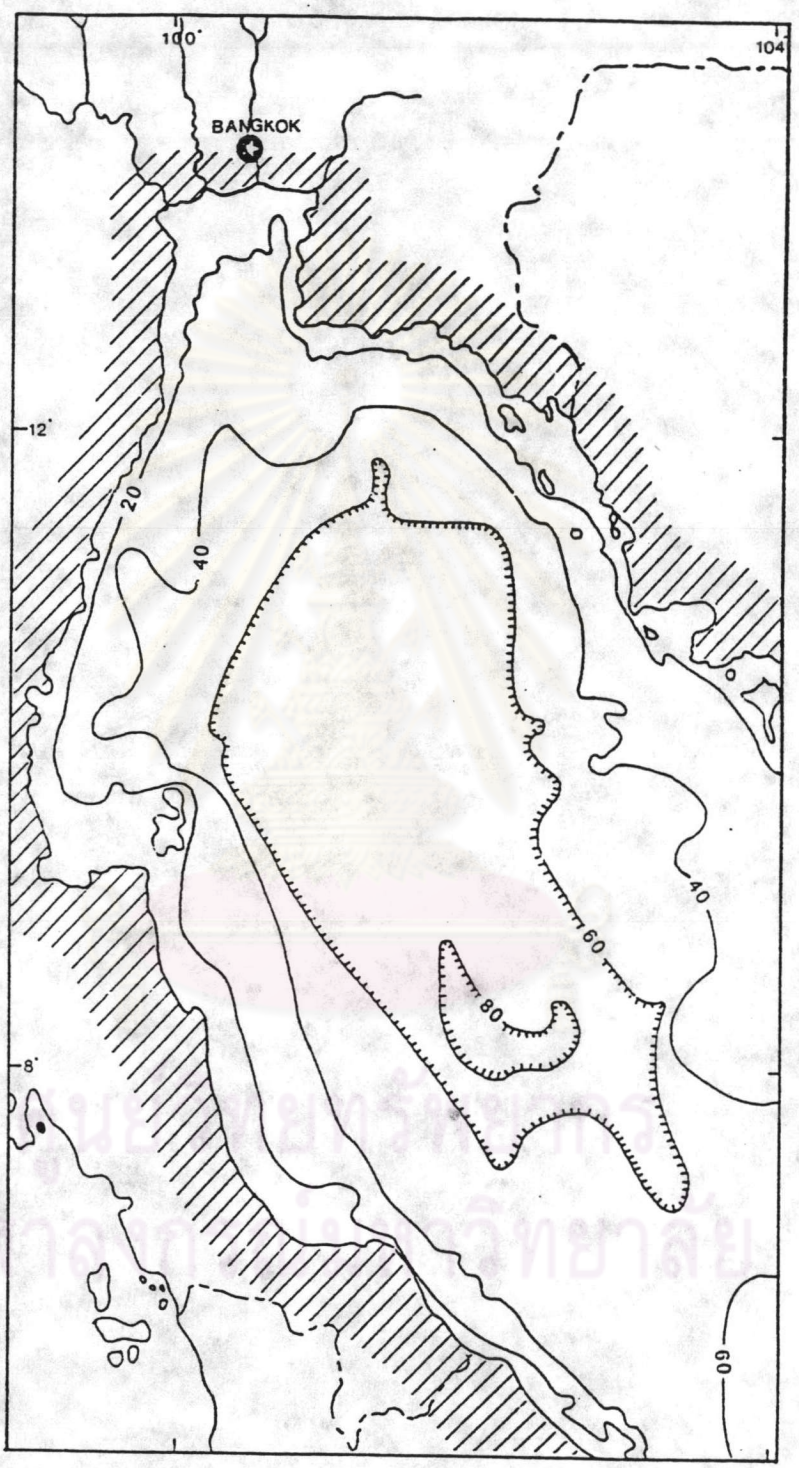

Figure 1.3 b Bathymetric chart of the Gulf of Thailand.
(after Emary and Niino, 1963)

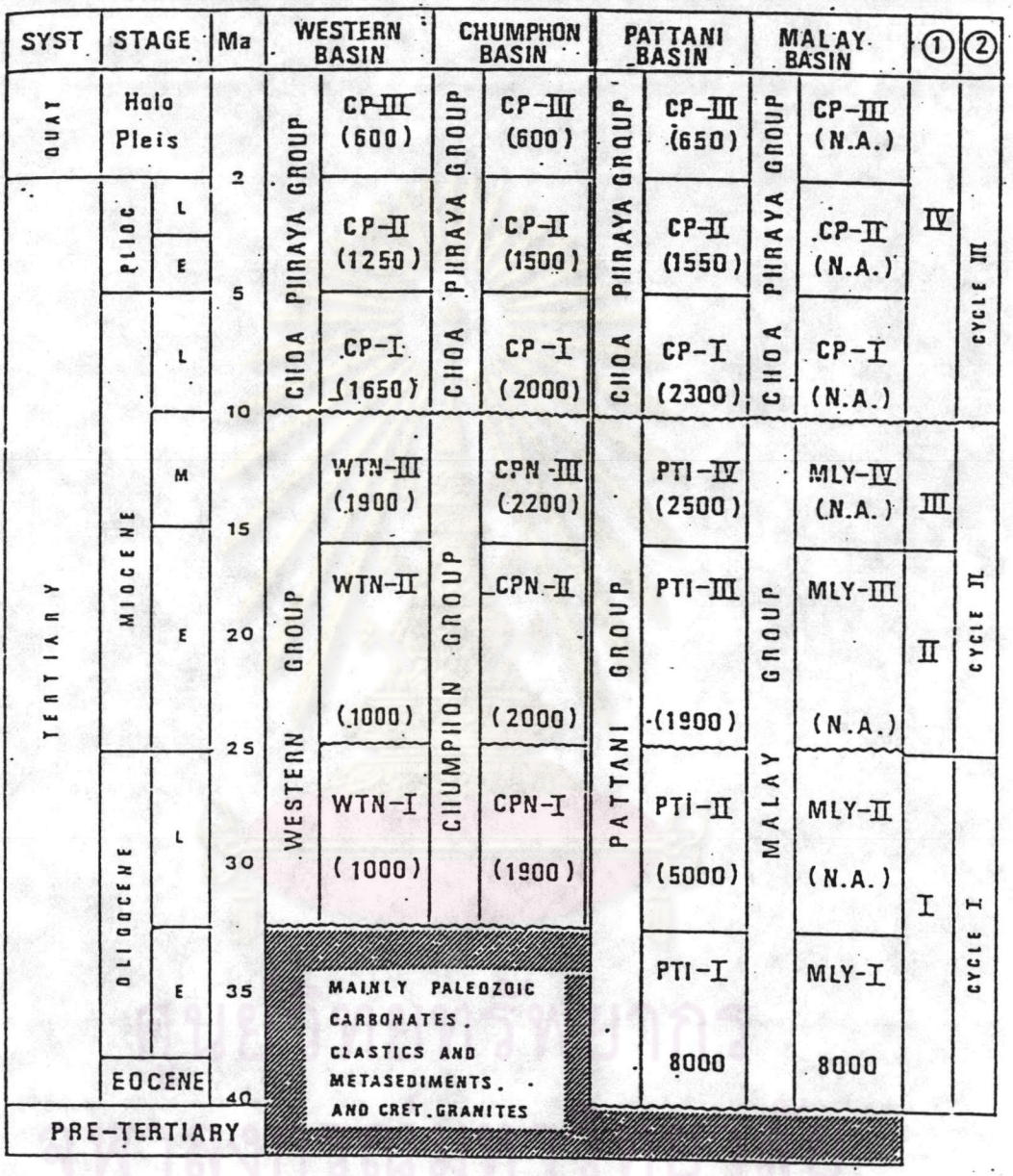

Figure 1.3 c The stratigraphy of the Tertiary basins in the Gulf of Thailand. (1): Lian & Breadley, 1986 ;(2): Woolands & Haw, 1976. (after Pradidtan et.al., 1990)

Pattani Group, and Malay Group.

Location of the study area

The study area is situated in the northern part of the Western basin between longitudes 100°5'E-100°20'E and latitudes 11°3'N-11°36'N as shown in Figure 1.1 b. This area covers only the northern part of the Western basin. The covers approximately 2,300 square kilometres.

The Well 6-1-C that was drilled by AMOCO is located at latitude 11° 16' 25.199" N , longitude 100° 20'17.583" E (Fig.1.4 a) or shot point 50 in the seismic section line number 74-107 (Fig.1.4 b)

Exploration history of the northern part of the Western basin

The Western Basin has been covered by the petroleum block Nos.5 and 6. In 26th, November, 1971 the concession No.5 and 6 were awarded to the Amoco Thailand Petroleum Company.

The Amoco drilled the well 6-1-C in 19th,November,1975 to the total depth of 7,000 ft. Non commercial hydrocarbon was present.

Later on, the BG Thailand was awarded and subsequently the BG Thailand Limited relinquished the

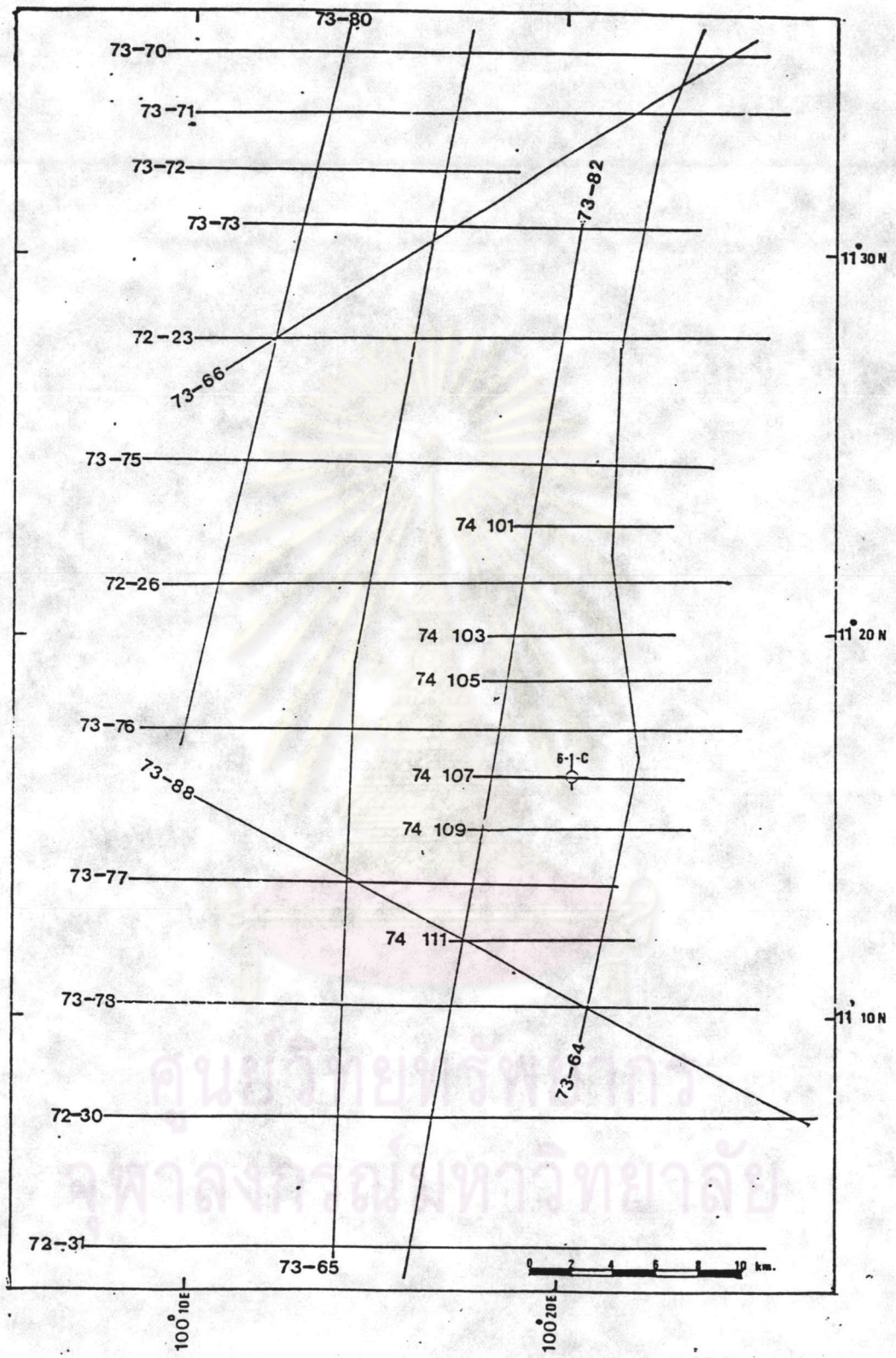

Figure 1.4 a The location of well 6-1-C and AMOCO seismic lines in the study area.

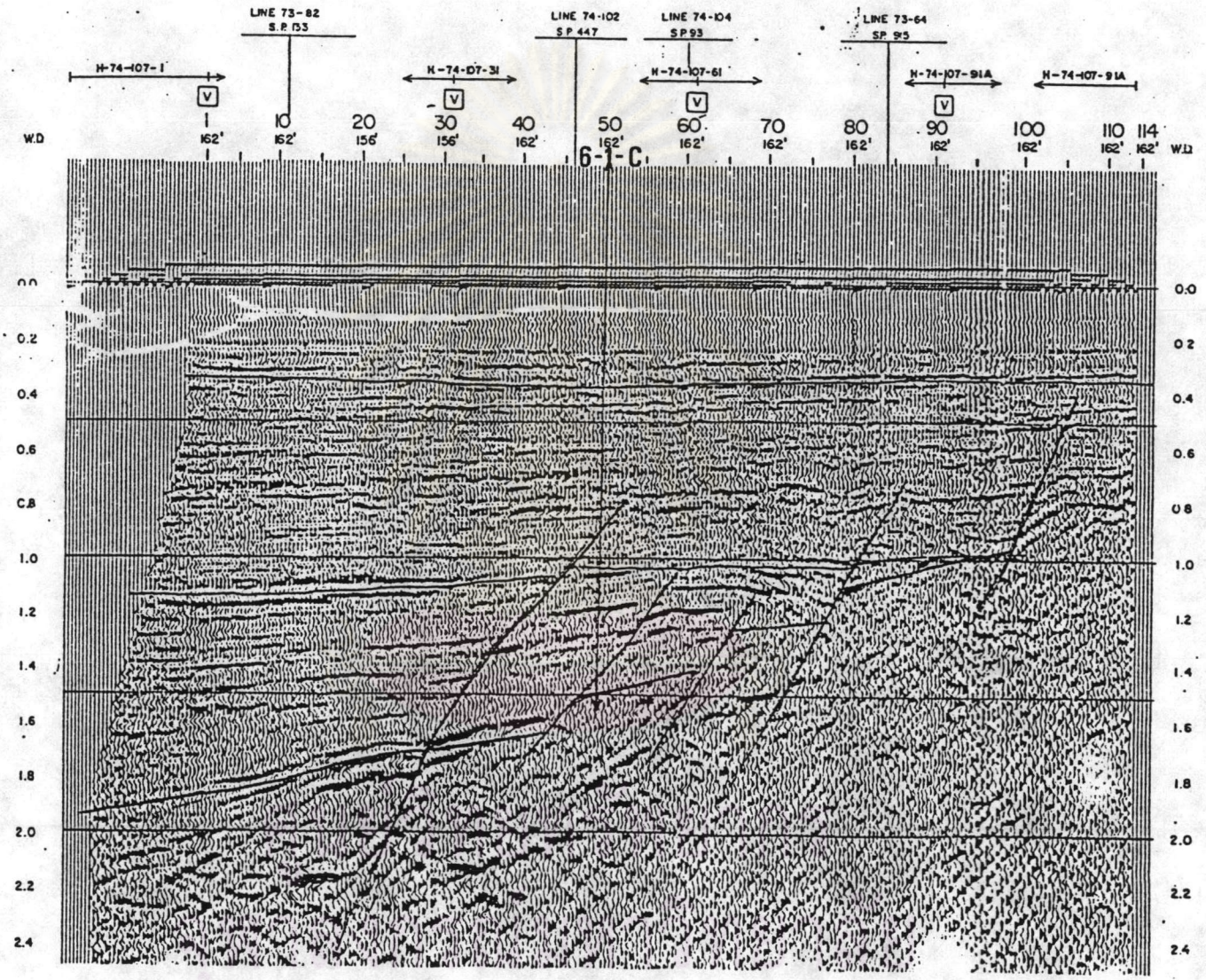

Figure 1.4 b Seismic line number 74-107.

exploration permit the concession of B5/27 to the Thai Government two years ago.

Objective of the study

-To assess the geology of the northern part of the Western basin and adjacent areas with emphasis on the upper sedimentary sequence of the basin.

-To reconstruct the geological evolution of the northern part of the Western basin in terms of sedimentation and tectonism.

-To conduct the preliminary assessment study of Cenozoic sediments and the petroleum potential of the northern part of the Western basin.

Data source

The data under the present study have been provided by the Department of Mineral Resources (DMR), Thailand. Under the Petroleum Act of Thailand (1971). Exploration data were given to the DMR after oil companies had relinquished their concessions. The data consist of seismic sections , 6-1-C well report, composite logs and electric wireline logs, biostratigraphy report, cutting and conventional cores.

1.Seismic reflection section consists of 18 lines

on dip section, and 6 lines on tie section. There are approximately 640 line-kilometres stack seismic section of poor quality. So the migrated seismic section from BG that explored in this area in 1991 has also been provided.

2. It contains 1 well report (6-1-C) and Biostratigraphy report.

3.The electric log of the 6-1-C well is composed of the Caliper, Self Spontaneous, Gamma Ray, Resistivity and Porosity log in scale 1:500 and 1:200.

4. 6-1-C report of lithology log.

5.Cutting and Conventional cores.

Study methodology

The study is focusing upon the geological setting of the northern part of the Western basin. In order to fully understand the geological history, sedimentation pattern as well as tectonic evolution, the petroleum geology of the northern part of the Western basin was studied using the following steps:

(1) Information on regional geology of the Gulf of Thailand are critically reviewed to serve as a background of the present study.

(2) Stratigraphic marker horizon were identified

using composite logs and biostratigraphic report.

(3) The relationship between the well data and seismic sections has been established.

(4) Seismic interpretation.

(5) The onset of oil generation was determined by using Lopotin's method.

(6) Heat flow analysis.

(7) Conclusion.

Previous investigations

The earliest study of the Gulf of Thailand was carried out by Emerry and Nino (1963), covering the bottom and dispersal patterns of surficial deposits and sub sea 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.

Achalabuti (1974) published the first paper dealing with the offshore oil industry 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. After that, he described the natural gas deposit of two gas-condensate fields

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.

Woolands 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.

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.

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

Lekuthai,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.

Pradidtan (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.

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.

Chinbunchorn, Pradidtan and Sattayarak (1989) 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.

Polachan and Sattayarak (1989) suggested that the development of North South trending Tertiary basins in Thailand were related to complex movement of NW to SE and N-NE to S-SW trending strike-slip faults as evidenced of the clockwise rotation of Southeast 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 Uttraradit, Ranong and Khlong Marui. The collision of Indian craton with southern Asia caused clockwise rotation of Southeast Asia, that subsequently led to movements on the strike-slip faults.

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

Bhuthaung (1990) proposed her thesis that the potential source rocks in Hua Hin basin are lacustrine facies and the potential traps are both stratigraphic and /or structural types.

Lekuthai (1991) prepared two structural contour maps in tha Kra basin, the pre-Tertiary basement and the

top of syn-rift sequence maps. The depo-centres and the basin outlines from that two maps including the restored fault in the pre-Tertiary basement map indicate that the Kra basin has extended in the same direction as the Three Pagodas fault movement.