

CHAPTER 1

INTRODUCTION

1.1 GENERAL OVERVIEW

Petroliferous basins in Thailand can be divided into two geological provinces; Tertiary and Pre-Tertiary basins. Tertiary basins are distributed throughout the country, both onshore and offshore. These basins are located in northern Thailand, the central plain, southern Thailand, the Gulf of Thailand and the Andaman Sea. In contrast, pre-Tertiary basins are restricted to the Khorat Plateau and its vicinities (Mineral Fuels Division, 1992).

There are many Tertiary basins in northern Thailand, ranging in size from 300 to 1,400 square kilometres. The narrow and deep basins include Thailand's first found oil field, the Fang basin. In the central plain, three main north-south trending Tertiary basins, namely the Phitsanulok, Phetchabun and the Chao Phraya basins, are sited 13 oil fields including, the most important Sirikit Field. In northeastern Thailand, gas has been discovered and production is being undertaken at Esso's Nam Phong Field. In the onshore southern Thailand, there are small basins containing Tertiary strata that are as yet no commercial production. In the Andaman Sea, gas and oil trace has been reported in the Mergui Basin. In the Gulf of Thailand, numerous Tertiary basins occur more or less in the N-S direction as grabens and half-grabens (Chinbunchorn and others, 1989). The area is separated by the N-S trending Ko Kra Ridge into 2 main parts; the western and eastern grabens. The western graben consists of 10 major narrow and small basins; namely Sakhon, Paknam, Hua Hin, Prachuap, N. Western, Western, Kra, Chumphon, Nakorn, and Songkhla.

Two biggest basins; the Pattani and Malay basins are located in the eastern graben (Pradidtan and Dook, 1992), (Figure 1.1). Major production came from the Pattani Basin. Gas and condensate has been found in the Malaysia-Thailand Joint Development Area (JDA). The exploration data reveal that the JDA's reserves are at least 6 trillion cubic feet. Exploration continues, and in the meantime natural gas production is due to commence on a commercial scale by 2000 (Petroleum Institute of Thailand, 1998).

Lian and Bradley (1986) described the geometry of the Pattani Basin, as a structural trough that elongates 400 km in the N-S direction and extends some 70 km east-west containing approximately 8 km thick of Tertiary sediments. These sediments consist almost exclusively of non-marine, fluvial-deltaic sediments which become shallow marine only in the uppermost sections. Following the discovery by UNOCAL in 1972 of commercial gas and condensate, the Pattani Basin has played a major role in the production of hydrocarbon for Thailand since 1981. At present, 21 minor sub-basins are in active exploration and production. (Table 1.1 and Figure 1.1).

1.2 REVIEW OF REGIONAL GEOLOGY

Woollands and Haw (1976) and Chinbunchorn and others (1989) classified Tertiary basins in the Gulf of Thailand and southern part of the South China Sea as intracratonic rift basins whereas Polachan and Sattayarak, (1989) classified as transtensional pull-apart basins. At present, most geologists believe that Tertiary basins are rift basins such as Bunopas, (1981) and Pradidtan, (1989).



Figure 1.1 : Map showing petroleum fields in Thailand (after Mineral Fuels Division, 1996)

Table 1.1 Pattani Basin, Gulf of Thailand production (as of January to September, 1998) (National Energy Policy Office, 1999).

No	Field in Pattani Basin Gulf of Thailand	Production	
		Oil (BBLPD)	Gas (BCF)
1	Erawan		298.00
2	Baanpot		15.00
3	Satun		212.00
4	Platong		106.00
5	Kaphong		
6	Gomin		26.00
7	Funan		212.00
8	Jakrawan		
9	Surat		10.00
10	Pakarang		
11	Trat		
12	Dara		
13	Plamuk		11.00
14	Pladang		38.00
15	Yala		
16	L-Structure		
17	Morakot		
18	Pailin		
19	Ubon		
20	Tantawan	6,733.00	95.00
21	Benchamas		
		6,733.00	1,525.00

These basins have originated as a result of the Eocene to Oligocene collision of the Indian plate with Eurasian plate. Tapponnier and others (1986) suggested that during the initial contact of Indian with Southern Asia, Southeast Asia lay to the east of India and was probably oriented in the NW-SE direction. With continued penetration to the north, Southeast Asia was slowly pushed out to the southeast and progressively rotated clockwise. The progressive rotation of southeast Asia had changed the angle of subduction of the Indian Ocean plate beneath the southwestern margin of Southeast Asia from perpendicular to oblique. Progressively increasing oblique subduction accelerated strike-slip motion led to the development of transtensional Cenozoic basins in this region (Figure 1.2).

1.3 STRUCTURAL FRAMEWORK

Convergence of India with Southern Asia was contributed at a great deal to the tectonics of Southeast Asia, especially to the formation of Cenozoic basins.

The Gulf of Thailand basin represents a northwards continuation of N-S structural features of Peninsular Malaysia and links them with the Chao Phraya and Central plain of Thailand. A series of N-S trending Tertiary rift basins in the Gulf of Thailand originated from N-S trending extensional faults which are spatially related to the movement of NW-SE and NE-SW trending strike-slip faults. The NW-SE trending faults including the Red River, Mae Ping, Three Pagodas and Sumatra faults are the principal strike-slip faults. The NE-SW trending faults including Northern Thailand, Uttaradit, Ranong and Klong Marui faults are

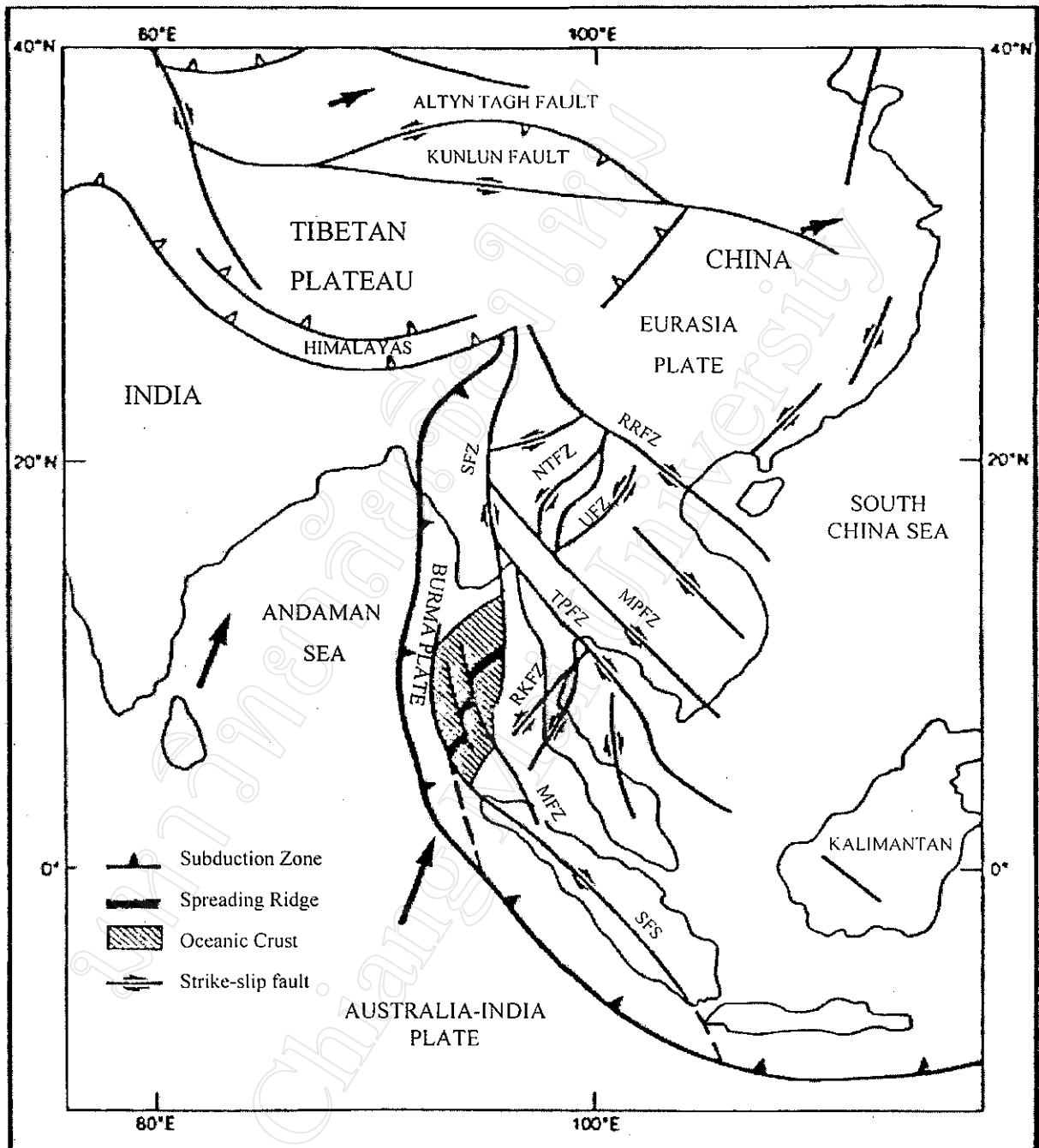


Figure 1.2 : Tectonic map of SE Asia and South China showing the main fault patterns and the relative movement of crustal blocks in response to the collision of India with Asia. SFS (Sumatra Fault System), MFZ (Mergui Fault Zone), SFZ (Sagaing Fault Zone), RKFZ (Ranong and Klong Marui Fault Zone), TPFZ (Three Pagodas Fault Zone), MPFZ (Mae Ping Fault Zone), UFZ (Uttaradit Fault Zone), NTFZ (Northern Thailand Fault Zone), and RRFZ (Red River Fault Zone) (after Polachan and others, 1991).

conjugate strike-slip faults (Figure 1.2). Movement direction of these fault has not been clearly described. Both sinistral and dextral movement along both faults have been reported by various authors.

Bunopas (1981) and Tapponnier and others (1982) proposed that the movement of NW-SE trending fault was left-lateral in the Tertiary. Using extrusion model, Tapponnier and others, (1982) suggested that as India penetrated further north to Asia, Southeast Asia was slowly sliced and pushed out southward along the NW-SE trending left-lateral strike-slip fault. In addition, Tapponnier and others, (1986) believed that the NW-SE and NE-SW trending fault changed from left- to right-lateral and right- to left-lateral, respectively, in the Late Miocene.

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

Polachan and Sattayarak (1989) further suggested that the large amount of left-lateral offset along the NW-SE trending fault zones as shown by Bunopas, (1981) and Tapponnier and others, (1982) was a result of E-W collision between the Shan-Thai and Indochina during the Late Permian to Middle Triassic. The same sense of movement may have been repeated in the Late Cretaceous to Early Tertiary when the Indian Craton started to collide with Burma. However, these faults were reactivated with a right-lateral sense during the development of Cenozoic basins in this region. In addition, the right-lateral displacement on these faults since the Oligocene is only some tens of kilometers, which is not sufficient to destroy a relict of the previous left-lateral offset. Movement along this conjugate set of strike-slip faults is interpreted to be

responsible for the development of the N-S trending basins (Polachan and others, 1991).

1.4 BASIN FORMATION

Polachan and Sattayarak (1989) suggested that the Tertiary Basins in Thailand originated and developed through dextral transtensional shear, based on the dextral NW-SE trending principal faults and the sinistral NE-SW trending conjugate faults, together with the evidence of clockwise rotation of crustal block. At present, this model is well accepted. With dextral shear and the present of N-S direction of pre-Triassic rocks grain, N-S extensional faults were extensively formed. These bounding faults controlled extensional rifting of the basins (Figure 1.3).

The precise timing of the opening of the basin is not clearly known. Pigott and Sattayarak, (1993) analysed the thermal subsidence of basins in the northern part of the Gulf and suggested that the opening of the rift basin was not instantaneous but spatially with time transgressive.

1.5 EXPLORATION HISTORY IN THE GULF OF THAILAND

In connection with the forbids in 1967. Thailand's portion of the Gulf of Thailand was divided into 19 blocks, generally of 10,000 sq. km each. Six companies; Gulf, BP, TENNECO, UNION OIL (UNOCAL), CONOCO, and AMOCO were awarded acreage (Figure 1.4). A considerable amount of geophysical survey was conducted in the period 1968 to 1970. The first well was drilled in the Pattani Basin, Gulf of Thailand by CONOCO, Surat-1 in 1971. In 1972, UNION OIL drilled 12-1 well, the first gas and condensate discovery. In addition, others

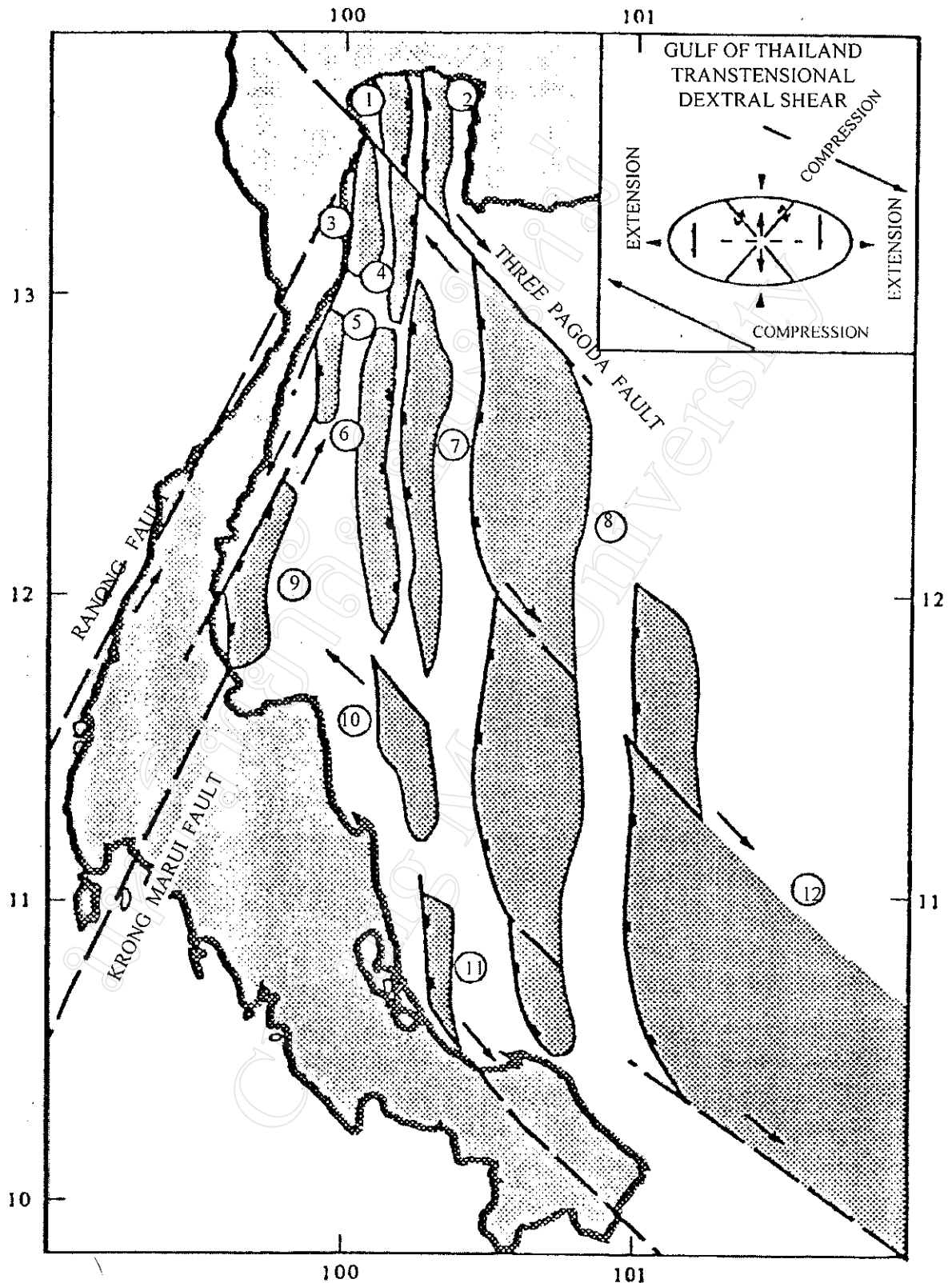


Figure 1.3 : Diagrammatic representation of the development of pull-apart basin in the Gulf of Thailand by the major strike-slip fault systems. 1. Sakhon; 2. Paknam; 3. Hua Hin; 4. N.Western; 5. Prachuap; 6. Western; 7. Kra; 8. Pattani; 9. Chumphon; 10. Nakhon; 11. Songkhla and 12. Malay (after Pigott and Sattayarak, 1993).

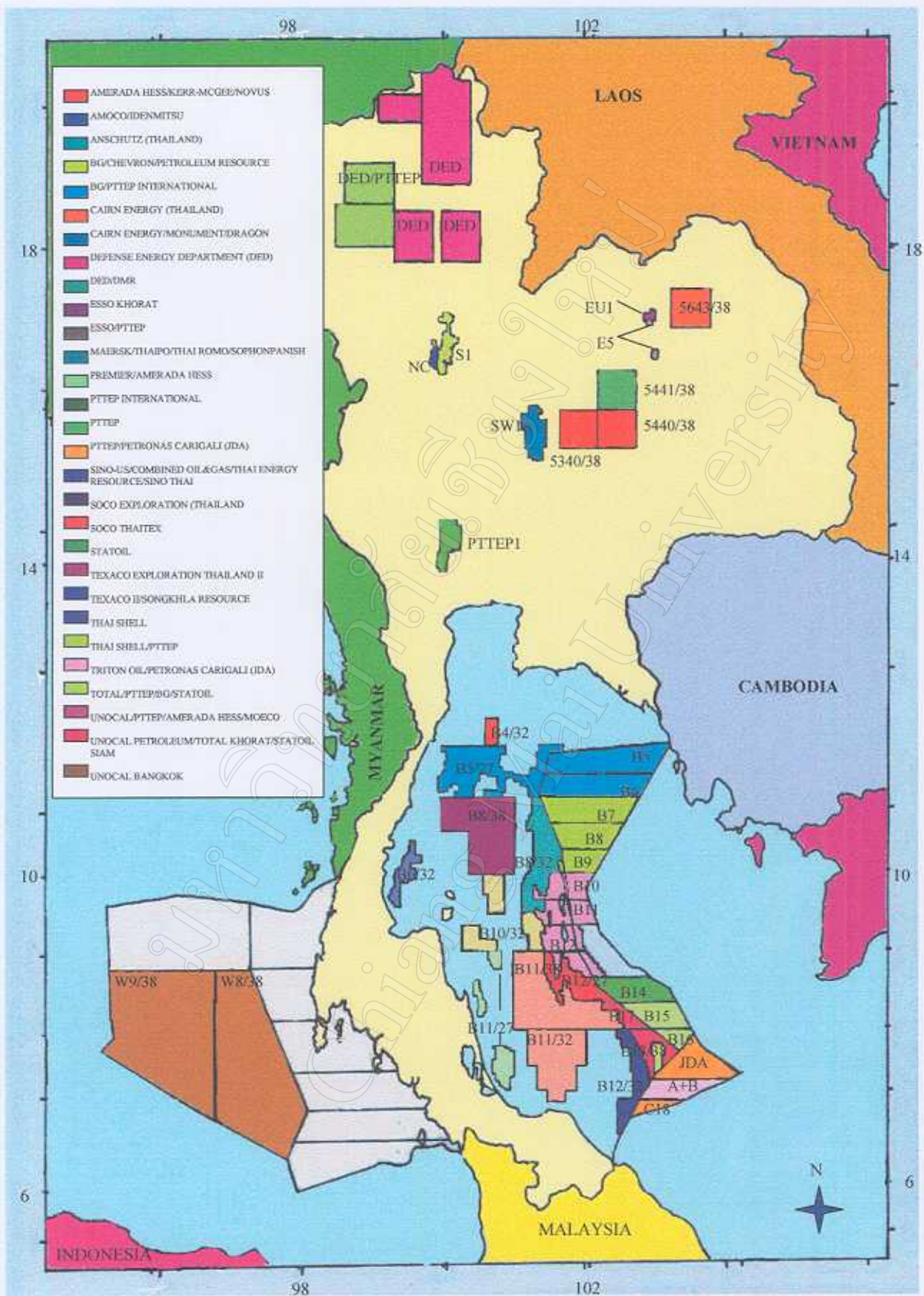


Figure 1.4 : Map showing petroleum operated blocks in the Gulf of Thailand (after Mineral Fuels Division, 1996).

drilling and exploration activity have been carried out since (Pradidtan and Dook, 1992).

The first natural gas production began in August, 1981 from Erawan field by UNOCAL. The big investment has been put to petroleum development since the end of 1990. The offshore activities have been dominated the scene. The petroleum development activities provide many advantages to the country, create and accelerate a lot of downstream industries and other businesses. Up to now, the total of 15 rounds of concession bidding have been announced, 120 applications submitted and 55 concessions awarded. At present, there are 18 holding concessionaires in the Gulf (Mineral Fuels Division, 1992).

The petroleum production in Thailand now consists of 1,671 billion cubic feet per day (BCF) of gas, 46.4 billion barrel per day (BBLPD) of condensate and 29,127 barrel per day (BPD) of crude as January to September, 1998 (National Energy Policy Office, 1999). The remaining petroleum proven reserves in Thailand consist of 7 trillion cubic feet (TCF) of gas, 167 million barrel (MMBBL) of condensate, and 137 million barrel (MMBBL) of crude oil. If including the probable and possible reserves, the total remaining petroleum reserves in Thailand consists of 21 trillion cubic feet (TCF) of gas, 250 million barrel (MMBBL) of condensate, and 200 million barrel (MMBBL) of crude oil. The potential undiscovered reserve of petroleum is expected to be half of these amounts (Mineral Fuels Division, 1996).

1.6 FLUORESCENCE MICROSCOPY HISTORY

Dating back to 1936, the fluorescence light technique was applied by Schocharadt to microscopic studies on coal, but only in recent years

have the equipment and methods been developed to such a degree of perfection that the fluorescence light microscope can now be used successfully for investigations not only on brown coal but also on low rank bituminous coal. In coal petrography, advantage can be taken of the fact that part of the macerals, in particular exinite, are auto-luminescent when irradiated with long-wave UV or blue light which is said that no fluorochromes needed to make them luminescent. In recent years, fluorescent-light microscopy has proved so useful for studies of coal, not only for scientific but also for practical purposes. This method is likely to be used in the future for routine petrographic analyses (Stach and others, 1982).

1.7 PURPOSE OF STUDY

The purpose of this investigation is to study the type of macerals, mainly the liptinite group, in the petroleum source rocks of the Pattani Basin, Gulf of Thailand. This study also aims to interpret the paleoenvironment and to establish a sedimentation model. The understanding of the component of source rocks led to estimated potential of the petroleum field.