CHAPTER 1
INTRODUCTION

Seismic method is used in exploring for petroleum, searching for groundwater and civil engineering. It is an important technique in petroleum exploration because of its high accuracy, high resolution and great penetration.

Seismic reflection profiles can be used to determine sub-surface geological information including structure, stratigraphy and depositional systems. Two-way time structure map and isochron map are constructed from interpretation of seismic profiles. The relationship between two-way time structure maps and isochron maps can be used to determine the development of geologic structures and identify hydrocarbon potential areas.

1.1 Objectives

The main objectives of this work are

1. To interpret seismic reflection data.
2. To study structural geology of the study area.
3. To determine the timing of structural development.
4. To identify the structure that may have hydrocarbon potential.

1.2 Study Area

The study area covers approximately 25 square kilometers in Phet Yai field, Pattani Basin, Gulf of Thailand (Figure 1.1).

1.3 Data Sets

The 2D seismic data were provided by Unocal Thailand Limited. The dataset consists of

1. A base map showing locations of seismic profiles (Figure 1.2).

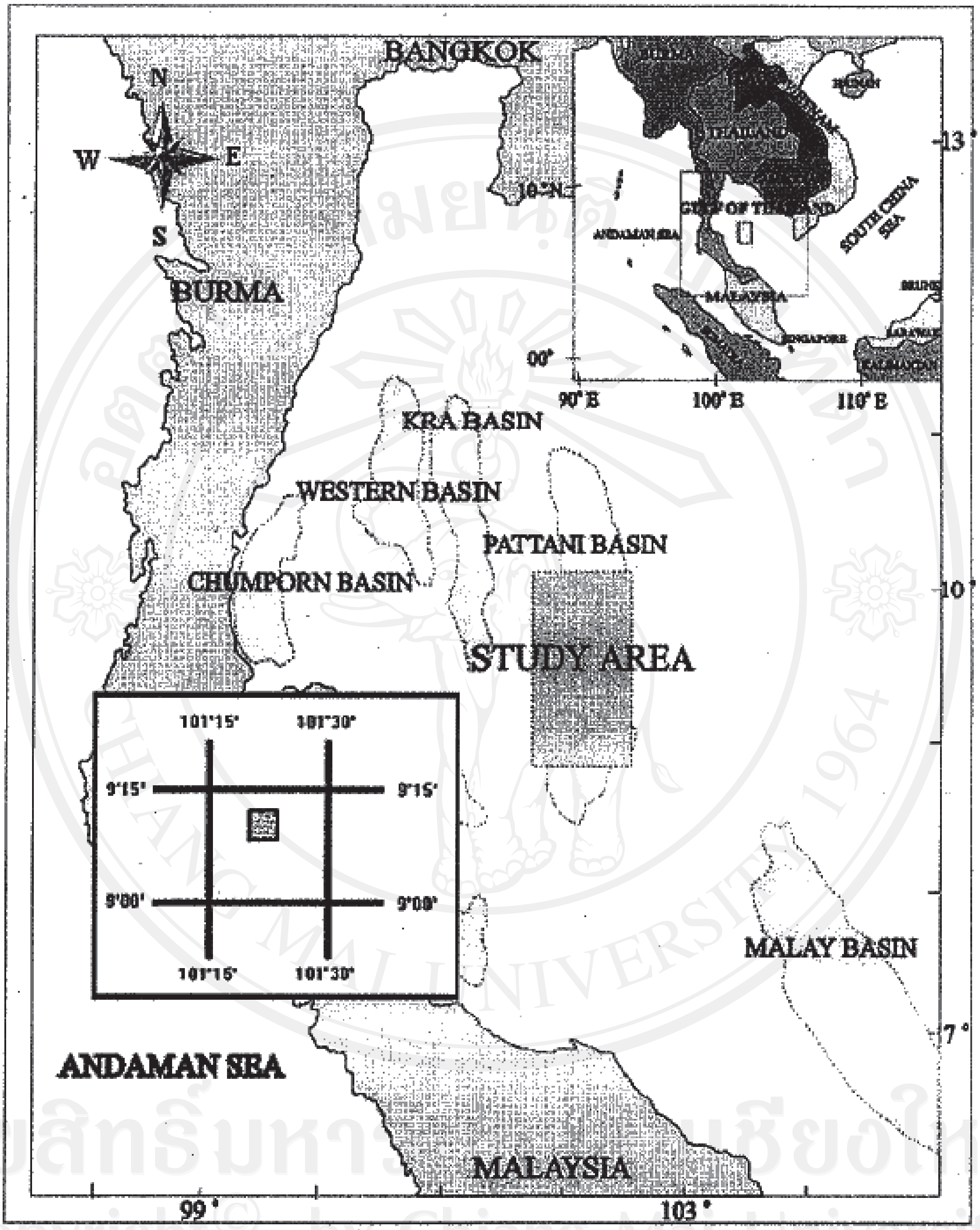


Figure 1.1 The study area in the Pattani Basin.

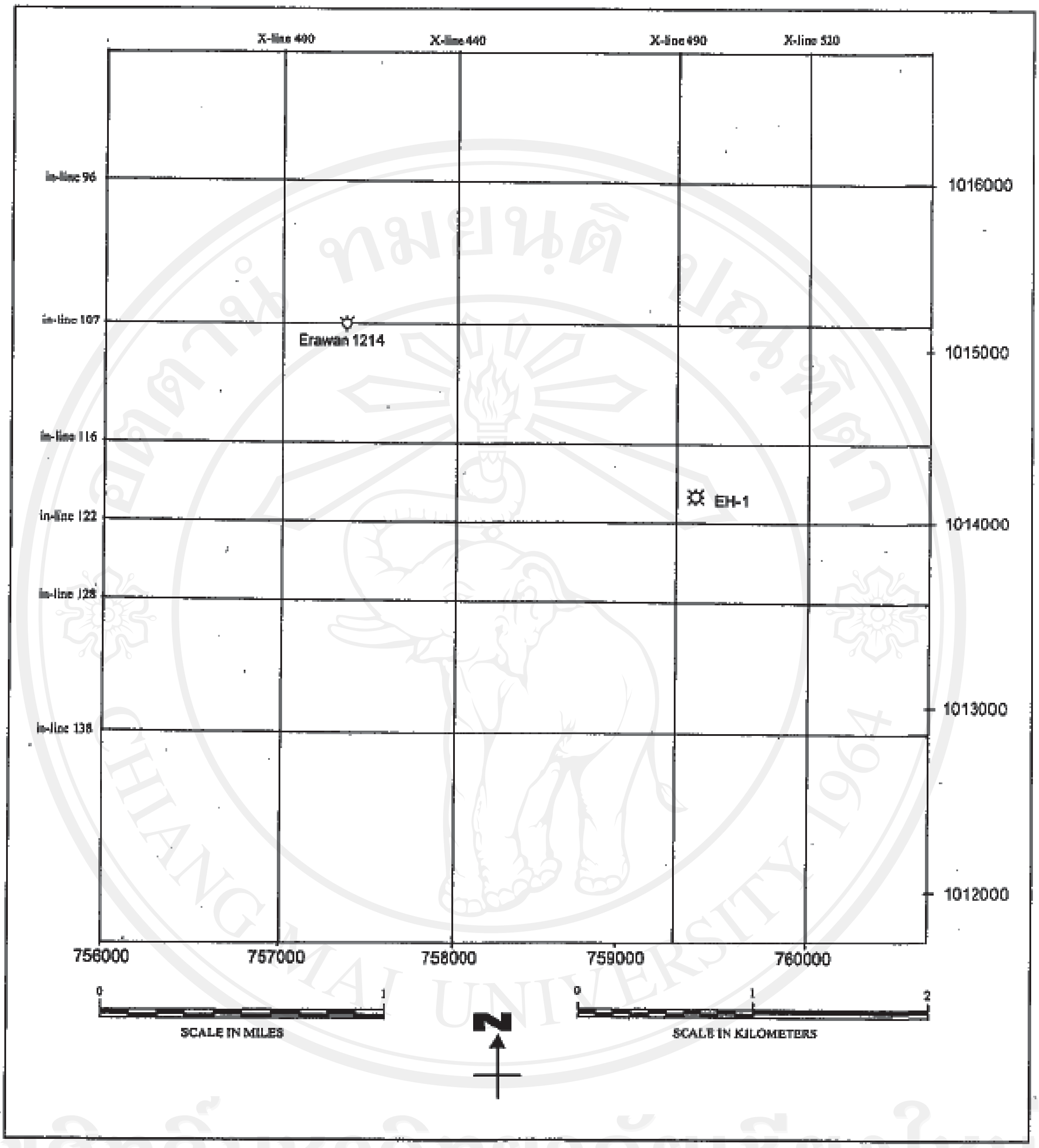


Figure 1.2 Base map of the study area showing locations of seismic profiles. UTM grid reference zone 47 N.

2. Six 2D E-W seismic "in-lines" (ER79-96,-107, -116, -122, -128, -138). The in- lines contain 189 traces.
3. Four 2D N-S seismic "cross-lines" (ER79-400, -440, -490, -520). The cross-lines contain 205 traces.
4. A Time/Depth conversion graph for Phet Yai field area.
5. Pattani Trough Stratigraphic Summary (Figure 1.3)

1.4 Literature Review

Chinbunchorn et al. (1989) classified Tertiary basins in the Gulf of Thailand and explained the southern part of the South China Sea as intracratonic rift basins and transtensional pull-apart basins. Tapponnier et al. (1986) proposed that Tertiary basins resulted from the Eocene to Oligocene collision of the Indian plate with Eurasia and the subsequent extrusion and rotation of Indochina. The Indian plate separated from Africa during Late Cretaceous time and, through northward movement, eventually collided with the Eurasian plate in the Eocene. With continued penetration to the north, South East Asia was slowly pushed out to the southeast and progressively rotated clockwise, with the angle of subduction changing from perpendicular to oblique (Tapponnier et al., 1986). Progressively increasing oblique subduction accelerated dextral movement of the NW-SE strike-slip faults led to the development of transtensional Cenozoic basins in this region (Figure 1.4).

1.4.1 Structural Framework

The structural framework of Tertiary basins in Thailand is governed by N-S trending normal faults associated with NW-SE and NNE-SSW conjugate strike-slip faults (Polachan and Sattayarak, 1989). The NW-SE trending faults, the Red River, Mae Ping, Three Pagodas and Sumatra represent the master right lateral strike-slip faults, and the NNE-SSW trending faults, the Northern Thailand, Uttaradit, Ranong and Klong Marui faults are left lateral which can be interpreted as a conjugate set (Figure 1.4). Polachan (1988) suggested that the dextral movement of the NW-SE

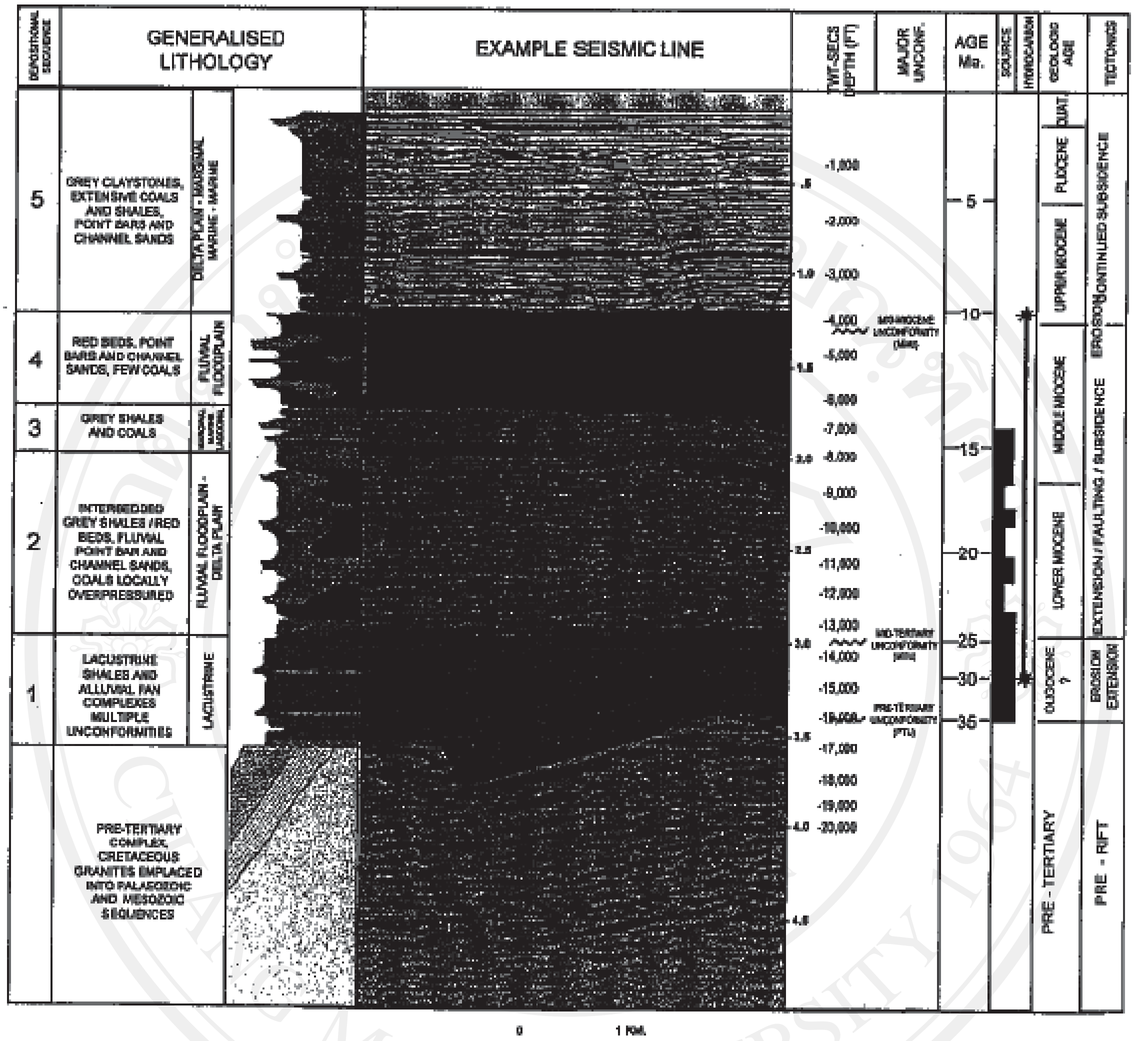
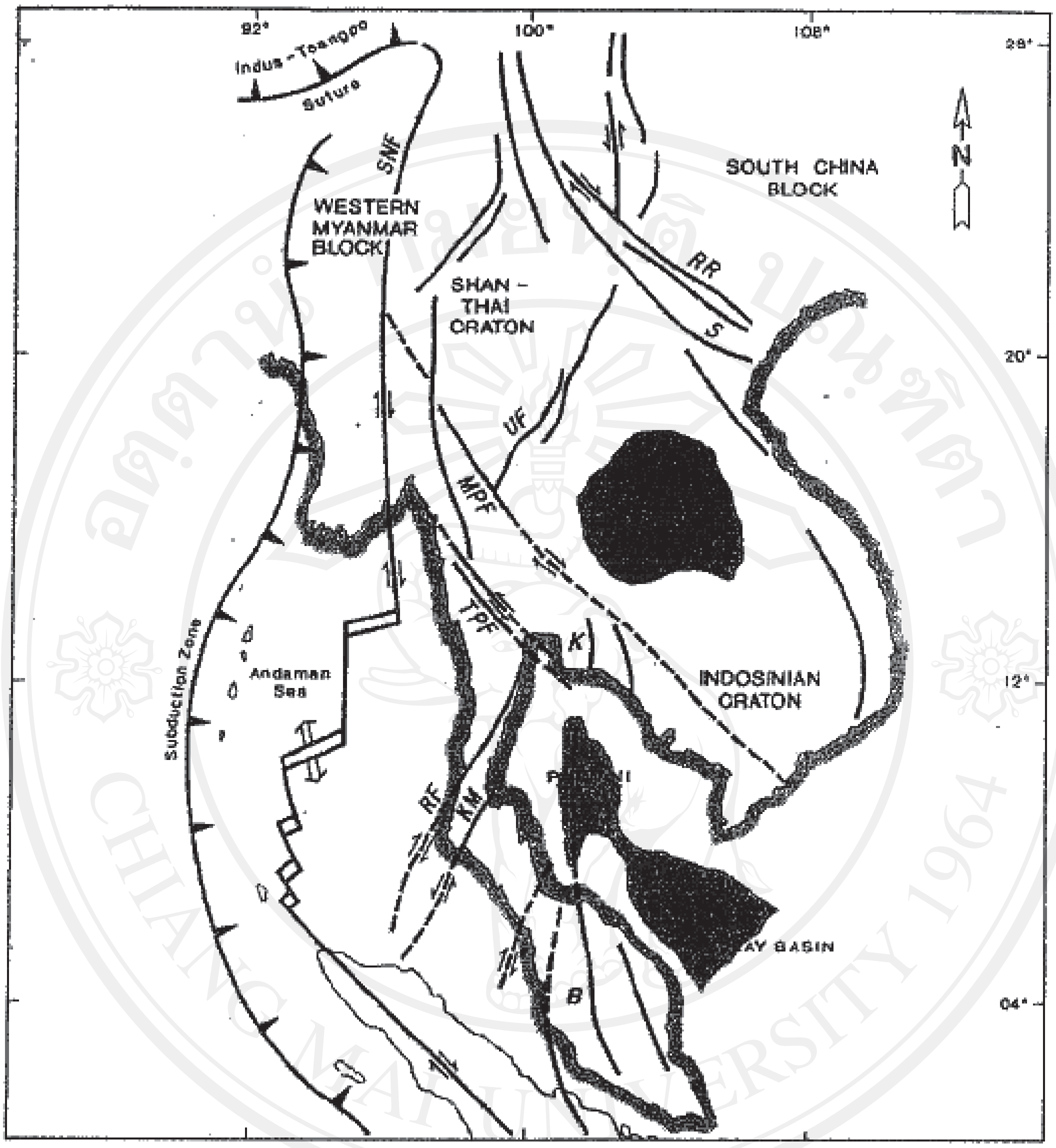


Figure 1.3 Stratigraphic Summary of the major depositional sequences in the Pattani Basin (after Unocal (Thailand), 1990).



LEGEND

S	Song Ma Suture	RR	Red River Fault Zone
RF	Ranong Fault	MPF	Mae Ping Fault Zone
KM	Klong Marui Fault	TPF	Three Pagoda / Khwae Noi Fault Zone
B	Bentong-Raub Line		
UF	Uttaradit Fault	SNF	Sagaing-Namyin Fault Zone
K	Sra Kaew Suture		

Figure 1.4 Major tectonic features of Southeast Asia (after Crossley, 1990).

strike-slip faults and the sinistral movement of the NE-SW strike-slip conjugate faults probably occurred initially in the Oligocene. Based on the dextral and sinistral conjugate faults, together with the evidence of clockwise rotation of the crustal block, Polachan and Sattayarak (1989) suggested that the Tertiary basins in Thailand originated and developed through dextral transtensional shear. At present, this model is well accepted. With such a dextral shear, N-S extensional faults were extensively formed. These bounding faults controlled extensional rifting of the basins.

The Pattani basin is located near the geographic center of the Gulf of Thailand and is a linear trough approximately 450 km in length and 100 km in width. The basin trends north-south. Crossley (1990) suggested that the basin morphology was controlled by a series of major en-echelon listric faults that bound half-graben basins in a linear belt running the length of the trough. The Pattani basin graben features characteristically consist of normal down-to-the-basin growth faults penetrating from basement and occasionally up to the Upper Miocene section above the Mid-Miocene Unconformity. The grabens are bounded by major graben bounding faults which are set of en-echelon basin-dipping normal faults and antithetic riedel shears.

1.4.2 Development of Basin

Packham (1993) summarized the sequence of events associated with the development of the basins in Thailand.

(1) Early Oligocene (or possibly earlier) - commencement of rifting and basin formation induced by dextral shear.

(2) Early Oligocene to Middle Miocene – relative tectonic quiescence but with continued extension, progressive expansion and deposition outwards from the initial rifting sites.

(3) Late Middle Miocene – possible increase in dextral shear with local basin inversion and erosion, concurrent with sea level fall.

(4) Late Miocene to Quaternary – decrease in tectonism, lithospheric cooling, and marine transgression in the Gulf of Thailand.

1.4.3 Stratigraphy in the Pattani Basin

A thick Tertiary section is evident in the Pattani basin with as much as 8,543 m of Oligocene and younger sediments in the deepest part of the basin and less than 305 m over the shallow subcropping pre-Tertiary highs.

Chinbunchorn et al. (1989) proposed that stratigraphic sequences in the Tertiary basins can be devided into syn-rift and post-rift sequences. The syn-rift sequence was formed during Late Oligicene to late Middle Miocene and bounded by two major unconformities. Internally, the syn-rift sequence can be subdivided into three units: lower, middle and upper units which consist of flood plain, fluviatile, fluvio-lacustrine and lacustrine sediment. The post-rift sequence overlies the syn-rift sequence and contains up to 1700 m of sediments in Late Miocene to Quaternary. This sequence consists of high-energy, fluviatile coarse sand with some interbedded varicolored organic-rich clay and thin coal bed but immature clay.

Lockhart et al. (1997) studied early Tertiary deposition in the southern Pattani Trough using Mayura-1 exploration well data as a reference suggested that stratigrapic intervals within the Pattani Trough include five major sequence divisions. The stratigraphic section is best described in terms of five depositional sequences (Figure 1.3) and has been described by Crossley (1990).

Sequence 1 (Oligocene) is considered up to 2136 m of lacustrine shales which minor interbedded turbiditic sandstones. This is considered a mixture of alluvial fan/alluvial plain sediments on the half-graven margin areas, grading into a lacustrine sequences in the half-graben centers.

Sequence 2 (Lower Miocene): consists of up to 3051 m of intercalated red and gray shales, sandstones and coals. With the filling of the Oligocene half-grabens they appear to uplift and erode with peneplanation occurring. This unconformity is referred to the Mid-Tertiary Unconformity (MTU). The fluvial meanderbelt trend directions were north-south or northwest-southeast.

Sequence 3 (early Middle Miocene) represents an entirely grey shale section and consists of up to 915 m of maginal marine-lagoonal delta plain sediments. Sands may not be restricted to simple fluvial meanderbelts, but could possibly contain some more widely developed marginal-marine sand bodies.

Sequence 4 (middle-Upper Miocene) consists of red beds more than 1220 m of entirely fluvial red bed sediments. The top of Sequence 4 is marked by a major regional unconformity known as the Middle-Miocene unconformity (MMU).

Sequence 5 (Upper Miocene-Quaternary): Above the MMU, there is a change of lithology from grey shales to a delta plain environment. The MMU is associated with large channels and conglomeratic sands at the interface. This section appears fluvially dominated as evidenced by the presence of shallow meanderbelts.

1.4.4 Hydrocarbon Occurrences

The petroliferous Pattani basin is one of at least twenty Tertiary-age rift basins. Taylor et al. (1980) summarized two petroleum systems were operative in the Pattani basin. One sourced from abundant Miocene coals and carbonaceous shales deposited under fluvio-deltaic environments and a second system sourced from Oligocene/ Lower Miocene lacustrine shales. Source rocks of the Pattani Basin are in the lower syn-rift unit (Lower Miocene). This unit is very thick with minor grey to dark grey lacustrine shales (Lian and Bradley, 1986). Sandstones of the Tertiary syn-rift sequences and the Pre-Tertiary carbonates are considered as important reservoirs. The sandstones are immature and have been deposited by small and weak river systems in fluvial and lacustrine deltaic environments (Pradidtan and Dook, 1992).

Chinbunchorn et al. (1989) suggested that the structural traps of Tertiary basins in Thailand were developed during the middle to late Miocene time. The important traps in the Tertiary basins are faulted anticline, rollover, tilting faulted block and buried hill, however, stratigraphic traps such as pinched-out sand, distral fan and unconformity are also believed to play an important role in petroleum exploration in the future.