GEOLOGY OF KAMPUNG PAK KANCIL, PERMAISURI, TERENGGANU AND SEISMIC INTERPRETATION OF ABU FIELD, TERENGGANU OFFSHORE

by

NUR ANIS SYAFIRA BINTI DIN

(E19A0088)

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FACULTY OF EARTH SCIENCE
UNIVERSITY MALAYSIA KELANTAN

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Geology of Kampung Pak Kancil, Permaisuri, Terengganu And Seismic Interpretation of Abu Field of Terengganu Offshore

ABSTRACT

Kampung Pak Kancil situated at Permaisuri, Terengganu where it has been long acknowledged as meta-sediment area. The purpose of this project is to update a geological map with a size of 5 x 5 km^2. Several analyses, including petrography, stratigraphy, geomorphology, and structural geology, were conducted for this study. Geological mapping was performed to obtain relevant data, and a sample was collected for petrography examination. The analysis was backed by an old research article and scholarly publication. The research region has four different types of rock: phyllite, slate, schist, and mudrock. In the Charu/Sungai Perlis Bed, phyllite and schist make up the lithology. The structural geology discovered consists of significant syncline and anticline folds. It is proposed that structural geology be the subject of a comprehensive study of the region. The Abu Field is part of the Malay Basin and is located offshore Terengganu, Malaysia. It has been identified as a sedimentary region containing a hydrocarbon resource. The seismic series has been the primary focus of substantial hydrocarbon exploration in this region. Abu field has not yet been subjected to a full stratigraphic and structural analysis, and it is suggested that this be the focus of future research. Using three-dimensional data, six seismic sections spanning the research region have been identified. Four principal reflectors have been identified as sequence boundaries, with each sequence including a seismic facies unit based on seismic characteristics. On the basis of the structural features discovered within the research region, such as faults and anticlines, it may be claimed that this area has probable hydrocarbon deposits.

Geologi Kawasan Kampung Pak Kancil, Permaisuri, Terengganu Dan Tafsiran Seismos Di Wilayah Abu , Lepas Pantai Terengganu

ABSTRAK

Kampung Pak Kancil terletak di Permaisuri, Terengganu di mana ia telah lama diiktiraf sebagai kawasan mendapan meta. Tujuan projek ini adalah untuk mengemaskini peta geologi bersaiz 5 x 5 km^2. Beberapa analisis, termasuk petrografi, stratigrafi, geomorfologi, dan geologi struktur, telah dijalankan untuk kajian ini. Pemetaan geologi telah dilakukan untuk mendapatkan data yang berkaitan, dan sampel telah dikumpulkan untuk pemeriksaan petrografi. Analisis itu disokong oleh artikel penyelidikan lama dan penerbitan ilmiah. Kawasan penyelidikan mempunyai empat jenis batu yang berbeza: phyllite, slate, schist, dan mudrock. Di Katil Charu/Sungai Perlis, phyllite dan schist membentuk litologi. Geologi struktur yang ditemui terdiri daripada lipatan sinklin dan antiklin yang ketara. Dicadangkan bahawa geologi struktur menjadi subjek kajian menyeluruh di rantau ini. Padang Abu adalah sebahagian daripada Lembangan Melayu dan terletak di luar pesisir Terengganu, Malaysia. Ia telah dikenal pasti sebagai kawasan sedimen yang mengandungi sumber hidrokarbon. Siri seismik telah menjadi tumpuan utama penerokaan hidrokarbon yang besar di rantau ini. Medan Abu belum lagi tertakluk kepada analisis stratigrafi dan struktur penuh, dan dicadangkan ini menjadi tumpuan penyelidikan masa depan. Menggunakan data tiga dimensi, enam bahagian seismik yang merangkumi kawasan penyelidikan telah dikenal pasti. Empat pemantul utama telah dikenal pasti sebagai sempadan jujukan, dengan setiap jujukan termasuk unit fasies seismik berdasarkan ciri seismik. Berdasarkan ciri-ciri struktur yang ditemui dalam kawasan penyelidikan, seperti sesar dan antiklin, ia boleh dikatakan bahawa kawasan ini mempunyai kemungkinan mendapan hidrokarbon.

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LIST OF SYMBOLS

%	Percent
°	Degree
m	Meter
km	Kilometer

LIST OF ABBREVIATIONS

CL	Crossline
GIS	Geospatial Information System
GPS	Global Positioning System
HCL	Hydrochloric acid
HST	Highstand System Tract
IL	Inline
LST	Lowstand System Tract
mfs	Marine-flooding Surface
MFS	Maximum Flooding Surface
PETRONAS	Petroliam Nasional Berhad
PPL	Plane Polarized Light
TST	Transgressive System Tract
T-Z	Time-depth
UMK	Universiti Malaysia Kelantan
XPL	Cross Polarized Light

CHAPTER 1

INTRODUCTION

1.1 Research Background

Geophysics studies Earth's unseen parts. This study measures Earth's physical attributes. Geophysics studies Earth's physical properties below the surface. Reflection seismology aids hydrocarbon exploration. Reflection seismology uses elastic waves to find hydrocarbon, water, and ore deposits and gather geological engineering data. Seismic survey data will be combined with well log data and geological data to reveal the geological structure and distribution of rock types under the earth's surface. Technology will simplify data collection and processing. This is one reason why seismic cross-section is important.

Each exploration's seismic cross-section shows the earth's interior. Geological data on structures, strata, and subsurface characteristics is analysed. Dony (2010) suggests using seismic cross-sections to interpret the earth's subsurface. The cross-section shows subsurface geological structures including anticlines, synclines, faults, and others. Seismic data can also establish rock strata. Mitchum et al. (2019) were the first to claim that high-quality exploration seismic data can reveal structures and bedding.

Seismic analysis uses seismic data to understand sedimentation and stratigraphy (Mitchum et al. 2019). Researchers will identify and link deposition sequences using the form pattern of strata and the reflection series termination. This will reveal the first sequences deposited. It also estimates lithofacies units and evaluates sediment deposit environments. The seismic cross-section can be divided into groups of reflections aligned and separated by the surrounding surface. Several methods are available. Investigating the systematic endpoints of a reflection reveals a nonconformity and its source. Reflective packages between inconsistencies, known as stratum ends, can be classified into truncation, top lap, on lap, and down lap, in that sequence. The local, regional, and global sea level cycle controls most depositional sequences.

Seismic investigation of the terrain identifies seismic sequences that provide data on sedimentation, changes in sea level, and age estimations. Each seismic unit consists of a collection of seismic reflections with unique shape, amplitude, continuity, frequency, and velocity characteristics. These features are referred to as seismic unit characteristics. All of the features, including High stand systems tract (HST), Low stand systems tract (LST), and Transgressive systems tract (TST), can be used to analyse the strata's history, the lithology, and the system tracts (TST). In addition to well-drilling techniques, field outcrops, and drill core sampling, the reflection seismic methodology is an efficient method for detecting sequential sequences. This is one method for recognising sequential sequences. The resultant seismic reflection indicates the strata's surface, which can be related to chronostratigraphic information because it is a composite of reflections produced by strata with various elastic characteristics. In addition, it may be utilised to determine the relative location of the sea level, the hydrocarbon boundary and the boundaries of the various rock types, the lateral rock changes, the stratigraphic traps of hydrocarbon piles, the disconformity boundary, and the sediment depositional environment. Using this procedure, it is possible to determine each of them.

The study is undertaken, and the most recent seismic data may be utilised in the interpretation of data, which entails the investigation of seismic properties known as reflection seismic waves. The term "seismic attribute data" refers to information derived from "seismic data" through either direct measurement or logical reasoning and experience (Adigun, A.O. and Ayolabi, E.A. 2013). Measurements of mass, amplitude, and frequency are all examples of seismic attributes. Other examples include the magnitude of the earthquake. Components of the complicated 1-D seismic trace created by are the envelope amplitude, instantaneous phase, instantaneous frequency, and apparent polarity. Other frequently cited criteria include coherence, least curvature, azimuth, and similarity dip with the highest degree of similarity. According to Adigun, A.O. dan Ayolabi, E.A. (2013), seismic features are a part of the technique used to qualitatively analyse seismic data in order to enhance structural and stratigraphic interpretations and provide lithology and substance content estimates. The qualitative interpretation of seismic data includes this method. In other words, the use of this technique has the potential to increase the efficiency of locating the likely hydrocarbon resource.

1.2 Study Area

1.2.1 Location

The study area is divided by two part, which are at Kampung Pak Kancil, Permaisuri, Terengganu. The first study area is located at Kampung Pak Kancil, Permaisuri, Terengganu with coordinate 5° 30’ 31.26” N and 102° 46’ 53.47” E (A), 5° 30’ 31.26” N and 102° 50’ 74.35” E (B), 5° 28’ 15.90” N and 102° 34’ 53.47” E (C) and 5° 28’ 31.26” N and 102° 44’ 53.47” E (D). All four locations will span approximately 25 km^2 of study area. The study area is roughly 5 km by 5 km in size. Google Earth depicts the location of the research region shown in Figure 1.1 and Figure 1.2. Kampung Permaisuri is a township in Terengganu and situated neighbouring to Kampung Baruh Terbak, and near to Kampong Gong Terbak.

The offshore region of Terengganu was discovered in the Malay basin. It shares a boundary with the coast of Terengganu. Despite being surrounded on the east by the coast of Peninsular Malaysia in southeastern Thailand and on the west by Vietnam and Peninsular Malaysia, the Malay basin is home to a great number of native species. The basin has combined with Thailand's Pattani Trench to the north-west. Moreover, it spreads from the northwest to the southeast within Indonesia's Natuna West Basin. It is anticipated that the Malay basin will include a total land area of 100,000 km2. The area under investigation is in the Malay Basin, notably the Abu field. It is located off of Terengganu's shore. Abu is a region located west of the Malay Basin.

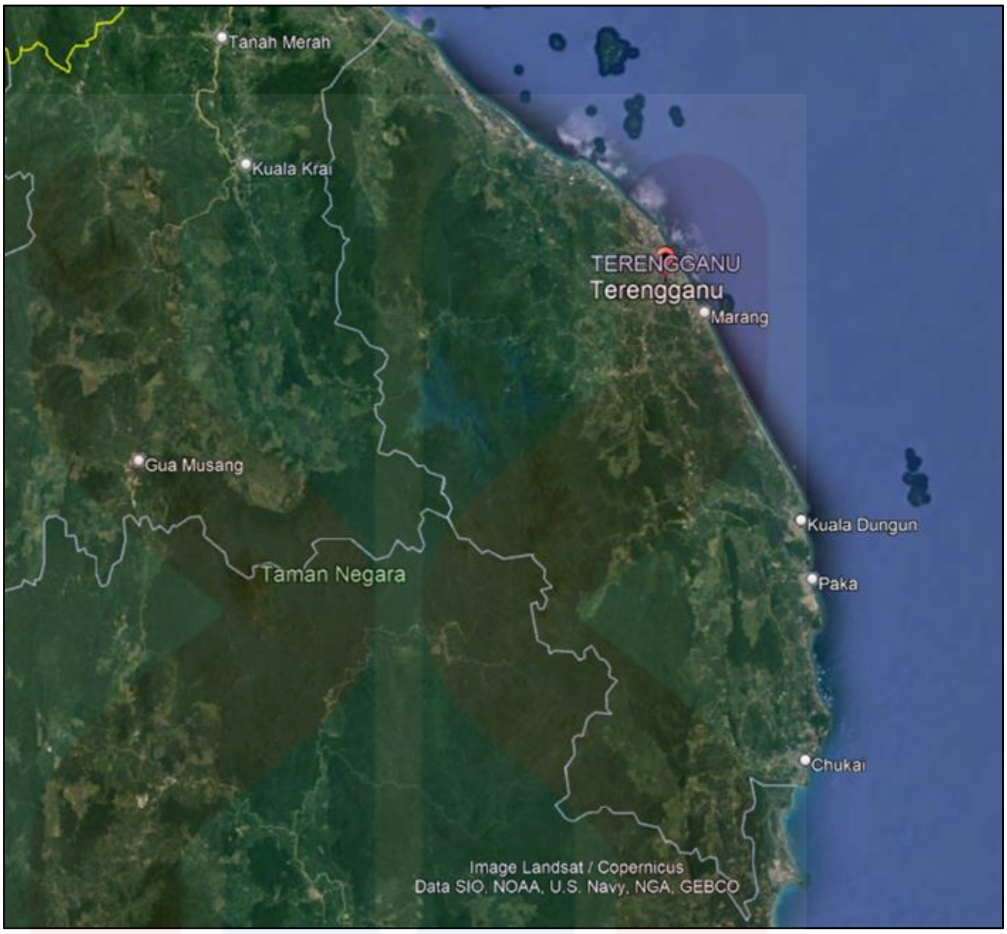


Figure 1.1: Map of Terengganu, Malaysia using Google Earth Pro Application

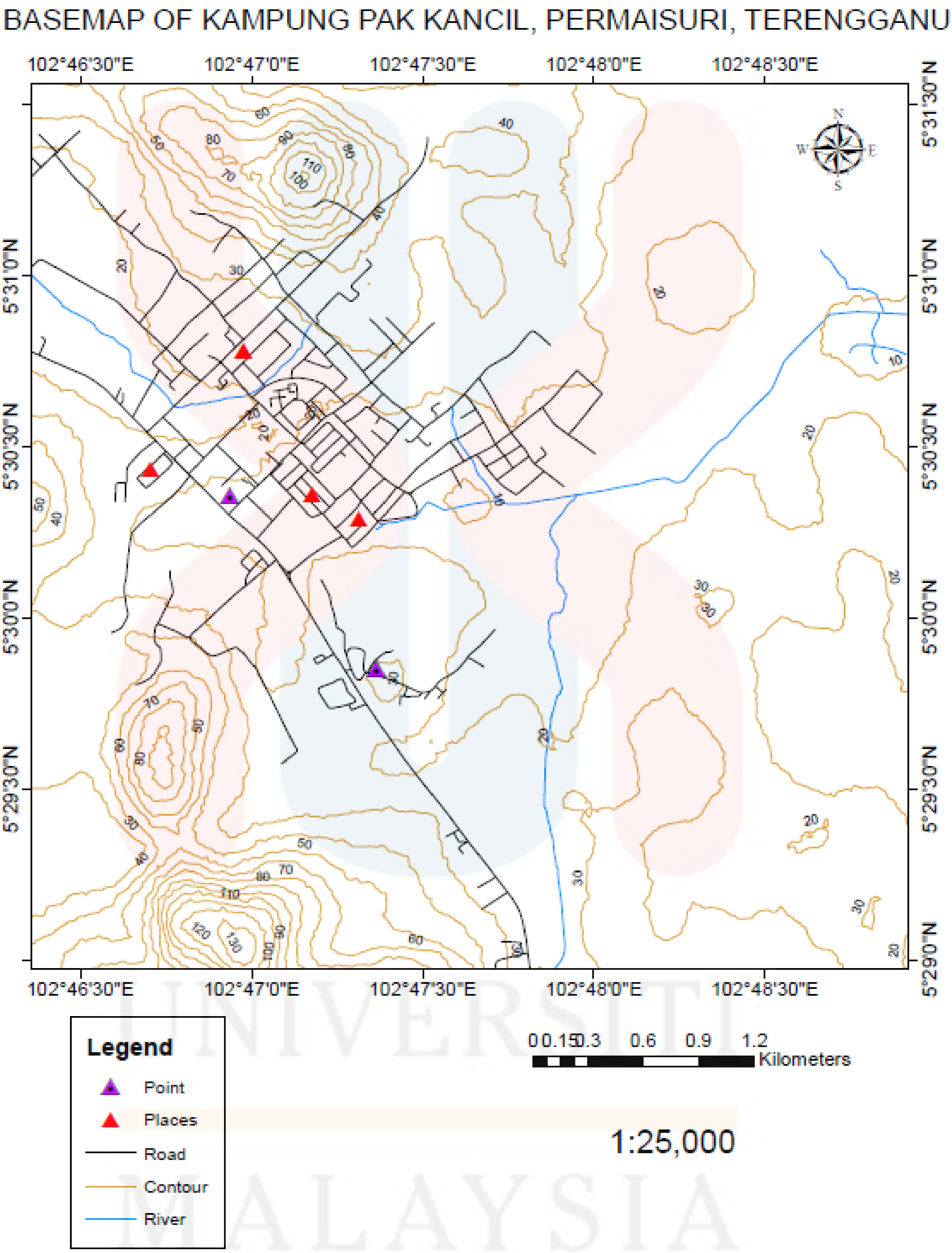


Figure 1.2: Basemap at Kampung Pak Kancil, Permaisuri, Terengganu, Malaysia

1.2.2 Accessibility

Several roads lead to the place that is the subject of the research area. The Laluan Persekutuan 3 Highway was the principal connection between the cities of Permaisuri and Kuala Terengganu. Additionally, there are numerous village roads, roads in residential neighbourhoods, and dirt roads that go to the study area and are all accessible. There is no portion of the road that is inaccessible by car, motorcycle, or foot. Access to the area under investigation, which is crucial for doing research, is facilitated.

1.2.3 Demography

Demography is the study of human population in a particular place. This study takes into account births, deaths, and migrations of humans. Understanding the social and economic challenges through the lens of demography is very helpful. People are able to take action to solve certain problems thanks to demography, which, at the same time, empowers people to take action. According to the Malaysian Department of Statistics, the total population of Terengganu in the year 2020 is projected to be 1,149,440 people with a population density of 88.70 persons per square kilometre. Terengganu still regarded as a low-population state in Malaysia. The population of the Permaisuri district alone was 59,651 individuals and the land area that covered the district was 1,304 km^2. There will be a 0.90 percent yearly change in the population from 2010 through 2020.

1.2.4 Land Use

The city of Permaisuri often referred to as a developing city. It is obvious from the fact that there is still an active construction project going on in the vicinity of this region. This neighbourhood is home to a university or college, in addition to a school and a kindergarten. In addition to that, there are a significant number of shops and factories. Up to forty percent of the total forest Permaisuri composes area. In contrast, agricultural land makes up only about 80% of the total land area in the Permaisuri district. A closer look at the research region reveals that the area of woodland and agricultural makes up fifty percent of the whole study area. A territory that fully founded on the Minapolitan concept should rely on fisheries, aquaculture, and marine commodities to the same extent that their economic worth derived from the sea.

1.2.5 Social Economic

The services sector generated 54% of Terengganu's total gross domestic product, followed by the manufacturing sector's 32% contribution. 9% of Terengganu's gross domestic product was supplied by agriculture. The service sector employs the greatest amount of people in Permaisuri (66.9%), followed by the urban sector (21.1%), agriculture and fishing (17%), and the manufacturing sector (16%), which employs the smallest proportion.

1.3 Problem Statement

The Malay Basin study region has the potential to be a hydrocarbon reservoir. This study aims to identify a prospective hydrocarbon-containing reservoir area. In addition, the association between the findings and well log data within a radius of the research region can be determined. Correlating these data need additional research to aid regional interpretation. Other than that, new well data will aid in the identification of possible hydrocarbon-trapping rocks in the study region. Abu field offshore is a big area to do research and previous research not covered all Abu Field's area. Next, the existing geological map of the Kuala Terengganu region must be updated to reflect the evolution of geological features.

1.4 Objectives

The objectives of this research are:

I. To update a geological map of the Kampung Pak Kancil, Permaisuri, Terengganu
II. To identify hydrocarbon potential at Abu Field, Terengganu offshore.

1.5 Methodologies and Scope of Study

The study area was divided in half for the purpose of this investigation. This inquiry will encompass a total area of 25 km^2 in Kampung Pak Kancil, Permaisuri, Terengganu, where its geology will be explored. This research region will be geologically mapped to provide a geological overview of the subject area.

Next, focus on seismic interpretation off the coast of Terengganu. It will examine Terengganu's offshore geological features. To investigate seismic stratigraphy, the well log data and seismic data will be integrated. The notion of the study is built of a variety of analytic methodologies. Refer to Sheriff's (2000) theory, specifically seismic sequence analysis, seismic facies analysis, and seismic reflection analysis features. Examine the subject area's geological structure, facies analysis, and depositional environment in order to locate any potential hydrocarbon reservoirs by analysing seismic data. The Petroliam Nasional Berhad (PETRONAS) data will be delivered as SEG-Y data as well as other data types. The data will subsequently be analysed using software from the KINGDOM.

1.6 Significance of Study

This research will generate an up-to-date geological database and geological profile of the studied area. For example, add missing streets and drains to the most recent maps of the research region. A geological map will be constructed after all the information has been collected. The map is one of the important pieces of information for geologists, the government, and others to explore, conserve, and develop the region's natural resources.

The results of the seismic study will then aid the government in locating hydrocarbons that may contribute to increasing country economic. In addition, it will provide a description of the methods used for the researcher.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter examines previous research about the tectonic evolution of Southeast Asia and the Sunda Plate, as well as its location in Permaisuri, Terengganu, and the offshore Terengganu, Malaysia basin. Southeast Asia and the Sunda Plate are the study's locations. This presentation is intended to provide an understanding and visualisation of the broad geological areas of the study, as well as serve as references prior to the interpretation of seismic data. This research made use of secondary seismic data from the PETRONAS database. Using the Kingdom 2021version computer programme, these data will be analysed and evaluated. The report generated from the well logs can provide a summary of the geological conditions and existing hydrocarbon resources. This chapter is of the utmost importance since it serves as the foundation for guaranteeing that activities can be carried out accurately and without incident.

2.2 Tectonic History and Evolution of Southeast Asia

2.2.1 Tectonic Element

Due to the collision of three major tectonic plates 500 million years ago, Southeast Asia is one of the most geologically complex places in the world, with several microcontinents. This is because Southeast Asia is one of the most geologically complex regions. It consists of several somewhat active tectonic plates, such as the Pacific Plate in the east, the northeast of the Philippine Plate, the north of the Eurasian Plate, and the south of the India-Australia Plate. In general, the transitions between continental crusts occur beneath shallow oceans with a depth of less than 200 metres, when the oceanic crust is deeper. The interaction between the lithosphere flash and the tectonic plate, usually known as the plate, best describes the significant tectonic event that occurred in Southeast Asia. Southeast Asia comprises three major lithosphere plates. The India-Australia Plate, the Pacific Plate, and the Philippine Sea Plate are included. This is concentrated on the Eurasia plate and has a relative velocity of 6 to 8 centimetres each year. This tectonic plate boundary contains an active subduction zone (Metcalfe, I. 2011) This zone extends from the Arctic Ryukyus in the northeast, via the Philippines, Java, and Sumatra, to Myanmar in the northwest. At the boundary between continental plates, the northward motion of the India-Australia plate is markedly oblong across the whole arc of Sumatra. Due to the presence of a substantial shear component, subduction may assume a unique form as a direct result of the deformation process (McCaffrey 2016; Malod and Kemal 2016).

South East Asia consists of the early continental terraces of the Early Tertiary known as the Sunda plate. This plate comprises the majority of Myanmar's western region and is located south of Borneo. The huge outcrops that may be found in the eastern region of Vietnam are among of the oldest in the Sunda plate. During the Mesozoic and Early Cenozoic eras, the area that is now Peninsular Malaysia and the southwest of Borneo once formed the mass of earth. This area has since been elevated to the status of a dignity. Geologically speaking, Southeast Asia made up of sedimentary sediment that is relatively recent and continued to accumulate between 50 and 60 million years ago. Beds that fold up and can be found almost entirely in Sarawak and Sabah, which are located in northern Borneo.

During the Oligocene, the South China Sea basin is the oceanic crust extended between the South China Sea, Vietnam Sea, and Borneo Sea. This occurred in the region separating Vietnam and Borneo (Taylor, B. dan Hayes, D.E. 2018; Briais et al. 2015). The Lucania and Reed Bank blocks are two examples of expanding continental blocks that currently overlap at the basin's base. It was hypothesised that the beds of the Fold-Thrust Belt in the basin's southern region reflect the incremental prism. Incremental prisms are prisms formed by collisions between fragments of Saint Lucia and Reed Bank and the West Borneo Basement (Hazebroek, H.P and Tan, D.N.K. 2017).

2.2.2 Early Tertiary Evolution

During the Paleozoic and Mesozoic eras, the slow collapse of the supercontinent Pangea and the development of the waters east of Tethys happened concurrently with the tectonic expansion of Southeast Asia. During the Palaeozoic and Mesozoic eras, the Tethys Sea forms the base of a triangle formed by Gondwana and Laurasia, Pangea's two branch continents. Studies in stratigraphy, paleo biology, and paleo magnetism have indicated that the continent of Southeast Asia is composed of numerous huge topographic terrestrial regions that arose sequentially during the development of Pangea and the opening and closing of the Tethys oceans. These studies reveal that the continent of Southeast Asia consists of a number of significant terrestrial terrain areas (Metcalfe 2008, 2011, 2016). Metcalfe (2016) reveals that during the collision phase, at least three Tethys sequences are located in close proximity. The Sunda plate comprises of two distinct terrain composites separated by an ophiolitic suture zone extending from Thailand to the south of Peninsular Malaysia and maybe as far as Sumatra.

2.3 Geological Setting of Permaisuri

Within the East Line's boundaries can be found the entire state of Terengganu. Sedimentary rock, including metasedimentary rock, and granite rocks make up the majority of the terrain, with the majority of the sedimentary rock being Carboniferous and Permian in age. According to MacDonald (2020), the meta-sediment rocks that can be found on the east coast of Peninsular Malaysia are a mitochondrial sedimentary. The majority of these rocks considered low-grade metamorphic rocks that produced from sandstone. In addition to this, the rocks in this Carboniferous aged region noted on the geological map of Peninsular Malaysia that released in 2003 by Chung and authored by the Geological Survey of Malaysia. Idris and Zaki (1986), who conducted research in the Batu Rakit area, discovered a fossil whose age corresponded to the Carboniferous period for the sedimentary rock in that region.

In the region surrounding Kampung Pak Kancil, Permaisrui, metasedimentary rocks such as slate, phyllite, and quartzite dominate the landscape (UPEN 2015). Due to their metamorphic nature, the argillite rocks have been eroded to the point where they resemble siltstone and mud stone in certain spots. At the exposed road-cutting zone as well as the beach area outcrop, metamorphism features may still be observed. Two generations established dolerite dykes at Kampung Pak Kancil, and they used to quarry granite in the region. Another east-northeast-bound dyke has cut a dyke that is almost on a north-south axis. On the northern side of Kampung Pak Kancil, there is an occurrence of igneous dyke. It is approximately 10 metres wide and has been weathered.

It is assumed that the dyke is a porphyry quartz due to the presence of relatively plentiful quartz minerals in the residual soil that composes the igneous's body. These assumptions are based on the existence of the minerals. At one place, a dyke of intermediate composition pierced through the porphyry quartz. There are many crystalline chiastolitic crystallites with a relatively wide distribution in the area of the dyke. This region is not too far from the igneous body at its base since the temperatures and pressures here are relatively low and comparatively high, respectively, causing certain minerals to be influenced more by the former than the latter.

2.3.1 General Structural Geology

According to the lineament analysis, the north and northwest directions are almost parallel along the parts of the ridge. In addition, this region broke into three deformations known as the south deformation, the centre deformation, and the east deformation. The major lineament generally ran from north to south to the northwest. The north-to-south lineament is rather straight, but the northwest-to-southeast lineament is slightly curved. The lineament that went primarily north-northwest and east-southeast was responsible for severing and relocating the lineament that ran north-south and northwest.

The preponderance of north-to-northwest-trending inverse faults and over thrust faults are either east-northeast or west-southwest oriented. These faults are oriented north and northwest. The fault is much sharpest in the north-northwest direction, suggesting that the horizontal displacement to the right may be the result of the final phase of deformation. In the northeast corridor, a prominent fault suggests horizontal movement to the right, whereas the timed-state indicates horizontal movement to the left.

Additionally, a quartz vein is displayed. Typically, igneous dykes travel in either a roughly north-south or east-west direction. Observations made in the northern portion of Kampung Pak Kancil revealed that a north-to-south dyke was severed by an east-to-west dyke.

2.4 Stratigraphy

Sedimentary, metamorphic, and igneous rocks can be distinguished within the geological sequence of Kuala Terengganu. The sediments and metamorphic rocks were then subdivided into several units, such as the Charu/Sungai Perlis bed and the alluvium, which underwent their respective processes during the Early Carboniferous and Quaternary periods. The Charu/Sungai Perlis bed consists of metasandstone including evidence of phyllite, slate, argillite, carbonaceous phyllite, metasiltstone, metasandstone schist, and calc-silicate hornfels. Sand, silt, and clay are the basic constituents of alluvial deposits, and they are most frequent in the river basins with low elevations.

Quaternary alluvium is present between the capes along the coast as beach ridges along the major rivers Sungai Kemaman, Sungai Dungun, and Sungai Terengganu as fluvial deposition and as paludal deposits along the glide and in structurally controlled depressions inland, according to Bosch (1988).

To the north of Kuala Terengganu is the largest area that is wider than 4.5 kilometres. Nonetheless, huge expanses are also visible south of Kemaman and Kerteh. Members of the Matang Gelugor Member, beach ridges, are prevalent throughout this coastline. These beach ridges have also been discovered approximately 10 kilometres inland in Kemaman. According to Nossin (1965), beach sands are typically well-sorted, and their median value might range between 150 and 780 m.

The graben with clastic alluvium of Oligocene age and topography is the oldest sedimentary basement in the world. In the oldest graben, it is possible to find sediments dating back to the late Eocene and early Oligocene (Hutchison 2018). The sump rocks, which date back to the Oligocene and Lower Miocene epochs, contain sediments ranging from coarse granular fluvial to mild fluvial. At the graben structure, lacustrine shale deposition was discovered. The earliest sediments in the basin were deposited around the basin's perimeter. During the Oligocene and lower Miocene, it is assumed that this lacustrine shale operated as the source of oil and gas.

In general, the Malay Basin contains the transgression deposition that began in the late Miocene and persisted throughout the Pleistocene (Tjia and Liew 2006). The bulk of these places were susceptible to erosion during the Pleistocene, which led to the creation of river channels around the basin (Tjia 2004).

On the basis of seismic data, Hutchison (2018) asserted that it exposes sediment thickness several kilometres below the Upper Oligocene strata and proposed that the Malay Basin originated prior to the Oligocene epoch. The coarse-grained sandstone that makes up Oligocene age reservoirs and early Miocene reserves can be found everywhere between an estuary deposition and an alluvium deposition (Chu 2012; Hutchison 2018). At the remote graben, lacustrine shale has collected since then (Hutchison 2018). Graben is the source of the earliest sediments in the basin, which were deposited there locally. This lacustrine shale is assumed to be the source rock for the Oligocene reservoir and Early Miocene oil, gas, and condensate (Creany et al. 2004; McCaffrey et al. 2018; Cole and Crittenden 1997; Todds et al. 2007).

2.5 Malay Basin

The Malay basin is situated in the southern portion of the Gulf of Thailand, between Vietnam and Peninsular Malaysia. This basin has a surface area of approximately 80,000 km2 and is filled with 14 km of Tertiary sediments (Abd Rahim Md. Arshad et al. 1995). The Malay Basin extended northwest and merged with Indonesia's Natuna West Basin.

The Malay Basin is roughly 500 kilometres long and 200 kilometres wide, and it is located in the planet's northwest. The silt in this basin is at least 12 kilometres thick and dates to the Oligocene epoch. This sediment from the Oligocene is often a land deposit with minor marine effect, whereas material from the Miocene to the present is a coastal deposit extending into a shallower sea. The Malay Basin is situated on the Sunda plate in the geographic centre of Southeast Asia. It is believed that it emerged at the start of the Tertiary period. The Malay Basin is oriented along a broad northwest-southeast axis, with sedimentary, igneous, and metamorphic pre-Tertiary rocks at its base.

2.5.1 Exploration History

The Malay Basin can be divided into six distinct provinces based on its distinct reservoirs and physical locations: the Northeast, the Southeast, the North, the South, the West, and the Central province. The exploration efforts in the Southeast are at their most intense in the Central region, followed by the Northeast, and then the Southeast again. After the Production Sharing Contract first implemented in 1985, the only region in which exploration efforts conducted was the Northeast region during the late 1980s.

In 1968, enterprises owned by Esso Production Malaysia Incorporation and Conoco were granted the first offshore concession in the east of Peninsular Malaysia. Tapis-1, the first well ever drilled by Esso, was drilled in July 1969 to the south of this basin. The regular north-south fault severed by the enormous anticline known as Tapis, which runs in an east-west direction and slices across the landscape. In 1975, it was revealed that the fields of Seligi, Tapis, Pulai, and Bekok contained oil and gas resources from the Oligocene to the early Miocene. While natural gas was discovered in the fields of Angsi, Besar, and Belumut (Ahmad Said 2002).

While the Tapis-1 well produces gas generated from Groups J and K sandstone, the Tapis-2 well, which was dug in 1974, led to the finding of oil derived from Group

J sandstone. Following this, two wells were drilled to study the Jerneh regions in the basin's centre. In 1970, drilling activities were conducted in the fields of Jerneh, Pilong, Sepat, Bintang, and Belumut by Esso. Since 1971, continuous prospecting has led to the finding of oil in the Seligi and Bekok regions. In 1978, Pulai and Tapis fields commenced oil production for the first time. Constant drilling led to the discovery of Angsi, Besar, Palas, Gruntong, Irong, Irong Barat, Semangkok, Tinggi, and Dulang (Sheriff, R.E. 1980).

At the end of 1997, a total of 342 wells had been explored and drilled in the Malay Basin, in addition to the acquisition of 441,000 km of 2D and 3D seismic lines. Due to the exploration activities that were done, oil and gas resources were discovered (Madon et al. 2006). Implementation of the Production Sharing Contract at the end of 1976 created a pattern for exploration in the Malay Basin that was extraordinarily successful (Ahmad Said 2002). The exploratory scenario encompassed all three periods of the Production Sharing Contract, from 1976 to 1995.

2.5.2 Source Rocks

The presence of a significant quantity of oil and gas in the Malay Basin indicates the presence of high-quality source rocks. The source rocks that derive from the lacustrine sediments barely penetrate to a shallow depth at the margin of the hydrocarbon surface sink that derives from the mostly fluvial-delta precipitate at the centre of the basin. Groups 1 and E are the ideal places to look for source rocks deposited in fluvial-delta environments (Madon et al. 2006).

With Total Organic Carbon (TOC) levels between 1% and 4% and hydrogen index values as high as 750, the source rocks of lacustrine deposition are of outstanding quality (Creaney et al.). Creaney et al. (2004) demonstrate that migration in parallel strata predominates, but they also found evidence of migration in intersecting strata. The majority of its migration happens in the south-eastern region of the south-western portion of the Malay Basin.

Similar to mangrove swamps, which are a rich source of paralic, deltaic, and estuarine origin in other basins of Southeast Asia, shale rock and coal-shale have a high proportion of Pr / Ph. In Southeast Asia, both shale and coal-shale are present (Todds et al., 2007).

2.5.3 Reservoir Rocks

Sandstone belonging to Group D through Group K is where one can look for hydrocarbons in the Malay Basin. According to the stratigraphy, different environments were responsible for the deposition of various sandstones. The majority of fluvial channels found in older groups (K, L, and M) originate from lakes. Group J and other younger groups contain sandstone on the beachfront and subtidal sand as well as complicated channels trapped in the fluvial delta that flows to the estuary.

The main deposition of sediment facies, mineral composition, and diagenesis of the deposit all have a role in establishing the reservoir features of Late Oligocene to Miocene sandstones in the Malay Basin. The texture and mineral composition of the E, I, J, and K Groups, which are the groups being interpreted by seismic analysis, have been determined by petrographic surveys and studies to vary significantly. Group K is composed of braided stream deposits discovered in a shallow marine setting. These deposits contained high-quality, moderately-sized fine grains. The matrix of Groups E and I sandstones, which are commonly found in estuarine environments, is both fine-grained and abundant.

The pattern modifications that occurred because of diagenetic post-deposition significantly impacted by the original mineral content of the sandstone. Sandstone that has been cleaned and allowed to grow typically has a high primers porosity. Quartz cementing and the production of authigenic clays are two processes that can frequently result in the loss of porosity.

2.6 Seismic Attribute

The seismic attribute is one of the quantitative ways for measuring seismic characteristics. Since 1930, the interpretation of seismic data has significantly improved from the analysis of several properties. Barnes (2000) asserts that he recommended using features that are closely related to one another when employing a variety of seismic attributes. Utilizing physical characteristics and characteristics gathered during the reservoir construction process to prevent any incorrect correlations (Kalkomey, 1998). All quantities that can be obtained from seismic data are referred to as "seismic characteristics." These characteristics include the intermediate velocity, impedance acoustic inversion, prediction of pore pressure, reflection termination, and complicated sensor characteristics. Seismic properties also account for complex sensor attributes.

According to Chopra and Marfut (2005), there would be a dearth of estimations based on complex computations such as impedance inversion and prediction of pore pressure; as a result, they concur with the criteria of recording data utilising geostatistics or other methods of data integration. In other words, the assignment of attribute names to quantities derived by sophisticated calculations will be inadequate.

The features of seismic waves are divided into two distinct categories by Tanner et al. (1994): the geometry group and the physical group. The major objective of this geometric feature is to facilitate comprehension of the geometric properties of seismic data, such as dip, azimuth, and continuity, among other things. There must be a link between the physical characteristics and the subsurface physics parameters, which are tied to the lithology. This applies to the signal's amplitude, phase, and frequency. This classification can be divided into post-stack and pre-stack properties, respectively.

Brown (2004) classified these qualities using a tree structure. Time, amplitude, frequency, and attenuation formed the main branch of the tree. Pre-stack and post-stack groups emerged from the secondary branch of the tree. Time characteristics can offer stratigraphic and reservoir environment information.

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

In this chapter, the methods utilised to conduct the research will be described in depth. It will provide a guideline for researchers to follow in order to appropriately follow the materials and procedures employed in this research. Additionally, it will make it possible for others to explore this line of inquiry by utilising the offered criteria. The materials and methodology to be employed in the research are chosen first. The research will be enhanced by both the collecting and analysis of data.

The approach that will be taken to carry out the research will serve as the primary focus of the investigation. In order to ensure that the materials are compatible for the method that will be utilised, it is necessary to identify those materials. The research approach that we employ in order to carry out the research is depicted in Figure 3.1.

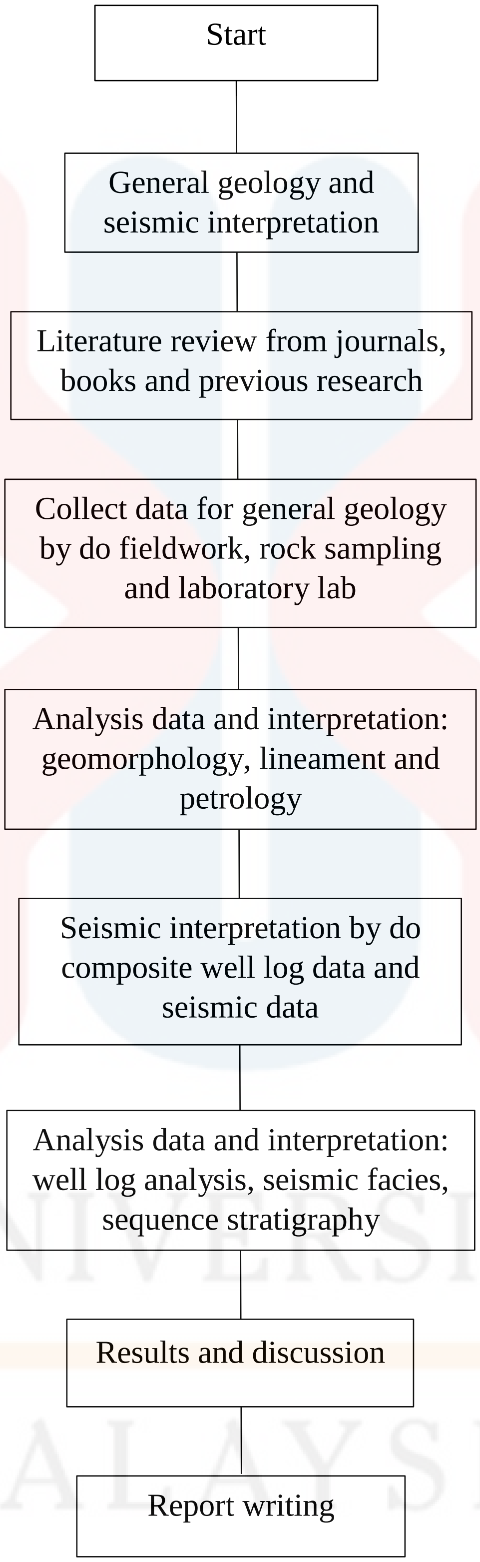


Figure 3.1: Flowchart of methodology that being used in this research study

3.2 Materials

3.2.1 Geological Mapping

To conduct this investigation, the researcher is utilising a number of different materials. Geological mapping of the study area, which is located in Kampung Pak Kancil, Terengganu, is necessary for geology-related research. Global Positioning Systems (GPS), geological hammers (tip points and chisels), compasses, geological sample bags, hydrochloric acid, measuring tape, field notebooks, hand lenses, and field note books are included. All of these items can be found in the laboratory of the Faculty of Earth Science, Universiti Malaysia Kelantan (UMK). In addition, the government publications, journals, and official references that will be read during the mapping process will aid in the execution of this mapping.

To proceed forward with the locations, the study area's coordinates are necessary, and samples must be marked with their corresponding locations. All of these will require Global Positioning Satellite Systems (GPS). The location will be marked on the GPS and a box will be formed to aid in determining the precise location of the study area. When the sample is collected, the location will be indicated and recorded in the field notebook for future reference. GPS is one of the systems with a high level of sensitivity and faster satellite data reception. Additionally, it allows users to determine their location regardless of where they are travelling.

Either a geology hammer with a chisel or a tip point will be utilised to break and shatter outcrop rock for sampling purposes. The sample is utilised to determine the composition, minerology, and history of the rock.

Either a Brunton or a Suunto compass is the instrument of choice for geological mapping. Compass Brunton should be chosen if the researcher seeks the most precise option. Typically, the clinometer contained within the compass is used to measure strike and dip at outcrops. It can also be used to determine the orientations of sedimentary rock bedding planes.

When it comes to mapping, the geological sample bag is one of the most essential components. It is utilised for the storage of the mineral, rock, and fossil collection. Geological sample bags must be protected from rocks or fossils shattering or becoming contaminated in any way. When utilised, the sample will be safeguarded for subsequent analysis. To minimise the potential of an error arising during the process of organising the field sample, the bag was labelled with the coordinates, the expected types of rocks, the location, the date, and the time in the correct format.

Electronic image sensors used in cameras to capture images, which can subsequently be transmitted to and stored on an internal memory card or other storage device. Using this instrument, outcrops and a broad picture of the research region were acquired on video. When catching the outcrop, the techniques you employ are vital. When photographing the outcrop or collecting a sample, you must always have a scale on hand.

Hydrochloric acid, sometimes known as HCL, is an acid that has several applications in industrial settings. The mineral acid HCL is a corrosive and powerful acid. Geologists in the study of geology use the term “acid test”. This test involves pouring a drop of diluted hydrochloric acid ranging from 5 to 10 percent onto a rock or mineral and observing it to see whether or not bubbles of carbon dioxide gas are produced. The bubbles will have a violent reaction if the rock has a high concentration of carbon dioxide gas. The acid test is a method that can be utilised to determine which rocks have carbonate minerals within them. For instance, in order to distinguish between limestone and dolostone, the rock in question subjected to an experiment in which a drop of hydrochloric acid placed on it. The rock is classed as either limestone or dolostone based on the results of this experiment.

The measuring tape used by geologists is often of the reel-in form, and it bears both metric and imperial markings. Outcrops in the field measured in terms of their length and height with the use of this tape. When measuring tape is not available, researchers will sometimes resort to the pacing method in order to determine the length and height of any outcrops or other geological features that can be observed in the research area.

A magnifying glass also known as a hand lens is a type of magnifying glass that uses a convex lens to produce a magnified image of an item. Before continuing the inquiry in the laboratory, a hand lens was typically utilised in the field to determine the type of mineral that was present in the rocks and to examine any microfossils that discovered in the rocks.

3.2.2 Seismic Interpretation

Petroleum Management Unit, a subsidiary of PETRONAS, supplied the information required for seismic interpretations. It includes seismic reflection data, a base map, seismic sections in the form of SEG-Y data, a T-Z graph, and other data such as a geology report and the final well log report for the area under investigation. Everything contributes to the research. The time-depth curve was also used to depict the PETRONAS velocity survey recording wells. This depth of time was also used as the primary data source in this investigation. In addition, the information you supply will be processed by software known as Kingdom 2021 software.

PETRONAS generated a time-depth graph (T-Z graph) from the well velocity survey in the field in order to estimate how long it took the seismic wave to travel from the surface to the planned hydrophone at a certain depth. This survey will aid in locating and learning about the area's landforms and other features.

The three origins of reflection seismic data are the input sources, the sensor arrays, and the recorders. The source of sound that generates vibrations with a specific amount of energy, time, frequency, maximum amplitude, and phase. The source that flows beneath the earth's surface will generate a wave that is reflected and refracted, which will be detected by geophones, which are a sort of detector. This reflected wave is then recorded by the seismograph. Various sensors and recorders will detect distinct wave impulses. This is related to the functionality of sensors and recorders.

The seismic cross section is a cross section of the earth beneath the seismic survey line. Seismic cuts are printed on paper and consist of distinct lines that resemble waves. Using processed seismic surveys, seismic cuts requiring interpretation can be obtained. There are a number of "shot sites" near the top of each seismic segment that are exploited to build maps. On the map, each seismic section shot point is depicted.

3.3 Methodologies

3.3.1 Preliminary Studies

For this research, preparatory studies are being conducted to gain an initial understanding of the overall picture and the topic of the research. It gave researchers a sense of what the research would entail, including the geological background of the study area, its shape and drainage, how to get seismic data, and how to conduct the research properly.

The initial step of this research is to identify the issue and formulate a research question. This subject consists of two sections: geology in general and seismic interpretation.

After identifying the issue and the topic of your research, you can begin collecting the literature review. It may derive from an old journal, book, or thesis of research. Observations were conducted with the use of both a topographic map and a satellite image.

3.3.2 Data Collection

After the preliminary studies, researchers began compiling all the necessary material and submitting it to the Petroleum Management Unit, a division of PETRONAS, to request data. The requested information includes a combination of well log data, seismic data, and other geological reports compiled by PETRONAS for the research region.

For this study to be completed, the study region must be observed for at least two weeks. This is referred to as geologic mapping. The entire 25 km² within the box must be covered. The field research is an integral part of the research approach. By doing so, researchers can gain a deeper understanding of the investigated topic and accomplish their study aims. To enter the study area, approval from the local authorities was required. Due to safety concerns, several areas of the study area are off-limits. Conversations with locals were beneficial because they have intimate knowledge of the area and can assist researchers in locating an outcrop not depicted on the base map. The field research involves locating outcrops, geomorphology, and geological structure in the topic area. All images of outcrops and geological features in the study area were taken with a camera, and a scale must be placed next to each object or geological feature to estimate its size.

After direct observation, geological samples, such as fossils and rocks, must be collected from the research area in order to understand about its geology. To maintain the mineral composition of the sample, it is important to gather new rocks from the study area.

3.3.3 Data Processing

Geological mapping transfers data to the laboratory for thin section preparation. Researchers must perform thin sections on fresh samples in this region. It helped them figure out how to analyse the sample. The Petroleum Management Unit offers fundamental maps, seismic templates, T-Z curves, and well log information as part of the secondary seismic data. This data must be changed using the digital version of Kingdom version 2021 for processing and interpretation. This software provides various layers of data processing and interpretation, including data management, data analysis, data interpretation, and modelling. This SEG-Y data format must be imported into the Kingdom's software version 2021 prior to data analysis. The sum of the crossline and inline survey lines will be displayed upon completion of the data importation process. The next phase includes the importation of global coordinates. With the precise coordinate value, the study area will be presented on the computer screen as an orthogonal shape.

3.3.4 Analysis and Interpretation

The lab work had been conducted by a petrological analysis and interpretation. Petrology is the study of how rocks are made and what minerals they are made of based on their physical and chemical properties. It will explain what minerals the rocks in the study area are made of and how they are put together. The analysis and interpretation are done in a clear way so that mistakes do not happen and important information is not missed.

After finishing the geological structure, land use, drainage pattern, and petrographic analysis of the data acquired in the field. The information will be entered into the Geospatial Information System after the findings are compiled. Using Geospatial Information System, researchers will study and turn the coordinates into numbers (GIS). GIS is a form of software that can be used to analyse, manage, and display a variety of geographic data types. This will help the researchers achieve their primary goal, which is to update the geological map of the investigated area. It will generate a more accurate geological map with enhanced perspective.

There are three layers of seismic reflection: collecting the data, analysing the data, and determining what the data implies. The process of interpreting data is complex and involves an in-depth understanding of the information to be interpreted. According to Mc Quillin (2016), skilled and experienced geologists can analyse seismic data. In order to interpret seismic data, an interpreter must have extensive expertise and experience. Interpreters should determine the source of noise and eliminate it. When attempting to determine what is occurring, it is important to search for seismic characteristics that indicate top onlaps, under onlaps, and front onlaps. This is because top onlaps, beneath onlaps, and front onlaps indicate where erosion will occur next, indicating the presence of two distinct formations.

Prior to successfully recognising and correlating a sequence, its boundaries must be identified and established. Typically, sequence boundaries are defined by non-linear layer interactions and non-conformity. Given the extent of an unconformity at a specific location, the geological ages above and below the unconformity are determined. The moment sequence boundaries are identified by lateral the layer may become parallel, but the pause is indication that the nonconformity is being constantly decided. Finally, it is possible to discern sequence boundaries between parallel layers that lack evidence of hiatus and conformity-related nonconformity. The significance of sequence boundaries in seismic interpretation of stratigraphic sequences cannot be overstated.

A "transgressive surface" denotes the beginning of a relative rise in sea level relative to its occurrence. This stratigraphic surface illustrates that relative sea level rises have facilitated the deposition of additional sediments in nearshore and coastal zones. This surface was also used to indicate that the rate of nearshore sedimentation was declining. The slope of the continent and the basin's base.

Marine-flooding surface (Mfs) is the dividing line between younger and older geological strata. This illustrates how swiftly the water depth varies. Typically, this surface is located towards the base of marine shale. It shows how the environment in which the shale was deposited changed between the shallower portion at the bottom and the deeper portion at the top.

Maximum Flooding Surface (MFS) is also known as the line between a transgressive unit and an aggradation or regency unit above it. When the transgression relative sea level reaches its peak, this surface is formed. According to the sequence stratigraphic theory, this surface implies that relative oceanic rates, which are normally greater than sedimentation rates in nearshore to shallow marine environments, have been declining until they are presently lower than the depositional rate. This surface also indicates that the deposition system switches from the direction of the land to the direction of the basin as the rate of sea level rise varies.

A basin's primary genetic unit is the depositional sequence, which is bounded by an unconformity plane. This indicates that the sequence is a unit of geologic time. Therefore, all of the sequence's layers were set down at a particular time. Typically, the layers in a series are parallel and have genetic links to the initial deposition events. A sequence consists of separate lithofacies; however, it may also contain lateral isochron strata that span distinct lithofacies.

The depositional system is connected to the system tract via the system tract. System tracts are identified by their position in the series, their proximity to surfaces of discontinuity, and the location of the build-up pole of the para sequence. In each system tract, the analysis is linked to specific components of the relative sea level cycle that compose the series. Typically, three systems are used to characterise the various segments of the sea level within a single cycle. Their relative designations are the Lowstand system tract (LST), the Transgressive system tract (TST), and the Highstand system tract (HST).

LST is the oldest and is located at the end of the list in the optimal arrangement. LST was placed at a location where the relative sea level was decreasing until it reached the location where the relative sea level was steady. While the TST is located in the midst of the optimal sequence, with the transgressive surface at the bottom and the surface with the greatest amount of flooding at the top. The rising water level is leaving behind this system trace. It occurs when the rate of accommodation increases at a quicker pace than sedimentation. This can be demonstrated by bringing a deposited or turned-around pole to the surface. In a certain order of concepts, HST is the most recent. It is determined by the order of deposits made after the maximum has been reached. This system appears to be characterised by a slowing of the sea level, which results in a pattern of the sea level rising and then falling. MFS is the bottom edge, followed by the subsequent sequence bounds.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

In this chapter, the general geology results of the research area, which is located in Kampung Pak Kancil, Permaisuri, Terengganu, Malaysia, will be discussed in depth for the reader. The accessibility, settlement, forestry and vegetation of the research region, as well as traverses and observations, will all be included in this report. In addition to this, the geomorphology of the region including its categorization, drainage pattern and weathering will be discussed. In addition, petrographic research, lithostratigraphy and structural geology are all treated in this chapter.

4.2 Accessibility

Kampung Pak Kancil, Permaisuri is located in Setiu, Terengganu, which is makes it easier access by the main road from Jerteh. Kampung Pak Kancil also have road that connected to Kuala Terengganu. Next, there are a great number of village roads that are also known as housing roads, and have dirt roads. Villagers and construction vehicles use these roads. The majority of the roads are easily accessible by vehicle and motorbike to the study area. This is true for the majority of the roads.

During the time that the research was being done, several of the areas were undergoing replanting and construction, which rendered them inaccessible to outsiders because the workers at the site would not let them in because so many large vehicles passed through. Nevertheless, the constructer permitted researchers to do research in certain areas. It is possible to say that it would be beneficial for the researcher to enter the location using a four-wheel drive vehicle.

4.3 Settlement

Kampung Pak Kancil is mostly dominated by the village area. Kampung Pak Kancil also has resident areas, schools, private universities, colleges, construction, replantation sites, quarry sites, a forestry department, and an animal breeding center. The residential area consists of the villages and modern houses. Modern houses are newly and currently developed in the study area. The quarry sites consist of active and inactive sites for quarry activities. The study area can be said to be one of the strategic locations of settlement because it has fulfilled the basic needs of residents nearby.

4.4 Forestry and Vegetation

Kampung Pak Kancil, Permaisuri, Terengganu is one of Permaisuri, Terengganu's impoverished districts. Nonetheless, a moderate forest persists in the study region.

In addition, the study region contains numerous planting areas. The palm estates are owned by a private palm plantation enterprise. However, the people of Kampung Pak Kangil own the rubber plantations individually.

Figure 4.1: Forests in the Kampung Pak Kancil, Permaisuri

4.5 Traverse and Observation

During geological mapping, traverse is one of the field activities performed. The traversal is utilised to record the researcher's path while conducting research. During a traverse, scientists make observations and record their findings in order to create a geological map. Figure 4.2 is a traverse map with observations depicting the path travelled during mapping operations. The waypoints on the map that indicate observations have been added to Table 4.1, which details all observations made throughout the tour.

Table 4.1: Observation recorded for each point in traverse

WAYPOINT	COORDINATES	OBSERVATION
FIRA 001	05˚30’35”N 102˚46’10.”E	Analysis outcrop and identify structures
FIRA 002	05˚30’35.38”N 102˚46’10.56”E	Rock sample of Phyllite
FIRA 003	05˚30’36.73”N 102˚46’12.83”E	Rock sample of Slate
FIRA 004	05˚30’36.20”N 102˚46’12.37”E	Rock sample of Schist
FIRA 005	05˚31’35”N 102˚47’30”E	Observation geomorphological
FIRA 006	05˚31’35”N 102˚47’30”E	Rock sample of sandstone
FIRA 007	05˚31’39.08”N 102˚46’12.76”E	River observation
FIRA 008	05˚30’35”N 102˚47’30”E	Rock sample of mudrock
FIRA 009	05°29'9.976"N 102°47'30.1"E	Rock sample of meta mudrock
FIRA 010	05°29'94.68"N 102°47'30.1"E	Observation geomorphological
FIRA 011	05°29'58.023"N 102°46'26.726"E	Rock sample of phyllite
FIRA 012	05°29'59.946"N 102°46'45.366"E	Rock sample of schist
FIRA 013	05°29'33.992"N 102°47'12.902"E	Rock sample of slate
FIRA 014	5°29'4.227"N 102°29'18.538"E	Rock sample of mudrock

FIRA 015	05°29'4.053''N 102°47'18.869''E	River observation
FIRA 016	05°29'45.882''N 102°47'49.133''E	Rock sample of sandstone
FIRA 017	05°30'9.91''N 102°47'24.92''E	Rock sample of phyllite
FIRA 018	05°30'2.65''N 102°47'42.012''E	Rock sample of schist
FIRA 019	05°30'45.722''N 102°47'35.096''E	Rock sample of slate
FIRA 020	05°30'13.13''N 102°47'36.851''E	Rock sample of mudrock

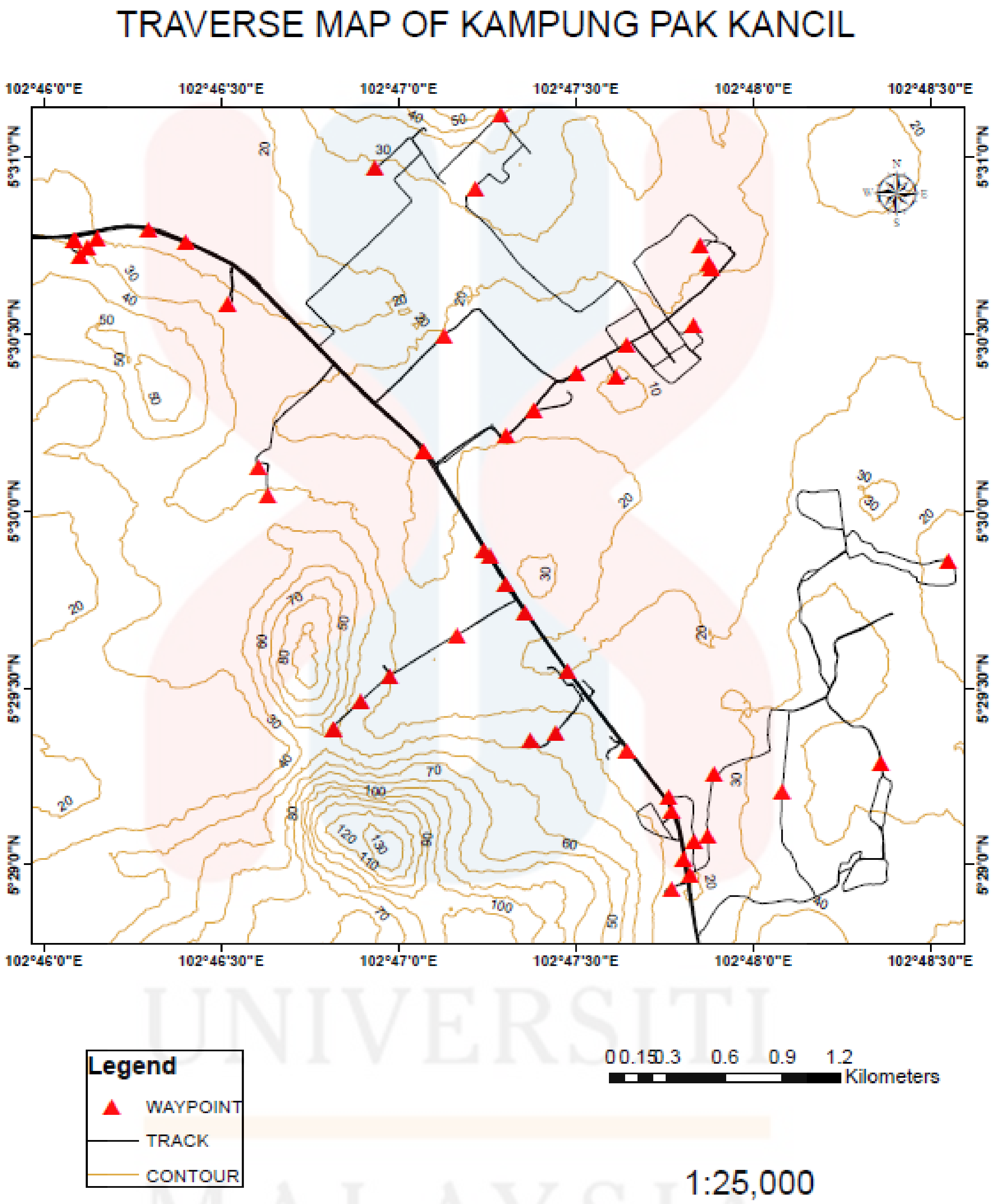


Figure 4.2: Traverse and Observation Map

4.6 Geomorphology

Geomorphology is the study of the physical features of the Earth's surface, including their origin, characteristics, processes, and evolution. The geomorphological research of Kampung Pak Kancil, Permaisuri, Terengganu, Malaysia was conducted by monitoring the landforms, analysing the weathering rates, and classifying the drainage pattern of the studied region. It is undertaken based on a topographic map, a drainage map, a review of relevant literature, as well as field observation.

4.6.1 Topographic Unit Classification

Based on an analysis of the topography map of the study area, the geomorphology of the study area is described as undulating and hilly. Based on the difference in mean elevation, Hutchison and Tan (2009) divided the topographic unit classification into five main groupings. These regions are low-lying, undulating, hilly, and mountainous. Table 4.2 displays Hutchison and Tan's topographic unit classification based on mean altitudes (2009).

The research area ranges in elevation from 20 metres at its lowest point to 130 metres at its highest point. This indicates that it fits into one of four groups of hilly landforms within the topographic unit. Figure 4.3 depicts the Datum Elevation Map, which was created using the elevation of the research region.

Table 4.2: Topographic unit classification

Classification	Topographic unit	Mean Elevation (m above sea level)
1	Low lying	<15
2	Rolling	16 – 30
3	Undulating	31 – 75
4	Hilly	76 – 300
5	Mountainous	>301

(Source: Hutchison and Tan, 2009)

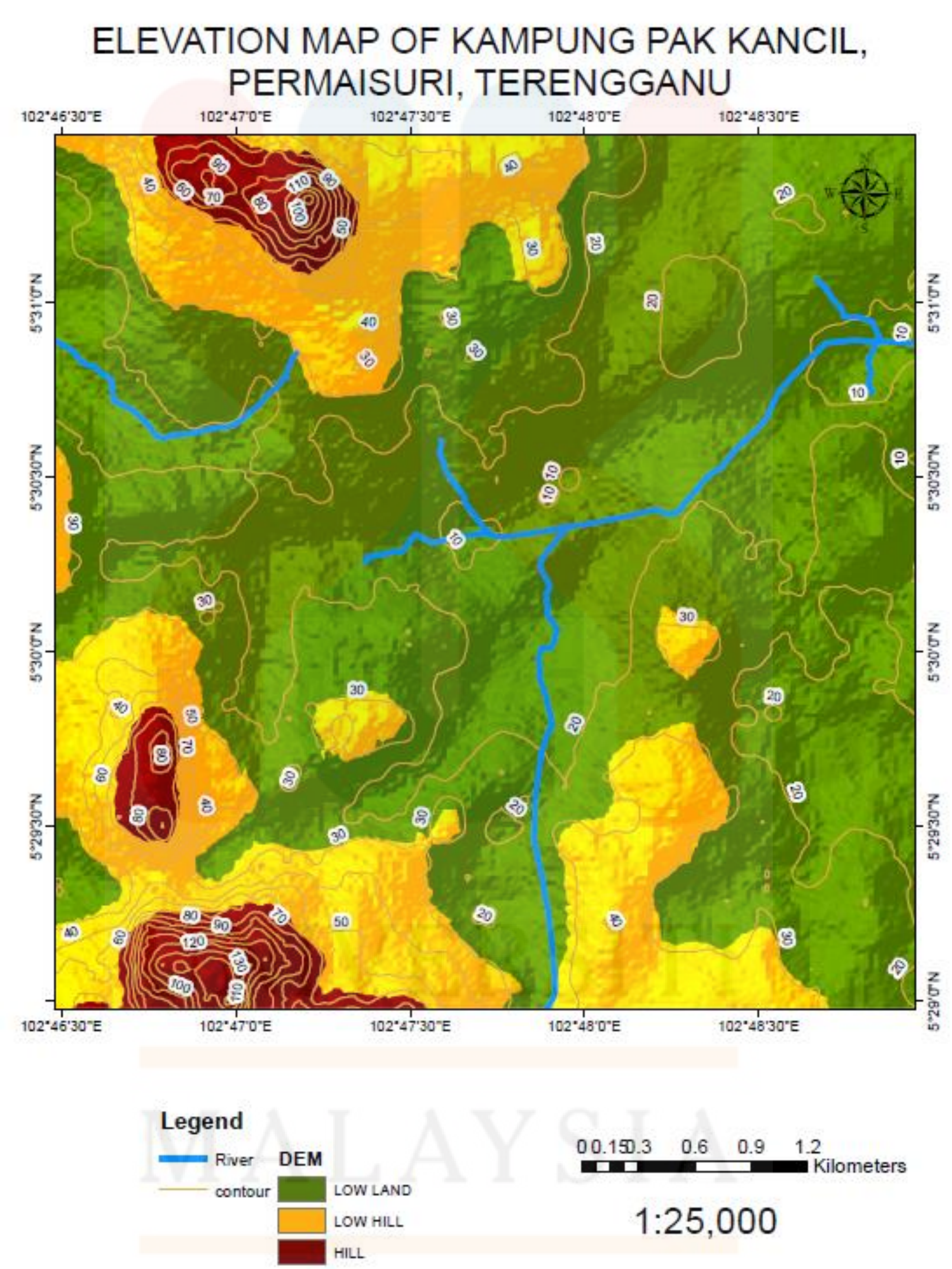


Figure 4.3: Datum Elevation Map

4.6.2 Drainage Pattern

The river is a body of water that runs through earth channels. A river begins on a plateau, hill, or mountain and flows down to the lowlands due to differences in gravity. A river begins as a little stream, but as it flows, it grows larger. The patterns of streams and rivers in a drainage basin can be modified by the shape of the terrain, the predominance of hard or soft rock in the region, and the absence or presence of bedrock structure. There are various drainage patterns, including trellis, dendritic, parallel, angular, twisted, and radial. Using a topographic map and an examination of the relevant literature, you may group items.

Typically, geomorphologists and hydrologists consider streams to be components of drainage basins. A drainage basin is the land area from which surface water, throughflow, and groundwater flow into a stream. A watershed is the region of land that separates two drainage basins. A watershed consists of all tiny streams that flow into a larger stream channel. Each region has a different number, size, and shape of drainage basins, and the more precise the topographic map, the more information is available for each drainage basin.

There are parallel and dendritic drainage patterns in Kampong Pak Kancil, Permaisuri, Terengganu. A parallel drainage system is a pattern of rivers generated by steep slopes with a certain amount of relief. Due to the steepness of the terrain, the streams are swift, straight, and flow in the same direction. When there is a steep surface slope, two drainage patterns parallel to one another form. In regions with lengthy, parallel landforms, such as protruding rock bands, a similar pattern arises.

In contrast, dendritic patterns are by far the most prevalent. It forms in areas where the rock or loose material beneath a stream lacks pattern or structure and can be eroded in any direction. Examples include granite, gneiss, volcanic rock, and sedimentary rock that has not been folded.

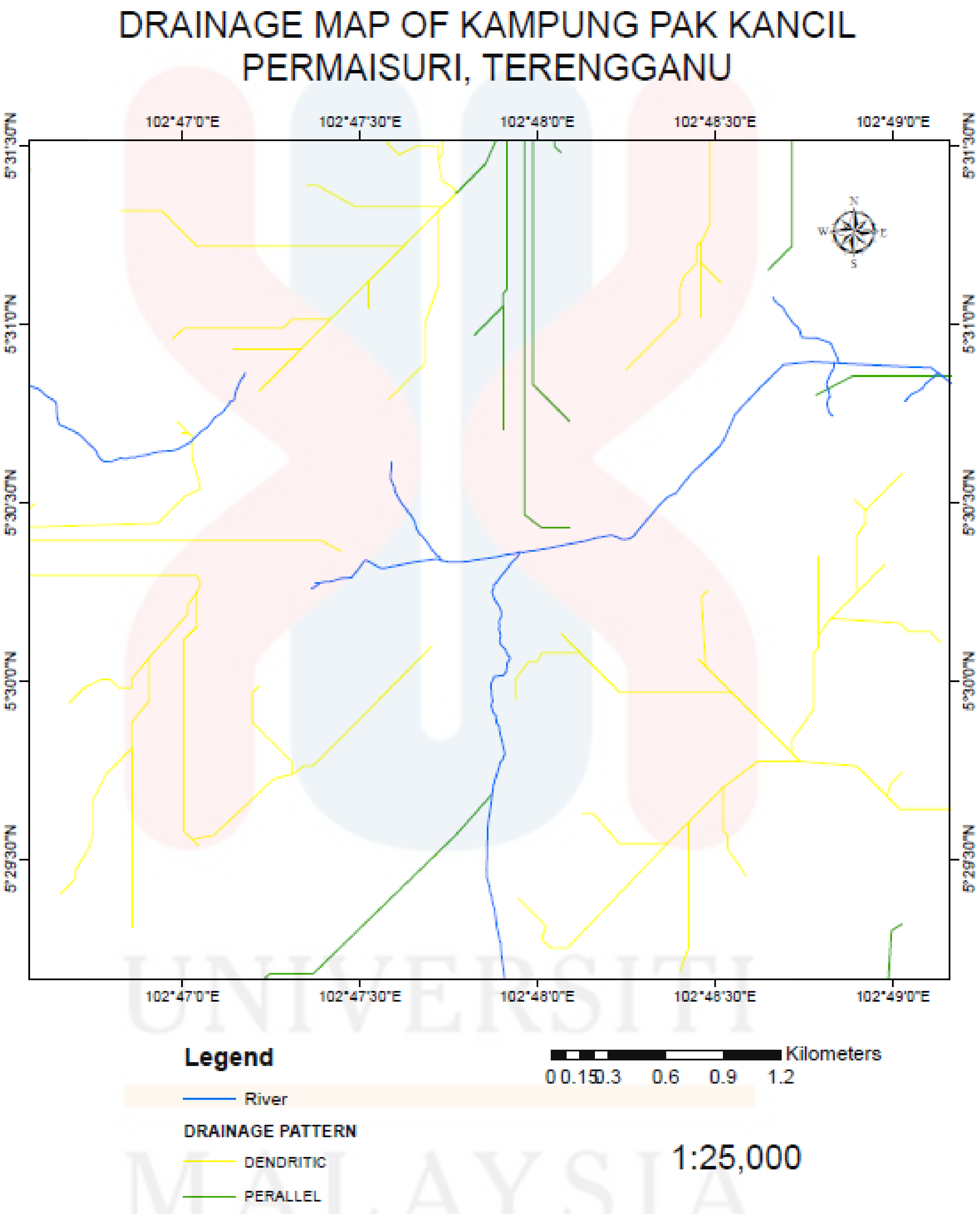


Figure 4.4: Drainage Map

4.6.3 Weathering

Peninsular Malaysia is in a humid area with temperatures in the middle of the temperature range, high humidity, and a lot of rain. So, for this situation, the weathering of the bedrocks is more likely to happen in an environment that is good for it. There are a few different kinds of weathering, such as physical, chemical, and biological. All of these things happened because of the weather in the area.

i) Physical Weathering

Changes in temperature have an effect on rocks that leads to their disintegration. This process is known as weathering. Water occasionally aided the process. The two primary types of physical weathering are freeze-thaw and chemical. Freeze-thaw occurs when water seeps into fractures and repeatedly freezes and thaws. Destruction of the rock in the end. Exfoliation occurs when parallel fissures appear on the surface of the land. This occurs because ground pressure drops as a result of uplift and erosion.

The majority of physical weathering occurs in areas with little soil and few plants, such as mountainous regions and hot deserts, where there is limited opportunity for plants to thrive. Mountains and tundra are generated by continuous melting and freezing of water. When the top layer of rocks that have been burned by the sun expand and shrink, hot deserts are generated.

This type of weathering is present in the area of investigation. Figure 4.5 depicts the physical weathering that may have occurred to the rock due to external forces or physical qualities. Physical weathering is the process through which rocks disintegrate into smaller fragments without altering their chemical composition.

Figure 4.5: Physical weathering

ii) Chemical Weathering

Rainwater combines with the minerals in rocks to form dissolvable minerals such as clays and salts. It is known as chemical weathering. When the water is slightly acidic, the frequency of these processes increases. These chemical processes require water and proceed more rapidly at higher temperatures, thus it is best to dwell in a warm, humid environment. Chemical weathering, especially hydrolysis and oxidation, is the first step in the formation of soils.

Different types of chemical weathering exist. When acidic rainwater dissolves rocks, this is one of the most crucial types. Specifically, precipitation with dissolved CO2 degrades limestone. Some individuals refer to this process as carbonation. Hydrolysis is the process by which acidic water dissolves clay and salts from rock. Oxidation is the process through which oxygen and water erode rock. Iron-rich, worn rocks frequently have a rusty hue. Figure 4.6 depicts how oxidation on the outcrop led to the formation of the reddish brown iron exides on the rocks.

Figure 4.6: Chemical weathering

iii) Biological Weathering

Rocks undergo biological weathering when plant roots or root fluids disintegrate them. The process is slow, but it could have a significant impact on the formation of the landscape. The rate of biological weathering increases until the ideal level of biotic activity is attained. After that, it decreases because biotic activity has a diminishing impact on weathering.

Putrefaction occurs when living organisms, such as plants, decompose stone by imparting an offensive odour to them. Along with other types of weathering, it accelerates the decomposition of rock materials because it is more affected by environmental elements such as biotic and abiotic influences.

Figures 4.7 and 4.8 illustrate the effects of biological weathering on the outcrop. In the photograph, vegetation can be seen sprouting on the outcrop. The pressure exerted by plant roots fractures the rock, forcing it to collapse to the surface.

Figure 4.7: Biological weathering

Figure 4.8: Biological Weathering

4.7 Lithostratigraphy

Lithostratigraphy is a branch of geology that looks at rock layers and rock strata. Geochronology, comparative geology, and petrology are the main topics of this research. There are a few general rules that are used to explain why the strata are there. When a hard rock is cut by another rock formation, can say that the hard rock that did the cutting is younger than the rock that was already there. Geologists can figure out what happened on Earth in the past by looking at the composition, texture, structure, and other features of rocks that were found during geological mapping.

4.7.1 Lithostratigraphy Position

The study area's lithostratigraphy is set up from oldest to youngest, with the Charu/Sungai Perlis bed as the unit.

Table 4.3: Stratigraphic column of lithology in the study area

Lithology	Unit	Formation Age	Era	Description
	Schist	Carboniferous	Palaeozoic	Schist typically forms during regional metamorphism accompanying the process of mountain building (orogeny) and usually reflects a medium grade of metamorphism. Schist can form from many different kinds of rocks, including sedimentary rocks such as mudstones and igneous rocks such as tuffs.
	Slate	Carboniferous	Palaeozoic	The tectonic environment for producing slate is usually a former sedimentary basin that becomes involved in a convergent plate boundary.
	Phyllite	Carboniferous	Palaeozoic	Phyllite is a foliated metamorphic rock rich in tiny sheets of sericite mica. It presents gradation in degree of metamorphism ranging between slate and mica schist.
	Mudrock/sandstone	Permian	Palaeozoic	Mudrocks are one of the several names for fine-grained, argillaceous sedimentary rocks, also broadly called shales and mudstones

4.7.2 Unit Explanation

The main lithological unit inside the study area is the Charu/Sungai Perlis bed unit. There are two kinds of rocks in the Charu/Sungai Perlis bed: sedimentary rocks and metamorphic rocks. Sandstone and mudrock are two types of sedimentary rocks. On the other hand, phyllite, slate, and schist are all types of metamorphic rocks.

a) Phyllite Unit

The outcrop of phyllite was near where the houses had been. The weathering on the outcrop ranges highly weathered. The rock outcrop is 50 m high. Most of the land around the outcrop is hilly, and the outcrop itself has some plants on it. Figure 4.9 shows the outcrop of phyllite in human size.

Figure 4.9: Phyllite Outcrop

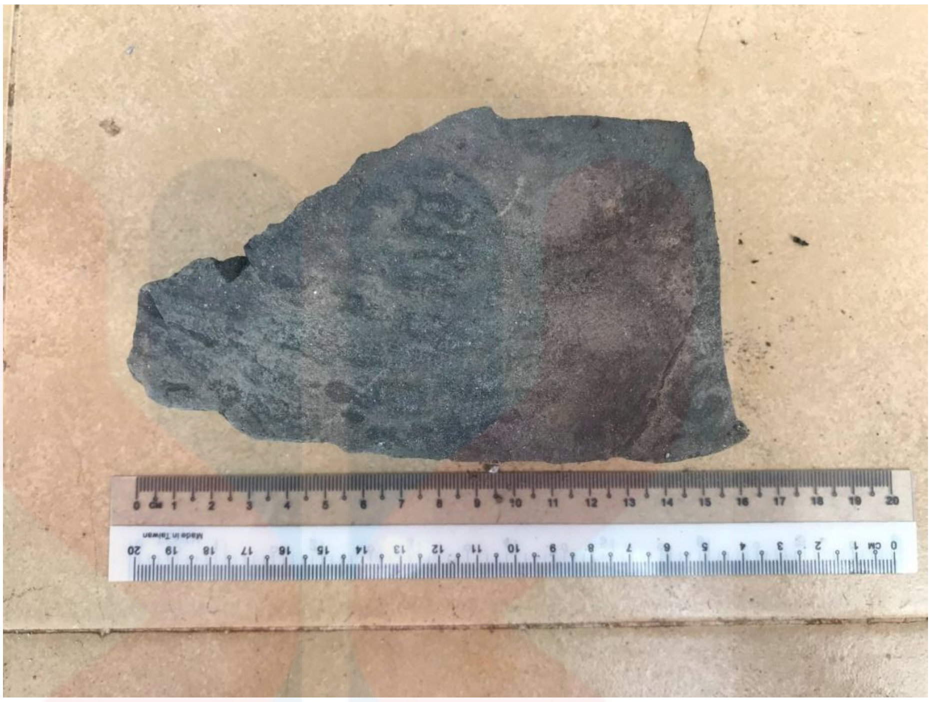


Figure 4.10: Phyllite hand specimen

Based on a hand specimen with a megascopic, the parameters of the rock's colour on the megascopic hand specimen tend to look like black ash-green. When a thin section of phyllite is looked at under a microscope with a 10x ocular enlargement lens and a 5x objective enlargement lens, there is a slaty, schistose structure that can be seen. It has also seen a palimpsest texture, which is blastoporphyritic–blastopellite and covers grains with sizes between 1/256 and 0.6 mm. Plane Polarized Light (PPL) of the thin section of phyllite is shown in Figure 4.11, and Cross Polarized Light (XPL) is shown in Figure 4.12.

According to what the PPL and XPL see under a microscope, a few minerals can be named. Figures 4.11 and 4.12 for PPL and XPL views under a microscope show that there is quartz mineral. Under PPL, the mineral looks white, but under XPL, it looks ashy black. It has low relief, no cleavage, low pleochroism, and the shape of an anhendral crystal. With a 4% abundance percentage, quartz is spread out in thin sections.

When in PPL, lithic pieces look brown, and when in XPL, they look dark. It is made up of quartz mineral, opaque minerals, and spots, which make up 6% of its total amount in the thin section. It can be seen from Figures 4.11 and 4.12.

In the PPL and XPL, the colour of chlorite clay minerals is greenish black, and has one direction cleavage. It has low to medium pleochroism and a medium amount of relief. It can be seen in Figures 4.11 and 4.12 and on thin sections with a 58% presence.

In Figure 4.11 and Figure 4.12 show the silicate clay minerals in the PPL and XPL. On PPL, the colour looks white and ashy, and on XPL, it looks black and ashy. It looks like a crystal, and there are no cleavage in it. 35% of it can be seen in the thin section. Aside from that, the attached figure shows that the 3% presence of opaque minerals can be seen with dark colours in both XPL and PPL.

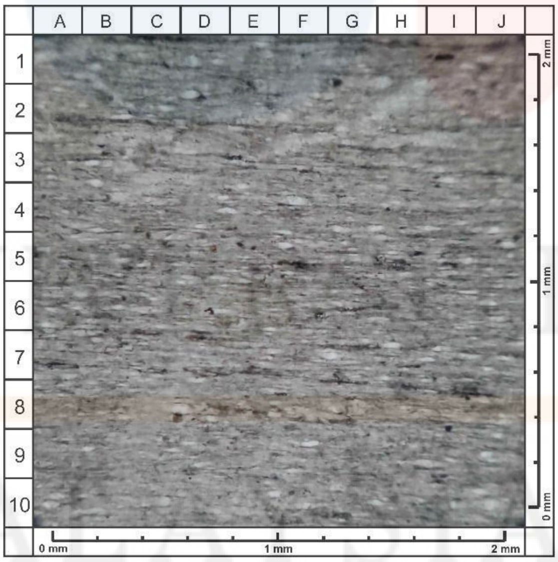


Figure 4.11: PPL view of phyllite thin section under microscope

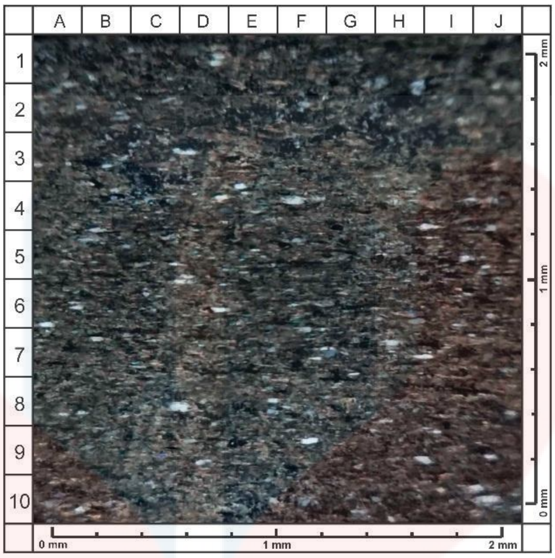


Figure 4.12: XPL view of phyllite thin section under microscope

b) Schist Unit

c) From the north-east to the west of the study area, there were outcrops of schist. The weathering on the outcrop is partially weathered to very weathered. The rock outcrop is 50 m high. The land around the outcrop looks the same as the phyllite, which is mostly hilly, and the top of the outcrop is covered with plants. The schist outcrop is shown in Figure 4.13. Based on a hand specimen with a megascope, the parameters of the rock's colour on the megascope hand specimen tend to look like black ash-green. When a thin section of schist is looked at under a microscope with an ocular enlargement lens of 10x and an objective enlargement lens of 5x, the foliation structure can be seen. It has also seen a palimpsest texture, which is made of blastopsamit and covers grains that are 1/256 mm to 1/2 mm in size with medium sorting. Figure 4.14 shows the PPL of a thin section of schist, and Figure 4.15 shows the XPL.

Figure 4.13: Schist outcrop

According to what the PPL and XPL observe under a microscope, a few minerals can be appointed. Figures 4.14 and 4.15 for PPL and XPL views under a microscope show that there is quartz mineral. Under PPL, the mineral looks white, while under XPL, it looks ashy black. It is flat and has no cleavage. Low pleochroism and the shape of an anhendral crystal. Quartz is found in thin sections with a 35% presence rate.

Sericite can be seen in Figures 4.14 and 4.15. It has a white-ashy colour under PPL and a brown-red ashy colour under XPL. It had low pleochroism and low relief. No cracks, and the shape of an anhendral crystal. 30% of it is there in the thin section.

Figure 4.14 and Figure 4.15 show the silicate clay minerals in the PPL and XPL. On PPL, the colour looks white and ashy, and on XPL, it looks black and ashy. It looks like a crystal, and there are no cracks in it. 35% of it can be seen in the thin section.

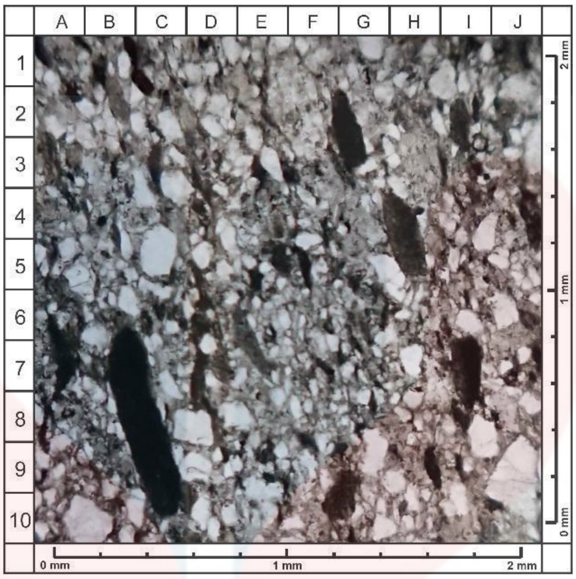


Figure 4.14: PPL view of schist thin section under microscope

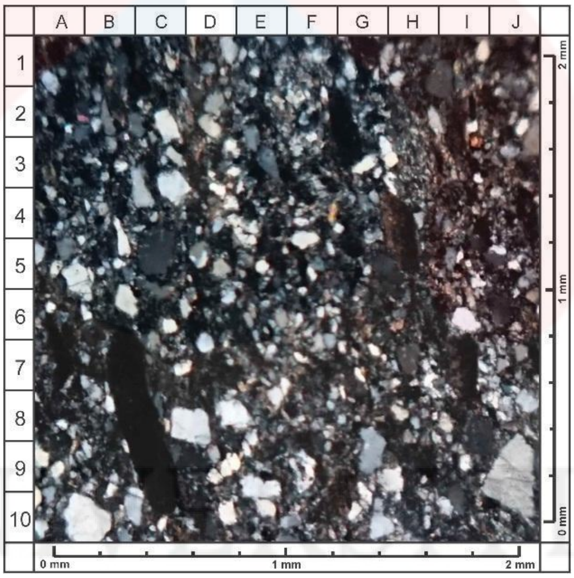


Figure 4.15: XPL view of schist thin section under microscope

c) Slate Unit

From the north-east to the west of the study area, there were also slate outcrops. The weathering on the outcrop is anywhere from partially weathered to very weathered. The rock outcrop is 30 m high. The land around the outcrop is mostly made up of hills, and the top of the outcrop is covered with plants. Figure 4.16 shows the outcropping of slate. The observations were made with a 10x ocular magnification and a 5x objective magnification. The foliation structure was seen to be slaty cleavage, the texture was blastopellit, and the grain size was between 1/256 mm and 1/32 mm. Figure 4.17 shows the PPL of a thin slice of slate, and Figure 4.18 shows the XPL.

Figure 4.16: Slate outcrop

Under a microscope, both the PPL and the XPL can see a few minerals that can be recognised. Quartz mineral at PPL has no colour when it absorbs light, low relief, no pleochroism, anhedral crystal form, and no cleavage. In XPL, the interference colour is gray-white order 1, with dark, wavy corners and no twinning. Quartz was found in thin sections at a rate of 2%.

Figures 4.17 and 4.18 at PPL show that the colorless-brown absorption colour of silica clay. On XPL interference colour dark grey to black. Contain silicate material that is a few microns in size. 83% of it is there in the thin section.

Figures 4.17 and 4.18 on PPL black absorption colour, low relief, no pleochroism, and euhedral–anhedral crystal form show an opaque mineral. On XPL, the first order interference colour is black, and there is no twinning. 15% of it is there in the thin section.

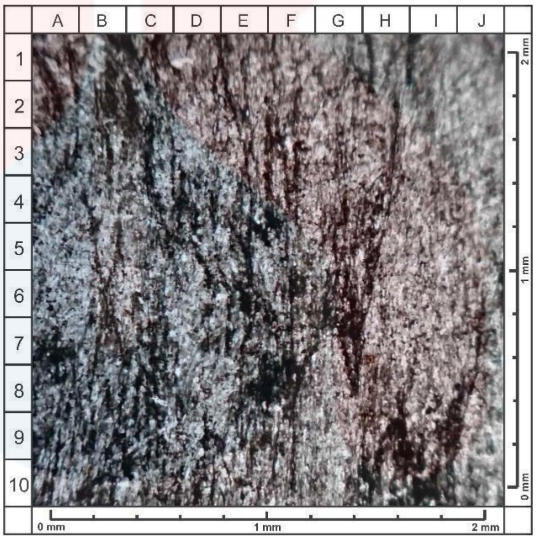


Figure 4.17: PPL view of slate thin section under microscope

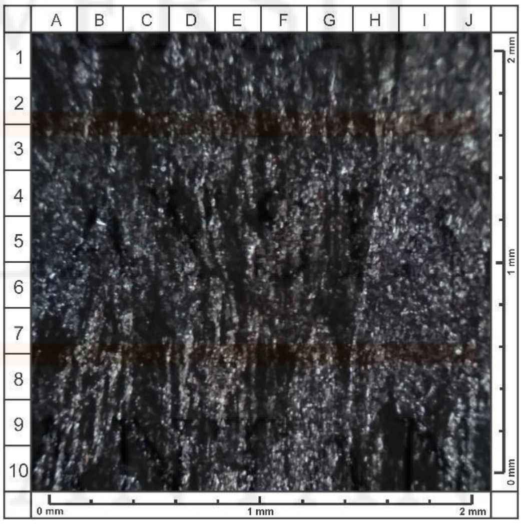


Figure 4.18: XPL view of slate thin section under microscope

d) Mudrock Unit

Mudrock outcrops covered the area from the north-east to the west. The weathering on the outcrop is highly weathered. The outcrop is 30 m high. The land around the outcrop is mostly hilly, and the top of the outcrop is covered by plants. The parent rock of mudrock is sandstone. The outcrop of mudrock is shown in Figure 4.19. Based on observations of hand specimens with the help of a megascope, the parameters of rock colour on the megascope hand specimen tend to look orange. While looking at a thin section of mudrock through a microscope, the ocular magnification is 10x and the objective magnification is 5x. Based on these observations, it is known that the mudrock has a massive structure, a texture with grains that range in size from 1/256 mm to 1/10 mm, and that the grains are well-sorted and loosely packed.

Figure 4.19: Mudrock outcrop

According to the PPL and XPL view under microscope there are a few minerals that can be identified. Quartz mineral at PPL the absorption color is colorless, low relief, pleochroism absent, anhedral crystal form, cleavage there isn't any. In XPL the interference color is gray – white order 1, wavy dark corners, no twinning.

Feldspar in PPL the absorption color is colorless, low relief, pleochroism absent, euhedral-anhedral crystal form, 1 way split. In XPL the interference color is gray –1st order white, parallel dark angle, albit twin – kalsbad – kalsbad-albit – polysynthetic.

Oxide clay in PPL the absorption color is brown. On XPL colors chocolate interference. Consists of a mixture of silicate materials and micron-sized iron oxide.

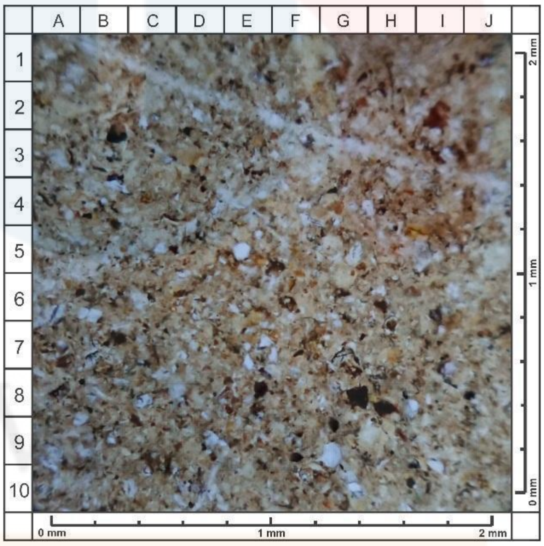


Figure 4.20: PPL view of mudrock thin section under microscope

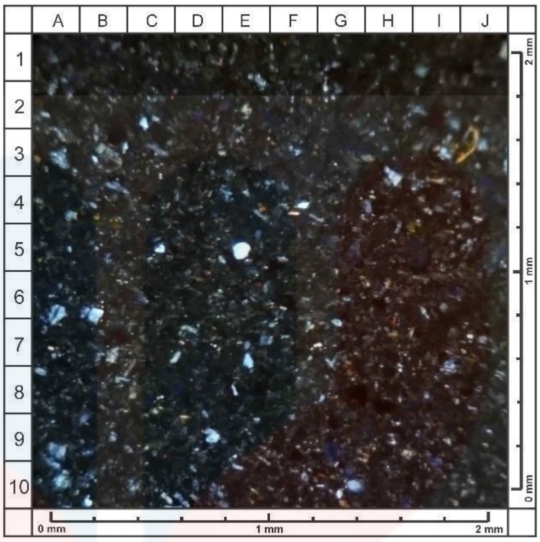


Figure 4.21: XPL view of mudrock thin section under microscope

4.8 Structural Geology

One of the sub-disciplines in geology that need to take a look during geological mapping is structural geology. It is the study of 3D distribution of rock unit with their deformations. Geological structures like veins and folds can be found in the study area.

a) Quartz veins

One of the structures observed in the study area is a quartz vein. The majority of protruding rocks in the research region are quartz vein. A quartz vein is a unique, mineral-crystallized sheet within a rock. It is formed when an aqueous solution moves or transports mineral particles through fissures in a rock mass and deposits them during the "precipitation" process. Frequently, hydrothermal circulation causes the hydraulic flow that results in the creation of quartz veins. Quartz veins are the veins that are present in the region of research. Between the rock strata, a quartz vein formed. Figure 4.22 depicts the quartz vein in a mudrock outcrop.

Figure 4.22: Quartz vein found in mudrock outcrop.

b) Fold

Folds are a form of geological feature that resembles undulations on the earth's surface. Early structure is composed of either vertical or horizontal layers of sediment. This structure was fashioned through deformation. The material is plastic and bendable. A fold is one of the structures that demonstrates clearly and generally that a site on Earth undergoes ductile deformation. In this subject area, there are two types of folds: anticlines and synclines.

i. Anticline

On phyllite outcrops in the research area, anticline can be observed. An anticline is a fold that convexes upward, while a syncline is a fold that convexes downward. A synclinorium is a big syncline topped with tiny folds. An anticlinorium is a huge anticline topped by tiny folds. Observations indicate that the largest folds in the study area are the largest anticlines. Figure 4.23 depicts the anticline fold in the research area.

Figure 4.23: Anticline fold

ii. Syncline

On the phyllite outcrop in the research area, a syncline fold may be observed. A syncline is the downward curve or arc of a fold created by forces within the crust of the earth. Folds can be created by anything from minute pressure changes in the earth's crust to massive collisions between the tectonic plates that comprise the crust. The majority of the time, these tectonic forces are compressions of the earth's crust. The amount and intensity of these compressions vary from location to location, creating a wave-like or undulating structure or pattern. Figure 4.24 depicts the syncline fold in the research area.

Figure 4.24: Syncline Fold

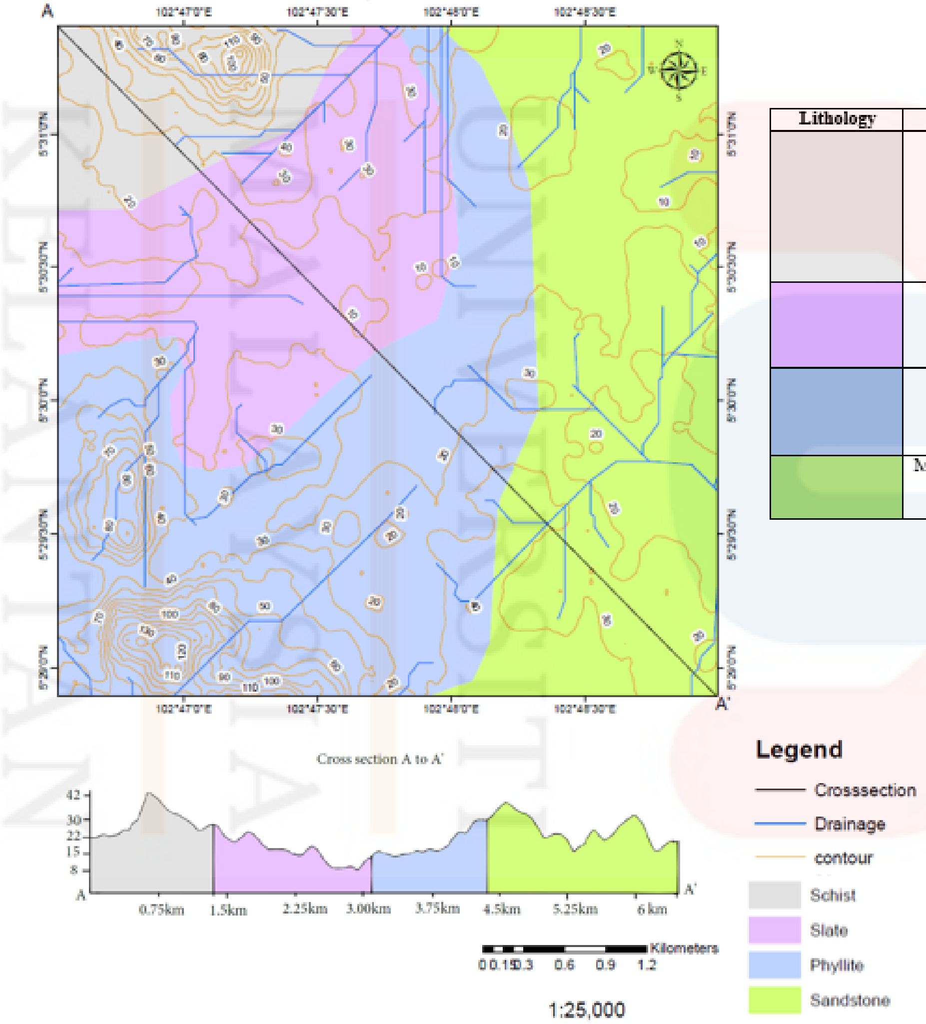
4.9 Historical Geology

The East Line traverses the entirety of Terengganu. Early Carboniferous and Cenozoic ages account for the majority of metamorphic rocks in the study area. The research region contains low-grade metamorphic rocks such as phyllite and medium-grade metamorphic rocks such as schist. Changes in pressure, temperature, or chemical activity in a gas or liquid can alter rocks through the metamorphism process.

In the area under investigation, the geological sequence is composed of sedimentary and metamorphic rocks. The sedimentary and metamorphic rocks were then separated into several units. The Charu/Sungai Perlis bed spanned the Early Carboniferous and Permian time periods. The Charu/Sungai Perlis bed consists primarily of metasandstone with traces of phyllite, slate, argillite, carbonaceous phyllite, metasiltstone, schist, and calc-silicate hornfels. In the studied region, only phyllite, sandstone, mudrock, meta-mudrock, and schist are present.

Figure 4.25 shows a 1:25,000-scale geological map of the study area. It indicates that the study region is composed of sedimentary and metamorphic rock.

GEOLOGICAL MAP OF KAMPUNG PAK KANCIL, PERMAISURI, TERENGGANU



STRATIGRAPHY

Lithology	Unit	Formation Age	Era	Description
	Schist	Carboniferous	Palaeozoic	Schist typically forms during regional metamorphism accompanying the process of mountain building (orogeny) and usually reflects a medium grade of metamorphism. Schist can form from many different kinds of rocks, including sedimentary rocks such as mudstones and igneous rocks such as tuffs.
	Slate	Carboniferous	Palaeozoic	The tectonic environment for producing slate is usually a former sedimentary basin that becomes involved in a convergent plate boundary.
	Phyllite	Carboniferous	Palaeozoic	Phyllite is a foliated metamorphic rock rich in tiny sheets of sericite mica. It presents gradation in degree of metamorphism ranging between slate and mica schist.
	Mudrock/sandstone	Permian	Palaeozoic	Mudrocks are one of the several names for fine-grained, argillaceous sedimentary rocks, also broadly called shales and mudstones

LITHOLOGY

Lithology	Description
	Schist has medium to large, flat, sheet-like grains in a preferred orientation. It is defined by having more than 50% platy and elongated minerals, often finely interleaved with quartz and feldspar.
	mainly composed of quartz, sericite and minerals of the chlorite group
	It has a crinkled or wavy appearance as its foliation. Phyllite is a durable and soft rock.
	fine grained sedimentary rocks consisting of mostly silt and clay size fragments. They are sometimes called argillites.

Figure 4.25: Geological map of the study area

CHAPTER 5

3D SEISMIC INTERPRETATION OF ABU FIELD OF TERENGGANU OFFSHORE

5.1 Introduction

In this chapter, it will discuss the findings for 2D seismic interpretation of Abu Field of Terengganu Offshore. Abu Field is located at the north-eastern part of the Terengganu Offshore.

This chapter will discuss the findings of the interpreted seismic section which includes sequence boundary, seismic facies and structural geology. The structures which can be identified in the seismic sections are interpreted according to the features of seismic facies. Trap for oil can come in two conditions such as stratigraphic and structural.

Deposition of sedimentary rock is the result which contributed to the formation of stratigraphic traps. The seals are created on top and beside the reservoir when the sedimentation occurs in discontinuous layer. When changes happened respectively to the process of sedimentation, stratigraphic traps can be categorised into main types. Primary stratigraphic traps occurred because of the changes which happened during the process of sedimentation. Meanwhile for secondary stratigraphic traps, it occurs from the changes which happened after processes of sedimentation these changes that occurred can lead to the cap like rock formation due to the change in rock porosity.

In other hand, structural traps is resulted from the structural deformation in the rocks. The shape and formation of traps is caused by the difference in types of deformation that occurred.

5.2 Sequence Boundary

Sequence are bounded by sequence boundaries which are recognised as notable erosional unconformities and their mutual conformities. In general, there are four sequence boundaries which can be identified that separate the major sequences. The four sequence boundaries are named as SB1, SB2, SB3 and SB4. However, a detailed study of this sequence was not performed because lack of well data.

In sequence boundary SB1, consists of the parallel to sub-parallel which is high amplitude and frequency. The sediments of this boundary deposited under the influence of varying lagoonal flat tidal.

In sequence boundary SB2, the reflection characteristics appear as sub parallel, moderate amplitude and low frequency. Although, sub-parallel also occurred after chaotic facies in SB1. The sediment in this sequence deposited under influenced of tidal, coastal fluvial marine environment.

In sequence boundary SB3, the characteristics of reflection appear as chaotic and contorted facies with moderate to low amplitude and low frequency. It is believed that the sediments in this boundary comprised of fan delta and high energy of fluvial deposits, alluvial plain and lacustrine sediments which is understood that the sediments deposited in rather shallow lacustrine environments.

In sequence boundary SB4, the characteristics of reflection appear as discontinuities facies with low amplitude and low frequency. Some reflectors less layered, contorted and usually bounded by sharp erosional base characterised by negative reflection.

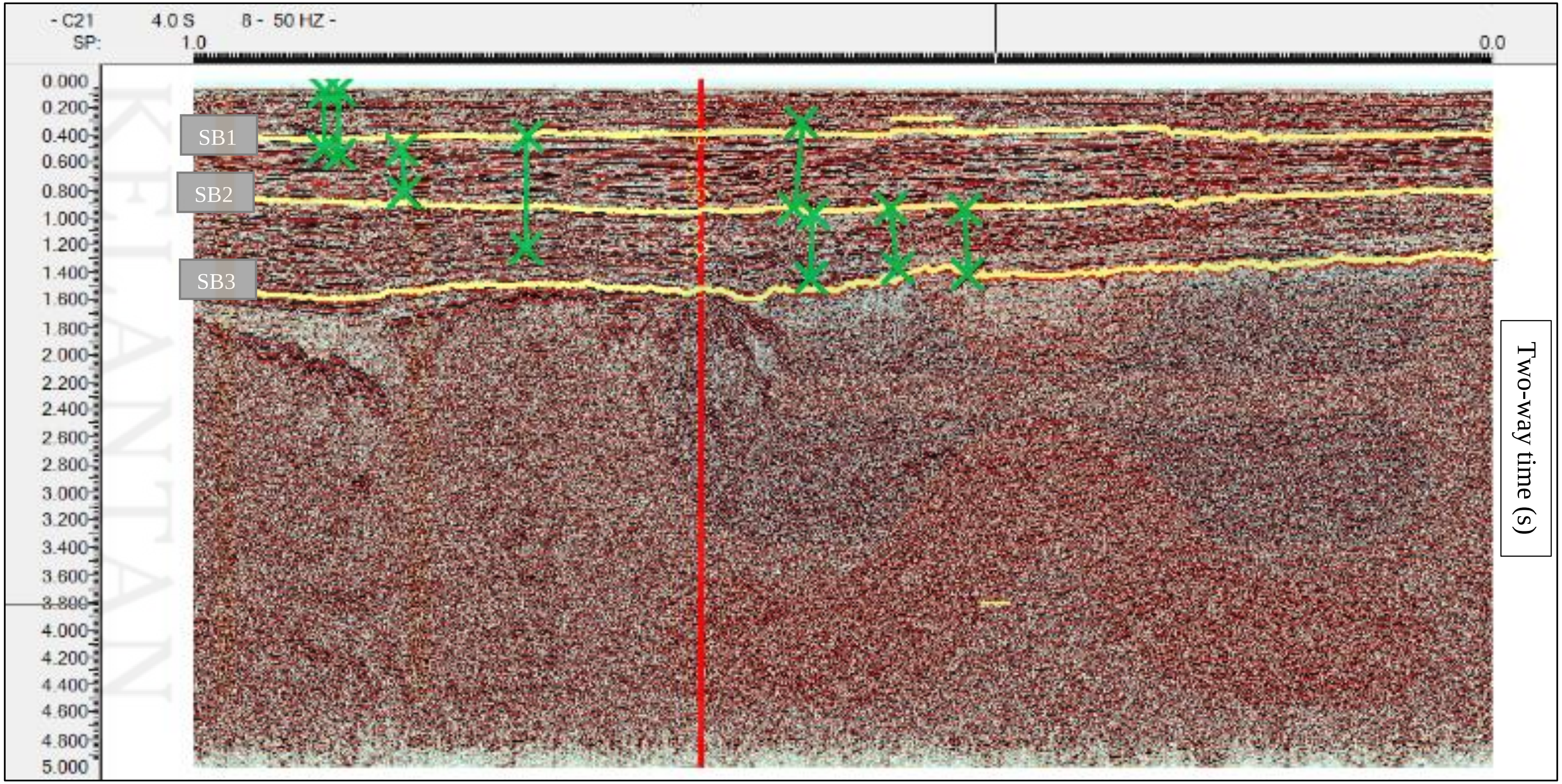


Figure 5.1: Line C21 4.05

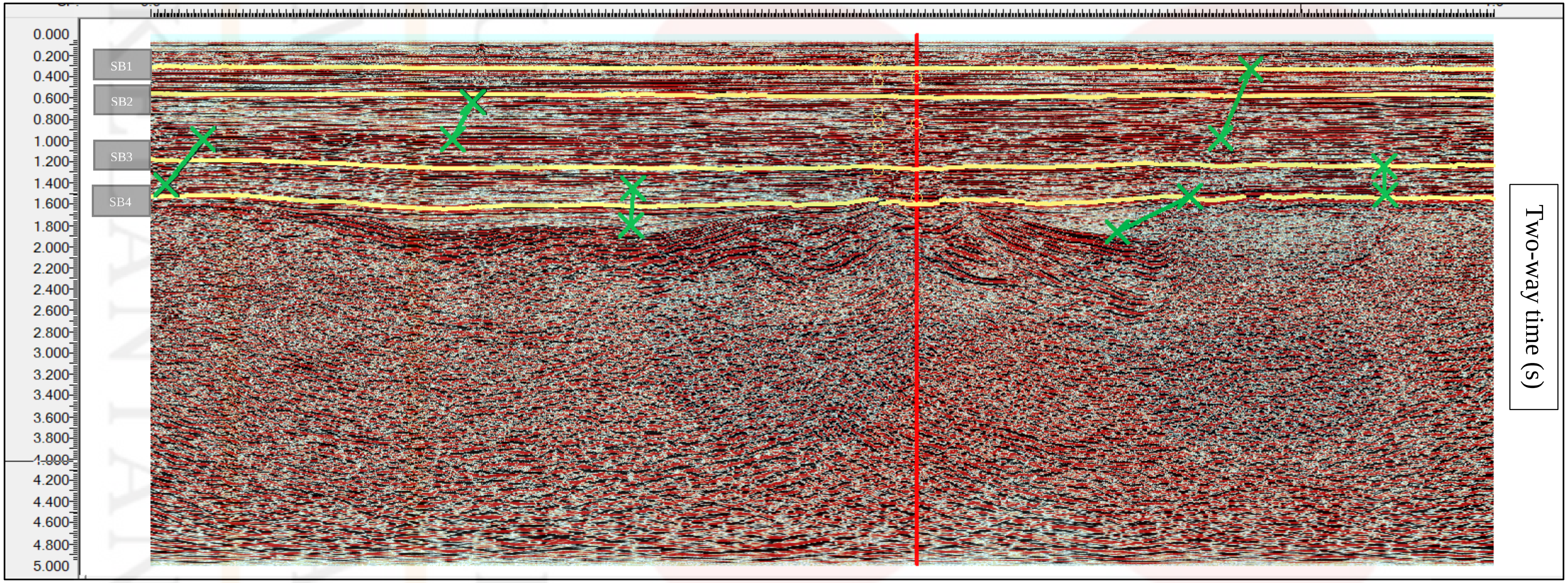


Figure 5.2: Line C21 Gates

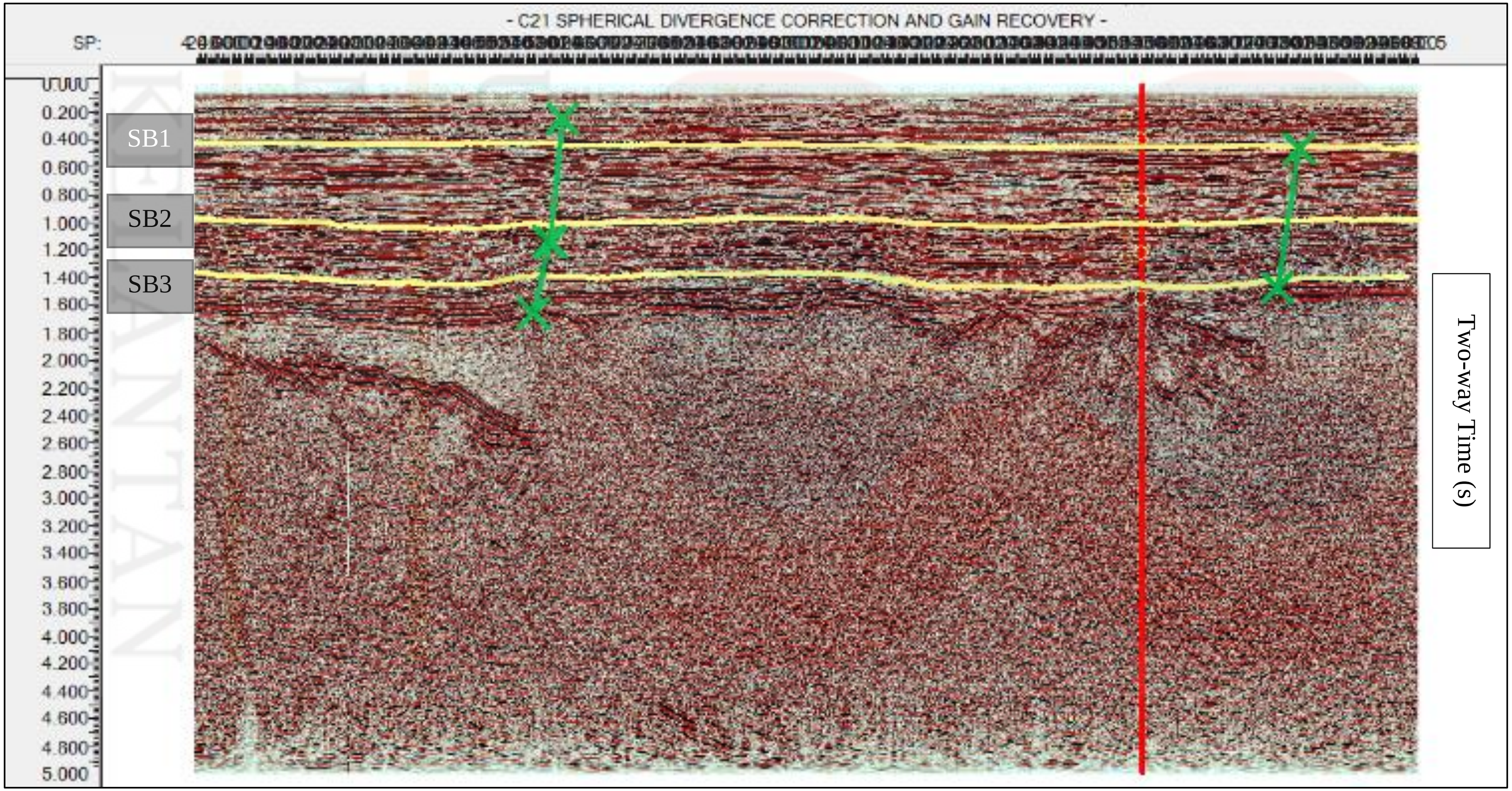


Figure 5.3: Line C21 Spherical Divergent

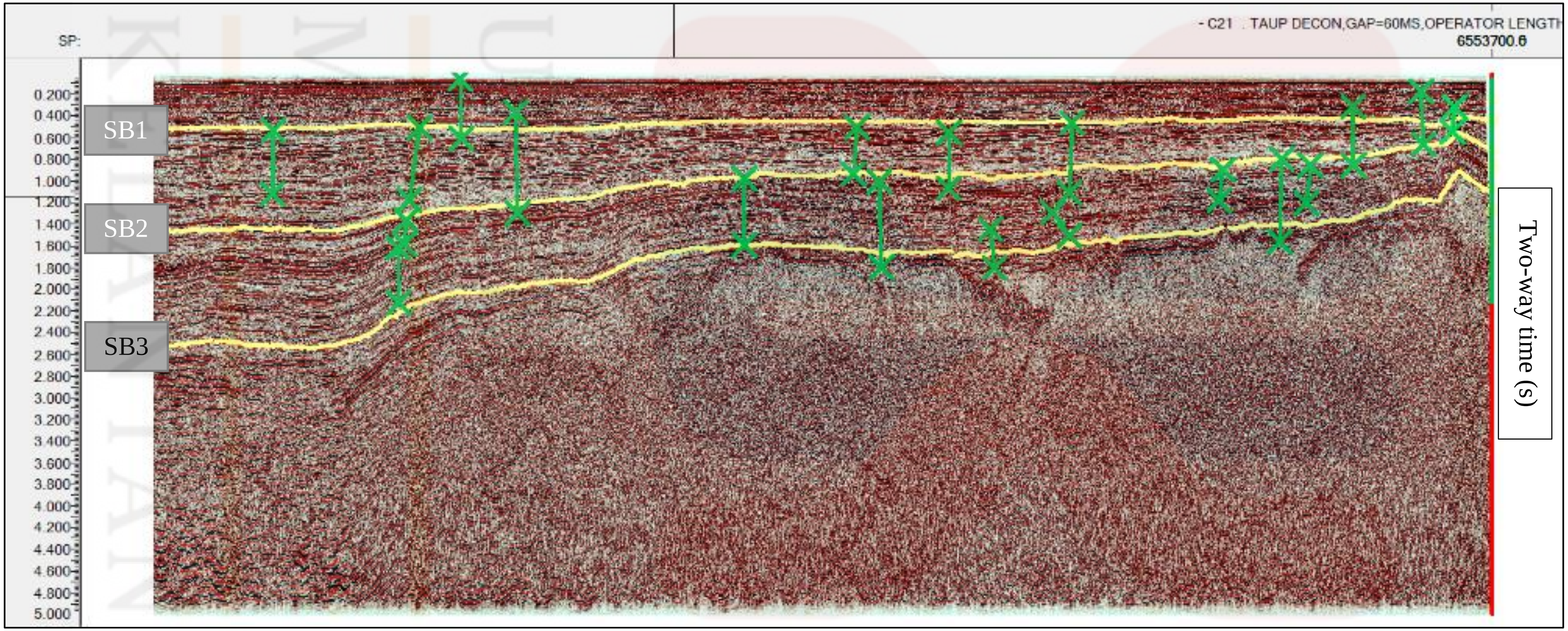


Figure 5.4: Line C21 Taup Decon Gap

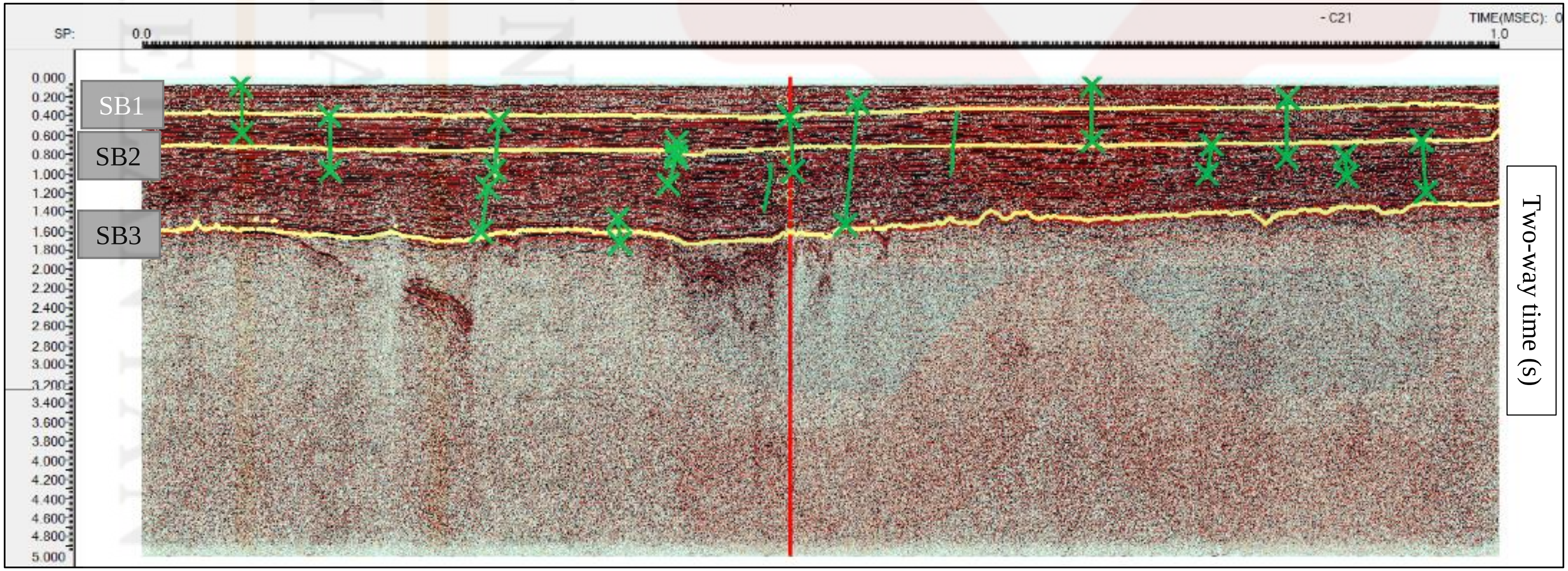


Figure 5.5: Line C21 Time (Msec)

5.3 Structural Geology at the Abu Field

The interpretation of a seismic cross section for geological formations necessitates meticulous research, particularly when identifying a fault and fold. However, the interpretation of this structure will be limited to the narrow structure of the research region along the seismic survey line. Most faults occur when weak and elastic rocks develop fractures. This causes the weak plane to shift, resulting in an irregularity at the sequence boundary. Faults can be discovered in the analysis of seismic data by examining the continuity of each reflection line. The fact that a line is non-homogeneous or non-linear demonstrated the existence of these fault structures. However, the direction of the aircraft must be understood before selecting the defect. On the seismic section, the fault line must cross the other line at a point that is not identical on both lines. The majority of the time, a fault will terminate at another deposit visible on a seismic section. It will also reach the opposite fault line.

Less than two kilometres separate the chosen seismic line for fault interpretations from a seismic survey, which frequently yields the same fault plane along the parallel line. According to previous study, the examined region has an extremely complex structure with difficult-to-understand aggregation and fault patterns. Even though the orientation of the fault plane is complex throughout this study, the normal fault frequently dominates the fault trend in the Kapal Field from a variety of viewpoints. A typical fault is produced when a sliding block drops along the fault plane. Graben is the word for the drop block.

Given the presence of anticlines, synclines, and faults, the Abu Field region's geology is particularly significant. Figure 5.29 depicts the structure that is accessible at Abu Field, which is one of the indicators of the presence of hydrocarbons in the area.

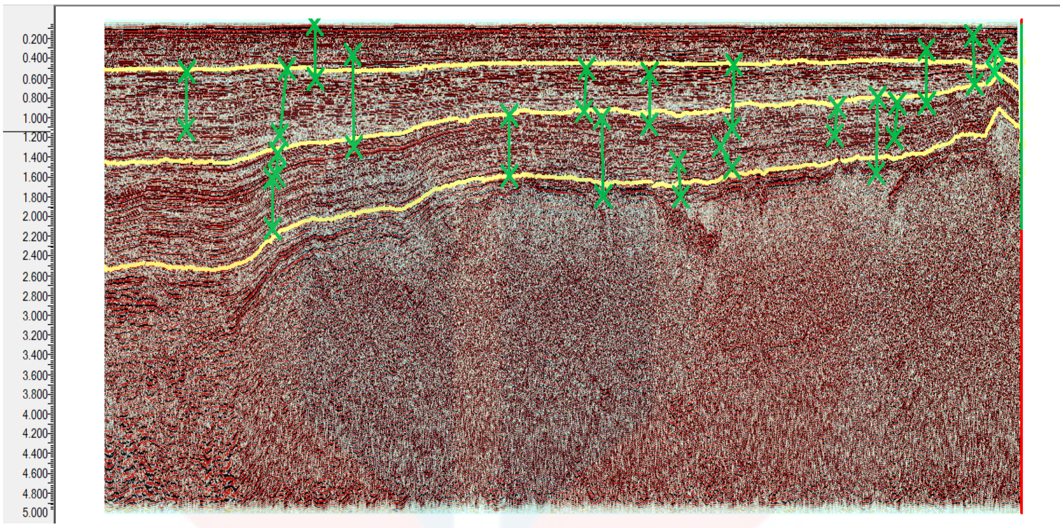


Figure 5.6: The structure of faults in Abu Field

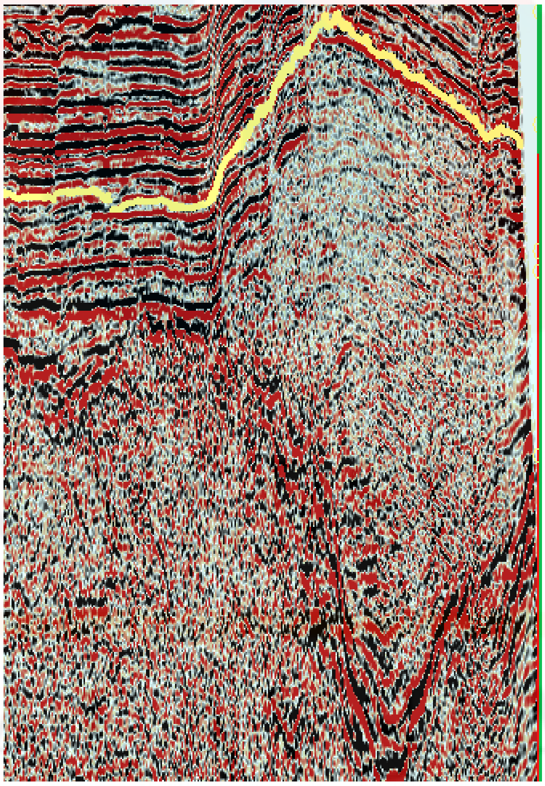


Figure 5.7: The structure of anticline in Abu Field

Figure 5.8: The structure of syncline in Abu Field

5.4 Seismic Facies Available at Abu Field

Seismic facies analysis is a method for determining the sequence of sediments by observing polar and other patterns in a seismic cross section. The interpretations may then be based on the shape of geological bodies, the kind of stratification, the geological environment, the deposition process, the direction of sedimentation, etc. In general, the seismic facies being discussed in the basin area can be divided into a number of classes, including parallel and sub-parallel facies, wavy facies, southeast-trending facies, and chaotic facies.

In each sequence, reflect facies is prominently displayed. The top amplitudes of parallel and semi-parallel facies are greater than the bottom amplitudes. It also possesses a moderate amount of consistency. As we approached the bottom, the frequency decreased and the amplitude decreased from high to moderate to low.

In the middle of the survey line, wavy facies can be recognised. It has a high amplitude, a high degree of continuity, and evenly distributed reflectors. It has an uneven cross-sectional shape as well. In addition, south-eastward-reaching polar reflections of significant amplitude can be observed at the study site. After then, a portion of the reflector polar seems disorganised, with variable amplitudes. Figure 5.9 depicts the nine predominant types of facies in the research area. In addition, there is a possibility that there is gas in the area of study due to the chaotic facies caused by the gas giving an error to a wave. When searching for hydrocarbons, amplitude analysis is very crucial. Bright-spot or flat-spot amplitude anomalies may indicate the presence of hydrocarbons.

A downlapping character with an S-shape that was sigmoid built outward and upward aggrading into a basin. Indicators of fine-grained, low-energy deposition include sigmoidal patterns. Reflectors were toppling in an oblique manner as they expanded outward into a basin. Oblique patterns show rates of sedimentation and frequently have clean sand in the top part of the bedform. Typically, oblique bedform types require water depths of 500 metres or greater. On the structure, there was a mounded area with directional downlapping reflectors that increased in number as they moved toward the centre. Allied forces surround the mound. This geometry might represent a deep-water marine fan or a carbonate mound.

Discontinuous reflector patterns of various kinds that support interdepositional systems. Discontinuous point bars and crevasse splays are examples of hummocky facies. Coarse-grained fluvial or turbidite channel fills are suggested by chaotic reflectors. Shale-prone debris flows may be seen in contorted structures. Divergent reflectors show lateral changes in depositional rates or gradual tilting of a depositional surface.

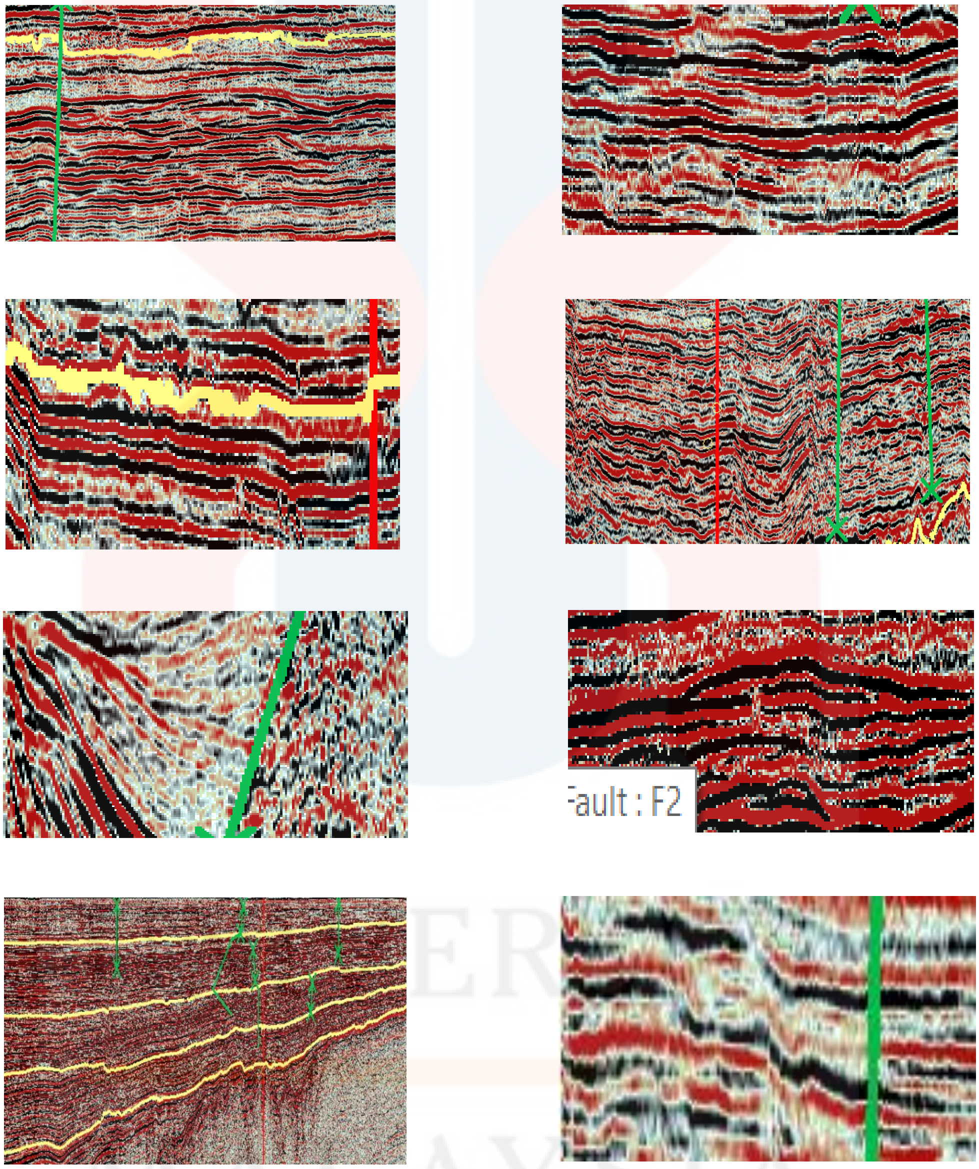


Figure 5.9: The major facies in Abu Field

5.5 Potential Hydrocarbon at the Abu Field

Based on the facies research that had been conducted and the existing structures, this field may contain hydrocarbons. This can be determined by examining the anticline and syncline markers of the hydrocarbon. The facies analysis reveals that the bright spot or flat spot on the seismic survey is the result of a facies. Moreover, if there are chaotic reflectors present, it may also be linked to the presence of gas in the field.

A bright spot is an anomaly in seismic data with a high amplitude (high reflectivity), indicating the presence of gas or "soft" oil, which travels at a substantially slower pace than brine-saturated rock. When water sand has a lower acoustic impedance than the surrounding shale, replacing the water in the pores with hydrocarbon increases the impedance gap between the sand and the shale. This increases the amplitude of seismic reflection, creating a brilliant spot. Seismic waves travel more slowly through oil than through pore water, but the difference is not usually significant enough to be detected on seismic sections. Fortunately, where there is oil, there is typically saturated gas or gas on top, thus brilliant patches can be utilised to locate oil exploration sites.

On a seismic section, a seismic anomaly that resembles a horizontal reflector is known as a "flat spot." When there is interaction between oil, gas, and water in a small area and the surrounding reflectors are not flat, flat spots will form. The flat spot is not an amplitude anomaly in and of itself, but since it is frequently connected with gas, the area may contain a bright spot. Flat patches can form when water-saturated sand is placed on top of hydrocarbon-saturated sand, which has a lower acoustic impedance. The flat spot is observed at the water–hydrocarbon interface. This is always a reflective surface with a positive coefficient of reflection. On a seismic section, the flat positive reflection can be distinguished from the other dipping reflections due to its flat depth.

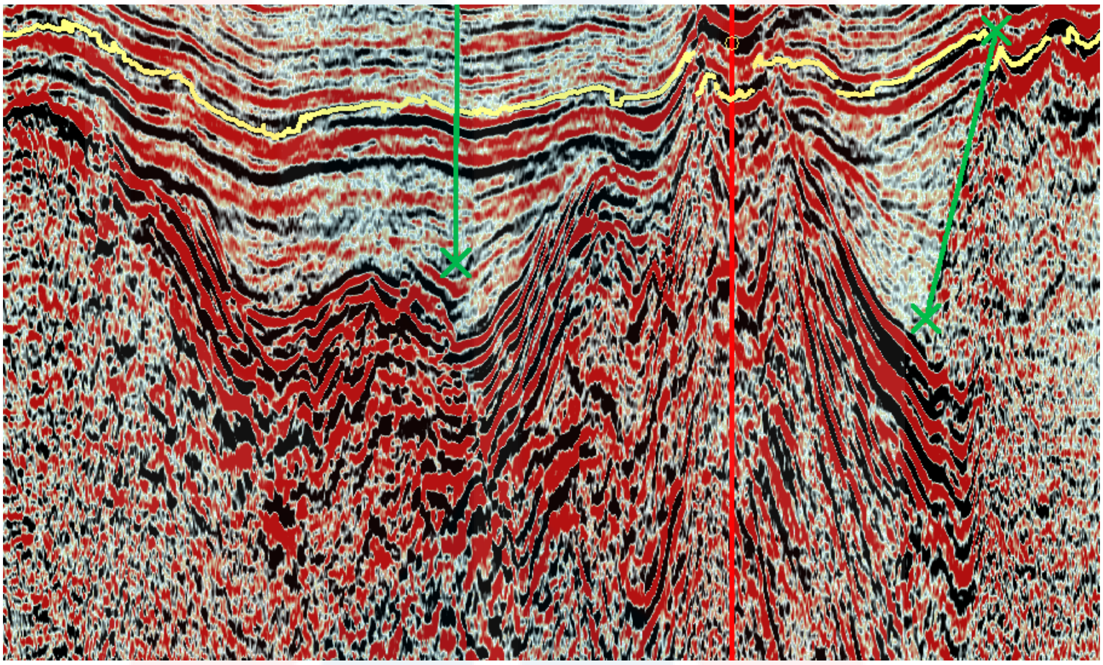


Figure 5.10: Potential Hydrocarbon at Abu Field

The chaotic reflector was then employed as an indicator, but it was a mistake because the gas screwed up the wave and caused it to be inaccurate. The structural analysis also indicates that it has the ability to trap hydrocarbons. All indications indicate that the hydrocarbon potential is between SB2 and SB4 once all analyses have been completed and compared.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This project aims to generate an updated geological map of Kampung Pak Kancil in Permaisuri, Terengganu at a scale of 1:25 000, and to assess the hydrocarbon potential of Abu Field in Terengganu Offshore.

After the research was done, the target to update the geological map of Kampung Pak Kancil, Permaisuri, Terengganu with a scale of 1:25,000 has been achieved. Geological mapping has been going on at the study area for almost two weeks. Phyllite, slate, schist, and mudrock are the four types of rock that have been found in the field data and petrography analysis. Geologically, there are also major folds of syncline and anticline and quartz veins.

Secondly, this study's goal is to determine whether there are any hydrocarbons in the Abu Field, which is located offshore of Terengganu. This field might contain hydrocarbons based on the facies analysis that had been done and the structures that were there. Analyzing the anticline and syncline of the hydrocarbon can reveal this. The bright spot or flat spot at the seismic survey is evident from the facies analysis. Additionally, if chaotic reflectors are present, it may be connected to the gas present at the field. Between the SB2 and SB4 limits, there is hydrocarbon potential in the research area.

6.2 Recommendations

After this research is complete, the next researcher should do a more in-depth study of the lithologies in Kampung Pak Kancil by doing a structural geology study in the study area. Based on the geology of the Terengganu area, it is also suggested that research look into the possibility of hydrocarbons being found on onshore in the Terengganu area. This study can help improve the economy of the country and give information for students.

Next, Abu Field is a big place, but this study does not cover all of Abu Field. So that the Abu Field can be looked at in more studies and research to come. Due to the limited resources of this research, the area under study also needs a detailed seismic stratigraphy and structural geology study.

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