GEOLOGY AND DEPOSITIONAL ENVIRONMENT OF METASEDIMENTS IN TAMAN AGROPOLITAN RANTAU MANIS, GUA MUSANG, KELANTAN

by

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Report submitted in fulfilment of the requirement for the degree of Bachelor of Applied Science (Geoscience) with Honors

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APPROVAL

"I/ We hereby declare that I/ we have read this thesis and in our opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Geoscience) with Honors"

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Date	:	……..

DECLARATION

I declare that this thesis entitled "Geology and Depositional Environment of Metasediment Taman Agropolitan Rantau Manis, Gua Musang, Kelantan" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

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Date :

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ABSTRACT

The study area is located at the southeast part of Gua Musang that bounded by longitude E 102° 04 18'.88" to E 102° 07' 02. 28" and the latitude is N 04° 58' 43.27" to N 04° 56' 01. 99". The focused of this research study is to produce geological map of the study area on scale 1:25 000 by conducting the geological mapping, petrography, structural, and lithostratigraphy. The determination depositional environment of metasediment by conducting the geological mapping, sedimentary log and identifying facies. Based on geological mapping the study area consists of three lithologies which are limestone, volcanics and metasediment unit. Further analysis from metasediments used for interpretation of depositional environment of study area. The depositional environment of metasediments in study area was indicated shallow marine. This study also can help in increasing the local economy in agriculture and discover the potential economic resources that can eradicate poverty of the area. In construction projects, the geological map may give information about the lithology and morphology in making decision for any development of the area.

ABSTRAK

Kawasan kajian terletak di bahagian Tenggara Gua Musang yang dibatasi oleh E 102° 04 18'.88 "hingga E 102° 07 '02. 28" dan latitudnya adalah N 04° 58' 43.27 "hingga N 04° 56 ' 01. 99 ". Objektif kajian penyelidikan ini adalah untuk menghasilkan peta geologi kawasan kajian dengan skala 1:25 000 dengan melakukan pemetaan geologi, petrography, struktur, dan lithostratigraphy. Penentuan limgkungan endapan bagi batuan metasedimen dikawasan kajian dilakukan dengan pemetaan geologi, pengambilan log batuan sedimen dan mengenalpasti fasis. Berdasarkan pemetaan geologi, kawasan kajian terdiri daripada tiga batuani seperti batu kapur, batuan volkanik dan metasedimen. Dimana analisis daripada batuan metasedimen digunakan dalam mengenal pasti lingkungan endapan kawasan kajian. Lingkungan endapan kawasan kajian ialah kawasan laut cetek. Kajian ini dapat meningkatkan ekonomi tempatan dalam bidang pertanian dan megenal pasti potensi sumber yang di kawasan kajian. Manakala peta geologi dapat member maklumat mengenai jenis batuan dan bentuk muka bumi untuk membuat keputusan dalam pembinaan kawasan tersebut

.

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LIST OF SYMBOLS

%	Percentage
<	Less than
>	Greater than
▲	Fining upward
▼	Coarsening upward

CHAPTER 1

INTRODUCTION

1.1 General Background

Geology is a part of Geoscience where it is about the study of Earth, which it made the materials, composition and structures (King, 2018). As known the Earth is very dynamic where it changes by process that was occurred and cause the evolution of organisms through time. This study reveals the history of Earth based on the rock record and it relation with the changes of internal and external systems and cycle where it influenced the depositional environment and the climate of Earth during historic time.

Depositional environment is the subtopic under sedimentology. Sedimentology is the study of the sedimentary rocks and the process of its deposited. Based on Sam Boggs (2011), sedimentology is the scientific study about the classification, its origin and the interpretation of sediments and sedimentary rocks. The study of sedimentology is more focused on physical, chemical and biological properties of sedimentary rocks and the processes where the properties it generated. To identify the depositional environment of the required area the combination of sedimentology and stratigraphy where both of these are the disciplines under geology.

Depositional environment is where the process of deposit of sediments take place. The study in characteristic of specific physical, chemical and biological process

that act on deposit sediments deposited help in interpreting the physical features, climate and environmental condition of earth in the pass. The geologist normally will study the sedimentary facies to know the depositional environment of the area.

The study about the depositional environment of Kampong Sungai Asap and the area that include in box five kilometre per square which located at Gua Musang, Kelantan. This study involves the geological mapping, construct the sedimentary log or lithology log of the outcrop in study area and also include the structure and the geomorphology of the study area in order to make the geological map. While the laboratory investigation is needed to identify the rock sample that was taken during the fieldwork.

1.2 Study Area

a) Location

The study area located at Southeast part of the Gua Musang, where the Gua Musang is located within the central belt of the Peninsular Malaysia. The study area covers 25 kilometres per area, covering only two main villages Taman Agropolitan Rantau Manis and Kampung Sungai Asap as the main village in the study area. The coordinate of the study area between longitude E 102° 04' 18.88" to E 102° 07' 02. 28" and the latitude is N 04° 58' 43.27" to N 04° 56' 01. 99". Figure 1.1 is the base map of study area where the highest contour range is from 340 meters to 120 meters.

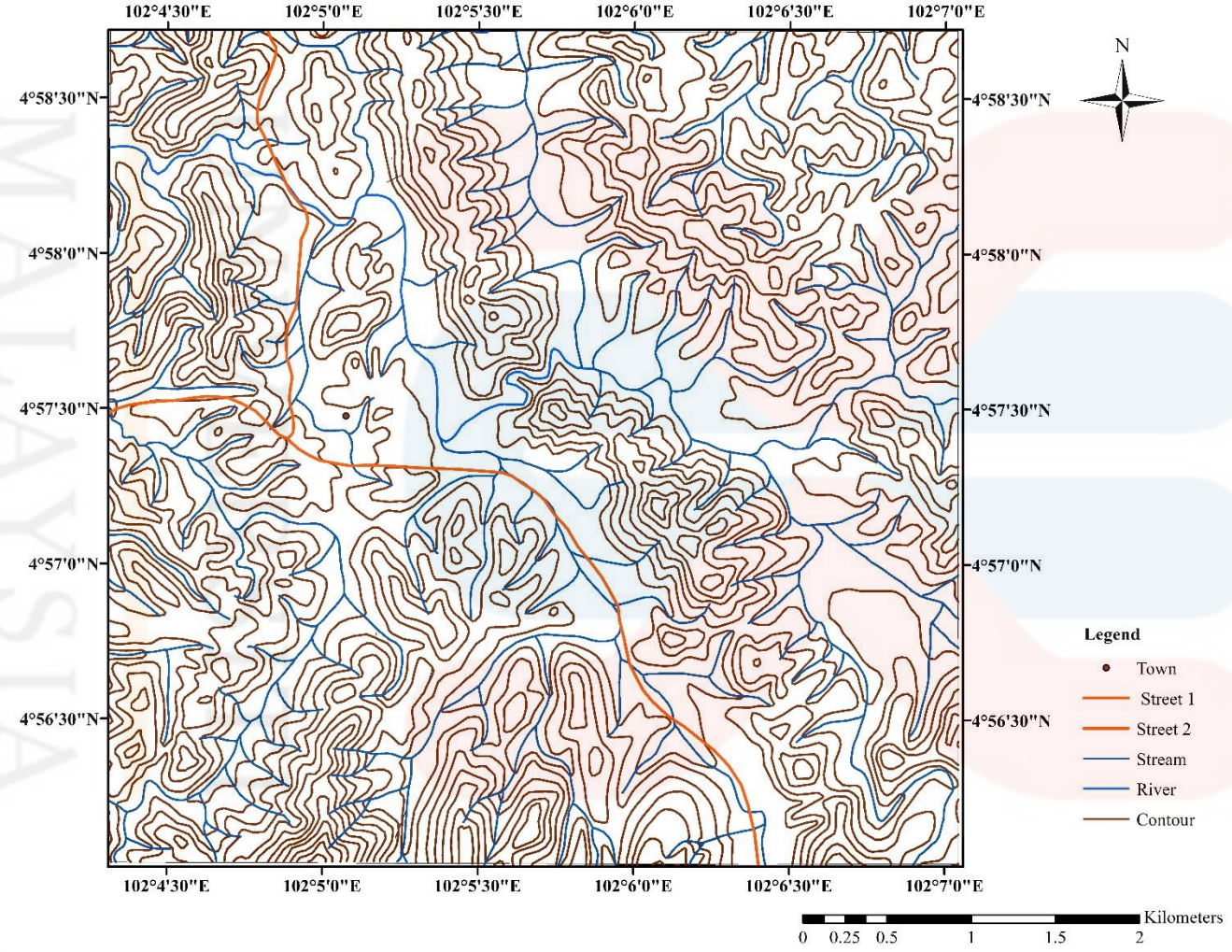


Figure 1.1: Base map of study area

b) Road connection/ Accessibility

Figure 1.2 shows the road that can be used to access to the study area is Dabong-Gua Musang road. The time taken is around 2 hours 15 minutes to reach the location. However, there is another option that can be take which is useing Kuala Krai- Gua Musang road where it takes 30 more minutes to reach the Gua Muasang. The distance from UMK to Gua Musang is 133 kilometeres

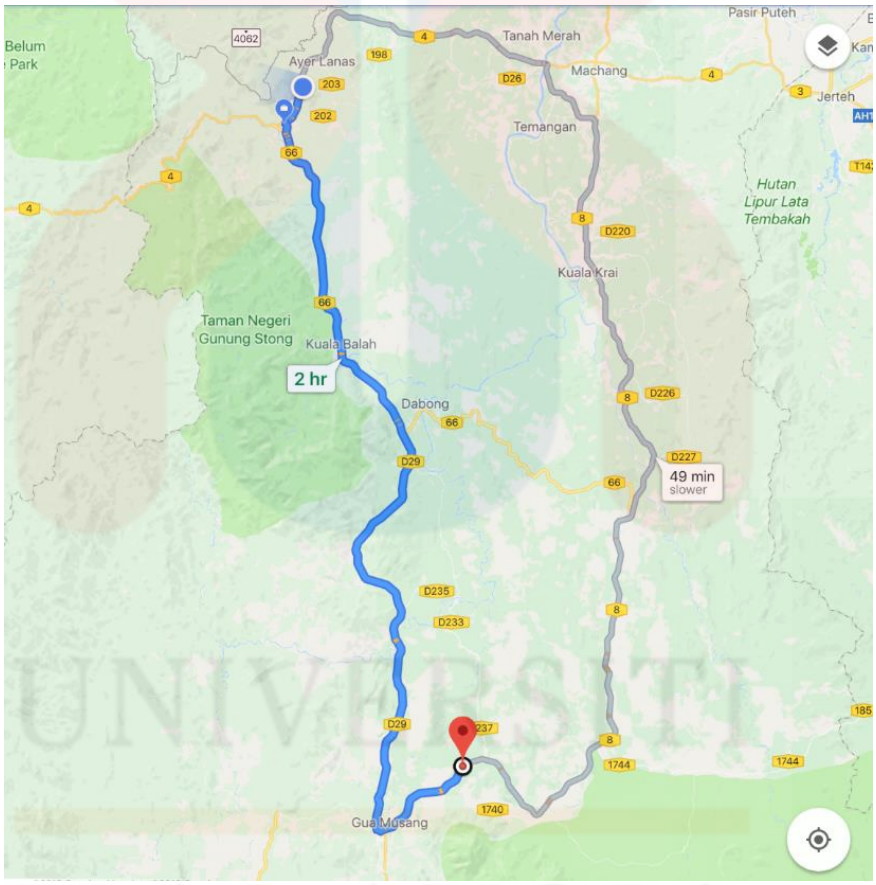


Figure 1.2: The location map from UMK to study area

c) Demography

Table 1.1 shows the statistic population in Gua Musang based on the Department of Statistic Malaysia. The population in Gua Musang is increasing from year 2000 until 2010 which from 76 655 to 90 057 population. The figure 1.3 shows the percentage race in Gua Musang. The major race is Malay with 76% follow by native 13%, Chinese with 5% and India 1%. The increasing of the population may cause by the development of urbanization and opening of new plantation area for oil palm. In both Kampung Sungai Asap and Taman Agropolitan haveThis may encourage the increasing of population at the area. Kampung Sungai asap can be a village that have basic facilities like mosque, school and community hall.

Table 1.1: The population of Kelantan from 2000 to 2010

Name	Status	Population Census 2000-07-05	Population Census 2010-07-06
Gua Musang	District	76,655	90,057

Source: Department of statistic Malaysia website

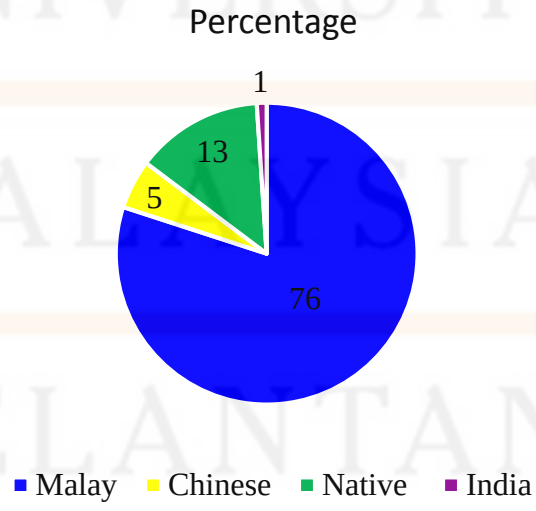


Figure 1.3: Chart of the population in Gua Musang

d) Land use

Gua Musang is the area of agriculture sector which most of the land were used for oil palm plantation and minor of rubber plantation. The area was developed by two agencies which South Kelantan Development Authority (KESEDAR) and Federal Land Development Authority (FELDA). But in Sungai Asap area the development of agriculture was done by KESEDAR. The land that used for rubber plantation in Sungai Asap is 1377.40 hectares and none for oil palm plantation (Fauzi Hussin & Hussin Abdullah, 2012). From the observation within the study area is mostly covered by the new oil palm plantation and the rest area is forest and karts.

Figure 1.4: The new oil palm plantation area

e) Social economy

The social economy in the study area can be considered as agriculture sector. This is because most of the area are newly to oil palm plantation, where there is the area in progress for oil palm tree growth. But there is also have other plantation like rubber plantation area. Certain of the villager work as businessman and small enterprise by opening a small stall that selling food and raw material like meat and fried bananas and "keropok".

1.3 Problem statement

The study area is included in Gua Musang area where Gua Musang is the common area for the student to run a research or doing their field work study. The common research that involved the Gua Musang mostly about the structures, but there is a few study that related to the stratigraphic and sedimentation that involved the Gua Musang area. However, it not gives much information that related to the research study. Furthermore, there is not much research that conducted at the Taman Agropolitan Rantau Manis and it nearer area. Besides that, the research or study that involve the depositional environment in the study area is not much which there is undetailed information that involved the study of the depositional environment in the Taman Agropolitan Rantau Manis area. In geological aspect there is no specific geological map that can be referred in small scale like 1:25 000.

1.4 Objectives

i. To produce geological map of the study area in 1:25 000 scale.

ii. To determine the depositional environment of metasediments in the study area.

1.5 Scope of study

The study was covered 25 kilometres square that include two main villages. The scope of study involved geomorphology, stratigraphy, sedimentology and structural geology that needed in produce the geological map of the study area. Besides that, the classification of lithology units, sedimentary structures and the fossil that can be find is used in order to identify the depositional environment of the study are in the pass. Then, the construction of sedimentary log based on the lithology units, sedimentary structures, geological structures and fossil is doing to determine the depositional environment area which it conducted at the good exposure of outcrop.

1.6 Significance of study

The important of the study is to produce the specific geological map of the study area. The scale of map that will produce is in 1: 25 000 which the map contents of lithology boundary of the study area and the cross section. This map can be useful to other students in the future in updating the geological map and as references about the lithology that involved the study area part which is five time five kilometre per area.

Next to identify the depositional environment of the study area. The identification of the depositional environment can help in classify the type environment and may be useful to the local in order to increase their economy such as in agriculture industry. Moreover, it also can help in giving information in sedimentation like the lithology units of the study area which is suitable or not for development of construction or it also may have a good potential resources that not be discovered. These can contribute to the better socio economy to local.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is the preliminary study of the research where in this chapter it reviews the previous works that related to the research. Literature review is important to give idea to plan the research and also as the guide during the research such as the suitable method that can be used and references to improve the research. The literature review is based on the title, objectives, study area and problem statements of the research, where all the readings have given suitable related information for the research.

2.2 Regional Geology and Tectonic Setting

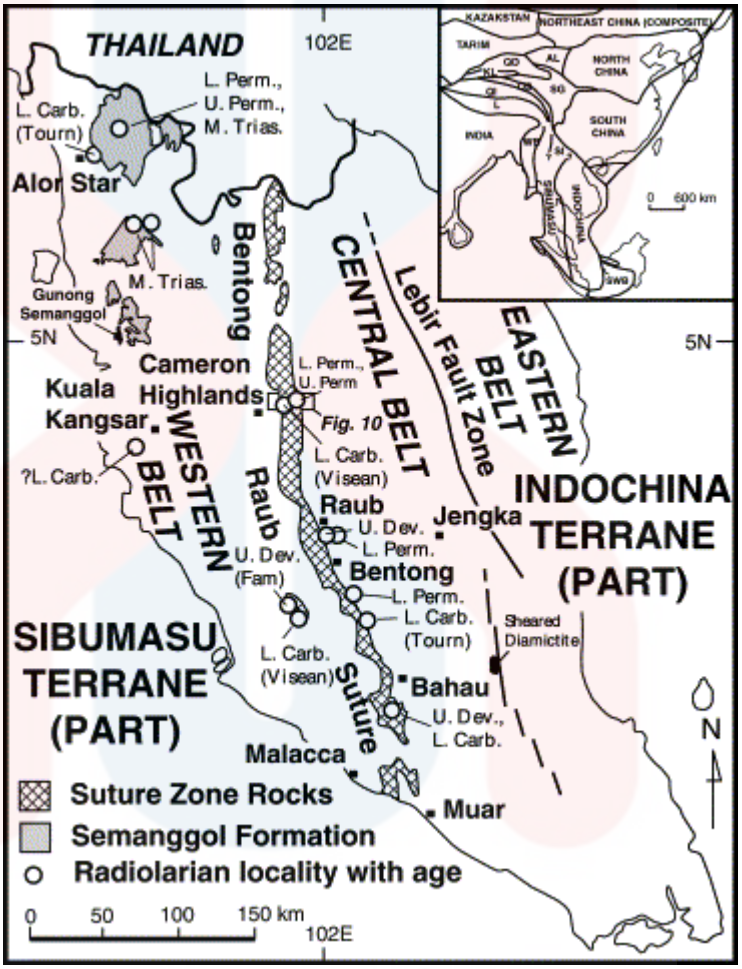
Based on Hutchison, (1989) the peninsular Malaysia is located at the intergral part of Eurasian plate, the South-east Asian part that known as Sundaland. The Sunda shelf is continuation eastward and southward where the Sumatra, Natuna and western Borneo are integral part of the same plate with less than 200 metre of water depth. The oceanic part of the Indian Oceanic- Australia Plate converges on Sundaland towards N 15°E (Milsom,2005). The right lateral fault system that dominated at Sumatra island resulted from the high oblique convergence of Sunda trench. the Andaman Sea

stretched from the Langkawi island in a north western direction where the Andaman Sea is an active back arc basin that lying behind the Sunda trench and above the Sunda subduction zone. In Late Triassic the colliding of Sibumasu with East Malaya and Indochina caused the thickening of crustal where in result, the tin-bearing S-type of granite characterised by the Main Range of the Peninsula, tin island of Indonesia and part of Central Thailand have association with high grade metamorphic core complexes and have not successfully intergraded inti regional analyses (Hutchison, 2014).

Based on figure 2.1 Bentong- Raub suture zone is the prominent line that separated the western belt with the central belt that occurred during the Mesozoic era. As known occurred by the collision of the Sibumasu with the Indochina block plate. The line that extend from Thailand until to the South of Peninsular Malaysia. The Bentong Raub suture or also known as the Benton Raub line is exposed along the area of the Gua Musang- Cameron Highland road which it wide zone of the deformed rock. Based on the Tjia and Syed Sheikh (1996) the rocks within the suture were divide into at least seven tectonic units.

According to Goh Swee Heng et al, (2006) the regional geology of Kelantan consist of central zone of metasedimentary and sedimentary rock that bordered at the west and east by granite of the Main Range and Boundary Range. The central zones are consist the window of granitic intrusives which Senting Batholith,Kemahang Pluton and the Stong Igneous Complex. The belts of granite and the country rock have nort-south trend and in west and central Kelantan belts continuous northward to the south of Thailand however at the east the Boundary Range granite is overlain by the coastal alluvial flat of Sungai Kelantan. The Triassic rocks are confine mainly to the central and south of Kelantan which are mainly argillo-arenaceous sediments with

intercalated volcanic and limestone. The central part is mainly the Triassic and Permian metasedimentary rocks that well associated with the volcanic rocks.



Source: Journal of Asian Earth Science 2000

Figure 2.1: Image of Raub-Bentong Suture

2.3 Stratigraphy and Sedimentology

Based on Peninsular Malaysia book, the pull a part basin along the transtensional portion of en enchelon faults may cause by the continuous dextral slip deformation during the Indosinian Orogeny. This condition occurred above under

lapping and over lapping stopovers released. Those basins served as the depocentres of sediment deposition. So the strata were deposited in pull a part basins.

According to Yee (1983) Peninsula Malaysia made up of 3 basins which western, central and eastern on the basis of the distinctive tectonic and sedimentary histories. The basin includes most if all the Lower Palaeozoic sediments well as Upper Palaeozoic formation. Most of the Permian and Mesozoic sediments in Peninsula Malaysia occupies at the Central Basin where it includes most of Kelantan, west Pahang, east Negeri Sembilan and west Johor. The eastern basin was separated by an arbitrary boundary that drawn along the trend of granitoid from Kelantan to South of Johor. The sediments in eastern basin mostly from the Carbon to Permian age. In the southern part of the central basin, some Lower Triassic ignimbrite and Upper Mesozoic continental sediments were crop out.

According to Metcalf (1983) the stratigraphic and sedimentation in central basin during the Permian to Early Triassic time, the Permian sediments of the Central Basin consist of shallow marine argillite, tuff, limestone, dolomite, arenite and volcanic rocks. In additional, in some place the limestone interbedded tuff is dominated. Near the centre of the basin which is Gua Musang area the sedimentation was continues from Permian to Triassic, where the sedimentation with *Palaeofusulina* from foraminifera phylum where appear to pass continuously upward into Early Triassic with *Claraia* which classified in group bivalve.

The sporadic outcrops of Carboniferous Limestone were recorded as the oldest sediments in the central zone. The Permian sediments which form the bulk of Upper Palaeozoic sediments occur as the linear belts that flanked the Mesozoic sediments of the zone on the both side. Apart from Taku schist which appears the anomalous in its lithology and possibly age, where the Upper Palaeozoic sediments of the central zone

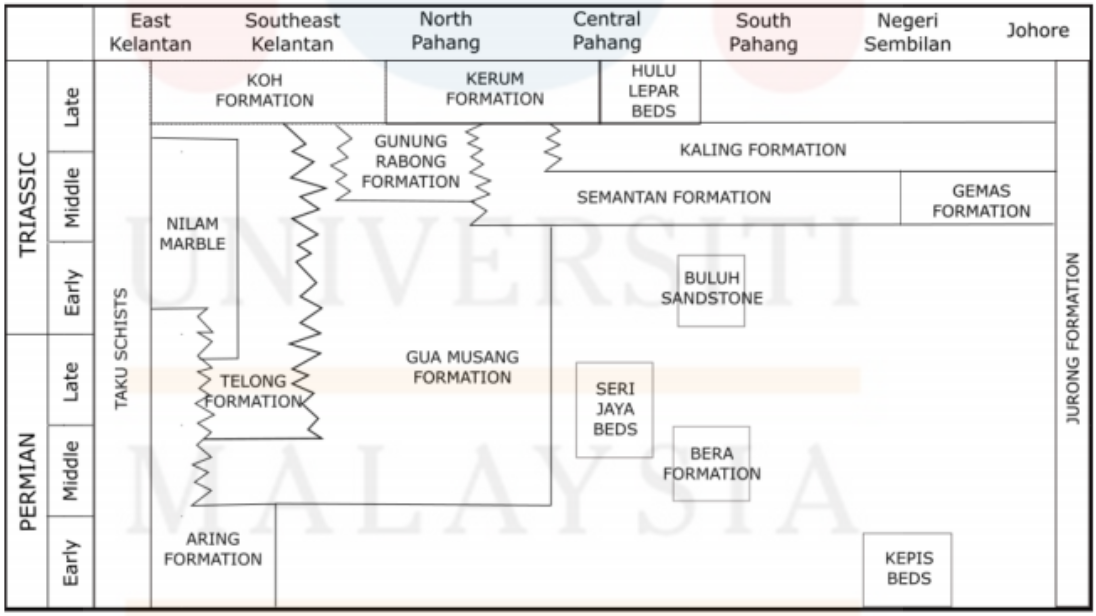
consist of four facies such as argillaceous, volcanic, calcareous and areaceous. The stratigraphic units that identified are the Raub Group, Gua Musang Formation, the Aring Formation and the Kepis Formation. The Raub Group known as Calcareous Series where it used to include all the Carbo-Permian strata that crop out along the central zone from Kelantan to Johor (Yee, 1983). The Gua Musang Formation mapped in south of Kelantan area. In this formation consist of predominantly argillaceous and calcareous rocks sequence interbedded with volcanic and arenaceous rocks (Peng, 1983).

According to Kamal Roslan et al (2016) the Gua Musang Formation located at the south of Kelantan have similar lithologies with Aring and Telong Formation where these facies changes could be gathered within the same group as long as the sediments were deposited in shallow marine environment in Gua Musang platform during the Permo-Triassic period which from Middle Permian to Late Triassic argillite, carbonate and pyroclastic facies within Gua Musang area. The relevance of grouping these formation lies behind the close observed of these formations in terms of sedimentological and paleontological aspect explained Mohamed and Leman (1994) and then later Mohamed (1995). Fontaine (2002) state that Permian sediments widely distributed along the main river such as Sungai Aring, Sungai Lebir and Sungai Paloh. The range of rock age in Kelantan is from Jurassic to Cretaceous which the youngest rock.

Table 2.1: Formations in Gua Musang Group, Modified by Lee (2004)

Name	Gua Musang formation	Telong formation	Nilam marble	Aring Formation
Origin of Name	Gua Musang, South Kelantan	Sungai Telong, South Kelantan	Sungai Nilam (of Sungai Chiku)	Sungai Aring, south Kelantan
Age	Middle Permian to Late Triassic	?Permian to Late Triassic	?Permian to Late Triassic	Carboniferous to EarlyTriassic
Boundary	Unknown lower boundary; Upper boundary overlain by Koh Formation	Lower boundary overlie Gua Musang formation; top boundary overlain by Koh Formation	Unexposed bottom and top boundary	Lower boundary unexposed. Tectonized upper contact with Telong formation and Koh Formation.
Correlation	Upper part of Gua Musang formation interfingers with Semantan Formation, Telong formation, and Gunung Rabong formation	Lateral equivalent to Gunung Rabung formation and Semantan Formation	Lower part coeval with Aring Formation, upper part coeval with Telong formation	Lateral equivalent to Gua Musang formation in Kelantan, metasediments in SE Pahang, Volcanic Series in NW Pahang
Lithology	Argillaceous and calcareous rocks interbedded with volcanic. Minor presecne of arenaceous rocks	Sequence of predominantly argillite associated with some tuff; turbidites	Calcitic marble interbedded with tuff and argillites	Basal dolomite marble, tuff, calcareous argillite, pyritiferous tuffs, subordinate lavas, argillo-tuffaceous limestone
Type Area	Gua Musang area (extended to north Kelantan and Pahang)	Sungai Telong, the upper reaches of Sungai Aring in south Kelantan	Upper reaches of Sungai Nilam	Sungai Aring, south Kelantan
Depositional Setting	Shallow marine shelf deposit, with active volcanic activity	Shallow marine environment with occasional pyroclastic	Open marine for growth of shelly fauna	Neritic with volcanic input

Source: Bulletin of Geological Society of Malaysia (2016)



Source: Bulletin of Geological Society Malaysia (2016)

Figure 2.2: Permo-Triassic stratigraphic correlation of central belt Peninsular Malaysia. Modified from Metcalf & Hussin (1995)

2.4 Structural Geology

Structures commonly related to tectonic process and deformation that occurred at the area. Where it involved the changes of rock either the rock become faulting or folding depends on the resistance to brittle or ductile. From the book structural geology, geologic structure is geometric configuration of rocks where it deals with formation of structures, distribution and configuration. When connected with tectonic often involved the regional process and external which external of rock volume. The plate tectonic is directly involved the movement and interaction of lithosphere plate such as subduction tectonic, collision tectonic and rift tectonic that applied to specific purpose (Fossen, 2016).

The geological structures of the Peninsular Malaysia show of complexity of the tectonic evolution. It was starting when the Sibumasu plate was colliding with Indochina block plate, where Sibumasu is part of western Gondwana. Tan (1984) and N.A Harbury et al. (1990) explain that the suture zone extends from Thailand to the Peninsular Malaysia accepted in most of all palaeo-tectonic reconstruction of the SouthEast Asia but believed that the Bentong-Raub line represent the major normal fault. The Peninsula can be divided into three major belts and believed that the three major belts and structural trends are the result from the tectonic activity during Mesozoic era. The three type of the major belts are Western belt which is the boundary of the separate Sibumasu terrane and Sukhoita arc that include Central and Eastern belt.

Based on the Metcalf (1989) the Triassic rocks at the central basin exhibit generally upright or gentle plunging fold with both asymmetrical and symmetrical that represent the single folding phase. This can be differs marked by the Carboniferous

and older rocks in Peninsular Malaysia that shows 3 phase of deformation, boudinage structures and crenulation cleavage. This clearly there was a major deformational event which affected the Palaeozoic but not affect the Triassic rocks. The available dat on the structure of the Permian and detailed structural observation of dated Permian rocks required to tie down the age of orogenic that occurred. The deformation during Jurassic-Creatceous Tembeling Group remarked similar to the general upright folds. The result from the compression in the deformation during the Triassic and Jurassic-Creataceous sediments appear to have WSW-ENE direction and may have transpressional in nature that related to the major left lateral strike-slip motion which the next to a latest Triassic oblique collision that involved the Sibumasu and East Malaya.

From the article that written by Dony Andriansyah Nazaruddin et al (2014) the main forces that act on the land mass of Peninsular Malaysia was compressional force and it effects faulting and folding in large or regional scale and local. Moreover the major fault can be classified into three types which namely terrane-bounding, terrane parallel and terrane-crossing where the terrane bounding faults is Bentong- Raub and the the Lebir Fault Zone that located near the central belt is located at Manek Urai which has Sungai Lebir while Raub-Bentong is along the Cameron-Gua Musang highway.

The Malay Basin is considered as the fault termination basin which explained by Noda (2013). The formation this fault formed under the transtentional stress at the end of strike-slip fault. The sediment thaen supply into the basin along the strike-slip fault where it dominated by the river. The subsidence of the basin is contributed by the tectonic depression and the high surface of the heat flow.

2.5 Historical Geology

During the Permian time, there is sinistral and strike-slip fault movement that occurred in Malay Basin that caused the extension of the crustal. Based on the Metcalf (1989) the Central Basin is the result of the formation of graben which is the pull apart basin. In Triassic time the basin is started to accumulates the sediments. Next, the early stage of the deposition, the sediments that deposited only the fine grain marine sediments then after that, followed by the coarse grain continental sediments at the Jurassic to Creatceous period.

As known Kelantan is located at the central basin therefore, it has the youngest rock of Jurassic to Cretaceous period. The Mesozoic sediments overlie the Permian shallow sequences conformably in places, unconformably with others. The oldest rock which is from the Permian period with a few record of Carboniferous observed in the central basin.

Gua Musang consist of the argillaceous, calcareous rock that interbedded with the volcanic rock like tuff. There is also presence of the minor arenacous. The correlation of the Gua Musang is the upper part of the Gua Musang formation is intterfingers with Semantan, Telong and Gunung Rabong formation.

The argillaceous facies is the most abundance of rocks in Gua Musang. Argillaceous facies consist of the shale, siltstone, mudstone, slate and phyllite. However, there is also have interbedded with Nilam Marble formation and Aring Formation that consist of calcitic marble that interbedded with tuff and argillite.

2.6 Depositional Environment

The sedimentology as known is related with the stratigraphy which the sedimentology is the study of the physical and chemical properties of the sedimentary rocks and the processes involved in their formation that include the transportation, deposition and lithification of sediments (Britannica, 2018). The study of sedimentary rocks involved the textures, structures and fossil content of the deposit layer of the sedimentary rock. The study of sedimentology can indicate the differentiate of the geologic environment based on their characterisation of deposit environment. The sedimentary rocks can be characterised by the distinctive textural and structural properties. Each sedimentary rock has different physical properties based on their characterisation which it can be classified into siliclastic and non-clastic (Boggs, 2011).

However, there is also the metasedimentary rock. Metasediments is metamorphic rocks with the protolith of the sediments. According to Shamsuddin, (2017) metasedimentary rocks are correlated with the temperature and pressure which it might be caused by the regional metamorphism or contact metamorphism. This condition may influence the rock properties however, the different types of rock with different properties can be formed due to the relation of the shear zones. The terms of the meta in sedimentary used when the sedimentary protolith of a metamorphic rock can be recognise clearly. So the rock must be classified by using the name from the sedimentary classification scheme (Hallsworth and Knox, 1999) which prefixed by ‘meta’ (Robertson, 1999). Mostly the metasediments is the retain of the sufficient protolith features sediments where the grade of the metamorphism that contact to the rock is low or medium.

Based on Kamal Roslan et al (2016), the low to medium grade of metamorphic rock bounded the northern boundary of Gua Musang platform which the rocks from the Carbo-Permian Mangga Formation (The Malaysian-Thai Working Group,2006) and Taku schist (MacDonald, 1967) in the north area. The northern boundary is subjected to future study for the further refinement where it same with the the poor delineated southern boundary.

Depositional environment is a unit of landform that formed by the sedimentary process which the sediments was deposited by the agents of weathering. The three major of common depositional environment are continental, marginal marine and marine. Based on Sam Boggs (2011), the sedimentary structures and textures is a reflection of the depositional process like suspension or current flow that was occurred. The facies associated when groups of facies that genetically related each other and have some environmental importance. The sedimentary structures or known as physical structures help in indicate the condition that formed them.

According to Kamal Roslan et al (2016) the formations that related within their study area were defined as warm, shallow marine environment deposit within the Paleo-Tethys Seaway of the central belt during the Permo-Triassic period which the conclusion was based on the sedimentological and paleontological. Where this can be proved by the dominance of benthic organism that inhabited the sea floor such as brachiopod and bivalves.

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

In chapter 3, it explains about the materials and what kind of methods are used in order to achieved the objectives of the research. Materials is the things or equipment that used for fieldwork such as basic things like topographic map, Global Positioning System (GPS), geological compass like brunton, hammer, notebook and other things that useful for fieldwork. Methods is the way of the research or project are conducting which it may have specification things that need to be done in order to get the data.

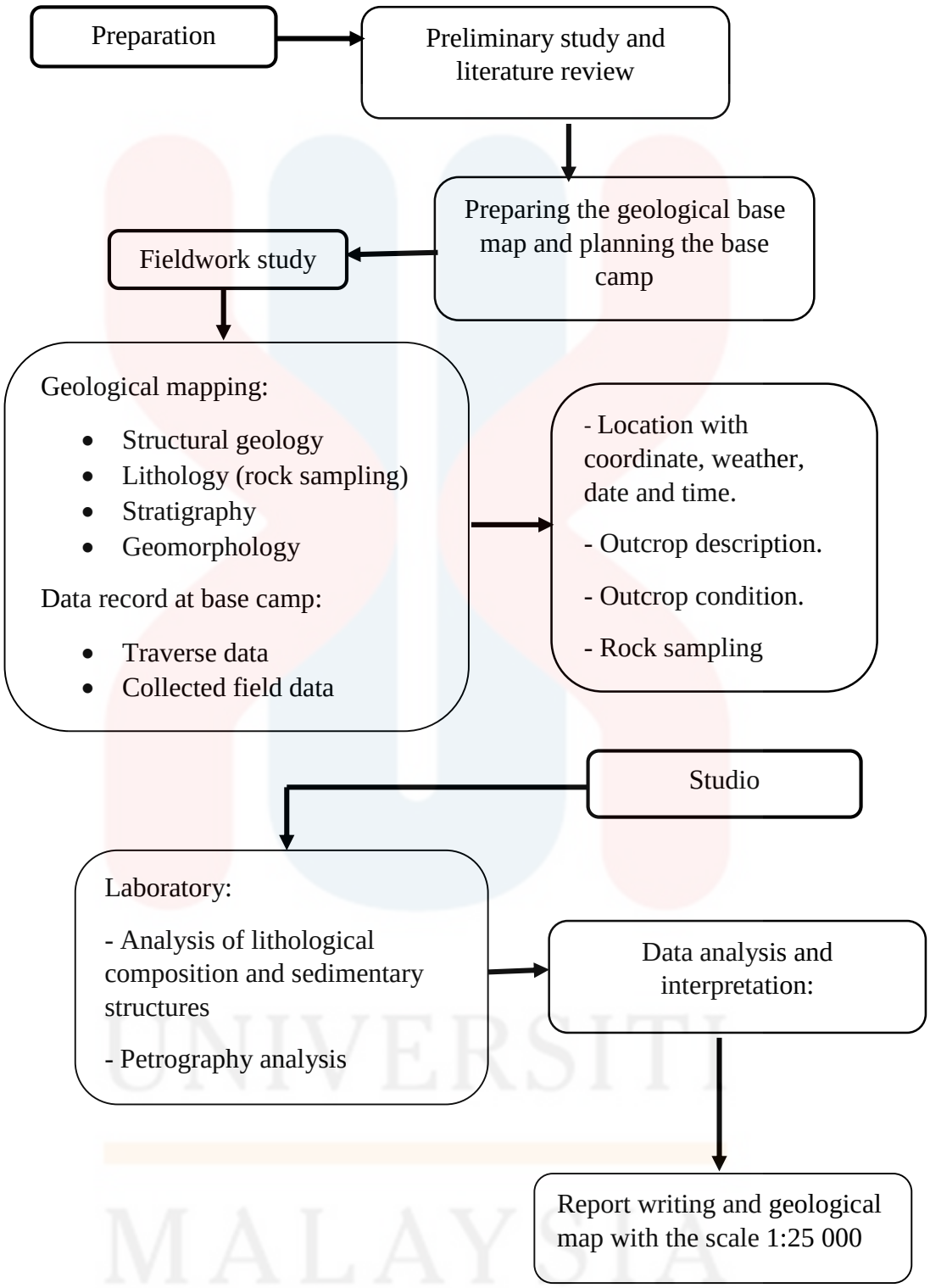


Figure 3.1: Flow chart of research study

3.2 Materials and Equipment

- Topographic map of the study area
- Global Positioning System (GPS)
- Hydrochloric acid (HCL)
- Geological Compass
- Measuring tape
- Geological hammer
- Sample bags
- Hand lens
- Field notebook
- ArcGis Software
- Stereonet software
- Sedlog software
- Georose software

Map is very important material which before going to the box of the study area, the analysis of map can be done. The analysis of map helps to identify the structures, the features of the area and give information in geomorphology like the hill and plain area. Besides that, it also used to mark the outcrop that found and make some lithology correlation and boundary.

GPS is another material that important when going to box because it functioning to identify the position. GPS will be used to mark the outcrop and make track which shows the area that not be covered during the mapping after the data had been transferred to the software like ArcGIS.

There are two types of hammer that usually used which tip point and chisel. Tip point used for the hard rock like igneous and metamorphic rock while chisel commonly used for soft rock like sedimentary rock. The hammer used to take the rock sample during the mapping and being a scale for the medium structures.

3.3 Research Method

3.3.1 Preliminary study

Preliminary study is the first step or method that used to conduct the research where it involves various types of literature readings. The study of previous journals and articles about that related research title and scope are help in planning the work before fieldwork. During this part the producing of topographic map was done by using the ArcGIS Software, which the topographic map is used before the field and during the field. This is because the interpretation of map or map analysis is done before the mapping. The contour pattern, lineament study were analyses in order to understand the study area. The contour pattern can be used to identify what type of lithology that presents within the study area which the small contour interval indicates the high resistance of rock like igneous and metamorphic rock while the wide contour interval indicates to the soft rock such as sedimentary rock. The lineament analysis is to identified the faults because it indicator of the fault structure. It can be identified based on the straight line of features like drainage pattern or the curve line of the contour. For example, the ridge may form from the compression and the valley form from the extension. The direction for both need to identify. The geomorphology analysis is done by using the Google Earth in order to identify the type of landform in the study area and in additional it also helps to find the road access to the study area.

. Literature review is the important part in gaining information about the topic, type of suitable method used that related with the research and knowledgeable things that can be included in the report. The literature may help during the writing, conduction of geological mapping and understanding the geological structures. Mostly the source of the literature review is gaining from the internet, book and previous articles. Literature review also involve in the preliminary study.

3.3.2 Geological Mapping

Geological mapping is the important part in this research and also take a long time to complete it. This is because during the mapping time, full observation about the study area is conducted to collect ever single data. The lithology units, sedimentary structures, geological structures, outcrop observation and geomorphology are the things that had been observed.

In lithology units the types of rock, textures, colour, composition and grain shape are observed. The types of rock will be classified based on the igneous, sedimentary and metamorphic. The observation of igneous rock is about the grain size either it phaneritic or aphanitic, minerals composition if it has coarse grain (phaneritic) that can be seen with naked eyes. The sedimentary rock is classified into clastic or non- clastic, where the texture is more to grain size whether it is coarse grain or fined grain. To classify the grain size in details the Wentworth scale will be used to identify the type of clastic rock. Colour of the rock is one of the basic ways to identify both igneous and sedimentary rock. The composition of the rock normally is where the rock is composed of matrix or fragments. The grain shape is about the sorting of the grain whether it well sorting or not can determined the transportation of the sediments or

particles. Observation of metamorphic commonly on foliation and lineation which formed that caused by high pressure and temperature but certain of metamorphic rock is non foliated like marble. The higher of temperature and pressure the formed of foliation and lineation is more obvious. Metamorphic rock three rank which low grade metamorphism, intermediate and high grade metamorphism

Besides that, the conduction of lithology of the outcrop is run in details where the measurements of the outcrop are taken, the details observation of the outcrop include type of rock, structures, sedimentary structure, bedding thickness, strike and dip and rock sample. This help in constructing the sedimentary log or litho log. The rock sample is taking as the laboratory conduction. The sedimentary log is manually make by using the sedimentary log template at the field where the thickness of the bedding measured, the grain size and type of rock observed and the sedimentary structure is identified. The strike and dip taken and others geological structure also observed.

The observation of the sedimentary structures is used as collection data for depositional environment information. Difference type of sedimentary structure can indicate the same depositional environment or different depositional environment. So the thickness measurement of the sedimentary structures need to take. Beside the sedimentary structures, fossil also helps in indicate the depositional environment. The distribution of fossil classified based on at what lithology the fossil found. The lithology also can indicate the depositional environment of the study area. The fossil found is taken as sample for laboratory analysis.

The geological structure is secondary structure that formed after the depositional happen such as fault, fold, joint and fracture. The orientation of those

structures are measured by using geological compass. The right hand rule technique is used to take the strike and dip of the bedding. Where the palm is placing to the bedding and the mothers finger show the strike direction and the others finger as dip direction. The orientation of fractures, fault and joints are taken as the joint and fault analysis. The geomorphology is just to identify the type of landform in the study area and make some observation for the structure analysis.

Every outcrop and important information or data that taken during the fieldwork are sketch and photograph with scale for report writing. The traverse, location of the outcrop and the geological structures that found are mark on the base map. The sample are label with coordinate, location and date before keeping it in the bag.

3.3.3 Laboratory work

Laboratory work is needed to understand the changes of chemical structures of the rock sample by using a few equipment like microscope. The used of microscope is for identification of the mineral structure observed. The data are analysed. From the lab result the interpretation of depositional environment of the study area is done.

All the rock sample that taken during the geological mapping are cut into thin section. Thin section is petrography preparation of rock before it undergone petrography analysis. The sample of rock that taken during the field work is cut into the smaller shape which the size of the cut rock must be suite with the size of glass specimen to be observed under the microscope during the petrography analysis. There

are three steps of the basic thin section such as drying of the rock sample, glue process to stick the sample to the slides then sawing and grinding.

After the rock had been cut inti suitable size it need to be polished to remove the cutting or scratch at the rock that caused by cutting process. Polish processed need silicon carbon which help polishing the sample. Figure 3.2 is the place where the sample had been cut.

Figure 3.2: Place for polish the sample

Then the sample left for drying or it also can be dry in the oven which can reduce time of drying before the sample had been glue to the slides. The glue process used two types of glue that needed to be mixed with portion of 1:2 in the paper cup.

The glue needed to stir until it is well mixed and make sure there is no bubbles to avoid the bubbles during the gluing process. Because the bubbles can affect the petrography analysis of the sample. The sample was left to dry before it can be thinned. After thinning process, the sample tested under the light to make sure the sample is really thin. If not the sample need to be polished again until it become really thin and the minerals can be seen when test by using microscope.

Figure 3.3: Process thinning the sample

Petrography analysis is the analysis that used the polarizing light or microscope in order to identify the structure of mineral and the colour changes. Different rock has different minerals that show it characteristic. Some minerals look same under plane polarization but give different reaction under cross polarization. From the petrography

analysis the appropriate name of rock can be determined based on the rock identification chart and the minerals that found. In addition, some rock contain microfossil that can be seen under microscope for example foraminifera.

3.3.4 Data Processing

The data processing is after the preliminary study, geological mapping and laboratory work, where all the data are processes before the analysis and interpretation are done. The geological map the data was get from the remote sensing while the geomorphology data was get from the Google Image and remote sensing also. However, the other data like geological data, such as structure, lithology and stratigraphy data were gathered during the field work.

The identification of depositional environment, the lithology, sedimentary structures and fossils are the data that get during the geological mapping. The rock sample and fossil that taken undergo petrography analysis are obtained. The data from geological mapping and laboratory are combined to produce geological map. The data processing is where all the data are gathered or combined to get the best data.

3.3.5 Data Interpretation and Analysis

All the data from GPS, geological mapping and laboratory are transfer to ArcGis Software to produce full geological map with 1: 25000. The data that related to geological structures are transfers to the Georose and Stereonet Software for the interpretation of the direction of the force.

The data at the outcrop that taken and the result from the petrography are used to construct the detail sedimentary log by using a related software like Coral Draw Software and Sedlog software. Based on the characteristic of the sedimentary that have plotted into the sedimentary log the interpretation of depositional environment of the study area can be proceed. Then, all the research findings that have been analyse and interpret are written in the report with simple language for the references in the future.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

In this chapter geomorphology, lithostratigraphy, structural geology and historical geology in detail of study area. All the information gathers during the geological mapping activities to understand the history and the process that happened in the past. Geomorphology is the study about the landform which the surface of the earth and the factors that involved in the process. Lithostratigraphy is under of stratigraphy that study of the rock layer or strata. It related with the depositional environment and the weathering process. Structural geology is the study of the deformation that happened and cause the changes to the area which it may cause by the tectonic setting. Historical geology is the techniques or principles that of geology in order to reconstruct and understand the historical geology of earth.

a) Accessibility

For accessibility in the study area is really easy to access by hilux, motorcycle and walking. The main road is Jalan Kota Bharu-Gua Musang and Jalan Limau Kasturi. The small road is commonly accessed by villagers to plantation area by motorcycle or walking. Figure 4.1 shows the example acces road in study area where figure (a) is the main road that connected Taman

agropolitan with Kota Bharu-Gua Musang Highway while (b) shows the road trail that usually used to access oil palm plantation

(a)

(b)

Figure 4.1: (a) road connection to Taman Agropolitan and (b) road trail in oil palm area

b) Settlement

The main settlement in the study area is Kampung Sungai Asap that located at west part and Taman Agropolitan Rantau Manis located at east part of the box. There is also have small area that discovered by villager that near the oil palm plantation in the middle of the box. Besides that, in the study area also have rest and services area that known as R&R where it becomes the pit stop for the people that use the highway to relax and rest. Figure 4.2 shows the example of settlement in study area that include the plantation and residential area.

Figure 4.2: Settlement in the study area

c) Forestry and vegetation

The study area mostly covered by new plantation of oil palm area that cause the developing of area. The forestry is only minor which located at South and North east area of the box. Figure 4.3 show the area of oil palm plantation, rubber plantation and forest.

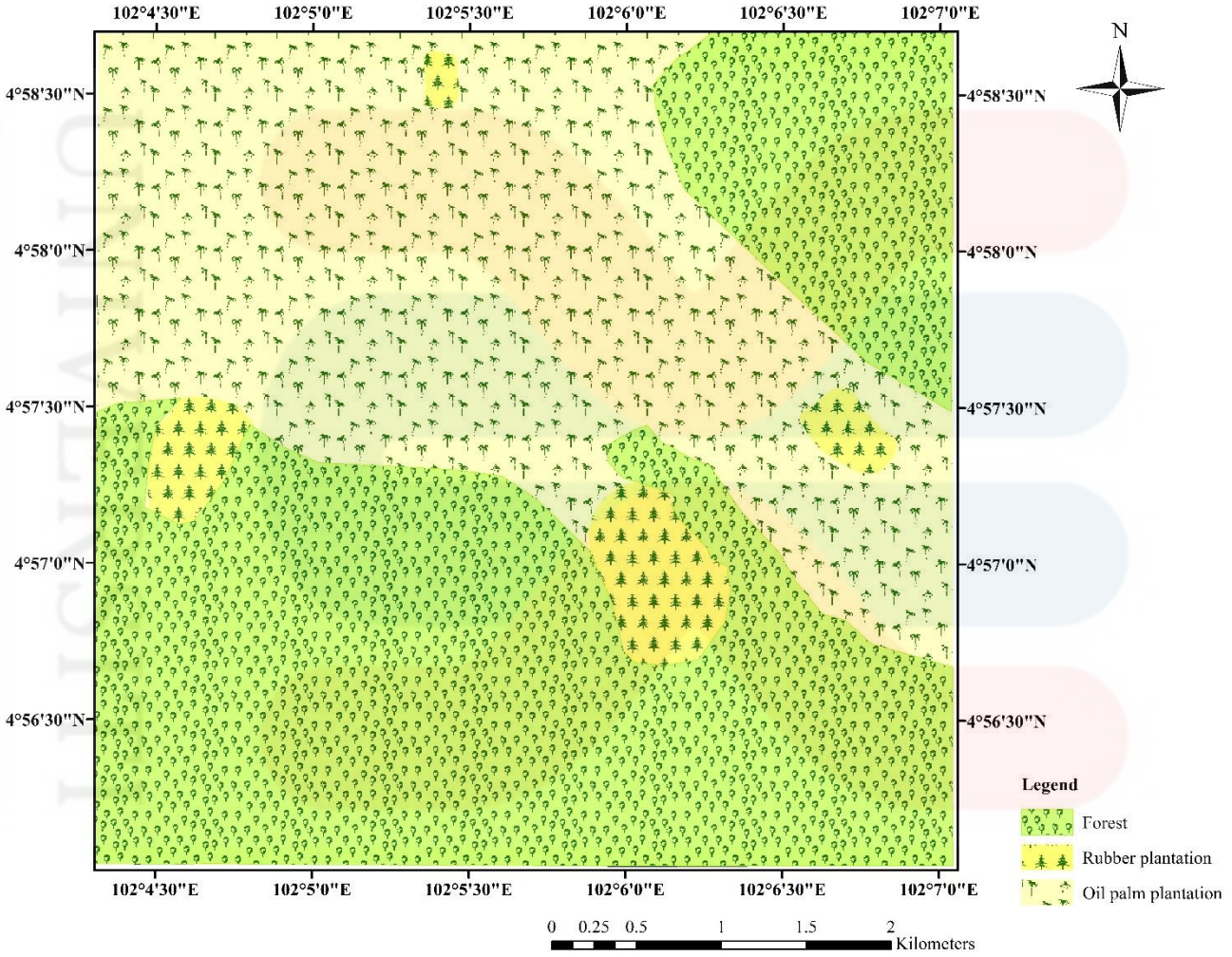


Figure 4.3: Vegetation and forestry map

d) Traverse and observation

Traverse is the track that had recorded during the geological mapping which show the area that already cover. The equipment used for recording the track is GPS. Observation is doing to the location that have good outcrop condition where the data can be collected.

Base on figure 4.4 the traverse map shows the green line which is the tracked of the area that can be accessed during the mapping. Mostly easily to access due to plantation area. The figures in the traverse map is the example of outcrop observation that had be done.

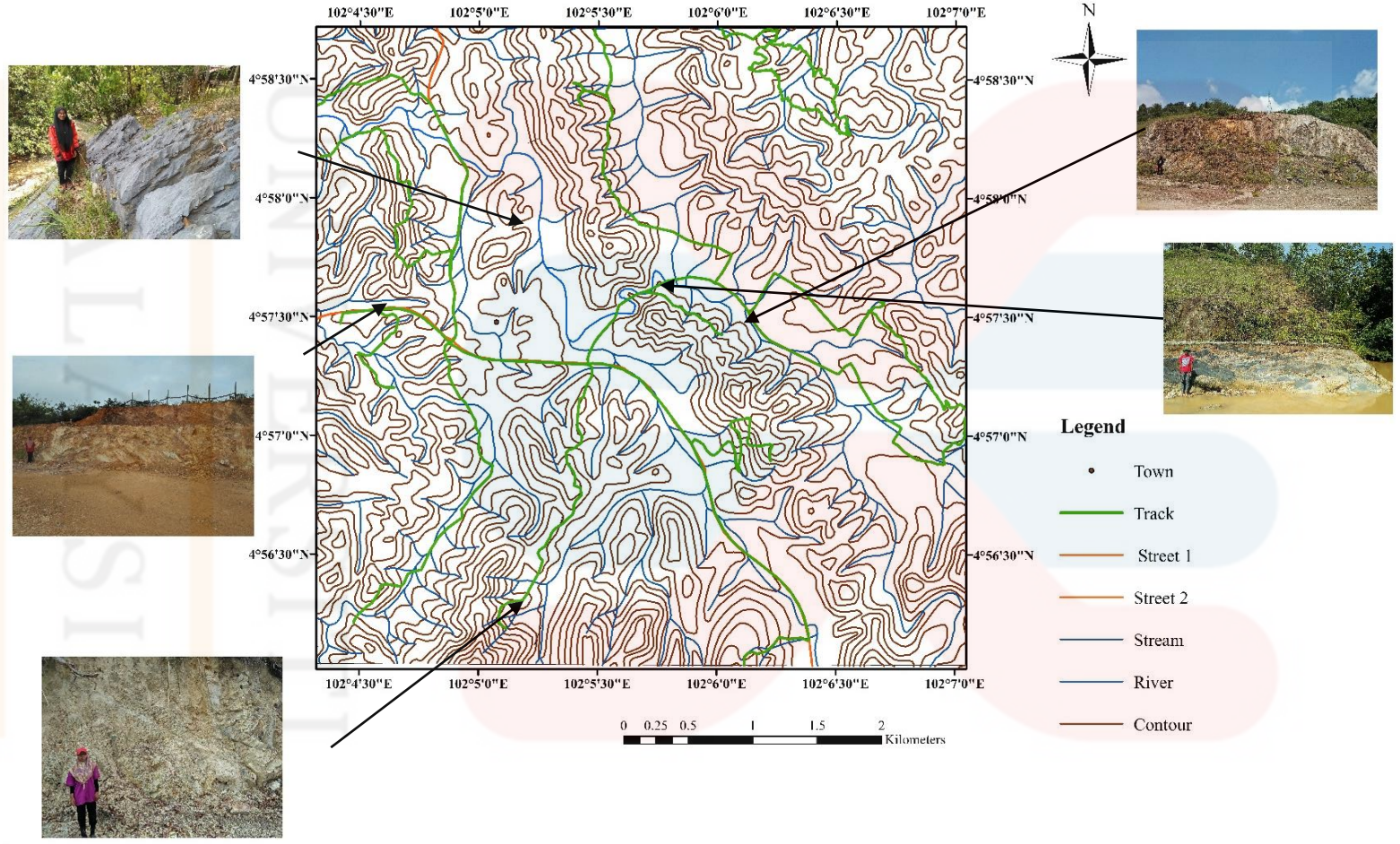


Figure 4.4: Traverse map and observation

4.2 Geomorphology

Geomorphology is the study of the landform, the process and also the sediments at the surface of lands. It includes all the visible features at the surface of the Earth such as mountains, valleys, river and deltas. The exogenic and endogenic process influenced the earth morphology. Exogenic is the process that involved the erosion and depositional that caused by weathering or mass wasting. The endogenic is the process that occur beneath the earth such as plate tectonic and earthquake.

4.2.1 Geomorphologic classification

Table 4.1 shows the topographic unit in generally. Based on the table, the study area mostly can be classified in hilly to minor of mountainous class which the elevation ranges from 100 to 300 and above. Figure 4.5 (a)is taken from the southeast part which the elevation around 200 meters while figure figure 4.5 (b) is taken from northwest part of study area with the elevation below than 200 meters.

Figure 4.6 show the morphology map where it divided into elevation which less than 200 meters and elevation more than 200 meters. The area that have elevation more than 200 meters can be classified as high hill where the area lower than 200 meters can be classified as hills area. So, from the map the area that have elevation more than 200 meters mostly located at the south part of box.

Table 4.1: Topographic units based on mean elevation

Topographic unit	Mean elevation above sea level (m)
Low lying	<15
Rolling	16-30
Undulating	31-75
Hilly	76-300
Mountainous	>301

(a)

(b)

Figure 4.5: (a) N 04° 56' 54", E 102° 06' 13.5" with bearing N62E and (b) N 04° 58' 28.6", E 102° 04' 29.1" with bearing N18E

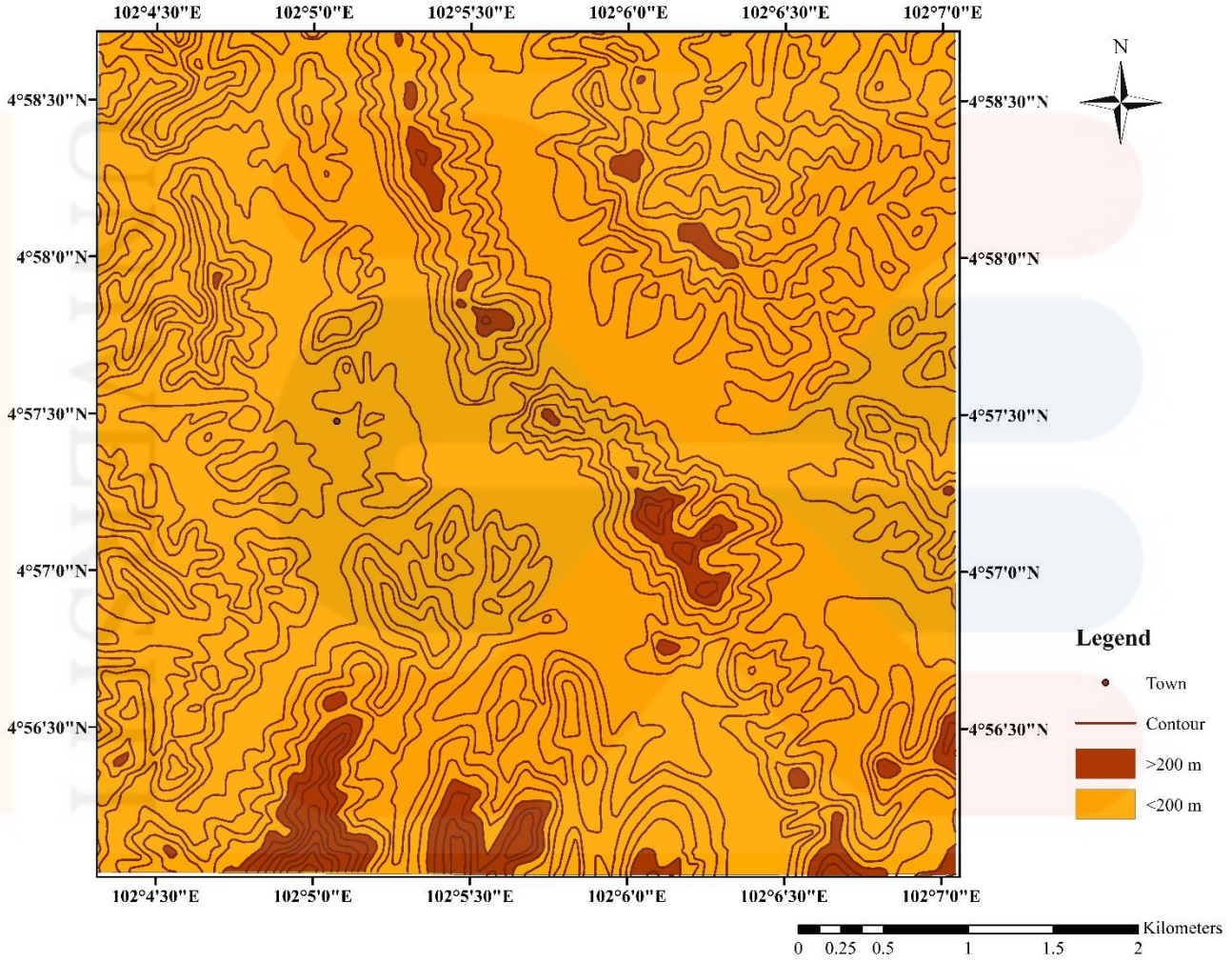


Figure 4.6: Morphology map

4.2.2 Weathering

The weathering in the study area can be classified into two which physical weathering and biological weathering. While the weathering grade in the study area is ranking from slightly weathered to highly weathered. The classification of weathering grade based on the condition of outcrop. The slightly weathered when the outcrop condition have some discolouration and opening defects. It is weak than fresh rock. The rock or outcrop is weaker than the fresh rock and part of the rock mass may have been changed to a soil. Rock material may be discoloured and defect and clast surfaces will have a greater discolouration, which also penetrates slightly into the rock material. Highly weathered is where half of rock or outcrop turned to soil.

The major weathering is biological weathering which most of the outcrop was covered by vegetation. Biological weathering commonly caused by microbes, plants and animal which can reduce the strength of the rock. For example, figure 4.7 shows the vegetation that grow on the outcrop in the study area.

Figure 4.7: Biological weathering at the outcrop

Physical weathering is the rock broken to particles without changing the chemical composition of sediment or minerals. Normally it caused by temperature, pressure, water and ice. Figure 4.8 is example of physical weathering where the outcrop is exposed to the surrounding condition such as changes in temperature during day and night that can cause contraction and expansion of rock. The atmospheric pressure also can influence the weathering process to break the rock when the outcrop had reached it limits due to the changing temperature of surrounding.

Figure 4.8: Example of outcrop that have physical weathering

4.2.3 Drainage pattern

Based on the figure 4.9, the major drainage pattern that can be observe in study area is trellis pattern and minor of rectangular pattern. The red circle shows the type of trellis while yellow circle is rectangular pattern. The trellis pattern is identified by the sub parallel stream or river that eroded perpendicularly to the main river and have small erosion like a vines.

The rectangular pattern is classified based on the stream with straight line and right angle bends that looks like rectangular. However, the classification of the drainage pattern also influences by the type of rock. the rectangular pattern also causes by the faulting or joint of the underlying rock. The figure also show the formation of rectangular drainage is from the trellis drainage. From the map, mostly the rectangular pattern formed near to the trellis pattern.

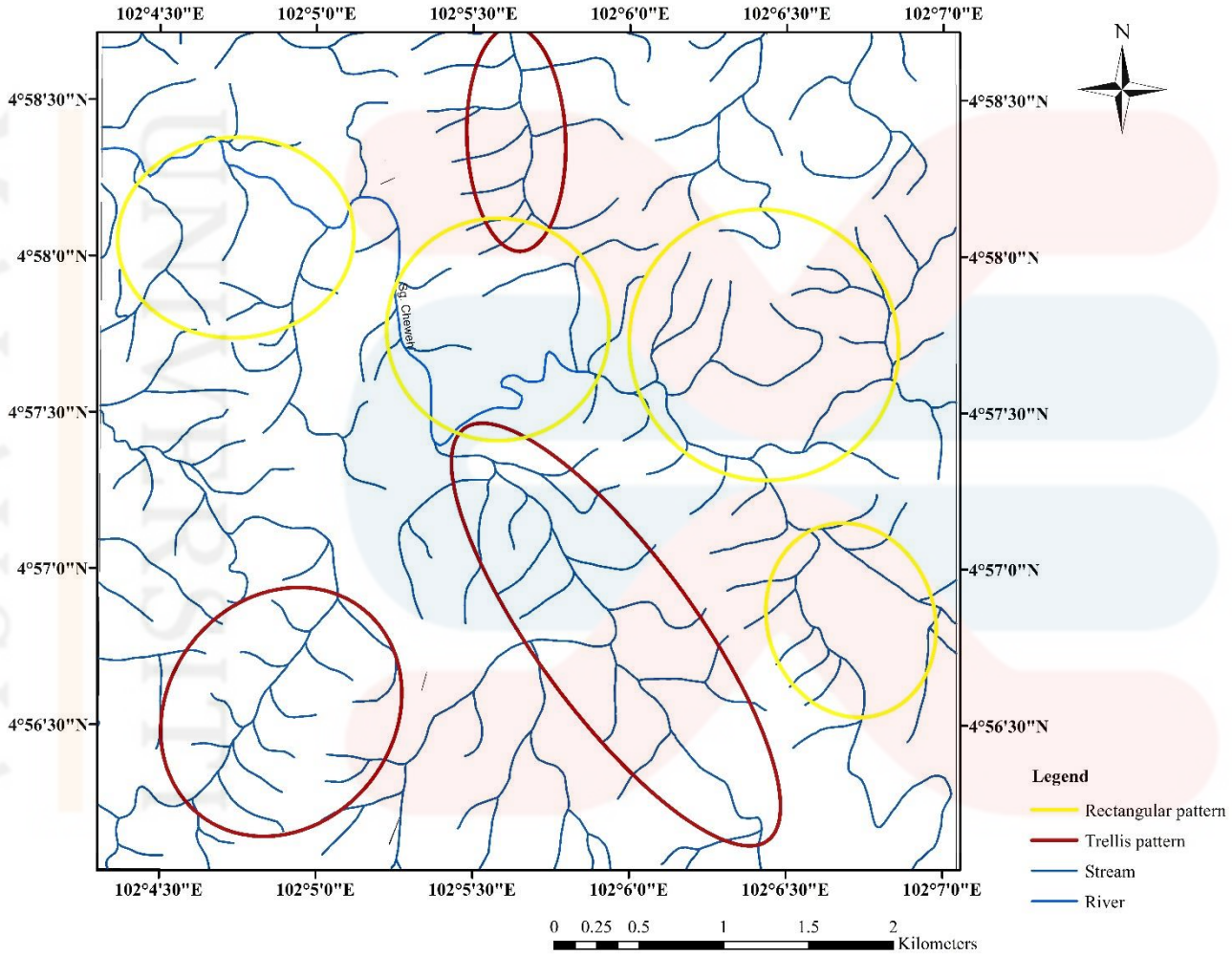


Figure 4.9: Drainage pattern map

4.3 Lithostratigraphy

Lithostratigraphy is the units or elements in the stratigraphy which it involved the relation of the rocks and the detail descriptions about the focused area. It also shows the sequence of the lithology unit based on their ages.

4.3.1 Stratigraphic position

The stratigraphic position of the study area is under the Gua Musang formation which based on figure 2.1 in literature review the range age of Gua Musang from Middle Permian to Late Triassic. Based on the figure 4.10 there are four lithology unit that can be identified in the study area. The oldest rock is metasediment where the age is from Middle Permian. The metasediment in the study area consist of slate, phyllite and laminated shale. Then follow by volcanic unit where the range is from Early Triassic time. The stratigraphic also show the consideration of intercalation from rhyolite which it can be found in south west part of study area. The youngest unit is limestone which the age of the unit is on Triassic Period.

The location of the rhyolite that had found with the coordinate N 04 56' 02.23", E 102 05' 01.94". The rock found in the middle to the top area of hill of that called as Rabong Forest Reserve. Based on Yee (1983), the Gua Musang formation composed of volcanic composition included of rhyolite to andesite and tuff, lavas and agglomerate. Figure 4.13 is the map of lithostratigraphy for the whole study area with the cross section

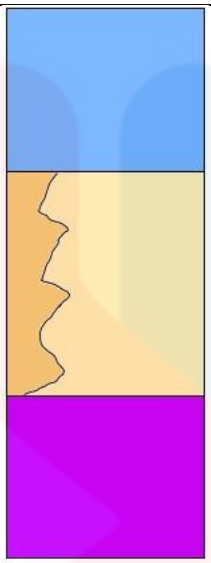
Age	Lithology units	Description
Triassic		Limestone: Mostly dark grey to grey colour.
? Early Triassic		Volcanic: Consist of tuff and rhyolite unit
Late Permian		Metasediments: Consists of laminated shale, phyllite and slate. Mostly the grains size from very fine to medium.

Figure 4.10: Stratigraphy of the study area

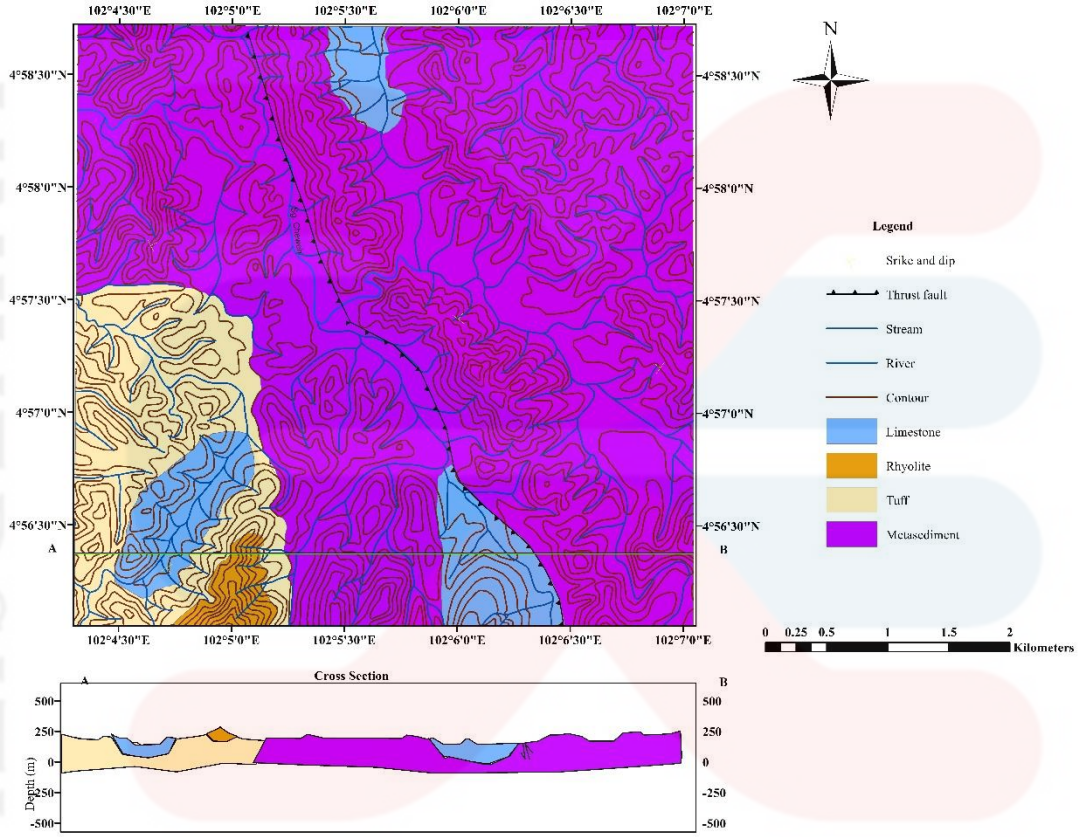


Figure 4.11: Lithostratigraphy of study area with cross section

4.3.2 Unit explanation

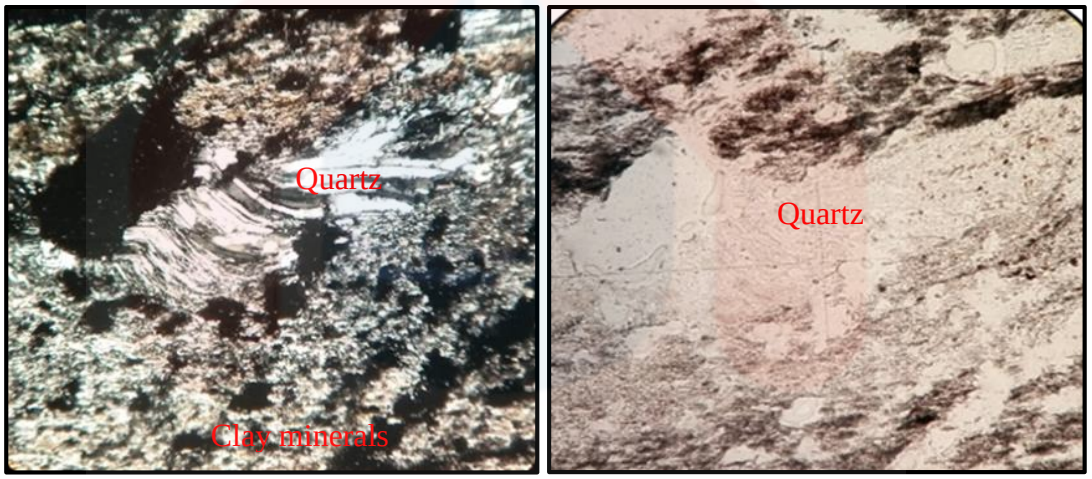
a) Type of unit: Metasedimentary rock

Figure 4.12 shows one of the hand specimen of metasedimentary rock which is shale that located at N 04 57 30, E 102 05 32 near the river. However, due to the low metamorphism, the lithology unit also classified as meta shale. This because, according to Robertson (1999) the term of meta used in sedimentary rock when the sedimentary protolith can be recognised at the metamorphic rock.

The condition of the outcrop is moderately weathered influenced by the structural and biological and physical weathering process. Besides that, the sedimentary structure like parallel lamination can be found in the bedding of the outcrop at river. Figure 4.12 show the hand specimen of metashale colour is light grey and have silt to very fine grain size.

Figure 4.13 shows the sample of thin section of shale under microscope with magnificent of 40x. It contains of quartz minerals, fine grain materials that consist of silty materials and clay minerals and alteration minerals which is sericite minerals. The silty materials are brownish colour while the sericite is more to blue colour. The thin section shows the characteristic of shale that that have undergo metamorphism.

Figure 4.12: Hand specimen of shale



Cross polarization Plane polarization

Figure 4.13: The shale thin section under microscope with magnificent of 40x

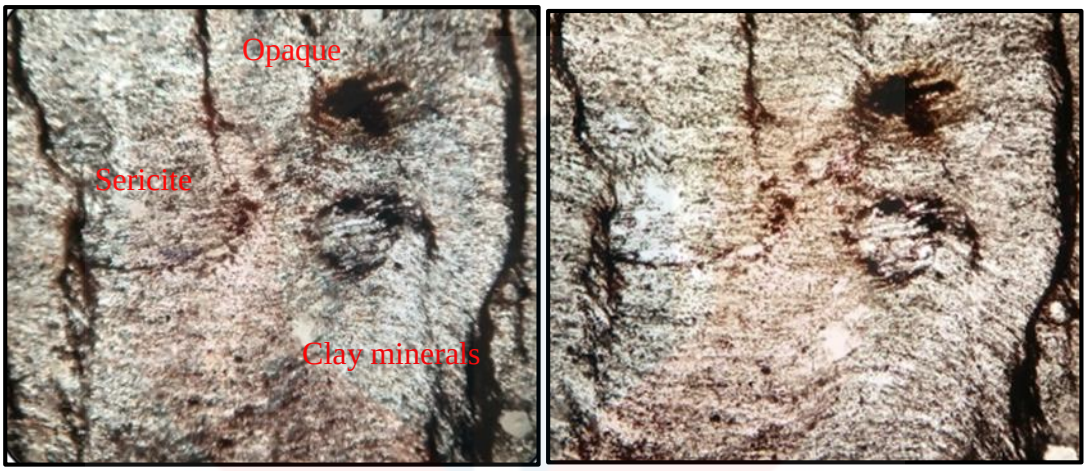
Table 4.2: Mineral composition of metashale

Minerals	Estimation (%)	Description
Quartz	5	Colourless under plane polarization and change from colourless to dark under cross polarization
Silty and clay minerals	65	Fine grain materials with brownish colour
Alteration minerals	30	Fine grain minerals that have blueish colour under cross polarization

Figure 4.14 is the hand specimen of phyllite. The location of the outcrop is at Malaysia Rubber Plantation area. The colour of rock is reddish where the grain size is silty to very fined grain. The condition of outcrop is also moderately weathered because of the physical and biological weathering. The foliation of phyllite cannot be seen.

Figure 4.15 shows the thin section of phyllite. Based on the thin section the foliation of phyllite can be seen clearly. The minerals content are some clay minerals, sericite and opaque minerals spotted.

Figure 4.14: Hand specimen of phyllite



Cross polarization Plane polarization

Figure 4.15: Phyllite sample under microscope with magnificent of 40x

Table 4.3: Table mineral composition of phyllite

Minerals	Estimation (%)	Description
Opaque minerals	5	Minerals that give dark colour in both cross and plan polarization
Silty and clay minerals	55	Fine grain materials with brownish colour
Alteration minerals	40	Fine grain minerals that have bueyish colour under cross polarization

b) Type of unit: Volcanic

Volcanic can be clarified as pyroclastic rock and igneous rock where it from the ash of volcanic eruption. Based on the figure 4.16 shows the outcrop of tuff located at N 04° 57' 29.5", E 102° 04' 25.3", near the main road. The condition of outcrop is slightly weathered which is exposed to physical weathering. Based on figure 4.17, the hand specimen of tuff has light colour like milk. The grain size of the tuff is very fine grain. Some oxidation of iron weathering can be observed at the hand specimen.

Figure 4.18 shows the sample of tuff under microscope with magnificent of 40. The tuff is consisting of quartz minerals, plagioclase, fine materials and opaque minerals.

Figure 4.16: Outcrop of tuff at location N 04° 57' 29.5", E 102° 04' 25.3"

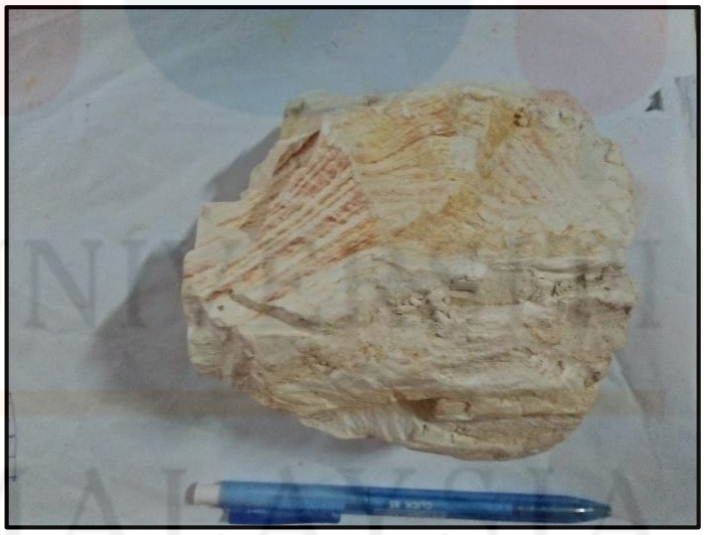
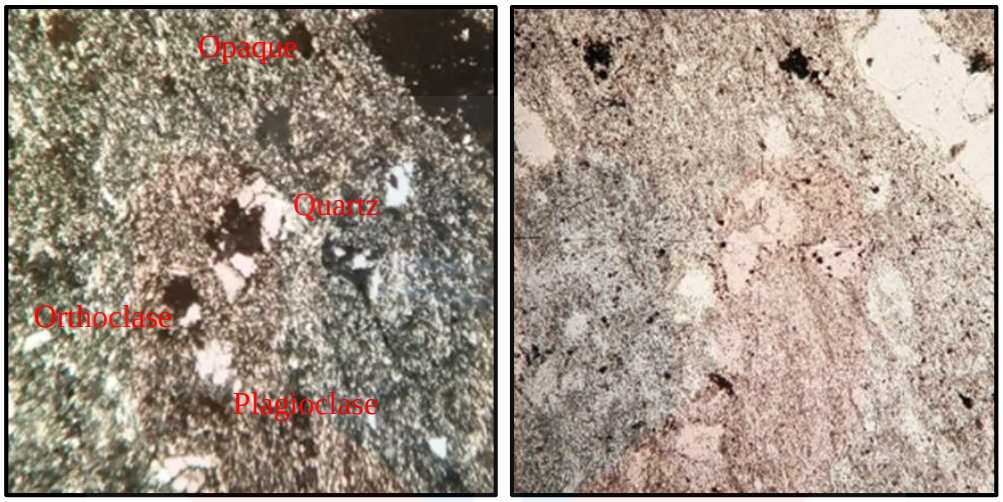


Figure 4.17: Hand specimen of tuff



Cross polarization Plane polarization

Figure 4.18: Thin section of tuff with magnificent of 40x

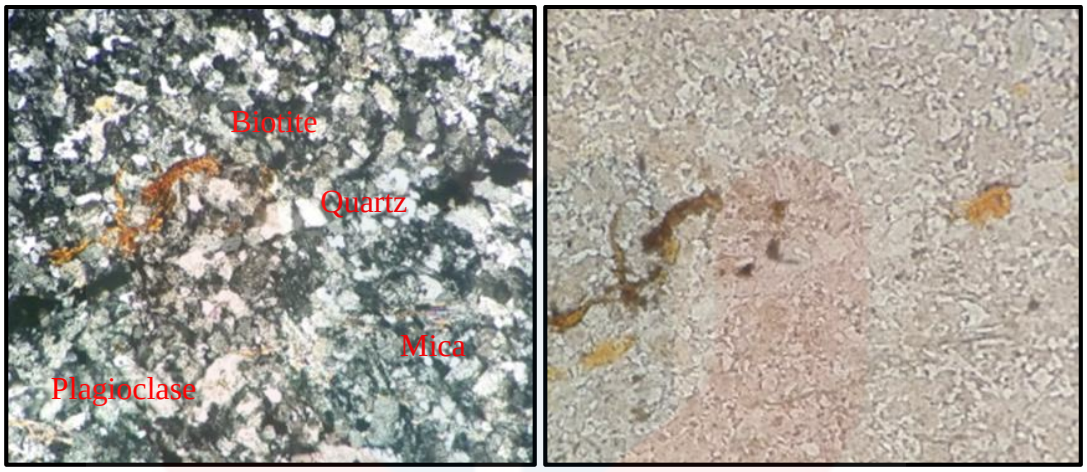
Table 4.4: Mineral composition of tuff

Minerals	Estimation (%)	Description
Quartz	50	Dark colour under cross and colourless in plane polarization
Plagioclase	35	Plagioclase minerals grey colour under cross polarization and have twinning. But it colourless under plane polarization.
Orthoclase	10	Same like plagioclase but it has low relief and has simple twinning
Opaque	5	Minerals that give dark colour in both cross and plan polarization

Based on figure 4.19, the outcrop of rhyolite is found in the middle of Rabong forest reserve. The outcrop consists of small pebbles in dark grey colour. Figure 4.20 show the hand specimen contain rounded dark grey rock. the colour is white and have very fine grain size. Based on thin section observation, the minerals that can be observed under microscope are quartz, biotite and mica.

Figure 4.19: Outcrop of rhyolite at N 04 56 22, E 102 05 05 of Rabong forest reserve

Figure 4.21: Hand specimen of rhyolite



Cross polarization Plane polarization

Figure 4.21: Rhyolite thin section with magnificent 40x

Table 4.5: Mineral composition of rhyolite

Minerals	Estimation (%)	Description
Quartz	45	Dark colour under cross and colourless in plane polarization
Mica	10	Turquoise colour under cross polar
Biotite	15	Give brownish colour under plane and dark colour under cross polarization
Plagioclase	30	Have twinning under cross polarization

c) Type of unit: Limestone

Figure 4.22 shows the outcrop of limestone at Cheweh river with coordinate N 04° 58' 05.13", E 102° 04' 55.45". The outcrop condition is moderately weathered due to exposure of physical and biological weathering. Based on figure 4.23, the hand specimen of limestone has dark grey colour. The calcite vein also clearly can be seen on the hand specimen.

Figure 4.24 shows the thin section sample of limestone with magnificent of 40x. on the figure the calcite minerals had been observed which

it contains of two cleavages. Under plane polarization the calcite is colourless but still can see its cleavages while under cross polarization the calcite colourful colour. The extension angle of the calcite cleavages is 38. Besides that, the matrix of calcite also found as groundmass.

Figure 4.22: Outcrop of limestone at Cheweh river

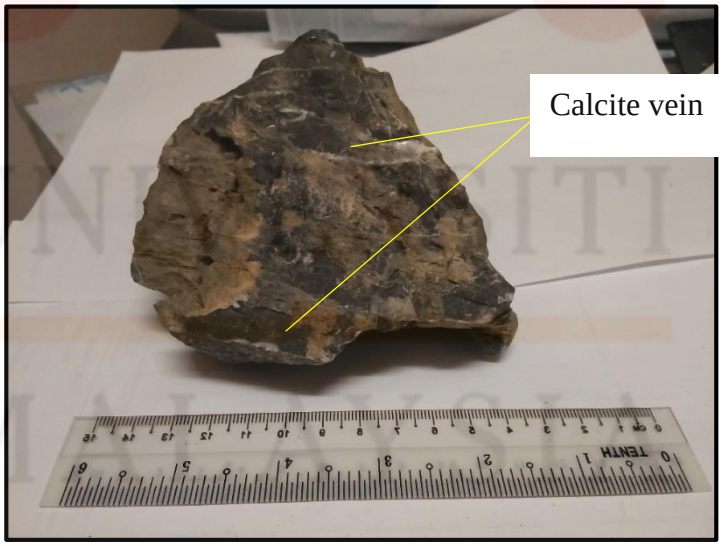
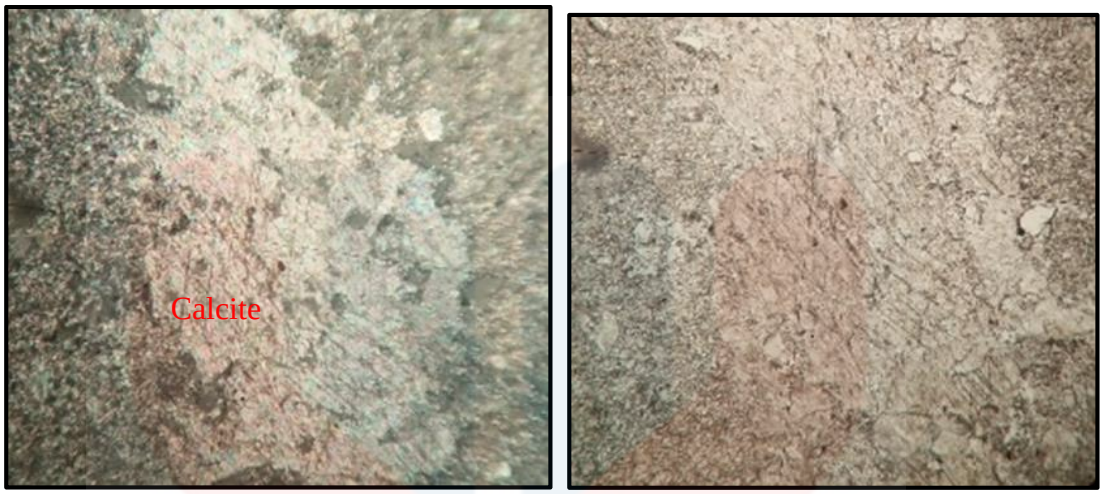


Figure 4.23: Hand specimen of limestone



Cross polarization Plane polarization

Figure 4.24: Thin section sample of limestone with magnificent of 40x

4.4 Structural geology

Structure analysis is the important element that must be conducted during the mapping. The structure analysis gives information about the tectonic activity that had happen in the past which that can lead to the deformation at the study area.

Strike and dip was taken in each outcrop but due to the weathering process the bedding of the outcrop cannot be seen clearly. Strike and dip shows the orientation or attitude of geologic features.

The indication of structure on the map can be identify based on lineament analysis but sometimes the drainage pattern also can be indicator to structure. Based on subtopic 4.2 about the drainage pattern, rectangular pattern usually formed cause by the faulting and joint of underlying bedrock.

4.4.1 Lineament analysis

Lineament analysis is any linear features in a landscape that can be indicator to the geological structure like faulting. But sometimes it also presents in curve linear. Commonly a lineament will appear as fault-aligned valley, straight linear river or stream and a series of fault or fold-aligned hill. Lineaments often appear in geological map or topographic map and can be seen clearly on aerial or satellite photographs.

Based on figure 4.25 The lineament analysis was made based on the straight line of the river that may cause by structure and the ridge that may form from the deformation. The ridge is result of the compression while the valley formed from the extension. The red line shows the lineament analysis in the study area.

From the lineament analysis, the rose diagram is made to identify the distribution of the lineament in the study area. Based on figure 4.26, shows the highest distribution of the lineament is at the north-north-east (NNE) part.

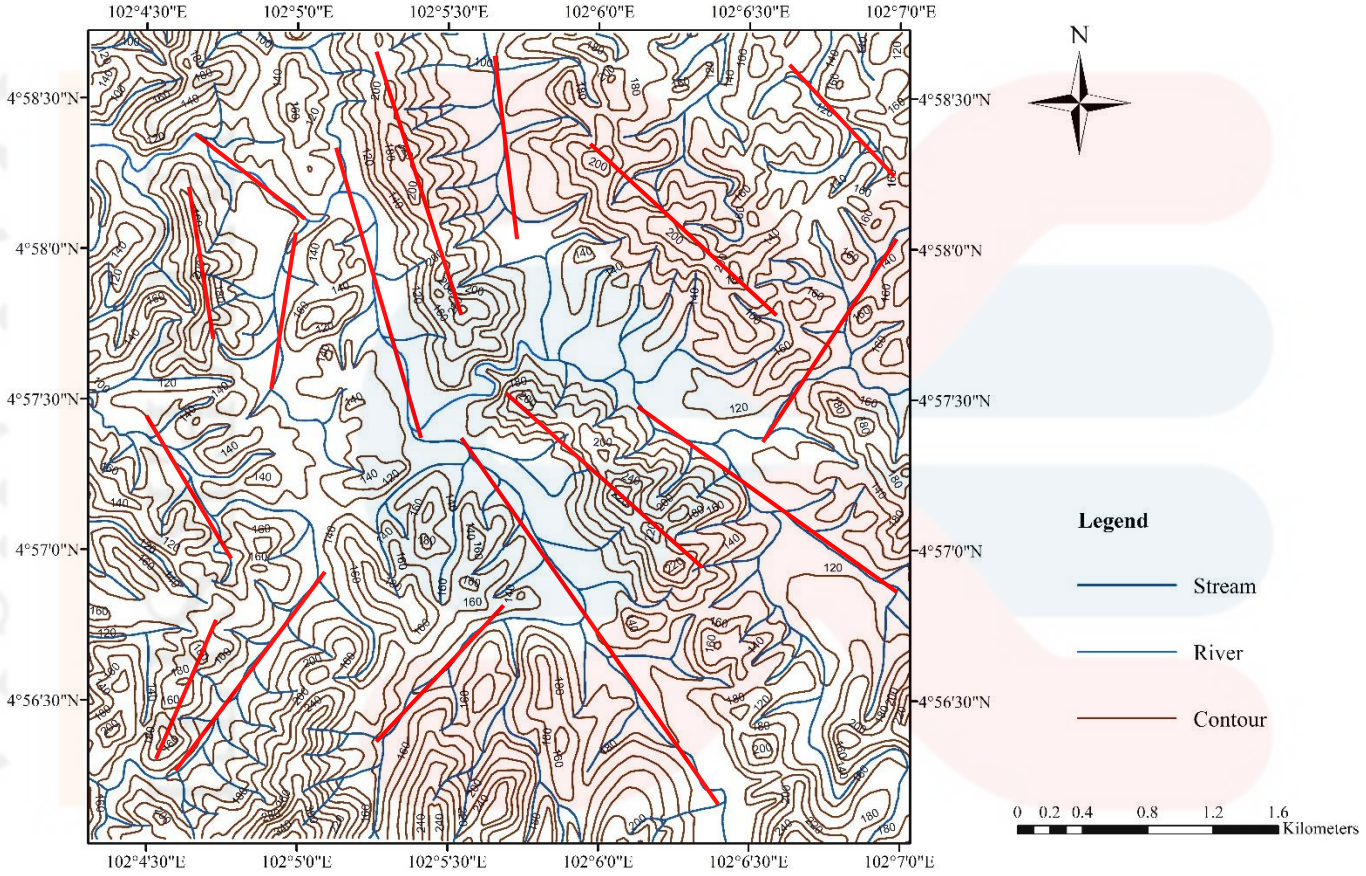


Figure 4.25: Lineament map

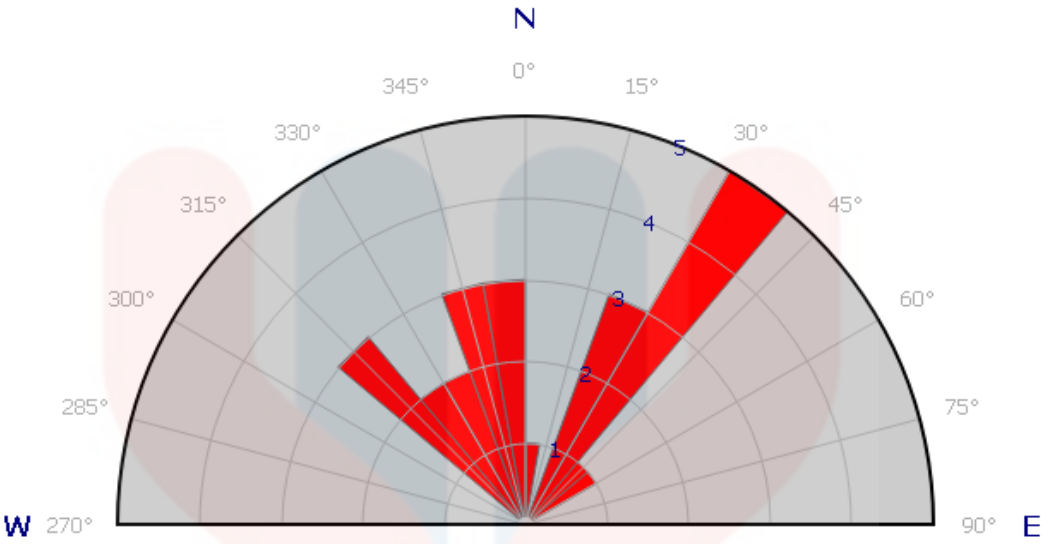


Figure 4.26: Rose diagram of lineament analysis

a) Vein

Veins is the crack on the rock that have filled with minerals like quartz or calcite. But mostly it filled with the quartz minerals. Vein formed when the aqueous solution of minerals deposited and then crystallized in the crack or fracture. It can be small or big depends on the of crack size.

From the figure 4.27 the quartz vein is oxidised with the iron that caused the dark red colour and figure 4.28 shows the brownish and white colour of quartz where the brownish colour is the weathered quartz. In this area there are abundance of quartz vein and some other structures.

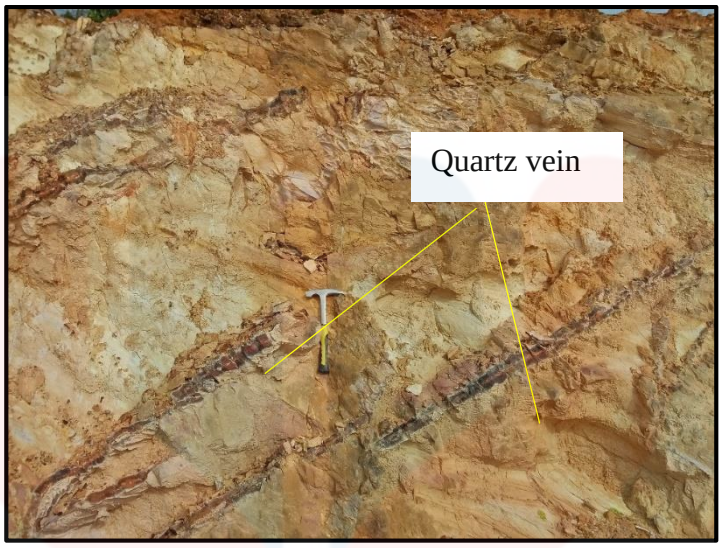


Figure 4.27: The oxidation of iron in quartz vein

Figure 4.28: The quartz vein structure

b) Fault

Fault is brittle deformation which it occurred due to compressional or tensional forces that act on the rock. Faulting can be occurred in small area or region which the displacement may take in centimetres or kilometres depends on the stress. Faulting can be in vertical, horizontal and inclination at any angle.

Figure 4.29 shows the outcrop that may have fault. But the indicator of the fault cannot be identified due to outcrop condition. The observation only can be made based on the changes of strike and dip taken. The yellow line is the estimation of the fault line.

Figure 4.30 shows the result of faulting by using the stereonet. The sigma 1 is the principal force that caused the brittle action to the rock while sigma 3 the is the lowest force that act on rock.

Figure 4.29: Outcrop at N 04° 57' 25.7", E 102° 06' 01"

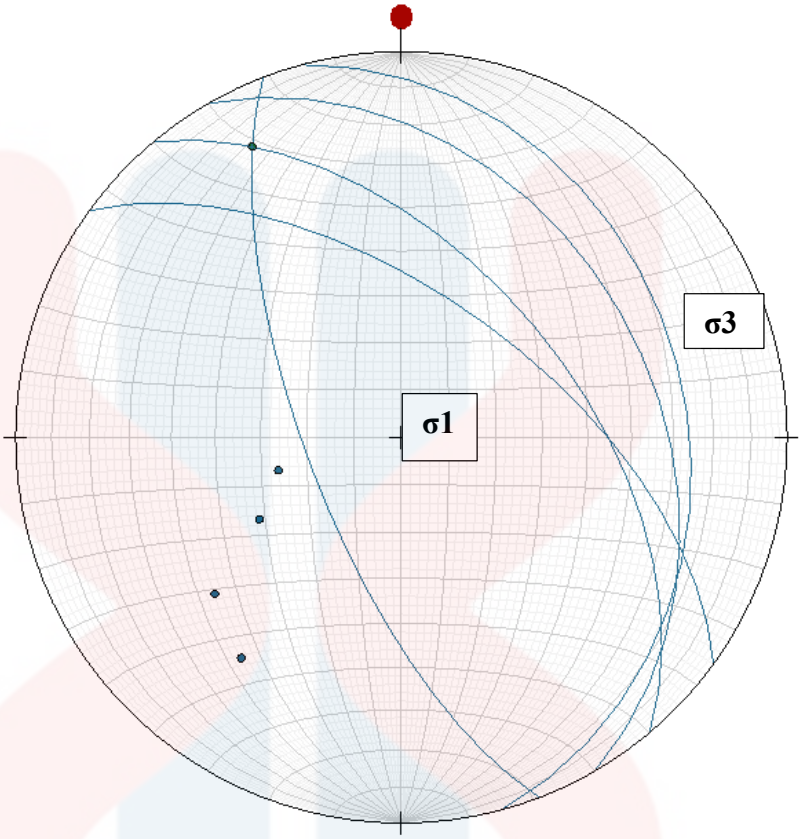


Figure 4.30: Stereonet of the outcrop N 04° 57' 25.7", E 102° 06' 01"

c) Fold

Fold is ductile deformation which the rock tends to bend when the force act on the rock. folds on the rock can be various size from the small to the mountain size which the folding formed the mountain itself.

Figure 4.31 shows the folding at the river which the intrusion of the quartz vein that also folded. The area also has many disrupted structure that cannot be observed. Based on observation the folding may be clarified as drag fold that cause by the faulting.

Figure is 4.32 is located at the road cutting. The condition of outcrop is very disrupted where the rock broken which can indicate to shear zone. The folding of the outcrop is vertical that which the principal force may come from bottom and upper part. Besides that, the outcrop also highly weathered.

Figure 4.31: Structure folding at N 04 57’ 30”, E 102 05’ 32.9”

Figure 4.32: Folding structure at N 04 57’ 33”, E 102 05’ 36.5”

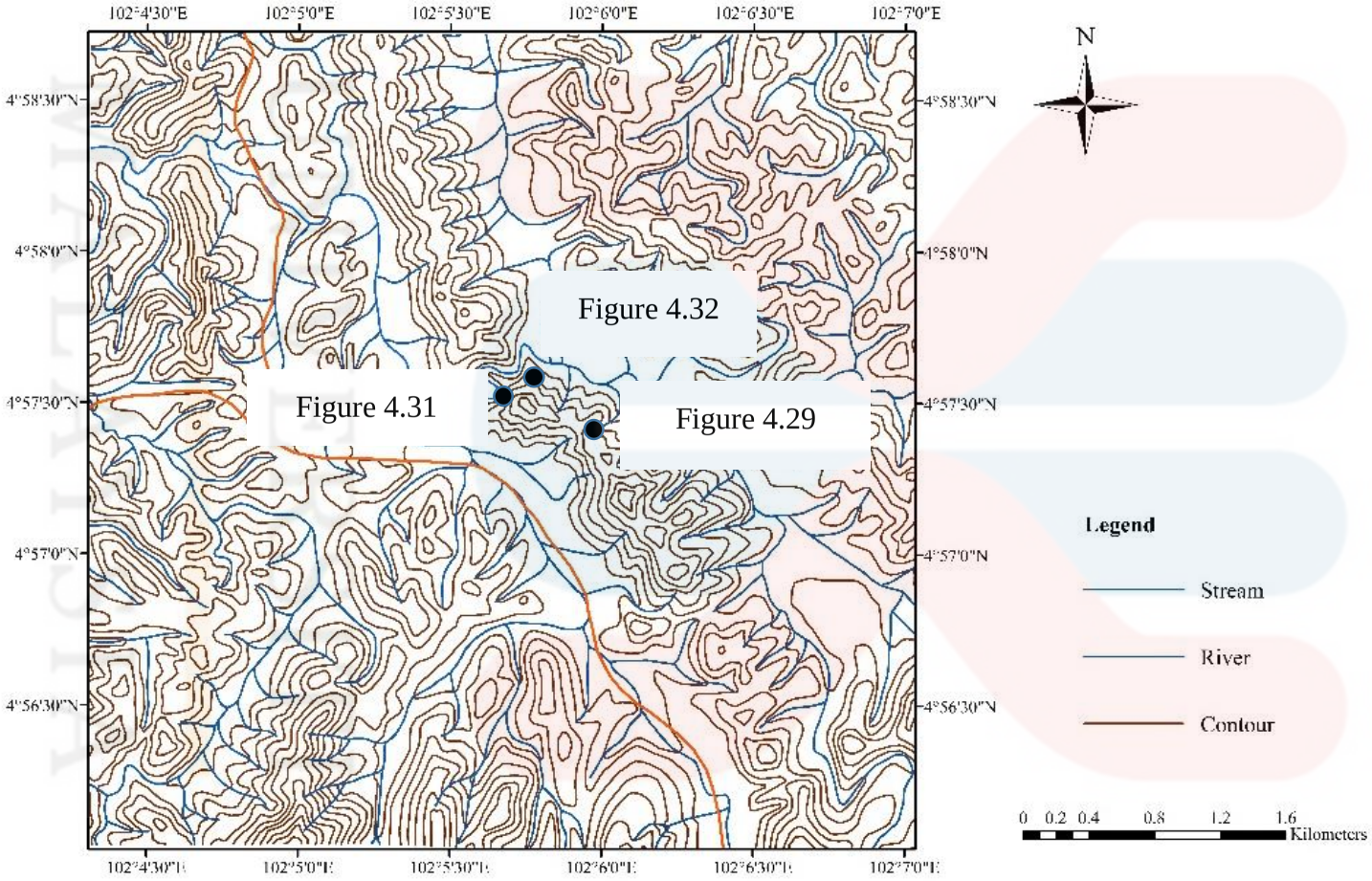


Figure 4.33: Location map of outcrop

4.5 Historical geology

The historical geology of the study area includes of the morphology and the lithology. The morphology has hills as the highland and plain area as the area where the deposition occurred or as the basin of sediments deposition. The weathering process that occurred by time erode the hills and the plain area to form stream or river. Besides that, it also caused the fresh outcrop to become weathered. The drainage pattern leads to the water system and certain drainage pattern control by the structural that occurred.

The study area is under Gua Musang formation and consist of 3 main rock unit which metasediments as the oldest rock which the time of deposition during Late Permian. The metasediment in the study area is the fine grain sediment that deposit at the centre basin that include Gua Musang. Due to the thrust fault that occurred at Bentong-Raub Zone that consist fine grain sediment to undergo low grade metamorphism.

The parallel lamination of sedimentary structure found at the certain bedding of the metasediments. This can give information on the depositional environment of the study area. Then follow by tuff that have deposited during Early Triassic that caused by the volcanic eruption. The youngest rock unit in the study area is limestone where it deposited during the Triassic time.

CHAPTER 5

DEPOSITIONAL ENVIRONMENT OF METASEDIMENT IN TAMAN AGROPOLITAN, RANTAU MANIS

5.1 Introduction

Depositional environment is the characteristic properties of sedimentary rock that generated through various action like physical, chemical and biological which make up sedimentary cycle. It is also specific type of place where the sediments are deposited like continental, marginal marine and marine. The layer of sediments that accumulated in each type of depositional environment have distinctive characteristic that provide information about the geologic history of the area. The characteristics that can be observed and measured during the mapping to identify the depositional environments include its lithology where the type of rock and the grain size. Next, the sedimentary structures and the fossil contains. The information of depositional environment is important in reconstructing the earth history and understand the earth process.

Sedimentary rock stratified in age sequence so it may record the situation of the area during the deposition and changing by time that caused by physical, chemical

and biologically. However sedimentary rock may undergo metamorphism and weathering process that can disturb it characteristic.

In this chapter, the depositional environment in Taman Agropolitan Rantau Manis is described based on the lithology, the grain size of rock unit, sedimentary structure and sedimentary log.

The weathering process and structural that occurred in the study area caused the indicators of depositional environment had diminished at the outcrops. Two sedimentary log were taken at the study area which one at the road cutting and another one is at river.

5.2 Location of specification study

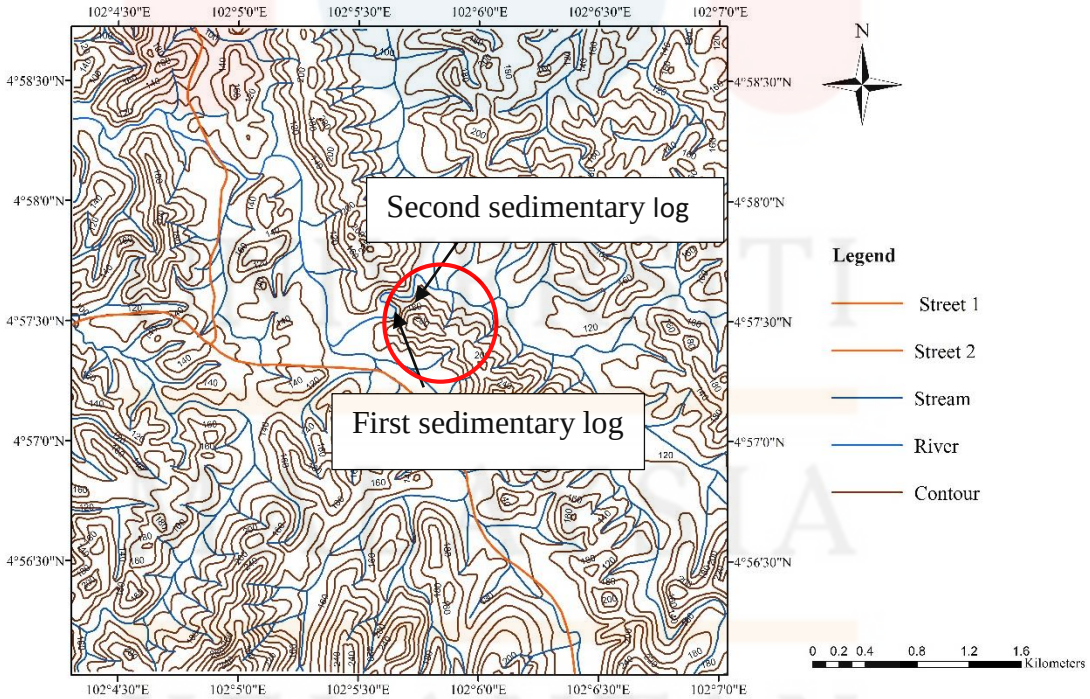


Figure 5.1: Location map

Based on the lithostratigraphy in chapter 4.3 the metasediments in the study area consist of phyllite, and shale that have characteristic of metamorphism. based on the figure 5.1 the specific conducted area for depositional area is at Taman Agropolitan Rantau Manis. The area total covered by metasediments rocks.

5.3 Type of rock unit,Grain size and sedimentary structure

Based on the lithostratigraphy in chapter 4, the unit in the specification area is more too metasediment rock unit which consist of shale, slate and phyllite. The metasediment is sedimentary rock that had undergo metamorphism where the characteristics of sedimentary and metamorphic can be observed on the outcrop, hand specimen and thin section sample. The characteristic of metamorphic can be seen by foliation and the alteration of some minerals. The sedimentary characteristic that can be observed usually based on the grain size at the hand specimen and the presence of minerals under the microscope observation. However, the sedimentary characteristic still dominated the lithology unit of metasediments in the study area

a) Type of rock

There are several type of rocks that had been found in specific study area, first is shale. However, due to the low metamorphism lithology unit was classified as meta shale. The used of term meta shale is because the characteristic of sedimentary for shale unit still can be observed and at the same time the unit also show the characteristic of metamorphic rock.

Based on figure 5.2 (a), the colour of the hand specimen is grey. The grain size of the rock can be classified from silt to very fine grain. The rock has broken to

cleavage. However, the outcrop condition shows the characteristic of sedimentary rock where the bedding still can be observed and the strike and dip can be taken.

Figure 5. 2 (b) and (c) are the image of thin section of slate under the microscope. The minerals of sedimentary rock that commonly found in the shale unit like quartz, clay and silty minerals still can be observed with some alteration minerals. Those minerals show the silicate characteristic of sedimentary rock still absence with the presents of alteration of minerals sericite that may cause by the low grade metamorphism.

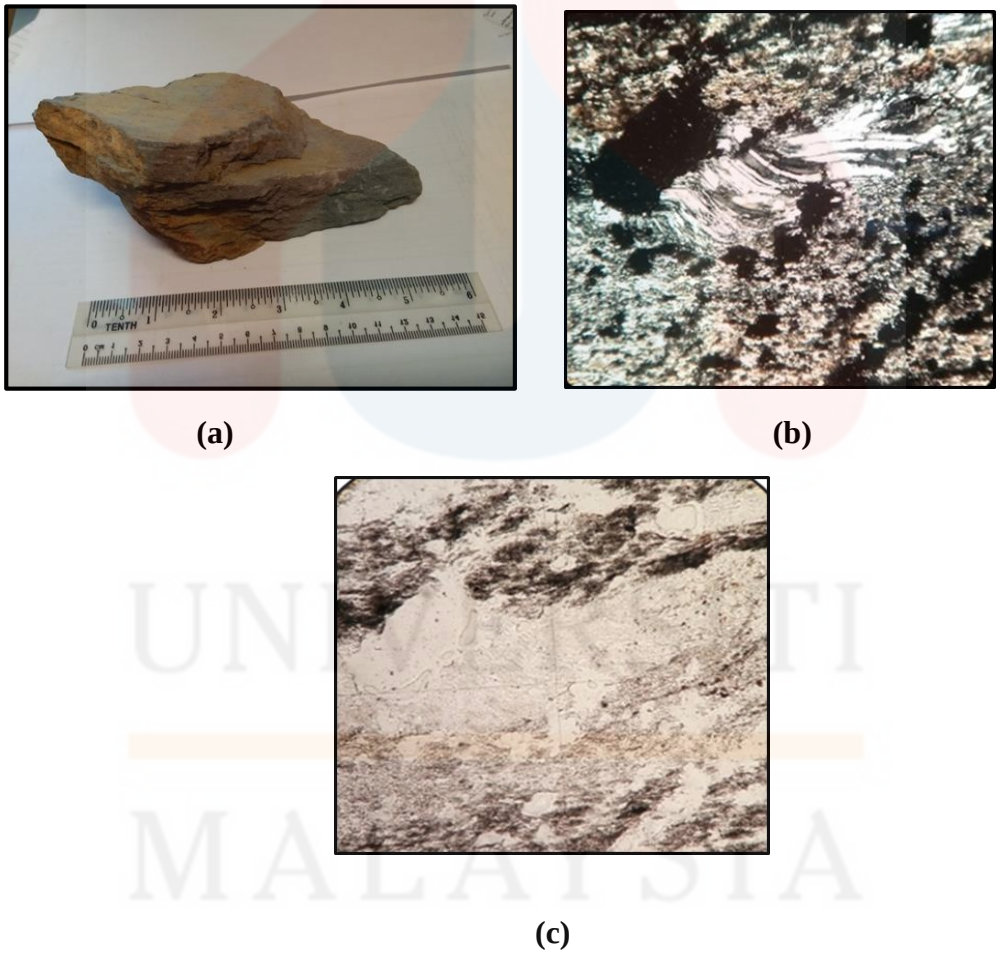


Figure 5.2: (a) hand specimen of meta shale, (b) and (c) thin section that of the meta shale

Second type of rock that can be identified is phyllite. Figure 5.3 show the hand specimen of phyllite with reddish colour. The grain size is still can be feel by fingers where it ranges from silt to very fine silt. At the field t

Under the microscope observation the phyllite foliated clearly can be observed compare to the hand specimen. The thin section shows the silty materials and alteration mineral. The groundmass with the blueish colour can be mica or sericite minerals. The minerals in the phyllite also shows the characteristic of its sedimentary rock minerals.

(a)

(b)

(c)

Figure 5.3: (a) hand specimen of phyllite, (b) and (c) thin section of phyllite

Based on the sedimentary characteristic of the outcrop of the rocks, the hand specimen and thin section for slate and phyllite, it indicates that the parent of the rock before undergo the lower grade metamorphism is shale. Because the shale is composed of the very fine clays that formed from the decomposition of feldspar and the presents of quartz, mica and organic matter. At the outcrop of the slate the lamination is spotted at the certain bed of the rock. Based on Sam Boggs (2011), the mud rock can be divided into two which laminated and non-laminated. Laminated mud is identified as shale that have fissile and non-laminated is identify as mudstone.

The depositional environment of the shale commonly at deep ocean, lagoon and swamp the condition of the water allow the very fine grain sediments and silt to deposit to the floor. According to the shale unit indicate the deposition where the water is still. Where there is no high of flowing energy.

b) Grain size of the rock

The very fine grain and the silty materials that had been observed for both type of the metasediment rocks shows that the deposits area for both rock have low density of the flow. Based on Boggs (2011) the turbidity currents can be divided into two which low density flow and high density flow. The low density flow made up of clay, silt and fine to medium grain size sediment particles. The high density flow commonly made up of coarse grain particles, pebbles to coble size of clast and also fine grain particles.

The very fine grain size for rock unit of slate and phyllite can be classified into the silty shale based on the figure 5.4 below. From the figure it also shows that, the

position of the shale based on it grain size usually deposited at the continental shelf or shallow area where the turbidity currents are slow and calm.

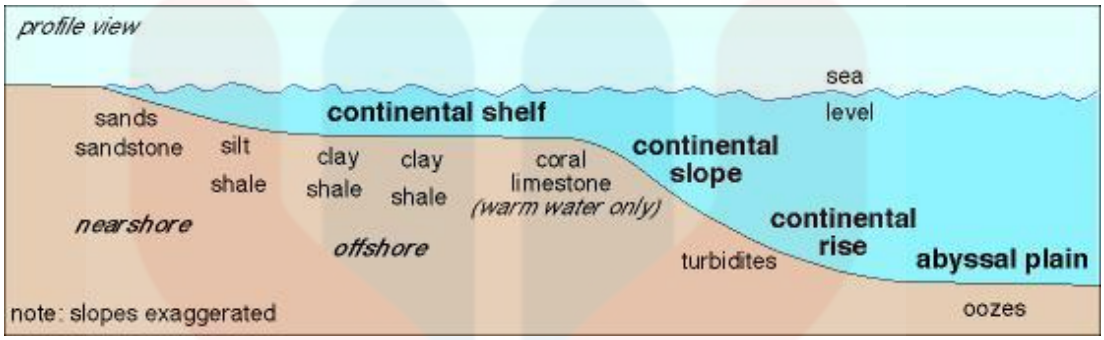


Figure 5.4: The position of shale based on grain size

c) Sedimentary structure

Based on figure 5.5 the sedimentary structures that be identified at location of study area is lamination. However, it cannot clearly have observed due to the condition of the outcrop that had influenced by weathering and other factors like metamorphism, only the certain part of outcrop can be observed the presence of lamination.

In sediment, the lamination is the common features of the shale that provide the information of sedimentary process with the addition of few evidences. The lamination is caused by the cyclic changes in supply the sediments where the changes occur in fined grain size. Lamination is small sedimentary structures that easily can be destroyed by bioturbidition. According to Arthur and Sageman (1994) lamination is used to distinguish the black shale where in the mudstone is identified as parallel arrangement.

Figure 5.5 shows the parallel lamination that can indicate that the fine grain sediments deposited at the area of environment that have low water tidal, quiet and calm

environment. For example, deep sea, sea floor of lacustrine and area that not have strong tidal current.

Figure 5.5: Parallel lamination sedimentary structure

5.4 Sedimentary log

a) First sedimentary log

The first sedimentary log taken at river with the coordinate N 04° 57' 36.2", E 102° 05' 40". The type of rock in the figure 5.5 is classified as the meta shale because the characteristic of the shale unit and the sedimentary structure still can be observed although the area had affected by metamorphism. Figure 5.6 show the outcrop of the sedimentary rock conducted.

Based on the sedimentary log in figure 5.7 the sub unit can be classified into it grain size. The first sub unit has very fine to silty grain size while second

sub unit has silty grain size. There is disruption in the sub unit 1. The parallel lamination of sedimentary structure can be identified at the upper part of the bedding. in sub unit 2 the quartz vein can be observed abundantly where caused the parallel lamination diminished.

Figure 5.6: Outcrop at N 04° 57' 36.2", E 102° 05' 40"

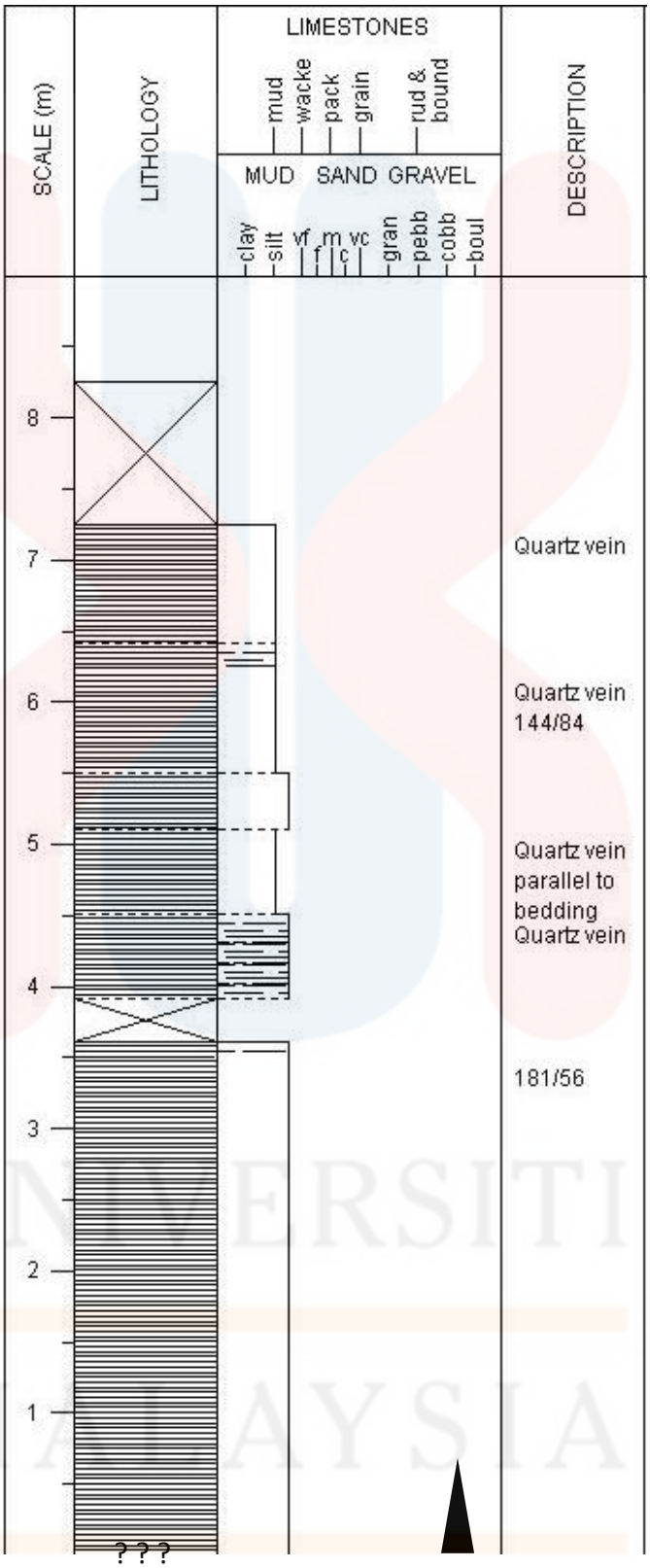


Figure 5.7: Sedimentary log at coordinate N 04° 57' 36.2", E 102° 05' 40"

b) Second sedimentary log

The sedimentary log taken at road side that near the river. Based on figure 5., the sedimentary log unit only classified to shale unit although it consists of slate and slightly of phyllite rock. This classification based on the characteristic of the unit of the metamorphic rocks where the sedimentary characteristic still can be observed

The first sub unit very fine grain. But there is also deposit of fine grain materials. The second part have fine grain sediment. The whole sedimentary log, the grain size is coarsening upward.

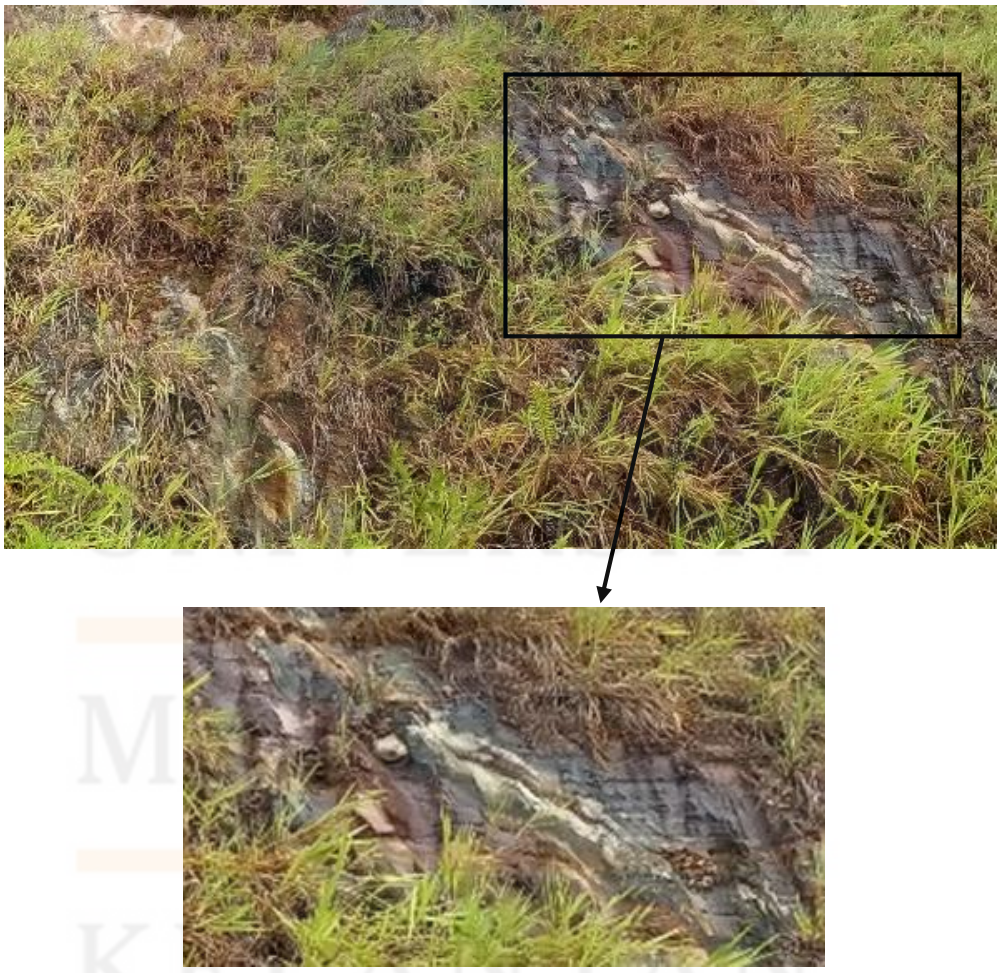


Figure 5.8: Outcrop N 04 57 36.2, E 102 05 40

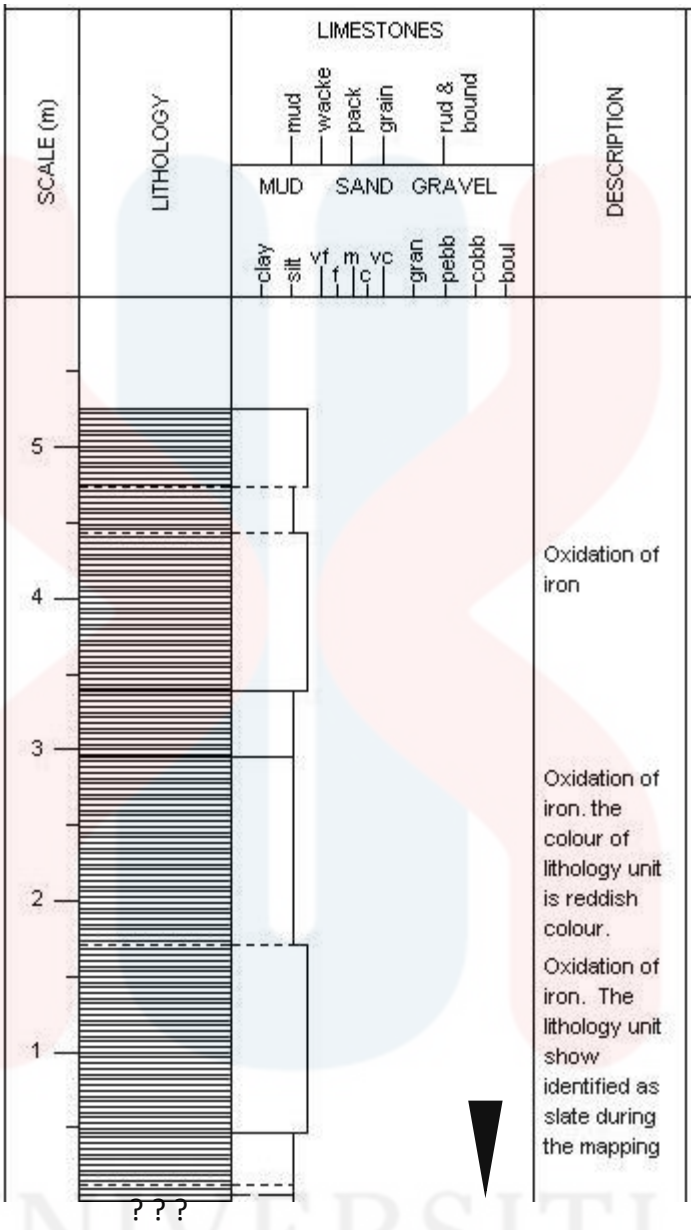


Figure 5.9: Second sedimentary log at N 04 57 36.2, E 102 05 40

Based on the grain size of sedimentary log 1 shows the grain size is fining upward while the sedimentary log 2 shows that the grain size can be conclude as coarsening downward. The difference in grain size shows that the area may experience the tidal process that involved transgression and regression during the past. The process of tidal commonly occur by the gravity influences. However, it also can be influenced of the climate where there is maximum transgression and regression occurred. According to Posamentier and Allen (1999) the maximum transgression occurred when the finest sediments reach the farthest landward. But the study area only influenced by the normal process of transgression and regression

Figure 5.10 is the example of model for the transgressive and regressive that can be related to the depositional environment of study area. Picture (a) shows the regression is occurred when the sea level decrease towards sea that cause coarse grain from the land filled the sea. Picture (b) transgression is where the sea level arises to the continental cause all the fine grain sediments from the sea filled the land and covered the coarse grain. Then it shows the grain is fining upward to the land. The zone x is considered as the area of the specification study conducted where the process of the transgression and regression occurred based on the grain size that had shown in figure 5.10.

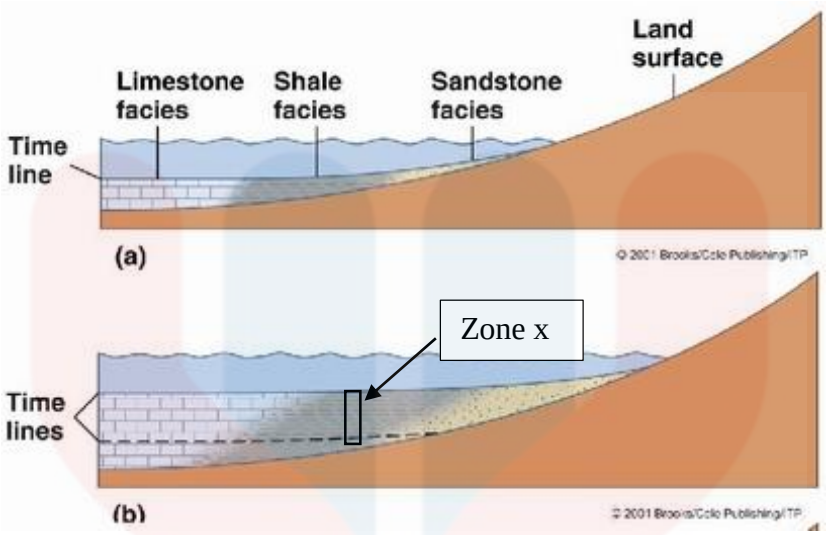


Figure 5.10: Model of transgression and regression

5.5 Conclusion

Base on the evidence that had had been discussed in 5.2, 5.3 and 5.4, the depositional environment is shallow marine. The range of the area is between the near shore and off shore which known as transitional area in the continental shelf. The evidences of the shallow marine depositional environment shown based on the parameters below like:

- The characteristic of the metasediment unit.
- The grain size of the unit based on lithology unit and grain size based on the sedimentary log conducted.
- Parallel lamination of sedimentary structure
- Seaward and landward transition based on the grain size

The unit found in study area is metasediments that consist of metashale, slate or phyllite that had been grouped as metasediment. Furthermore, the characteristic of the

lithology unit under microscope observation show the metasediment consist of fine grain of clay minerals and silty materials that indicate to the shale rock. The colour of the rock is grey and the grain size of unit ranges from silty to very fine based on the observation during the mapping. The horizontal lamination in figure 5.5 that had been found at the bedding of the outcrop can be evidence to determine the depositional environment of the specification location for the lithology unit. Then the sedimentary log that show the changes of the grain size that show the process of the transitional occurred. Yellow colour in figure 5.10 is the consideration zone of the study area based on the characteristic that had been discussed in this chapter

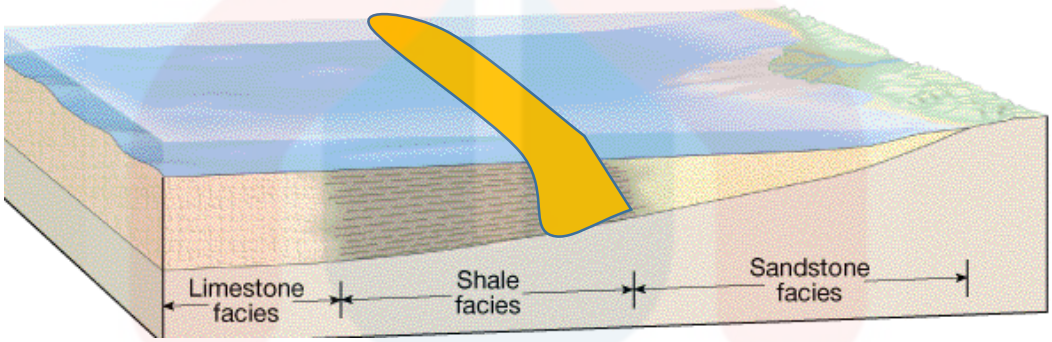


Figure 5.11: Zone depositional environment of study area

CHAPTER 6

CONCLUSION AND SUGGESTION

6.1 Conclusion

The main of the study is to produce the geological map with specific scale which is 1:25 000 and determined the depositional environment of metasediment in the study area. Based on chapter 4.3, the geological map consists of three main units such as metasediment that consist of metashale, slate and phyllite, volcanic rock and limestone. The oldest lithology unit is metasediment and the youngest is limestone. In addition, the new finding of acid extrusive of volcanic unit was determine during the geological mapping.

The depositional environment was analysed based on three main components which the type of lithology deposited, grain size, and sedimentary structure. The method used is more to lithostratigraphy where the sedimentary log is conducted during the mapping where the identification of the grain size at the outcrop had lead the process that influenced the sedimentary deposit. So, the depositional environment of metasediment of Taman Agropolitanis shallow marine at the transitional area of continental shelf.

6.2 Suggestion

In this study, the location conducting the sedientary log is very near to each other where it only has one unit of lithology which is metashale and limited changes of grain size. The suggestion for further study is to conduct the sedimentary log in difference location in the study area that consist difference lithology unit. So, that the correlation of the facies can be made in order to identify the depositional environment of the area. Then, used of suitable software to process data is important to make the data more attractive to read. Next, made some model of the depositional environment of the study area based on the collected data.

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