GEOLOGY AND KARST GEOMORPHOLOGY OF KAMPUNG KALA BARU, GUA MUSANG, KELANTAN

By

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APPROVAL

"I hereby declare that I have read this thesis and in my 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"

Signature :_____

Name of Supervisor :_____

Date :_____

DECLARATION

I declare that this thesis entitled “Geology and Karst Geomorphology of Kampung Kala Baru, Gua Musang, Kelantan” is the result of 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 degree.

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ABSTRACT

This study focused on Geological and Geomorphologic Mapping-based method to identify the karst formation/landforms. The study area located at Kampung Kala Baru, Gua Musang, Kelantan. The land of this area is mostly covered by karst limestone formation. The karst formation is one of the indicators of environmental history and landscape evolution. There is lack of study about karst geomorphology at Gua Musang. The karst landform of Kampung Kala Baru can give many advantages toward the economic development. The main purpose of this study is to update and produce a geological map, to identify karst formation/landform and to produce karst geomorphologic map of Kampung Kala Baru. The geological mapping was conducted to observe the geology in the study area. The study area is included in Gua Musang formation and consists of four types of lithologies; granite, limestone, tuff and metasediment. There are three types of karst formation/landforms has been found and identified at Kampung Kala Baru which are surface karsts, subsurface karsts and surficial landforms. Geomorphologic mapping was done with the help of satellite imagery to see the boundary of the karst. Field observation will help for further interpretation of the process and characteristics that own by the karst. Geomorphologic map were produced to show the karst formation/landform present in study area. Limestone karst is a unique landscape with attractive features and has their own type. The karst formation at Kampung Kala Baru has great potential use for geologist and other professional discipline since it offers diversified application such as cave tourism and hydrogeology.

ABSTRAK

Kajian ini memfokuskan kepada kaedah pemetaan geologi dan geomorfologi untuk mengenal pasti proses pembentukkan /rupa bentuk muka bumi karst. Kawasan kajian terletak di Kampung Kala Baru, Gua Musang, Kelantan. Tanah kawasan ini kebanyakannya diliputi oleh pembentukan batu kapur karst. Pembentukan karst ialah salah satu petunjuk kepada sejarah persekitaran and pengevolusian lanskap. Terdapat kekurangan kajian tentang geomorfologi karst di Gua Musang. Bentuk tanah karst Kampung Kala Baru dapat memberikan banyak kelebihan terhadap pembangunan ekonomi. Tujuan utama kajian ini adalah untuk memperbaharui peta geologi di kawasana kajian, mengenal pasti pembentukan/rupa bentuk muka bumi karst dan menghasilkan peta geomorphologi karst di Kampung Kala Baru. Pemetaan geologi dijalankan untuk memerhatikan geologi di kawasan kajian. Kawasan kajian termasuk dalam pembentukan Gua Musang dan terdiri daripada empat jenis litologi; granit, batu kapur, tuff dan metasediment. Terdapat tiga jenis pembentukan/rupa bentuk karts yang telah ditemui dan dikenal pasti di Kampung Kala Baru yang merupakan karst permukaan, karsts bawah permukaan dan bentuk tanah lancar. Pemetaan geomorfologi telah dilakukan dengan bantuan imejan satelit untuk melihat sempadan karst. Pemerhatian lapangan akan membantu penafsiran lanjut tentang proses dan ciri-ciri yang dimiliki oleh karst. Peta geomorfologi dihasilkan untuk menunjukkan pembentukan/bentuk muka bumi karst yang ada di kawasan kajian. Batu kapur karst adalah lanskap yang unik dengan ciri-ciri menarik dan mempunyai jenis mereka sendiri. Pembentukan karst di Kampung Kala Baru mempunyai potensi penggunaan yang besar untuk ahli geologi dan disiplin profesional lain kerana ia menawarkan aplikasi yang pelbagai seperti pelancongan gua dan hidrogeologi.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

etc.	al. and others
cm	centimetre
km	kilometer
m	meter
mm	millimeter
NE	North-East
SW	South-West
GPS	Global Positioning System

LIST OF SYMBOLS

“	Second
‘	Minute
°	Degree
°C	Temperature
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 General Background

Geology is the scientific study of the Earth which deals with its physical structure, the substance of the earth, their history, lithology of rock, physical properties and the processes which act on them. The area of Kampung Kala Baru, Gua Musang was chosen to do the research on the title "Geology and Karst Geomorphology of Kampung Kala Baru, Gua Musang". This study is to define and analyze the karst geomorphology that exists in the area. The idea to conduct this research is based on a reading of a few journal and articles on karst geomorphology formation. Apart from that, Gua Musang is a suitable place to conduct this research because it shows a unique karst geomorphology result from the dissolving action of water on soluble rock. In the geology aspect, there are a few things that need to study which is based on lithology, structural geology, topography, and geomorphology.

The investigation based on the general geology of Kampung Kala Baru must be done to obtain the data from the field and also laboratory data study is important to construct a map of 1:25000. The study area of this research is covered 25 km^2 and the geologic area of the study is bounded between longitude 101° 57' 8.68" to 101° 59' 48.92" and latitude 05° 0' 42.78" to 05° 03' 17.92". From the research at the study area, the lithology boundaries will be redefined and the road connection will be updated which can include on the map.

Geomorphology is defined as a study of the landform which includes its origin, evolution, shape and distribution throughout the physical landscape. Landforms are

produced by the erosion or deposition, as rock and sediment is worn away by these earth-surface processes and transported and deposited to different localities. The study of the geomorphology is divided into various geomorphologic processes. Examples of the geomorphologic process are fluvial, weathering, mass movement, glacial and geography. While the term karst applies to a type of landscape formed from the dissolution of soluble rocks. The types of rock include limestone, dolomite and gypsum which is characterized by sinkholes, caves and underground drainage systems.

Karst is characterized by the predominance of rock dissolution over mechanical erosion and is typical of present temperate weather it is cold or warm and tropical environments (Ford, 2007). Karst one of the type from the reaction of water-soluble bedrock. Karstification is produced through the process of weathering and erosion in the region of evaporates and carbonates rock. Mostly, karst is found in limestone by several factors which permeability or porosity, along with the fracture, joint and faults, bedding thickness and available relief (Stokes, 1999). There is a more prominent outcrop of limestone in the study area and it is formed the topography Karst, and easily recognizable. These rock units identified as Gua Musang Formation.

Throughout this study, it contributes to the extension of geological knowledge or future study on related geology topic, especially Karst Geomorphology study at Kampung Kala Baru, Gua Musang. It shows how the modern study can be utilized to infer the environment condition in the past.

1.2 Study Area

a. Location

Kelantan is one of the states in Malaysia. The biggest district in Kelantan is Gua Musang located in the southern part of Kelantan and encompassing an area of 8,177km^2. Gua Musang literally means "Cave of the Civet. The study area covered the area along Jalan Jelawang which located at Gua Musang district of Kelantan. Figure 1.1 shows the map of the study area. The study area has a dimension of 5km (width) x 5km (height), approximately 25km^2. The location of the study area is bounded between longitude 101° 57' 8.68" to 101° 59' 48.92" and latitude 05° 0' 42.78" to 05° 03' 17.92". The base map of the study area is shown in Figure 1.1.

The study area consists of the hilly area which mostly covered all the area. The area also consists of karst geomorphology and mostly covered by forest and a small part of the plantation. The highest elevation of the study area is 520 meters above sea level. The climate of this area is in a relatively warm and dry climate with seasonal drought. The area covered by tall dense tropical jungle. The climate is tropical and the weather pattern is influenced by the northeast and southwest monsoons tropical and the weather pattern is influenced by the northeast and southwest monsoons.

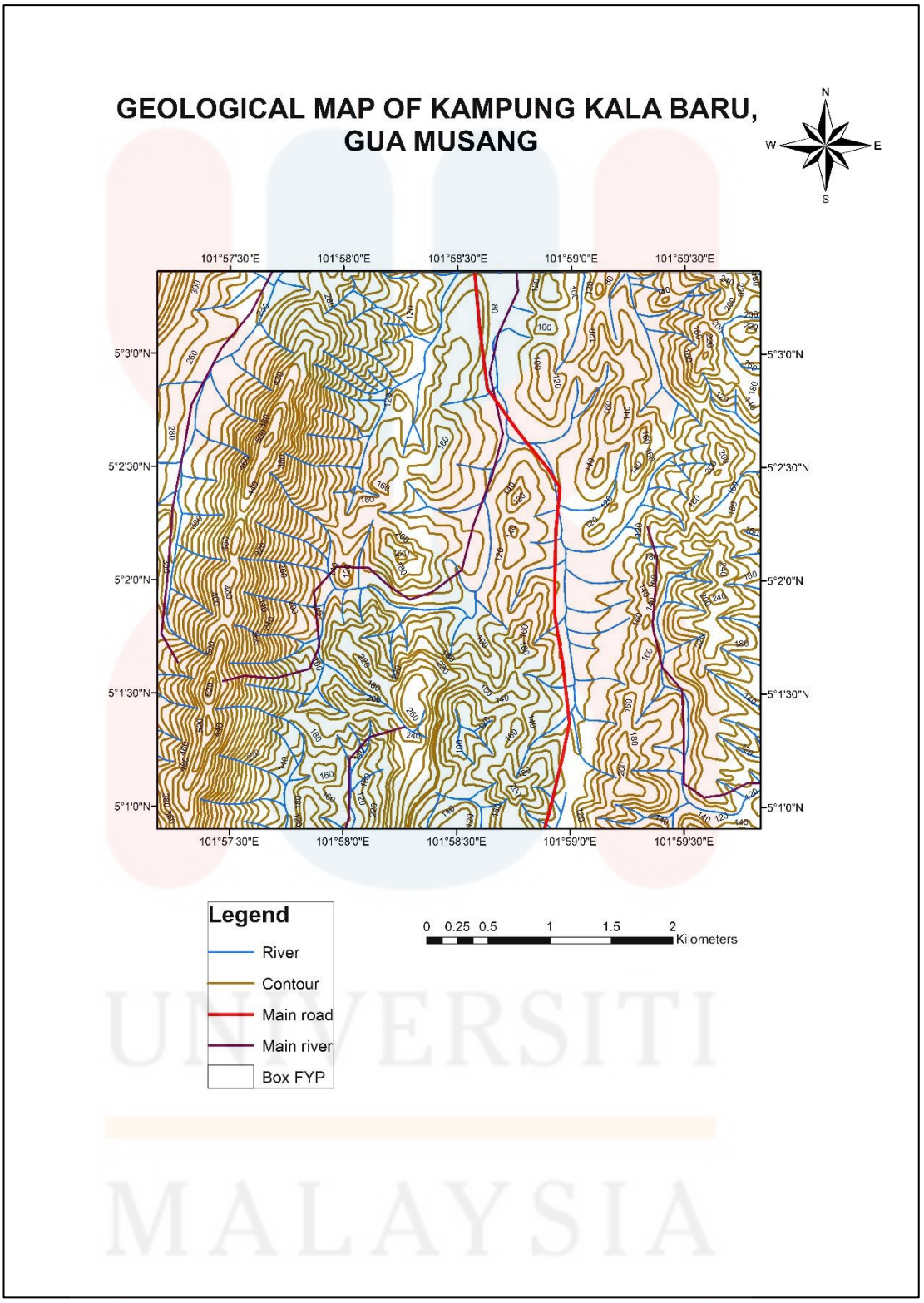


Figure 1.1: Geological map of Kampung Kala Baru, Gua Musang, Kelantan

b. People distribution

The distribution of people is a pattern in which and how people live in a particular area. Data related to people's distribution include race, gender, and primary income. The uneven distribution of people on Earth is caused by ethnicities in different places. The Kelantan population in July 2010 is about 1 539 601 people. Kelantan consists of 10 districts as shown in Table 1.1. According to the schedule, around 90 057 residents of Gua Musang in July 2010.

Table 1.1: The population of development in Kelantan

Source: Department of Statistic Malaysia (Web)

Name	Status	Population (2010-07-06)
Kelantan	State	1 539 601
Bachok	District	133 152
Gua Musang	District	90 057
Jeli	District	40 637
Kota Bharu	District	491 237
Kuala Krai	District	109 461
Machang	District	93 087
Pasir Mas	District	189 292
Pasir Puteh	District	117 383
Tanah Merah	District	121 319
Tumpat	District	153 976

Gua Musang district was populated approximately 76,655 people in the year 2000. The population was slightly increased in 2010 to 90,057 people. The percentage of average annual population growth rate was estimated at about 1.62% in 2000 until 2010. The total of Malay and other indigenous which is Bumiputera at Gua Musang is 76,823. While Chinese citizens are 3,870, Indian citizens are 350 and others citizens are 161 peoples. Figure 1.2 below shows the percentage of Bumiputera population at Gua Musang district.

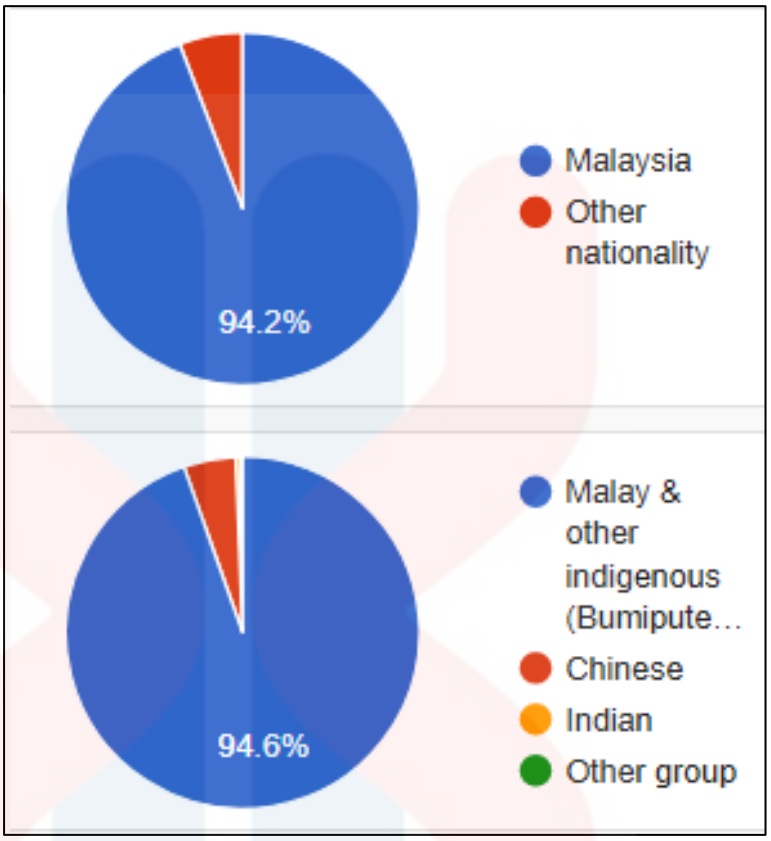


Figure 1.2: Chart of the percentage of the Bumiputera population, 2010 (City population Malaysia)

c. Rain distribution

Peninsular Malaysia is located on the equator line. Monsoon winds greatly affect the climate in this latitude. Monsoon season can occur seasonally due to the reversal of the semi-annual wind system. There are two types of monsoon season which are Northeast Monsoon and Western South Monsoon. The mid-season of the eastern monsoon season starts from November to February while the south-west monsoon season starts from May to September. Kelantan is usually heavily affected by the monsoon season especially the North East Monsoon season where rainfall is higher and can lead to major floods.

Table 1.2: Show the precipitation between the driest month and wettest month
© Climate-Data.org

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Average temperature (°C)	25.2	25.9	26.7	27	27.2	26.8	26.7	26.5	26.4	26.3	26.5	26.6
Minimum temperature (°C)	20.7	21.1	21.5	22	22.2	21.7	21.5	21.4	21.4	21.6	22.2	21.3
Maximum temperature (°C)	29.8	30.8	31.9	32.1	32.2	32	31.9	31.6	31.4	31	30.9	29.9
Average temperature (°F)	77.4	78.6	80.1	80.6	81.0	80.2	80.1	79.7	79.5	79.3	79.7	78.1
Minimum temperature (°F)	69.3	70.0	70.7	71.6	72.0	71.1	70.7	70.5	70.5	70.9	72.0	70.3
Maximum temperature (°F)	85.6	87.4	89.4	89.8	90.0	89.6	89.4	88.9	88.5	87.8	87.6	85.8
Precipitation/ rainfall (mm)	152	85	130	161	217	163	159	173	245	309	290	281

Based on Table 1.2 shows the precipitation between the driest month and the wettest month of Gua Musang district. Gua Musang has a tropical climate. The rainfall in Gua Musang is significant, with precipitation even during the driest month. Even though in the dry months but it still has rain. This climate is considered to be Af according to the Köppen-Geiger climate classification. The average annual temperature in Gua Musang is 26.4 ° C. In a year, the average of the rainfall is 2365 mm.

The total of rain distribution is higher from August to December. It happens because of the factor of Northeast Monsoon which brings the heavy rain at this month. While the driest month is in February, with 85 mm of rainfall. In October, the precipitation peak, with an average of 309 mm. The hottest month of the year is May,

with an average temperature of 27.2 ° C. At an average of 25.2 ° C, January is the coldest month of the year.

d. Road connection

Gua Musang is a district in Kelantan and can be accessed from all parts of Malaysia by train, car or bus. Universiti Malaysia Kelantan, Kampus Jeli is located about 110 km away from Gua Musang and accessible by car. The route to reach Gua Musang from Jeli is through Tanah Merah to Machang to Kuala Krai and finally Gua Musang.

The study area is located at Kampung Kala Baru, Gua Musang, Kelantan. It is easier to access the study area because it has only 1 main road which located in the between of the box. The main road of the study area is Jalan Jelawang connecting along Setelu, Gua Musang. From the city of Gua Musang, it takes about 28.2 km for 28 minutes to reach the Jalan Jelawang. The study area is bounded between longitude 101° 57’ 8.68” to 101° 59’ 48.92” and latitude 05° 0’ 42.78” to 05° 03’ 17.92”. Figure 1.3 shows the location of the study area along Jalan Jelawang, Gua Musang.

Figure 1.3: Location of the study area along Jalan Jelawang, Gua Musang (Google Earth Pro)

e. Landuse

Land use planning is an essential tool for pollution prevention and control. Land use is a category that focuses on different socioeconomic activities that take place in a particular area, the patterns of human behavior that they create, and their impact on the environment. The different place has different land use planning.

Like in Kampung Kala Baru, almost 70% of the area is covered with tropical forest and covered by karst limestone. There is only a small part of the study area are preserved from logging activity. Other remaining lands are used for plantation where rubber plants and oil palm are the main crops of Gua Musang. Plantation activity is run at lowlands and hillside area.

f. Social Economic

Social economics is the relationship between social behavior and economic activity of a particular place. Social economics is a very important aspect for places that need improvement in their daily lives. In the area of Kampung Kala Baru, the social economic activities that can be observed there are mostly involved with oil palm, rubber plants, and orchards. Mostly, the study area was covered by forest and plantation so the people around there are depending on the source of nature.

On the south part of Kampung Kala Baru, there is a Quarry which is Kuari Dinar Sdn. Bhd. was incorporated in 1989 which can help increase people's economy thereby emphasizing on the construction and premix manufacturing sectors through business diversification and expansion programs. Based on Figure 1.4 this quarry has increased the job opportunities for the villagers and increase their income.

Figure 1.4: Kuari Dinar Sdn. Bhd. Kampung Kala, Gua Musang
(Seri Barat Mixed Sdn Bhd.)

1.3 Problem Statement

Recently, there was no research study on geology that has been done in Kampung Kala Baru area. The data on geological survey collected from this study can be used for interpreted in detail on the geology aspect of the study area. There was no recent maps for the specific area in Kampung Kala Baru, Gua Musang itself because no geological mapping that has been done there before. The maps need to update which can be used to detect any changes in many aspects.

Various studies have been conducted in Gua Musang but those studies are more focuses on the stratigraphy, sedimentology and also paleontology of Gua Musang. There is a lack of study about karst geomorphology at Gua Musang that has not been interpreted yet. The karst landform of Kampung Kala Baru and its nearby can give

many advantages towards economic development in that particular place. The landform is not only good for agricultural only but also can give an advantage in the field of tourism and groundwater.

If there is no action taken to protect it from now, unique karst geomorphology in Gua Musang area may destroy and various ecosystems in karst may also destroy. Until now, limestone has not being classified on this area. The maps produce only show the distribution of limestone without showing in what types of karst the limestone belong.

1.4 Objective

- To update and produce the detailed geological map of the study area with scale 1:25000
- To identify karst/formation/landforms in the study area,
- To produce karst geomorphologic map of Kampung Kala Baru.

1.5 Scope of Study

This research covered the area of Kampung Kala Baru which located in Gua Musang district of Kelantan with a dimension of 5km (width) x 5km (height) which has an area of 25km^2. The location of the study area shows the coordinate which is bounded between longitude 101° 57’ 8.68” to 101° 59’ 48.92” and latitude 05° 0’ 42.78” to 05° 03’ 17.92”. The scope of this research is focused on the study of geological mapping and geomorphological mapping of the study area at Kampung Kala Baru, Gua Musang. The method used for geological mapping is done by traversing, while for geomorphological mapping was carried out by using GPS and Google Earth in a way to take data and observed the structure that has in the study area. This method generally achieved the objectives that have been stated which are

to update the geological map and to identifying the karst formation/landforms of the study area.

1.6 Significance of Study

This study is to produce a new and complete geological map of the study area. The geological map helps to provide the geological information of the study area such as structural geology, stratigraphy, and lithostratigraphy of the area. From the geological data, the geological map with a scale of 1:25000 was constructed. Next, this research also focuses on define the formation or landform of karst limestone in the study area. The types of karst can be classifying and the valuable karst that has potential in a site geo-tourism also will be identifying. Moreover, this study generates geological hazard assessment datasets for soluble rocks such as landslides, compressible ground and urban development planning such as sinkhole. This may help to avoid any geological hazard that might be happening in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature reviews are conducted to get information and research data from previous work, books, and journals which are related to the research in the study area. By studying the literature reviews, an early interpretation of purpose objectives can be achieved and give an early evaluation of the geological properties of the study area. The reviews of the study should be described, summarized and clarified the particular issue that is related to the research to provide informative knowledge, data, and the historical background of the study area.

2.2 Regional Geology and Tectonic Setting

Peninsular Malaysia which has a stable microcontinent or block with the W-dipping Philippine plate in the E and E-dipping subduction of Indo-Australian plate W and the S located in the southern part (Shub, 2009). According to (Metcalfe, 2011), Peninsula Malaysia is a part of the relatively stable continent of Eurasia plate (Sundaland) which represent low seismic activity. Before the Bukit Tinggi earthquakes, Peninsular Malaysia was experiencing only low seismic activity level tremors due to seismic waves generated by earthquakes (Shub, 2009). Geographically, Peninsular Malaysia has been categorized into three main tectonic belts which are West Belt, Central Belt, and East Belt. The division of the belt is depended primarily based on the geological and existence of rock distribution in the area. At the beginning of the Mesozoic Era, a large part of the newly-formed landmass of the Peninsula was uplifted and remained subaerially exposed (Abdullah, 1991).

The state of Kelantan located at the north-eastern corner of Peninsular Malaysia. It shares the boundaries with the west Perak, south of Pahang, east of Terengganu and it borders with Thailand to the north-west fronting the north of South China Sea. Kelantan covers a total of 14,922 sq. km of Malaysia and divided into ten administrative districts, which are Kota Bharu, Pasir Mas, Tumpat, Pasir Puteh, Bachok, Kuala Krai, Machang, Tanah Merah, Jeli and Gua Musang shown in Figure 2.1.

According to Kamal Roslan Mohamed (2006), southern Kelantan stratigraphically has been divided into four areas which are Kuala Betis, Gua Musang, Aring and Gunung Gagau. Only Gua Musang will be highlight through this research as the study area located here. Gua Musang formation has been named by Yin (1965) which the name encompassing an exposure of rock between the age of Middle Permian to the Upper Triassic (Mohd Shafeea Leman, 1993 and 2004). The formation of Gua Musang lies within the Central Belts of Bentong-Raub Suture and mainly subdivided into calcareous facies, argillaceous facies, arenaceous facies, volcanic facies, and metamorphic facies. Based on the Department of Minerals and Geosciences Malaysia (2003), Permian sedimentary rock occurs extensively on the eastern side of Kelantan which unconformable overlie the Lower Palaeozoic sequence in southwest Kelantan and grouped as Gua Musang Formation.

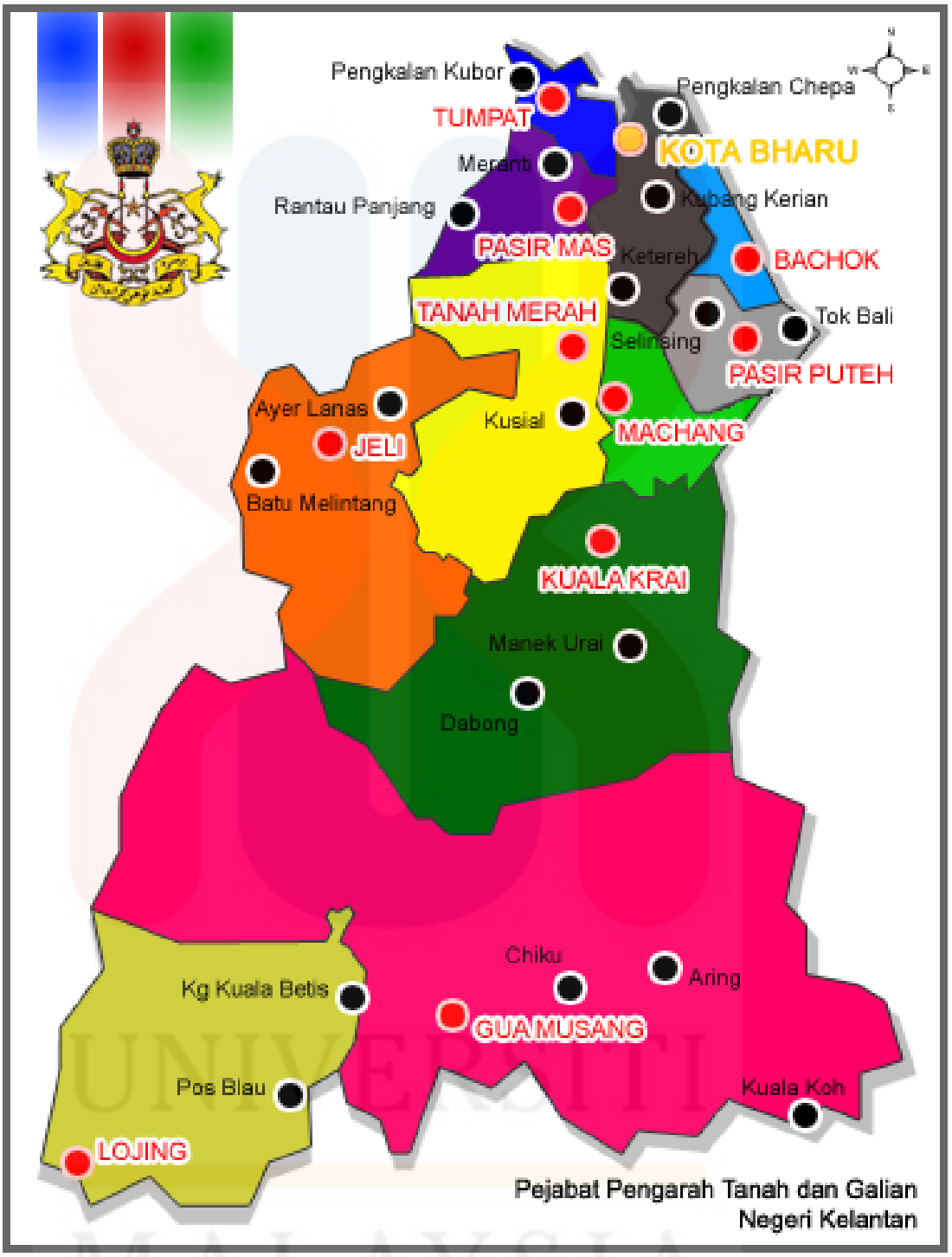


Figure 2.1: Map of Kelantan state
(The Official Portal Kelantan Director of Land and Mine Office, 2018)

2.3 Stratigraphy and Sedimentology

The proposed Gua Musang Group includes the current Gua Musang formation, Aring Formation, Telong formation, and Nilam marble (Mohamed, Joeharry, Leman, & Ali, 2016). The grouping of listed formations within the same group divides the new formations on the basis of lithologic units. Based on information compiled, stratigraphy of Kelantan built up by seven formations which are Aring Formation, Taku Schists, Gua Musang Formation, Telong Formation, Gunung Rabong Formation, Koh Formation, and Badong Conglomerate. Taku Schist and Aring Formation occur during the Paleozoic era, others are formed during the Mesozoic era.

The Gua Musang formation consists of a calcareous-argillaceous sequence of crystalline limestone with interbedded argillites and subordinate sandstones and volcanic. The sandstone includes greywacke, protoquartzites, and orthoquartzite but metaquartzite are the most common. The shales are usually grey but can vary to black when carbonaceous. The volcanic vary in composition from rhyolitic to andesitic and includes tuffs, lavas, and agglomerates. It is believed there tectonic activity before the Gua Musang Formation and cause the folding and uplifted of Paleozoic rock. In a late Carboniferous to Triassic age is indicated by the presence of fossils.

According to Yin (1965), Metcalfe (2000) and Shafeea Leman (1993) have listed that stratigraphy characteristics for Gua Musang Formation and the most important evidence are the discovery of the fossil. The different species of the fossils will explain the depositional environment and the lithology of the formation. Gua Musang Formation aged Middle Permian to Upper Triassic being proved by the presence of fossils.

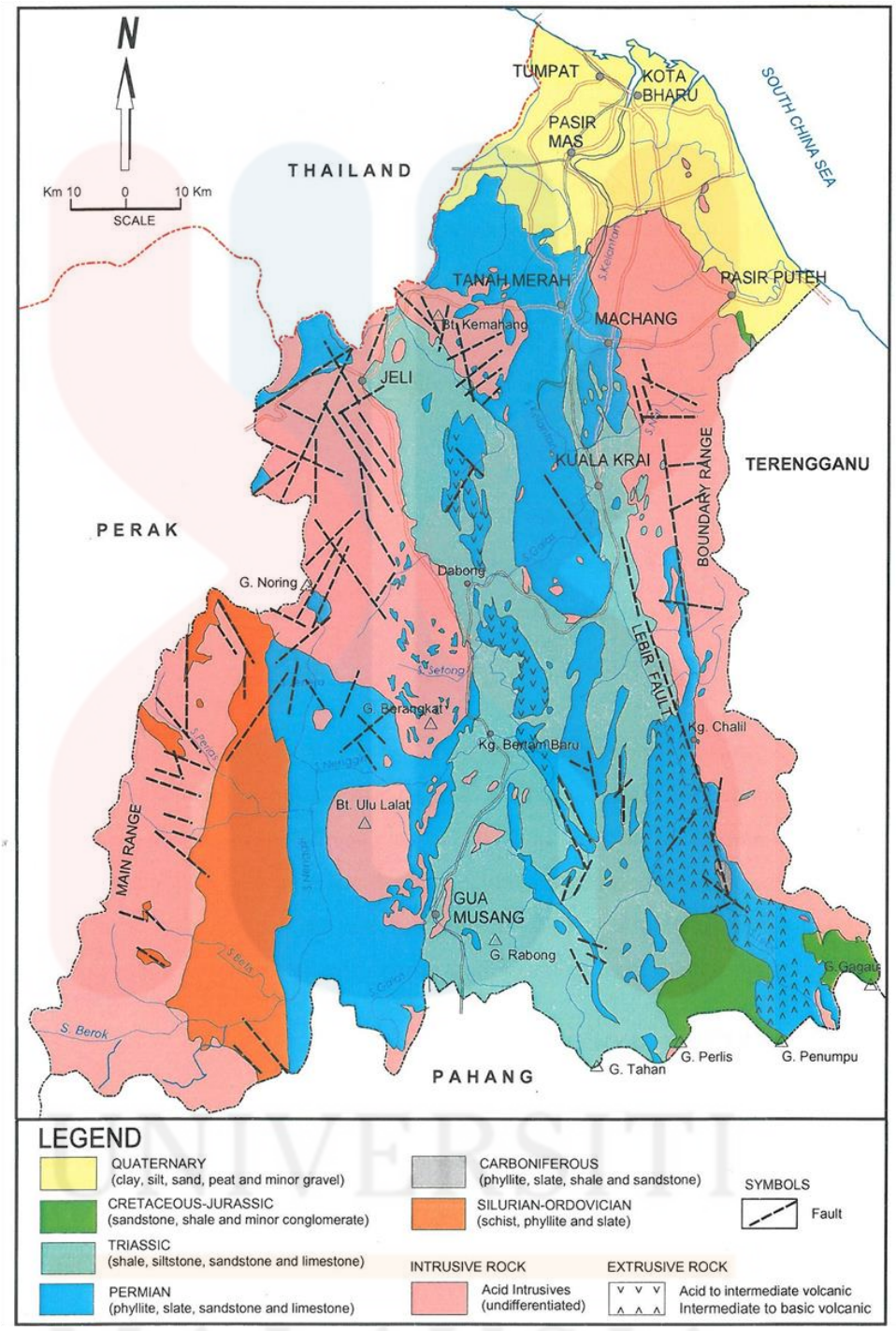


Figure 2.2: Geological Map of the Kelantan state
(Nazaruddin, Fadilah, & Zulkarnain, 2014)

Figure 2.2 above shows the geological map of Kelantan. Refer to the map shows that Kelantan consists of the age of Quartenary period, Cretaceous-Jurassic period, Triassic period, Permian period, Carboniferous period, and Silurian-Ordovician

period. The lithology of rock is consists of shale, limestone, sandstone, phyllite, and slate.

Nuraiteng Tee Abdullah (2009) wrote that the upper and lower boundaries of the formation are not exposed in the type area as she had written the sedimentology information in the book of Geology of Peninsular Malaysia. According to Aw (1974), the west of Gua Musang town in Kuala Betis are rocks similar to and identified as Gua Musang Formation that overlies conglomerate sandstone sequence comformably. Then, Nuraiteng Tee Abdullah (2009) explained about east part of Gua Musang Formation which sediment of Nilam Marble and Telong Formation are similar to the rock of Gua Musang.

Foo (1983) suggest that the Telong Formation is synonymous with Gua Musang Formation as the age of the depositional environment of Nilam marble are comparable to carbonate of Gua Musang Formation. According to Yin (1965), she discovered the calcareous rock to be the most intensive facies of Gua Musang Formation with widespread development in the Middle Permian and Triassic time.

2.4 Structural Geology

Rey (2004) defined structural geology as the characteristics of the structural deformation of geometry to describe the flow path by particles during the deformation of kinematics and to infer the direction and magnitude of forces involved in the driving deformation of dynamics. It is an essential geological feature in the Earth Science field. The variation in structural geology is mostly caused by the main factors such as the genesis of rock, scale, outcrop quality and the availability of heritage value in a structure as mentioned by Tajul Anuar Jamaluddin (2002).

According to Department of Mineral and Geoscience Malaysia, 2003, at least four tectonic activities occurred at the land mass of Peninsular Malaysia during Palaeozoic and Mesozoic era while the most prominent occurring is during the Triassic period. The main factors of this events are faulting and folding which have been observed as regional and localized structures.

Mustaffa Kamal Shuib, (1994c) wrote in the book of Geology of Peninsular Malaysia, along East-West highway and Cameron Highland-Gua Musang road, the thinly bedded chert overlies massive shale and this chert was deformed by bedding-parallel trusting and duplexing. Along the same road, he also wrote the bedded chert shows an isoclinals fold that had been refolded by the steep N-S reverse dextral fault. The main fold of Gua Musang Formation in the middle part towards north-south up to north-northwest – south-southeast. In the northern part of this main fold turned by granite intrusion and diorite pophire towards NE-SW (Geologi, 2010). While the main of fault in the Gua Musang Formation is a dextral fault and of sinistral fault.

2.5 Karst

Referring to the Provisional Draft of Gua Musang by Yin (1965), the research state that Gua Musang Formation comprises a thick succession of limestone and shale with subordinate pyroclastics and quartzites, representing deposition under a quiet neritic-shelf environment. While, based on the Hutchinson (2009), the Gua Musang formation is estimated to be 650 meters thick and made up of crystalline limestone, interbedded with thin beds of shale, tuff, chert nodules and subordinate sandstone and volcanic.

The limestone of Gua Musang Formation emerges to deposit on top of accretionary complex (Metcalfe, 2000). The main succession of this formation is

found on the western portion of the region. It is overlain by younger sediments on the central part and they form a synclinorium at the northeast part (Yin, 1965).

According to Jennings (1971), karst is defined as a terrain in which soluble rocks are altered above and below ground by dissolving action of water and that bears distinctive characteristics of relief and drainage. Karst landform development is closely associated with the hydrological cycle. As water passes into, flows through and emerges from karst terrain, the resulting landforms can be assigned to input or output roles. The principle of karstic landform development, the origin of caves and geomorphic, hydrologic and geochemical processes of karst have been researched a long time ago, since the 19^{th} century,

Karsts evolve in carbonate rocks and sometimes in evaporate rocks. Limestone is a sedimentary rock. Limestone and dolomite are a diverse group of rocks. Among the characteristics of limestone that experience karstification are lacking surface drainage, have a patchy and thin soil cover, containing many enclosed depressions and supporting a network of subterranean features include caves and grottoes. The limestone rock composed of calcite, $CaCo_3$ which form by inorganically or biochemical processes. There are many types of limestone with a variety of conditions under which it is produced. Dolomite contains at least 50% of calcium-magnesium carbonate (CaMg (CO3)2). Pure dolomite also called as dolostone that contains at least 90% dolomite.

Karst is divided into several types. According to Hugget (2007), karst is divided into two form which is surface karst form and subterranean karst form. Doline, polje, karren, urvala are the example of karst that appeared at surface karst form. While water subterranean karst form from stream sink into limestone flow through a karst drainage system. For example of subterranean karst, forms are caves and its features such as

flowstone, cave, popcorn, dripstones, and others. Figure 2.3 shows the schematic diagram of some karst features.

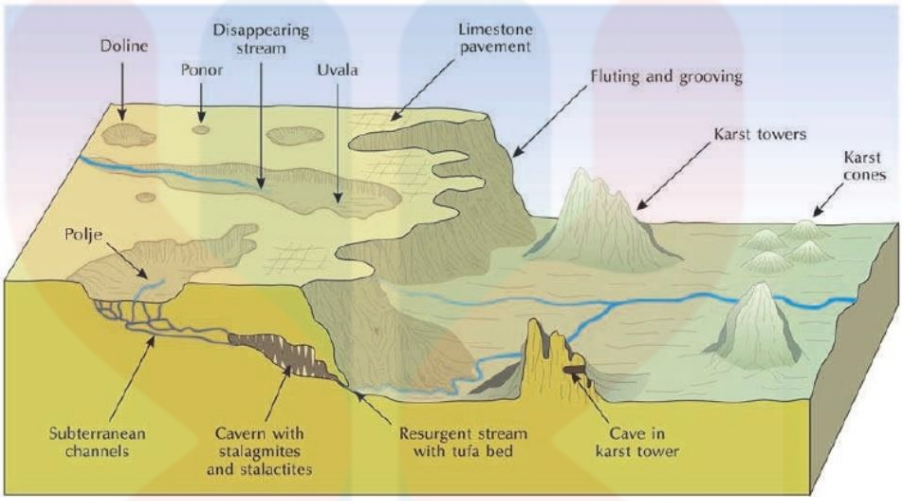


Figure 2.3: Schematic diagram of some karst features

(Huggett, 2007)

2.6 Historical geology

Hutchison (2007) states that the Central Belt of Peninsular Malaysia is extended from Kelantan to Johor with the Western part of the Central Belt are the upper Paleozoic rocks of the Gua Musang and Aring Formation in south Kelantan state and some Taku Schist at the east of Kelantan. The Gua Musang name came from the olden times as the discovered from the civets that can be found in the vast limestone. Gua Musang has a potential for urbanization and a fascinating with a recreational park for tourists destination. From his statement, today it was proven that the myth was enchanting the tourist from overseas and domestics to come and explore the thousands of cave at Gua Musang.

Gua Musang is a town or territory or is best known as a jajahan in Kelantan, Malaysia. The Central Belt of Peninsular Malaysia is extended from Kelantan to Johor with the Western part of the Central Belt are the upper Paleozoic rocks of the Gua

Musang and Aring Formation in south Kelantan state and some Taku Schist at the east of Kelantan. Gua Musang formation is limestone that forms a karst topography that is very easy to identify. There are a few formations that can be found in Gua Musang such as Gua Musang Formation, Aring Formation, Taku Schist Formation, Gunung Rabong Formation, and Telong Formation. Gua Musang is identified as a potential geosite for geological activities because of its unique formations and also its distributions of rock.

Gua Musang formation is estimated to be 650m thick and it is made up from crystalline limestone, interbedded with thin beds of shale, tuff, chert nodules, and subordinate sandstones and volcanic (Foo, 1983). Gua Musang Formation shows a variation of crystallization degree of limestone in different colours. The colour of the formation is from light to dark grey which indicates the carbonaceous material amount content. The structure of the limestone in Gua Musang formation can either be massive or with beddings. The abundance of different facies can be determined in Gua Musang formation such as wackestone, packstone and oolitic grainstone (Azhar, 1990).

2.7 Paleontology

In Gua Musang, there are a few places that are believed to have fossils. More than 35 fossils localities in Gua Musang which probably Triassic age have been found in the area (Aw, 1990). Some of the species were discovered from two outcrops belonging to Telong Formation which located within Felda Aring 5, Gua Musang. In Aring formation, the determination of the age was interpreted by the fossil localities that found in this area. Basir and Che Aziz Ali (1997) proved that there is Permian chert recorded in Pos Blau, Gua Musang which contains microfossils of a radiolarian. The estimated of the chert blocks cannot be properly as the lacking outcrops existed.

Based on the fossil found around the area of the research study, it is not impossible to have fossils at Kampung Kala Baru, Gua Musang.

A fossil is the trace of an ancient organism; died and been buried by sediment and will preserve in the sedimentary rock (E. W. Niels, 1987). Fossils are very important as the recorded for the ancient past life because in every type of sedimentary rock that contains fossil interpret as different geologic time. The best organism for correlation is the organisms that live independently in the environment. This research also focused on the depositional environment of the study area. From the fossil identification, the process of depositional environment that happened million years ago can be identified. Thus, the methods that can be referred to determine the environment is by interpreting the lithology and sediment properties of the formation.

2.8 Research Specification

This research is focused on "Geology and Karst Geomorphology of Kampung Kala Baru, Gua Musang, Kelantan. Gua Musang is believed to have a unique type of karst limestone. In Kelantan, Gua Musang is the best karst landscapes with the town are surrounded by limestone hills. By Yin (1965), Gua Musang formation has long been introduced to rocks around Gua Musang. Gua Musang Formation is not well understood and its development during the Permian-Triassic transition remains a problem. This study is a focus to identify the karst landform and formation of the study area. From the karst identification, the process of karstification environment and geomorphology of the karst that happened million years ago can be identified. Thus, the methods that can be referred to determine the environment is by observing using

the GPS in a way to take data and observed the structure, while satellite imagery method used to see the upper view of karst within the study area.

CHAPTER 3

MATERIALS AND METHODOLOGIES

3.1 Introduction

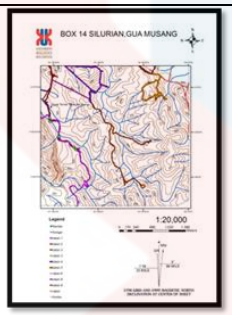
This chapter discussed the materials and methodology were used in conducting this research. The materials and method helped the students in providing the proper thought process and comprehension of the work given also help the rest of the process flows smoothly. The several stages of methods in this research were preliminary research, materials, field study, sampling, laboratory investigation, and data analysis. All the methods selected in this chapter were appropriate to fulfill the objectives of this research.

3.2 Materials/Equipment

Table 3.1: Equipment used for geological mapping.

EQUIPMENTS	FUNCTIONS
 GPS	It is used to locate the position, mapping lithology, tracking structures, measuring elevation, and saving the sampling point in the geological field mapping.
 HAMMER	Hammer is a basic tool for any geologists as it is used to collect samples. It is used for breaking rocks for fresh samples. Hammer also can be used as a scale.

 COMPASS	The function of the compass was to show the magnetic pole to the north direction and also for the purpose of dip and strike reading.
 HCL	HCL was used to determine whether the rock or mineral has a reaction or HCL has produced a bubble of carbon dioxide gas on the surface of the rock.
 HAND LENS	Used to examine tiny materials of rocks, sediment, soil, sand, and materials.
 PLASTIC SAMPLE	Used to store samples that were collected within the study area.
 MEASURING TAPE	The measuring tape is important for taking actual measurements of lithology and structures. It is used to measure the thickness of bedding and scale of outcrops in the field.

 POLARISED MICROSCOPE	Used to examine the minerals that are present in the rock.
 TOPOGRAPHIC MAP	The map is very important as a reference for geological fieldwork. To know the detail about the place or location.
 NOTEBOOK AND PENCIL	Field notebook and pencil used to jot down all the data and information that we got from the mapping field.
 CAMERA	It is essential to use a digital camera in geological mapping. It is used to capture the geomorphology, outcrops or any geological features that present in the study area.

3.3 Methodology

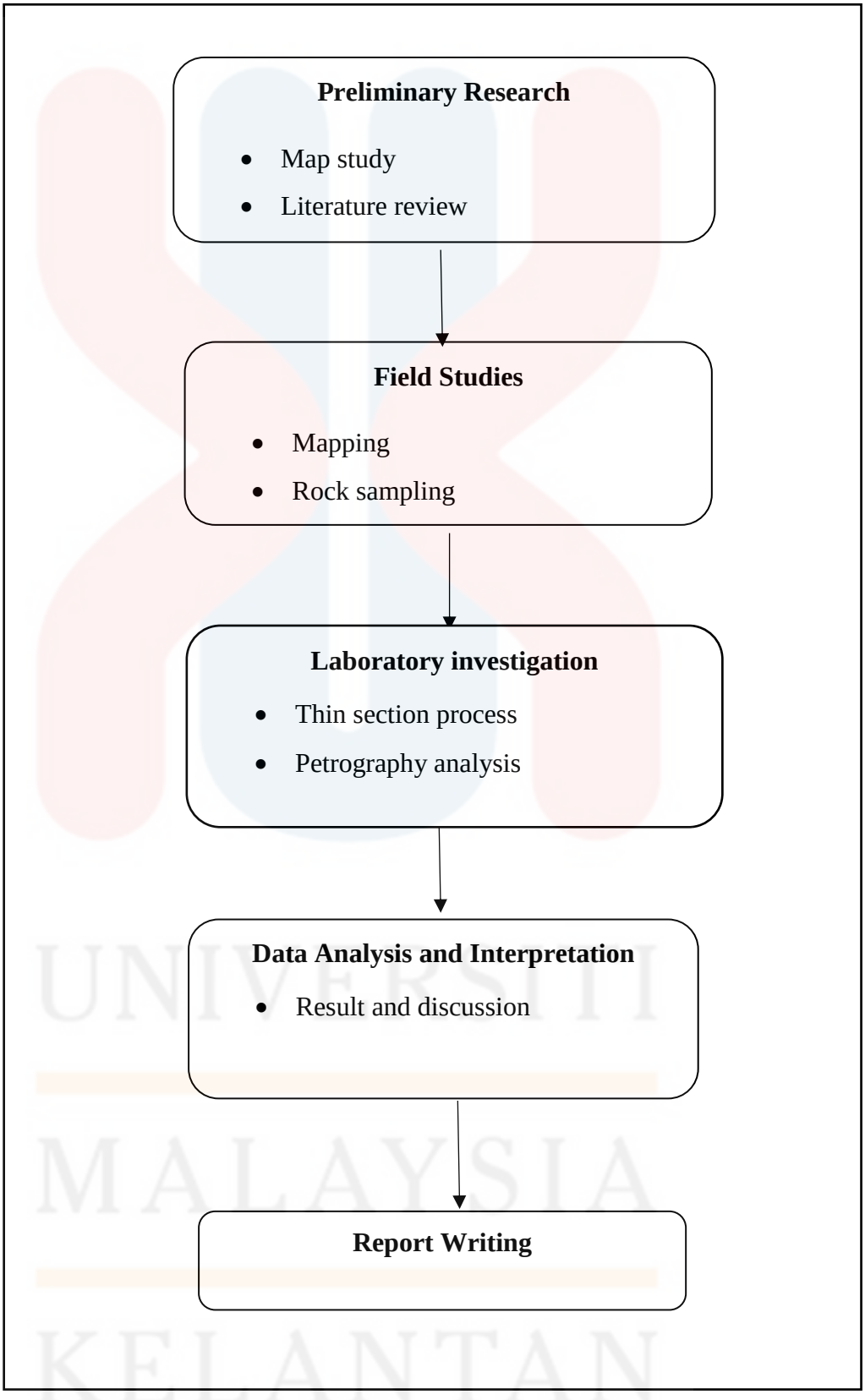


Figure 3.1: Research flow chart

3.3.1 Preliminary studies

Preliminary research is an initial step that is important to describe the prior work relevant to the proposal project. It was done before the detailed research carried out. Preliminary studies are important as establishing the experience and competence of the applicant to pursue the proposed research project and to provide support for the study hypothesis and research design. Before research is being set up, a preliminary study was done to get access and high knowledge of the study area, it's geological setting, drainage, morphology, and geological features. The data and information can do in a journal, thesis and previous report.

Apart from that, the preliminary research based on Google Maps is to get the satellite view of the recent condition of the study area. This can be the additional data to be added up to in making of the base map. The base map is used to give a concept image on the environment of the study area. In preparation to produce a base map, ARC GIS 10 will be used for inserting the layers of digital data.

3.3.2 Field Studies

The field studies aim to know and to find out more detailed about the study area. During the field study, general geological mapping of the study area will be observed carefully. The observation will include the lithology, geomorphology, structural geology, sedimentology and also stratigraphy for the outcrop being on the site of the study area.

In the data collection method, field study needs to perform which require fieldwork to the project site. This is the most important part of the research method as

it will give all the information required before an analysis will be done. To obtain a good analysis of result, good data collection will be the most important.

There a studies been carried out on karst geomorphology of Kampung Kala Baru, Gua Musang using Geographic Information System (GIS). GIS techniques are the proven efficient tools to produce karst geomorphologic map of the study area. GIS technique also can be used to identify the landform of the study area.

a) Geological Field Mapping

Geological field mapping comprises of different stages in order to get the results of research data. Survey of the area must be done to find out the geomorphological data of the study area. Next is to observe and take note of the entire visible outcrop within the study area. After surveying the study area, all readings of structures must be taken to be used in data interpretation for further discussion and as a result of the research. The readings that need to be recorded are strike and dip of beddings, fault, fold and also cracking of rocks. The data is then used in rose diagram software that enables the determination of force direction that forms the structures.

Rock mapping was carried out in order to gather the information of different types of rock within the study area. The method used for rock mapping is by traversing the whole study area with a size of 25 km^2. Mapping activities were carried out for sampling purpose where the sample was taken from outcrops encountered within the study area. Other than that, stream sediments samples were also taken to fulfill the specification of the research. There is 3 importance that

needs to be done in geological mapping which are geomorphological analysis, structural analysis, and lithostratigraphy analysis.

i. Geomorphology analysis

This analysis discovers the nature and origin of landforms for the study area. It concerned with the process that creates the shape of the earth's crust. Thus the landform of the area needs to be observed such as topography, drainage system, weathering process, mass wasting, and hillslope. The erosion and depositional of sediments were the factors that affect the shape of the landform where it was being transported and deposited at different localities creating a new landscape.

Geomorphological mapping is carried out by doing observation and identification of karst landform/formation in the field. GIS software also used to help the interpretation from Google Earth and Google Maps. The karst/landform/identified in the study area such as surface karst, subsurface karst, and surficial landform. GPS used to as tools to provide reading such as of the latitude and longitude of Earth.

ii. Structural analysis

Structural analysis is important to study the distribution of three-dimensional rock units and their relationship to deformational history. Moreover, it is also gain knowledge of the stress that resulted from strain and geometrics. Structural geology is a tool used by the geologist to understand the history of deformation from understanding and interpreting displacements, strains and rates through stresses, pressures, and temperatures.

iii. Lithostratigraphy analysis

Lithostratigraphy is the most fundamental kind of stratigraphic studies which composed of recognition, subdivision, and correlation of sedimentary rocks on the basis of their lithology. The lithology and stratigraphic relation need to be observed to interpret the lithostratigraphy analysis. There were three indicators used to consider this analysis. They were lithology, sedimentary structure, and presence of fossils.

b) Sampling

The random sampling method was being used during the geological mapping because rock samples were taken with the discovery of outcrops. Samples are taken at unevenly spaced intervals determined by random. More than 10 different localities of the sampling will be done to make the data interpretation more accurate. A geology hammer is used to break the outcrop into fragment rocks with a dimension of roughly. The samples were kept in the plastic sample and labeled with location taken.

The purpose of rock sampling is to do a thin section for petrography analysis and also for the fossils content. Several of rock samples were needed to prove varies composition. The sample of rock and fossils has been analyzed and interpreted in the laboratory.

3.3.2 Laboratory work

After the sampling process was done, the laboratory work will be performed later. Rock sample of each outcrop location was taken and brought to the laboratory for thin section preparation. In order to identify the content of minerals in rock

samples, a method of thin slices was performed for analysis under polarized microscopy. Petrography analysis was done in order to get the percentage of minerals contained in rocks and classify rock type. Besides, an accurate step of doing a thin section must be obeyed carefully in order to get an effective result.

a) Petrography Thin Section

Laboratory investigation is required in the study of petrography in order to study the properties of the rocks. The thin section is a laboratory preparation of sample use with a polarizing microscope. The minerals in the sample of rock were determined under the thin section process through a petrographic microscope and the name of the lithology will be determined. For microscopy study, it will more focus on the petrography study, microfossil in thin section, microfossil picking under microscope and microfossil identification.

The steps involved in the preparation of this section are sectioning, vacuum, impregnation, grinding, cementing, re-sectioning, grinding and polishing. First, the rock samples were segmented by using a diamond saw with the dimension of 1cm x 3cm. One side of the rock sample is polished to the desired thickness. Next, the polished rock attached to a glass slide with a dimension of 1cm x 4cm and left dried. Then, washed the sample and is left again to dry. With aid of Canada balsam, the surface of the sample is covered by thin glass and an air bubble is avoided from being trapped. Lastly, excess cement is removed by using methyl spirit.

3.3.3 Data analysis and interpretation

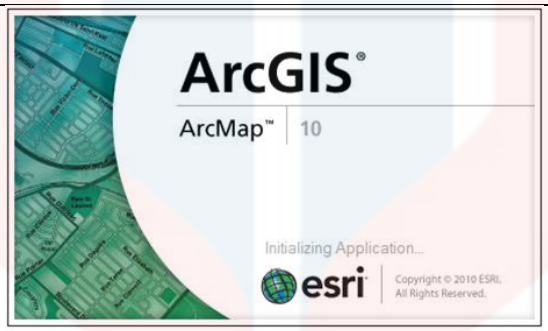
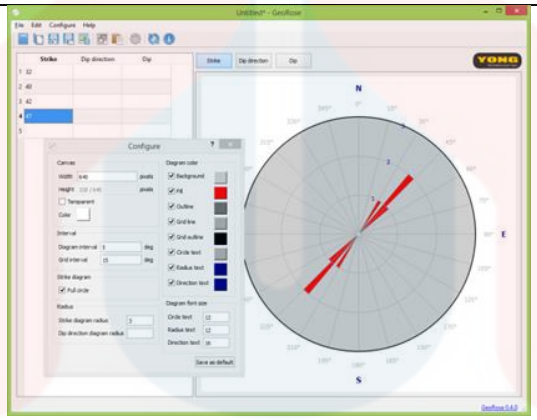
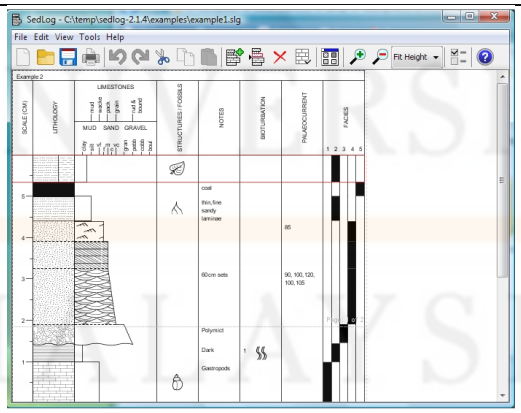
In all part, all the data gathered from both field studies and laboratory study is analyzed carefully to obtain precise interpretations. The data collected before can be managed systematically by grouping them according to the necessary task. This step makes the analysis process easier. The accuracy of the data collected is really important as it is used in the discussion and conclusion of this research. This interpretation should be related to the petrography analysis of the research area. The data are divided into two categories which are petrographic analysis and fossil identification.

Petrography analysis and interpretation were determined the detail information on the mineral content and the textural relationship within the rock. A complete analysis and investigation will be done on all rock sample. A detailed analysis was done using the petrographic microscope in order to observe the mineral content and texture in the thin section of the rock sample.

Data analyses and interpretation are done by using GIS software. GIS is designed to retrieve, manage, store, display and analyze all the types of geographical and spatial data. The data is transferred to GIS software and GPS which analyzed digital data in the form of digital maps and satellite images. The tool has been used to generate data and develop river drainage basin management strategies.

3.3.4 Software

Table 3.2: Software used for interpretation result

SOFTWARE	PICTURE	FUNCTION
ArcGIS		A software that used to create, edit, analyze and share information to build a map. It can use to produce different types of maps.
GeoRose		A software of rose diagram and stereonet plotting program which can plot structural geology rose diagram, equal area, and equal angle stereonet diagram. In the field, GeoRose is used to measure and identify the joint orientation.
SedLog		SedLog is a multi-platform software to generate graphic sediment logs. This is an easy way to make lithology of rock.

CHAPTER 4

GEOLOGY OF KAMPUNG KALA BARU, GUA MUSANG

4.1 Introduction

a. Brief Content

In this chapter, the geography and geology of the study area will be discussed. Geography is the study of the physical feature of a particular place and the relationship between the environment and the people distributed. The geography is described by the accessibility, settlement, and forestry of the study area.

The study area is good for agricultural activity as the land is used and covered by plantation and forest reserve. Majority of the plantation is covered by oil palm plantation and rubber plantation. Since the area is cultivated with the vegetation and forest reserve, the accessibility of the area is quite challenging. The South Kelantan Development Authority (KESEDAR) and the Federal Land Development Authority (FELDA) are two main agencies that develop land schemes in the district of Gua Musang. In the study area, it is not widely distributed in social economic since it is not a developed the town. But, some of the people living in the area working as the KESEDAR and FELDA workers and officers. Some of them also own a small business to complete the population's basic needs.

For the geology part, this chapter is basically discussing the general geology of the study area which is located at Kampung Kala Baru, Gua Musang in Kelantan state. It deals with the study of geomorphology, stratigraphy and structural geology of the study area. Geomorphology of the study area mostly covered by mountainous and hilly area which depends on the contour elevation of the study area. Next, lithostratigraphy is stratigraphic elements related to the description and nomenclature of the Earth's

rocks based on their lithology and their stratigraphic relationships. Last but not least, structural geology is the study of the geological structure of the earth and tectonic forces that formed upon it. The geological structures such as fault, folding and joint are the common types that can be found.

b. Accessibility

There is only a paved road available which is the main road located in the middle part in the base map of the study area. This main road in figure 4.1 is connected along Jalan Jelawang to Jeli and known as Jalanraya Jeli-Gua Musang. It is connected between Kampung Baru Star and Kampung Kala Baru. This road acts as the important main road to access other parts from the western and southern part of the study area.

In the plantation area, mostly the road is an unpaved road or gravel road which is used by the agency of plantation's workers for working. As for this type of road in figure 4.2, it is not suitable for the residents to use in every day as it is for plantation workers with lorries and four-wheel drive. It is required the Hilux car or motorcycle for ease the work along this road. In the deeper area, the unpaved road getting lesser, walking is needed to traverse the place that is impossible to get in by the Hilux car or motorcycle.

Figure 4.1: The main road of the study area known as Jalanraya Jeli-Gua Musang

Figure 4.2: An unpaved road in the plantation area

c. Settlement

The is a small village, known as Kampung Kala Baru located at the south of the study area. The majority of the villagers are made up of Malays with less than 10% of them are Chinese and Indian. Most of them involved in agriculture work in plantation agency as officers, staffs, workers, and drivers. Others than that, work in a small business like food stalls and grocery shops. They live in peace as a kampung-style house. Most of the families live there, the males are working to make a living while females are doing house chores and taking care of their children.

d. Forestry (vegetation)

The study area is covered by oil palm plantation, rubber plantation, banana plantation and forest reserve. Both oil plant and rubber tree plantation are managed by KESEDAR. There are a small of the banana plantation which only manages by a small company and also the residents around the area.

In oil palm plantation, most of the outcrop that found in this area are weathered into the soil. The rubber tree plantation is dominated at the western part of my study area while the other parts are distributed by oil palm plantation and reserved forest. The forest reserved is known as Hutan Simpan Sungai Terah and Hutan Simpan Nenggiri. It is dominated at the eastern part of the study area. Hutan Simpan Sungai Terah is matured which covered by thick forest.

The most dominant of the land use of the study area is forest reserved, followed by oil palm plantation, rubber tree plantation and least vegetation of banana plantation. Figure 4.3, 4.4 and 4.5 show the plantation area that is developed in the study area.

Figure 4.3: Rubber tree plantation

Figure 4.4: Oil palm plantation

Figure 4.5: Banana plantation

e. Traverse and observations

Traverse planning is done before going to the field by interpretation of remote sensing image. There is only a paved road available in the study area which plays an important role to access other parts of the study area. The method of traverse has been done by using Hilux car, motorcycle and by walking. Figure 4.6 shows the main road that has been used by the residents in the study area by using Google Earth Pro.

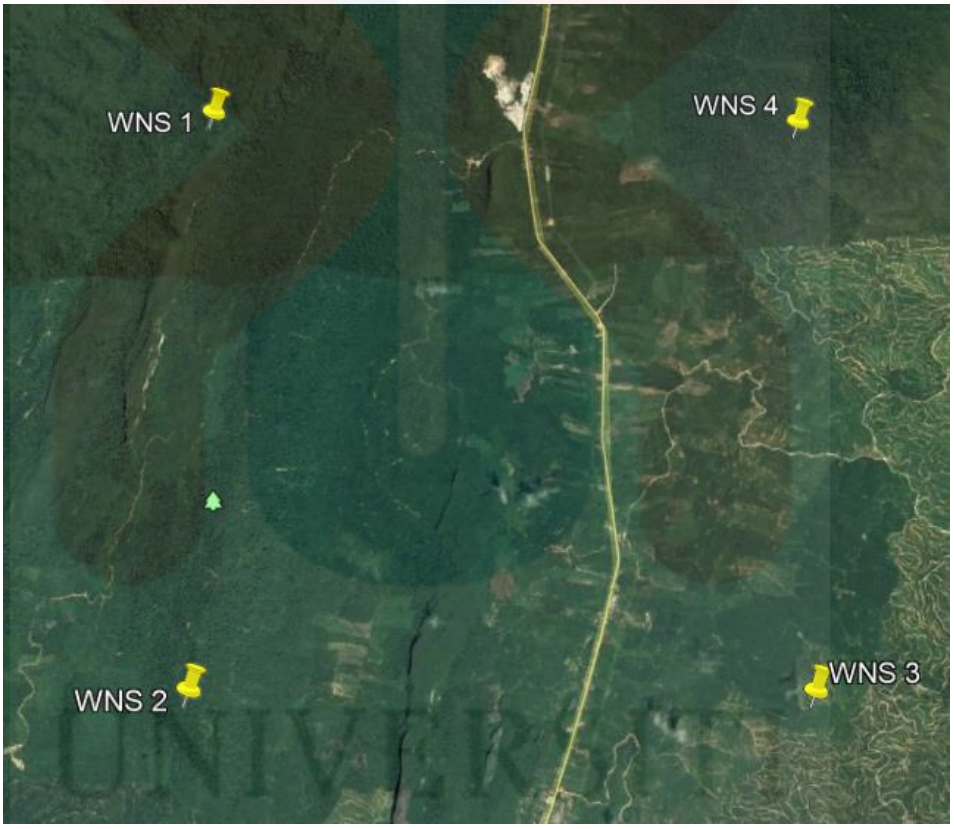


Figure 4.6: The only available paved road in the study area.

(Google Earth Pro)

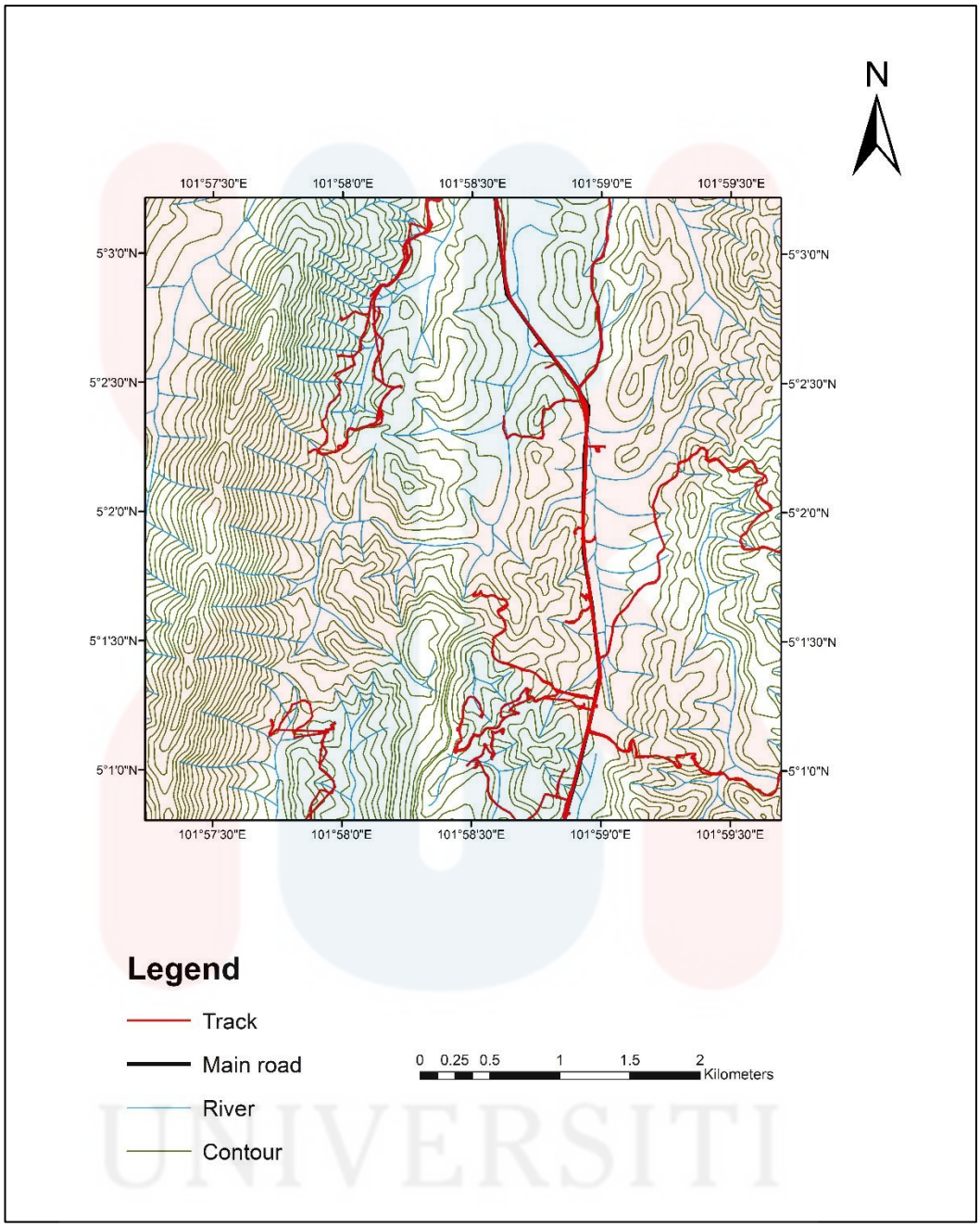


Figure 4.7: Path of traversing in the study area

4.2 Geomorphology

Geomorphology deals with the nature and origin of landforms or a landscape of the earth's surface and its geological processes. It describes the relationship of the landform with the geological properties of an area. It was created by the processes of weathering and erosion that occur in the atmosphere and hydrosphere. This process continually shape the earth's surface and generate the sediments that circulate in the Rock Cycle.

Geomorphological analysis of the study area is analysed and interpreted based on the outcrop found on topography map and satellite image. This subtopic discussed about three main aspects of geomorphology which are topography, drainage pattern system and weathering process of Kampung Kala Baru, Gua Musang.

4.2.1 Topography

The topography is a detailed characteristic of shape and features of the study area. It represents the detail general information of particular area includes mountain, hill, valleys and also the man-made area. The purpose of topography is to determine the position of any feature on earth to the coordinate system of longitude, latitude and also altitude.

Topographical features in Peninsular Malaysia specifically inland are rolling to undulating, hilly to mountainous. It is distinguished by the mean of elevation to represent the area whether low lying, rolling, undulating, hilly and mountainous.

Table 4.1: Topographic unit based on mean elevation (adopted from Geology of Peninsular Malaysia)

Topographic unit	Mean elevation (m above the sea level)
Low lying	Less than 15 m
Rolling	16 to 30 m
Undulating	31 to 75 m
Hilly	76 to 300 m
Mountainous	More than 301 m

It can be seen that the study area does not have a lot of social features such as town, facilities, and roads. This area is covered mostly by forest and a small portion of oil palm plantation, rubber tree plantation and banana plantation. There is only one population area known as Kampung Kala Baru near the sandy non-tree cultivation area which covered the very small area. The study area mostly covered by limestones rock.

Based on the topographic map of Kampung Kala Baru, the topographic unit of the study area can be divided into the hilly and mountainous unit. The distance between the contour line can be observed from the map to distinguish topographic unit in the study area.

The hilly area covers 70% of the study area in the middle and east part. The range elevation of the hilly area is 80 to 300 meters above sea level. It is a lower elevation than a mountain and has a gentle slope. Part of the hilly area is a flat and area which are composed of hard and soft rock. Based on figure 4.8, the rock that distributed the show in this area is more susceptible to weathering and erosion. The examples of rocks are volcanic rock, sedimentary rock, and metasedimentary rock.

Figure 4. 8: Hilly geomorphic unit in the study area

Besides, the mountainous topography unit composed of topography units with more than 301 meters above sea level and the highest elevation is 540 meters in the study area. The contour interval is smaller than the hills, showing that has a steeper slope. The rock distributed in this area is hard rock with high resistance to the weathering process. The igneous rock is common in the mountainous area. Figure 4.9 shows the mountainous hill in the study area.

Figure 4.9: Mountainous Geomorphic unit in the study area

Other than that, Karst hill is one of the important landforms in the study area to be observed. Karst is an area of land formations created by eroding and dissolving portions of limestone or other soluble rock layers above or below the ground. Dissolving soluble rock can take place above and below the ground to create formations and changes in the landscape. Above ground, formations may be weathered

and shaped by wind, rain, waves, and running water, as well as freeze-thaw erosion. Where water collects on the surface, potholes in exposed rock layers can be formed by bacteria, fungi, and algae that remove silica from rock minerals.

Soluble rock layers below the ground can be exposed to running water and collapse to form sinkholes and other changes in the landscape. Karst is where several or more of these changes occur in the same location to alter the appearance of the land. Figure 4.10 shows one of the karst hills that available in the area.

Figure 4.10: Karst landform in the study area

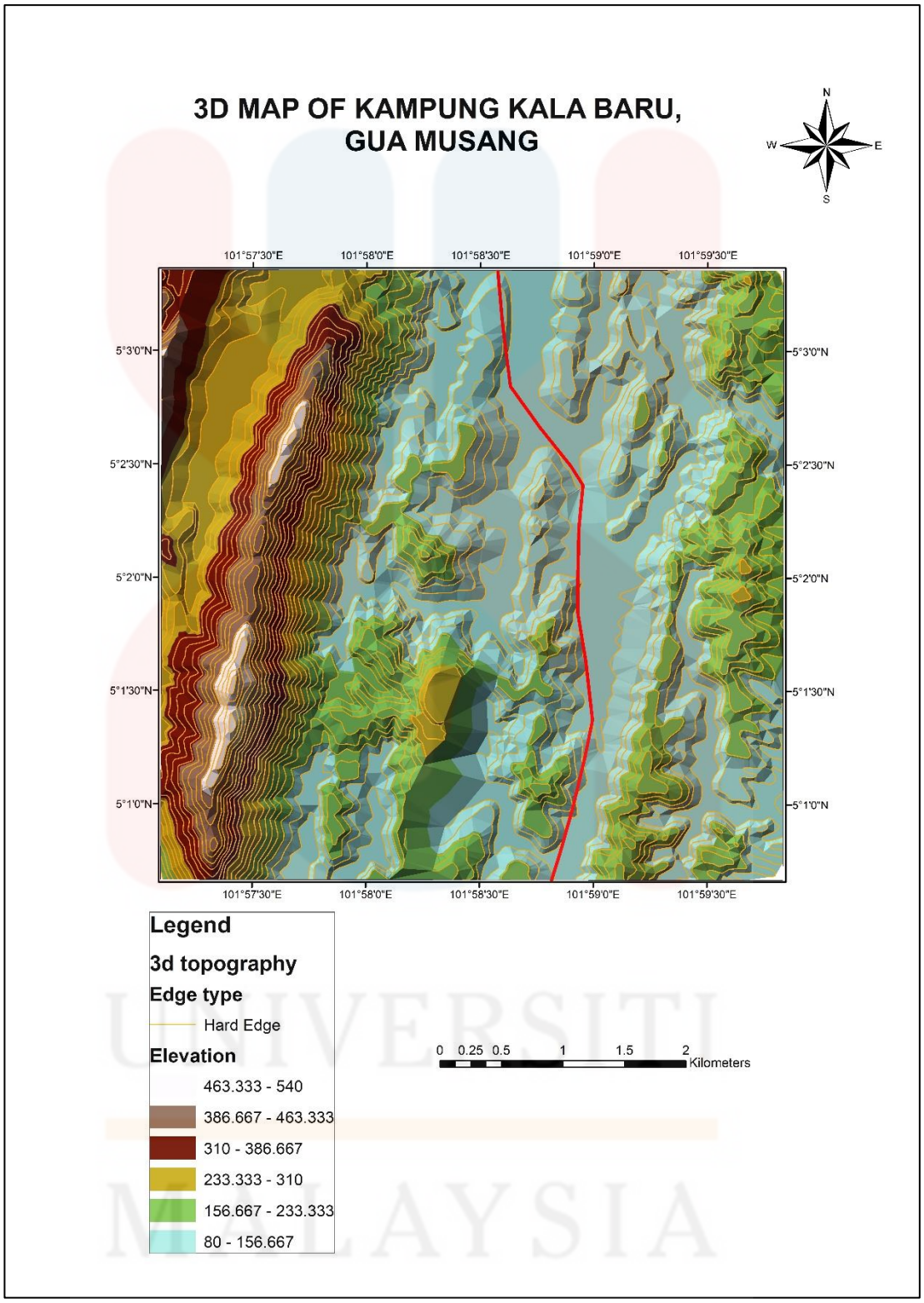


Figure 4.11: Topographic Map of Kampung Kala Baru.

4.2.2 Drainage system

Drainage is the water flow on the earth's surface. The drainage pattern is a river, streams or lakes that was formed due to the geologic structure adjustment governed by the topography of an area which is either covered by hard or soft rock. Drainage pattern presents a weak zone that allowed water flows to penetrate in.

The factor that influences the formation of drainage pattern is the slope of the land, the nature of soil and rock, rainfall distribution, weathering process, and human activities. It developed when the surface runoff is enhanced and the material of the earth has low resistance to erosion. The pattern of drainage depends on the elevation and rocks that made the surface of the area. They are also classified from the form and texture. The texture of the river is depending on the soil infiltration and the amount of water available before soaking into the surface. They are a few common of drainage pattern has been discovered as shown below.

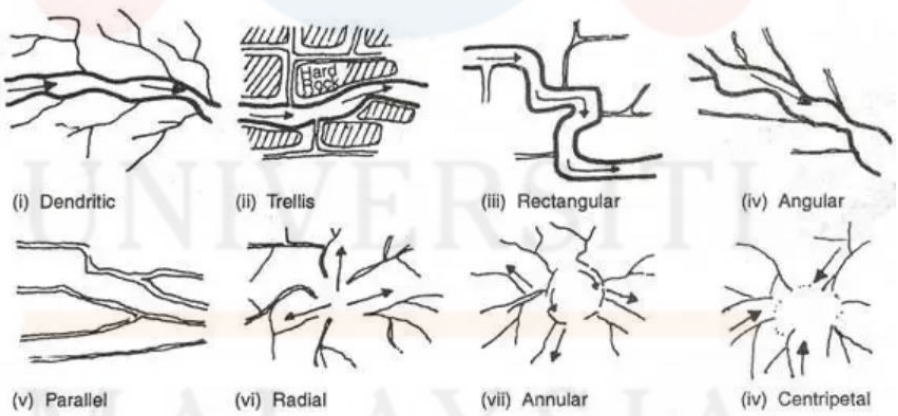


Figure 4.12: This figure shows the type f drainage pattern

Source: www.quora.com

Based on the study area, the drainage system is dependent on the small river as there is no main river in this area. The drainage pattern that can be seen on the map below in Figure 4.13 is a dendritic and parallel pattern. Most of the rivers in the study

area are parallel and subparallel. This pattern is known to have its river to flow downslope. The parallel is the type of drainage pattern that caused steep slope with some relief. Due to the steep slope, the streams are swift and straight with few tributaries and flow in the same direction as shown on the map. The pattern also implied that the river flow is controlled by gradient and there is a lack of structural interference (C. R. Twidale, 2004).

Other than that, the dendritic pattern of the river also covered in the study area. The elevation of the study affects the pattern of rivers as the water moves downslope of terrain. The shape of the river is influenced by earth topography of the study area which is made up of high elevation and some flat area. The dendritic pattern that implies the river is developed on a land surface where the rocks on it are uniform resistance to erosion. The map in figure 4.13 is the drainage map in the study area.

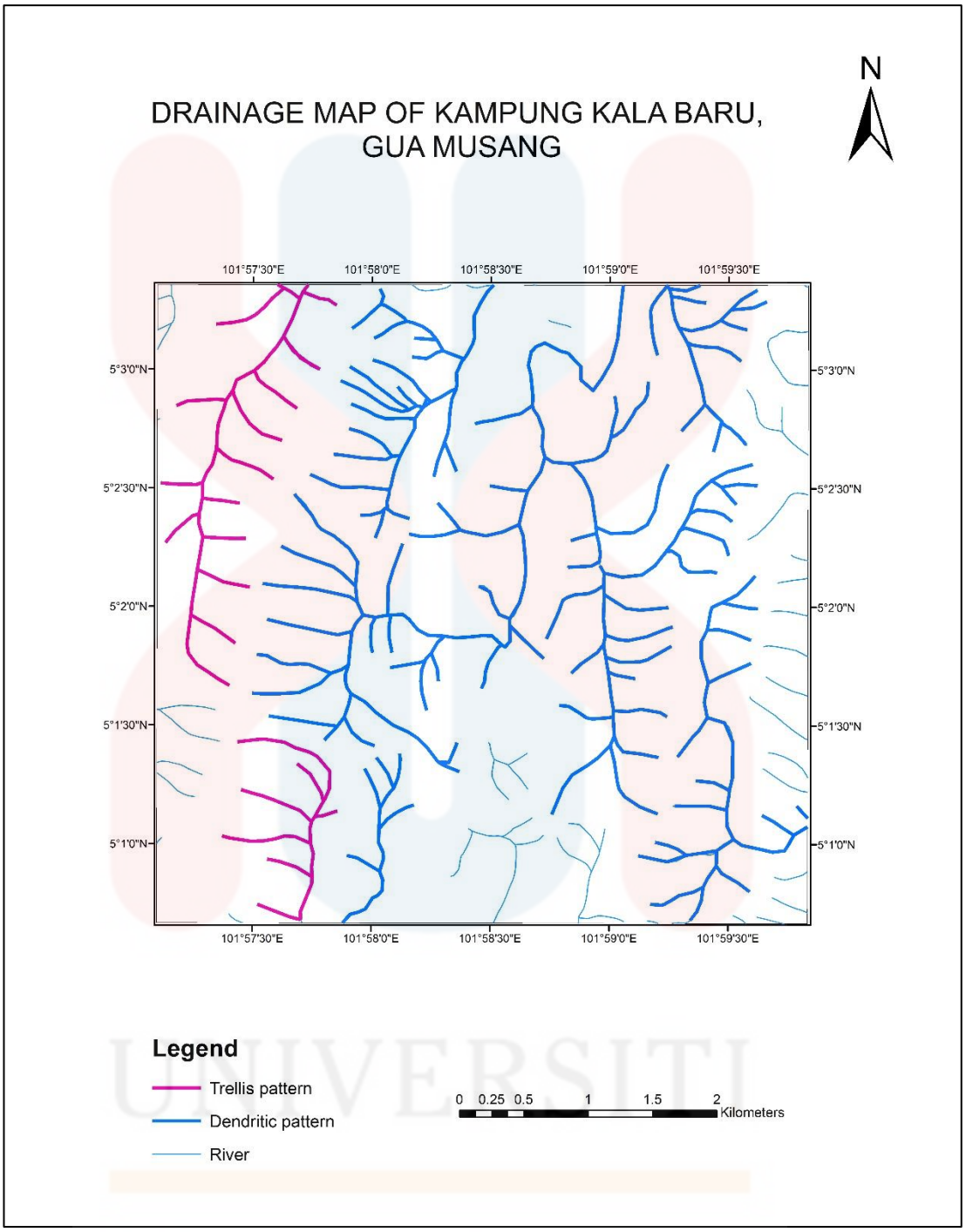


Figure 4.13: Drainage map shows the drainage pattern exist in the study area

4.2.3 Weathering process

Weathering is a slow and long process of breaking down of large outcrop into small rocks. It is an alteration of physical and chemical rocks and minerals at or near the Earth's surface that exposed to climate into products that are more in equilibrium with the conditions found in this environment. Weathering is an important factor that designing the shape of the earth which cause to produce unique landforms, forming new mineral in soluble rock and disintegrated rock into soil and others. Weathering can be either in the way of physically, chemically and biologically.

Physical weathering

Physical weathering is the mechanical process that causes the breaking of rock decomposition without changing its chemical composition dominated in cold and dry climates. They change rocks from hard state to become much softer and weaker thus making it more easily eroded. It results in mechanical disruption of rocks. In the study area, weathering factors are influenced by rock structures, rock contents, climate, and vegetation. The continual changing of temperature during the day and night caused the rock to expand and contract constantly and eventually loosen from the outcrop which can be seen from figure 4.41 below.

Figure 4.14: The physical weathering caused the rock fractured

Chemical weathering

Chemical weathering is a process of mineral decayed caused by rainwater react with the mineral grain in the rock to form new minerals. The chemical weathering of the study area was caused by the activity of water. The participation added to the river increases the acidity of the stream as the carbon dioxide gas combined with the rain before the rain enters the river. The increase of acidity in the flowing river enhanced the dissolution of the soluble rocks such as limestone. Figure 4.15 is the chemical process that occurs in the limestone rock.

Figure 4.15: Chemical weathering caused the dissolution of soluble limestone

Biological weathering.

Biological weathering is involving the disintegration of rock and mineral due to the chemical or physical agents of an organism which range from bacteria to plant to animal. The roots of bushes or trees that grow from cracks in the rock will push open the crack thus cause it to disintegrate just like in the figure 4.16. The growing roots in the rock exert stress and pressure to the rock. In this study area, the root grows release chemical on the limestone outcrop which causes the rock to have cracked and easy to break down.

Figure 4.16: Biological weathering by vegetation

4.3 Lithostratigraphy

Lithostratigraphy is a part of stratigraphy that study of rock layer and strata which are formed of the deposition process of ancient sediments. It is a fundamental kind of stratigraphic study by recognition, subdivision, and correlation of sedimentary rocks on the basis of lithology. Lithology involves with the correlation of the rock units with the physical contrast of composition, features, mineralogy, grain size and sedimentary structures. While the lithostratigraphic unit is defined by its lithology characteristic and stratigraphic relations.

By Yin (1965), Gua Musang Formation has long been introduced to rocks around Gua Musang. Gua Musang Formation is not well understood and its

development during the Permian-Triassic transition remains a problem. Evidence given below in table 4.2 shows Gua Musang Formation consists of several units or different limestone facies.

Table 4.2: Sequence Stratigraphic Formation of Gua Musang by Yin (1965)

Time	Lithology
Middle Triassic	Limestone, shale, volcanic rock.
Early Triassic	Argillaceous limestone, shale, volcanic rock.
Late Permian	Shale, siltstone rock
Middle Permian	Limestone with some shale rock.

Based on Table 4.2, the oldest rock age in range middle Permian period that is limestone. Then during the period of late Permian, Shale starts to develop. In a period of Triassic, the development of limestone, shale, and tuff begin. Any loose sediment and clay that found at river and stream area are in the age of Quaternary deposit.

The study area divided into four units which are classified based on its dominant lithology of a few outcrops found in the study area. The lithology of the study area is interesting as it composed of various rocks such as volcanic, igneous, sedimentary and metasedimentary rock. The most common rock in the study area is limestone as it is distributed ubiquitously.

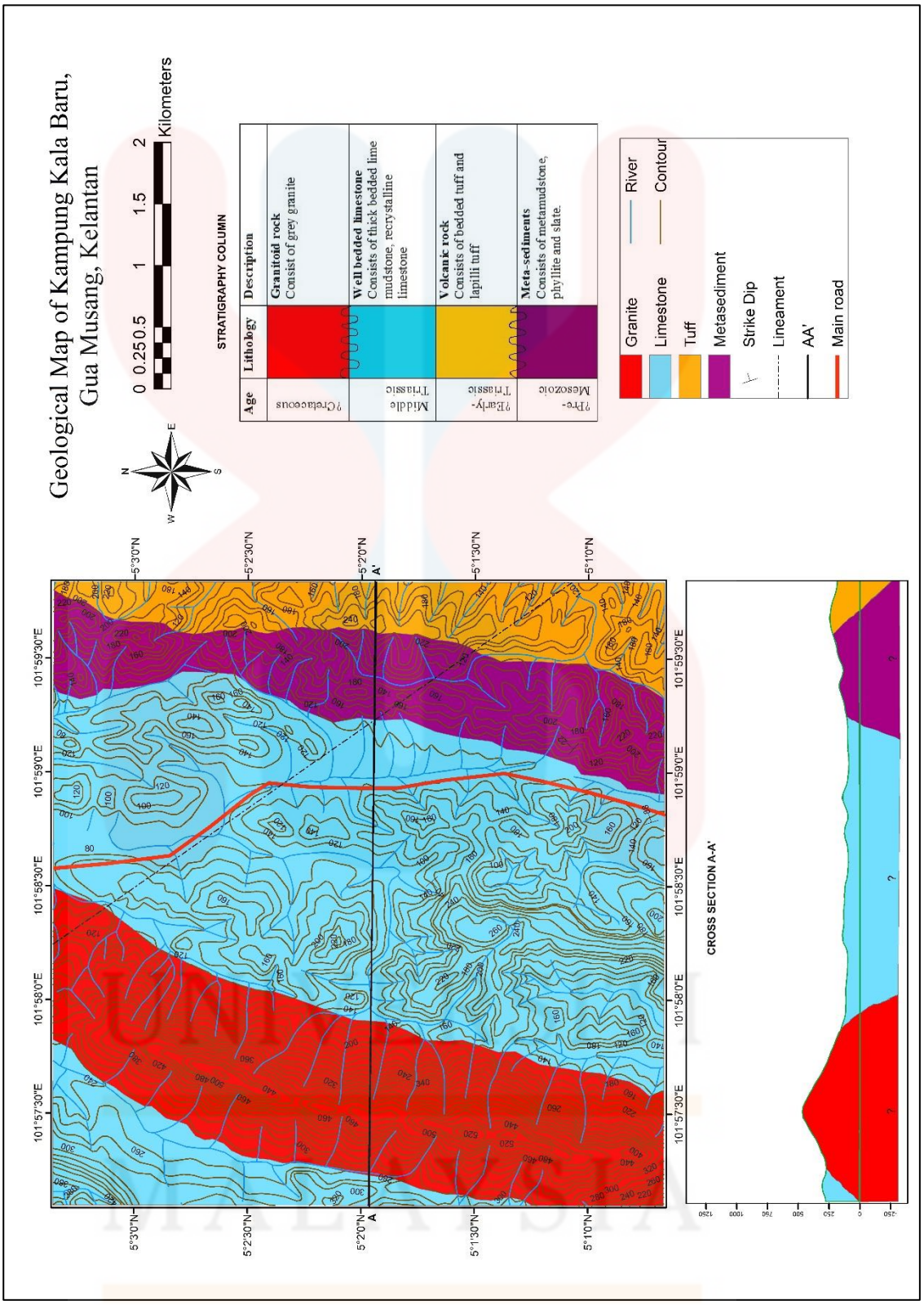


Figure 4.17: The Geological Map of Kampung Kala Baru with a cross section

a. Granite unit

The youngest rock in the study area is granite rock and believed as an intrusion result. This rock can be found at the western part of the study area. Most of the granite found are boulder size like in figure 4.18 which is believe had been transported from the nearest granite hills as seen in the Figure. The texture of the granite is phaneritic which is medium to a coarse-grained size that can be observed directly by naked eyes. It is a grey granite and the colour of the outcrop appears with the major of light grey, minor of black and light orange in colour. The colour occurrence indicated that the granite has come from the felsic type that has higher both silica contain and concentration of felsic minerals. During the sampling taken, the sample is really hard to handle since it is still a fresh state and the mineral composition interlocking compacted with each other. The sample of rock taken in figure 4.19 is very compact and heavy. It is hard to handle because the rock is still fresh.

Figure 4.18: Boulders of granite rock

Figure 4.19: Hand sample granite rock

In the aspect of the mineral composition, the granite rock is built up major with quartz contribution between 10 to 50% of felsic components and alkali feldspar with 65 to 90% of the total feldspar content. In the thin section of granite rock, the biotite that found was in brown colour under the cross-polarized microscope with moderate relief and euhedral grains and potassium feldspar consist of micro line. The figure 4.20 below is different between XPL and PPL thin section of granite rock.

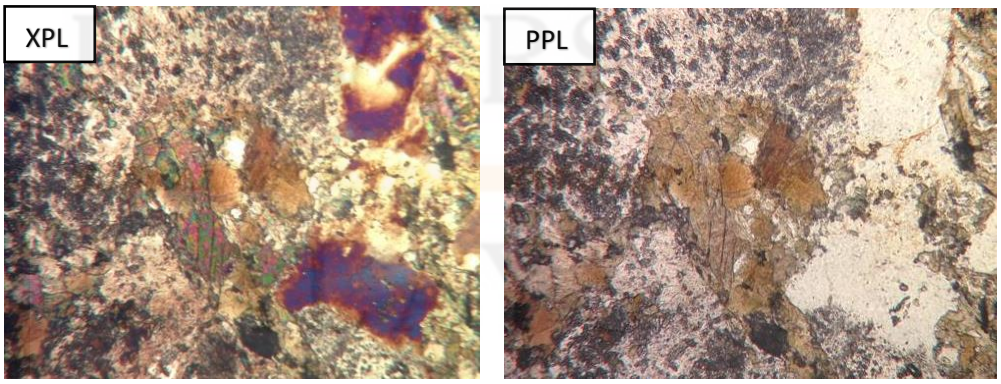


Figure 4.20 Thin section of Granite rock

b. Limestone unit

Most of the study area is covered with limestone rock. The limestone outcrop forming a huge cavity which forms a small cave inside it by a solution with rainwater of stream exist in paleoenvironments. The limestone is a build up mostly by the mineral of calcite. It is proven by applying the hydrochloric acid (HCL) on the outcrop and it will have a react vigourously. The limestone in figure 4.15 is light grey to slightly white in colour and most of them are recrystallized and turn to marbleized limestone. The limestone consists of the compact and grainy surface which is difficult to handle the sample because it is hard enough. Based on the outcrop in figure 4.21, the bedding shows coarsening upward which means that the coarser grain limestone is younger. According to the previous study, this limestone unit consists of Permian age which is similar to Gua Musang Formation.

Figure 4.21: Limestone outcrop

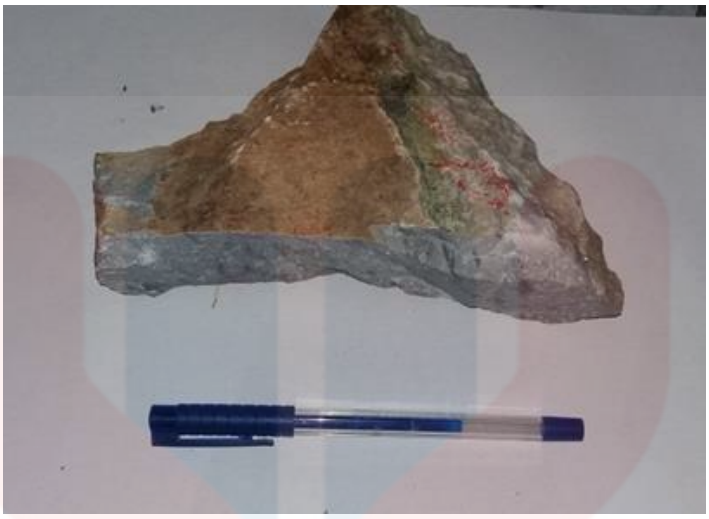


Figure 4.22: Hand sample of limestone

The thin section of a limestone sample collected at the locality of 101 58’ 48.0”E and 05 00’ 43.7”N. The thin section in figure 4.23 shows that the limestone is a framework and grained supported. There is a very thin layer of mud hence it is not supported because the grains size is highly compacted to each other. The grain sizes have an average of about 0.4 millimeters. The shape of the grains exists in both angular and rounded shape in an equal amount. In term of mineral composition, limestone almost dominant with the calcite mineral (C). Calcite mineral found is colorless with streak lines under both microscopes. The depositional structure is unable to recognize according to Dunham’s carbonate rock classification as this sample is considered to be a crystallized carbonate.

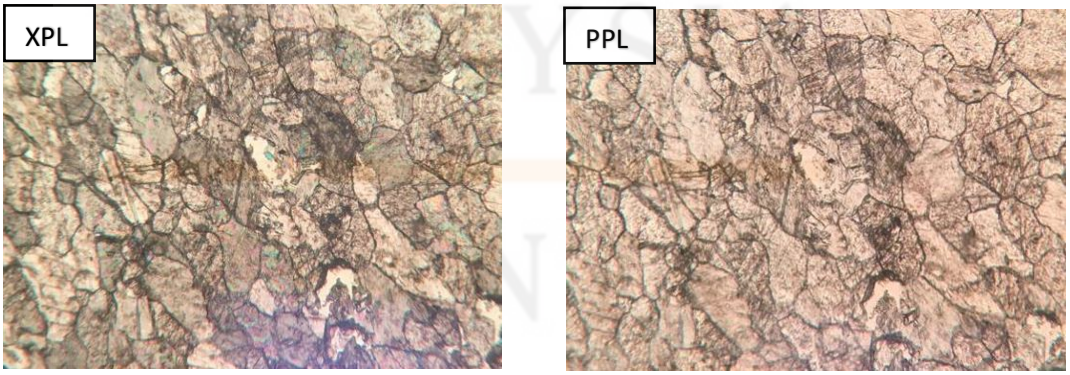


Figure 4.23: Thin section of limestone rock

c. Tuff unit

Tuff is one of the oldest rock in the study area. The tuff found is fine grained in size and has a smooth taste like a powder. The rock will stick on the tongue when testing it. It is white and grey in colour which undergoes low to medium weathering process. The weathered outcrop had altered to become soft brown soil with white quartz residuals. Tuff has many different colour depending on their mineral composition on the rock. The sample that found in the area is a pyroclastic consolidated rock which composed of compacted and cemented volcanic ash from volcanic eruptions. Tuff is a volcanic rock that forms from the products of an explosive volcanic eruption. In these eruptions, the volcano blasts rock, ash, magma and other materials from its vent. The figure 4.24 below shows the tuff outcrop.

Figure 4.24: Tuff outcrop

Figure 4.25: Hand sample of tuff rock

The thin section in figure 4.26 shows that the mineral in the tuff is very fine and hard to identify. It shows that the tuff rock consists of fine-grained of the crystal of plagioclase. The minerals are clear colorless in PPL and twinning in XPL. The brownish black colour of iron oxide (FeO) present in the tuff.

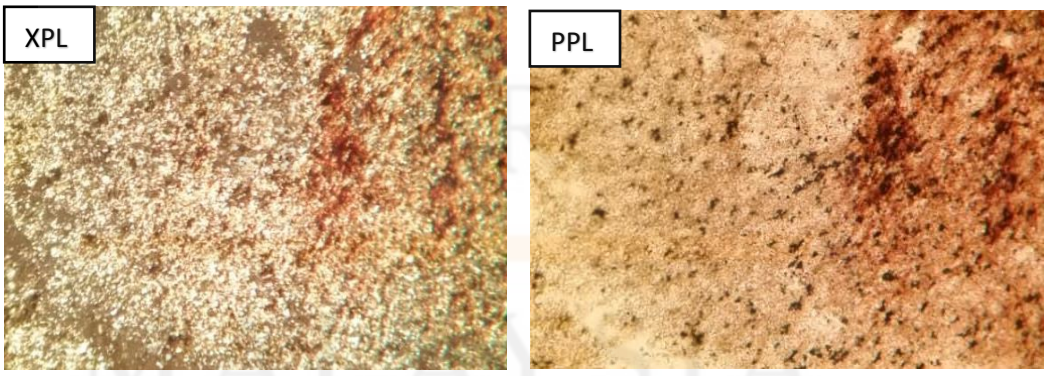


Figure 4.26: Thin section of Tuff rock

d. Metasediment unit

The oldest unit of the study area is metasediment unit. It is composed of metamudstone, phyllite, and slate. The most dominant rock of the metasediment unit in the study area is phyllite and followed by lower grade which are slate and metamudstone. The phyllite had undergone high weathering process which causes the colour become reddish orange. From the outcrop, the bedding of the outcrop can be observed. The phyillte can be classified as foliated texture. The size of the grain is fine-grained with a phyllitic bending of foliation. The outcrop in the figure 4.27 had undergone low degree of regional metamorphism resulted in a wavy and silky surface.

Figure 4.27: Phyllite outcrop

Figure 4.28: Hand Sample of phyllite rock

Figure 4. 29 below shows the thin section of phyllite under microscope. It shows the foliation with preferred orientation of the platy mineral. Its constituent platy minerals are larger but not visible with naked eye. The usual minerals in phyllite rock are quartz, feldspar, muscovite, mica, graphite and chlorite. But in this thin section, the only mineral contain in the phyllite include muscovite, quartz and iron oxide.

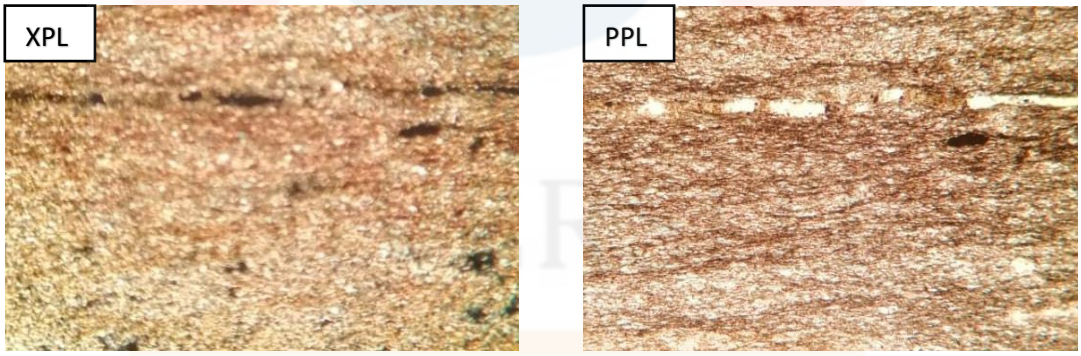


Figure 4.29: Thin section of phyllite rock

4.4 Structural Geology

Structural geology refers to the structural changes produced from the physical and chemical processes. It aims to characterize flow paths of the deformation and to infer the direction of magnitude of the forces. The rock undergoes deformation process in order to understand the stress and strain act on the rock body that changes its original shape. By studying about the dynamic of the stress, it linked with the important events that happen in the geologic past and understand its evolution. From geological mapping, structural geology concerns with features resulting from deformation include fractures, faults, folds, shear zones, cleavages, foliation, and lineations.

4.4.1 Lineament analysis

A lineament is a straight line feature that commonly underlying the geological structure such as a fault. The presence of lineament is caused by the action of tectonic force. The identification of the lineament in the map may help to indicate the geological structures that can be found in the area such as joints, faults, and folds. The study of lineament at the study area will provide information about the type of topographical features that may have tectonic relevance and how it was geometrically related to each other.

Lineament in the study area can be divided into positive and negative lineament. Postive indicates crest of ridges and the negative lineament indicates drainage lines or river valley. The study area is the lack of structures thus there is less interpretation of lineament analysis. Figure 4.30 shows the lineament map of Kampung Kala Baru, Gua Musang.

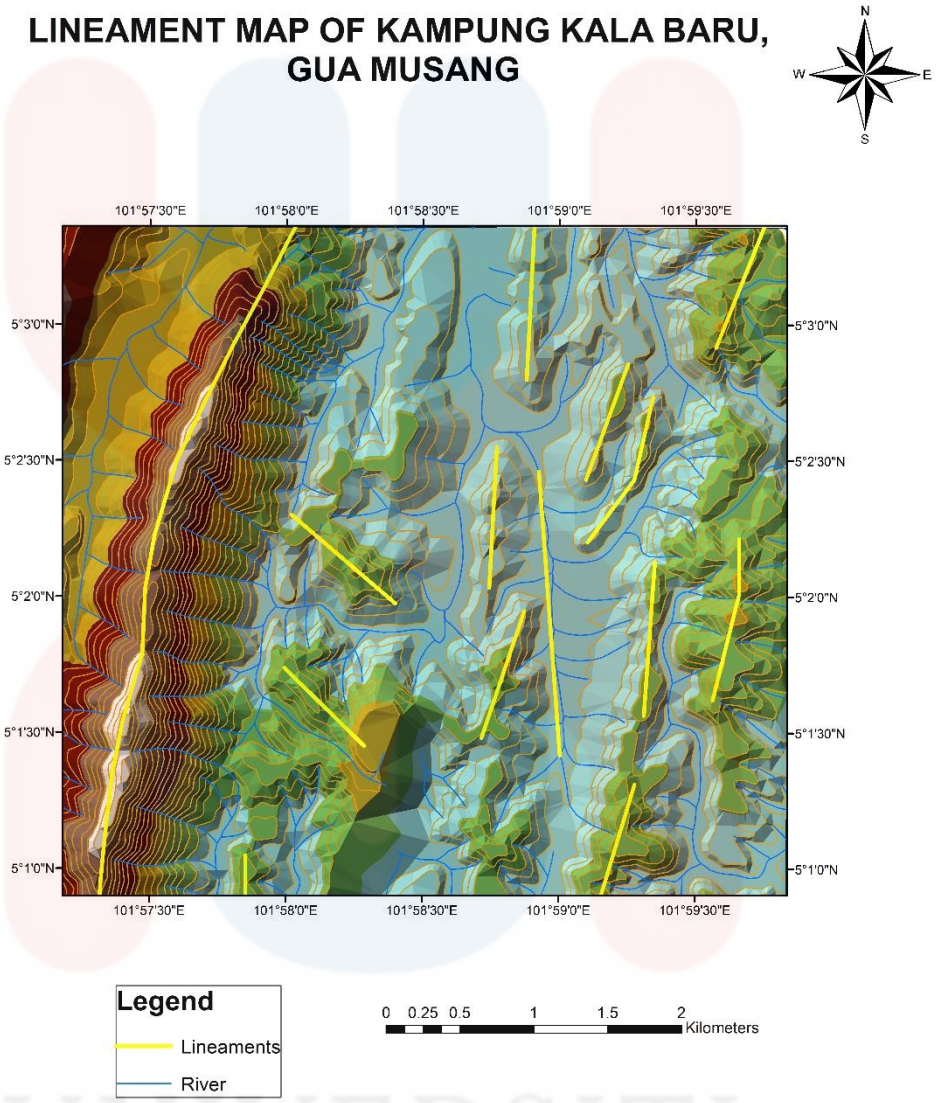


Figure 4.30: Lineament map of Kampung Kala Baru, Gua Musang

4.4.2 Joint analysis

Joint are significant structural geology refers to a fracture that forming in the outcrops. The joint represent clear-cut opening and gaps of different magnitude contributing to the weakness of the rock porosity and permeability. It is formed when the tensional stress pulled apart the rock shallow depth of the earth's crust (Plummer *et al*., 2016).

The planes which stress lost its cohesion in the rock causing the fractures that can be used to identify the direction of force and pale stress system act on the earth surface. The fracture divided the rock into two sections which no displacement or it is just a crack that forms a gap in the rock body. The joint analysis can be done by using the rose diagram to investigate the direction of the force acting on the body of rock. Figure 4.31 shows the joint on the limestone outcrop.

Figure 4.31: Joint structure on the limestone outcrop

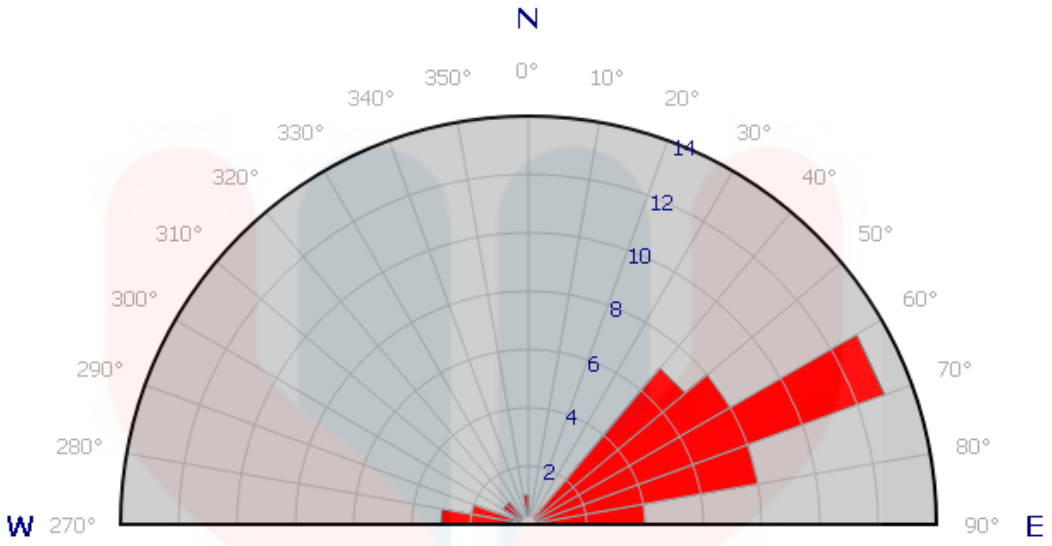


Figure 4. 32: Joint analysis on limestone in the view of Rose Diagram

Based on the joint analysis in figure 4.32 it shows that the force is dominated at the 50-60° North. The force direction is nearly parallel to the direction of the strike-slip fault of the study area. It is the force direction of the general form for strike-slip fault.

4.4.3 Bedding analysis

Bedding is structural feature occur in sedimentary rocks which every bedding may present significant and specific details of the depositional environments and to understand paleocurrent and paleoenvironment. The layer of the bedding has details about composition, grain sizes, and facies. Bedding analysis was done by measuring the strike and dip of the bedding on the field using a Brunton compass.

In the study area, the bedding that can be found in the limestone outcrop shows on the Figure 4.33. It was a thick-bedded of limestone which is coarsening upward. It is hard to identify the bedding because it has a thick bed.

Figure 4.33: Bedding of limestone outcrop

4.5 Historical Geology

The study area is located at Gua Musang, Kelantan where there is a lot of karst limestone formation. The distribution of limestone rock in the Gua Musang formation is the oldest as it happens to be early Permian age estimated around 290 millions years ago. The depositional environment of Gua Musang is a shallow marine environment which can identify by some features that show the activity of the environment in the karst formation. The sedimentary process occurs during Triassic which is about 248 million years ago. The process was being interrupted by the volcanic activities that eventually happen to be granite rock which form the area of the mountainous topographic unit at the study area. The landform of the area starts to undergo weathering process and create a different landform. The geomorphological landform is occurred due to the severe weathering process and highly eroded structure in the area. The types of landform of the karst form the action of the weathering in certain places.

CHAPTER 5

KARST GEOMORPHOLOGY OF KAMPUNG KALA BARU, GUA MUSANG

5.1 Introduction

This chapter explained about the limestone karst with the method used. The satellite imagery help in order to see the fully and upper view of the karst area. The data analysis from the mapping observation was supported based on the geomorphology process that takes place on the karst. The mapping session showed the feature inside, outside and the behaviour of the karst until at the end the limestone karst will be identified.

Kampung Kala Baru the coordinate which is bounded between longitude 101° 57’ 8.68” to 101° 59’ 48.92” and latitude 05° 0’ 42.78” to 05° 03’ 17.92” located in Gua Musang, Kelantan. The karst limestone forms and dominated along the main road. It is along Jalan Jelawang connected to Jeli and known as Jalanraya Jeli-Gua Musang.

Karst is composed of some of the most unique landscapes in the world, but it is also characterized by its distinctive landform. Karst landforms are produced by weathering and erosion in regions of carbonate rocks and evaporites. Surface landforms commonly include enclosed depressions, sinkholes, sinking streams, and springs. The landform of this features is available on the surface and underground. The process involved is defined as karstification and happened mainly below the ground surface. The typical karst landscape is shown in figure 5.1 below.

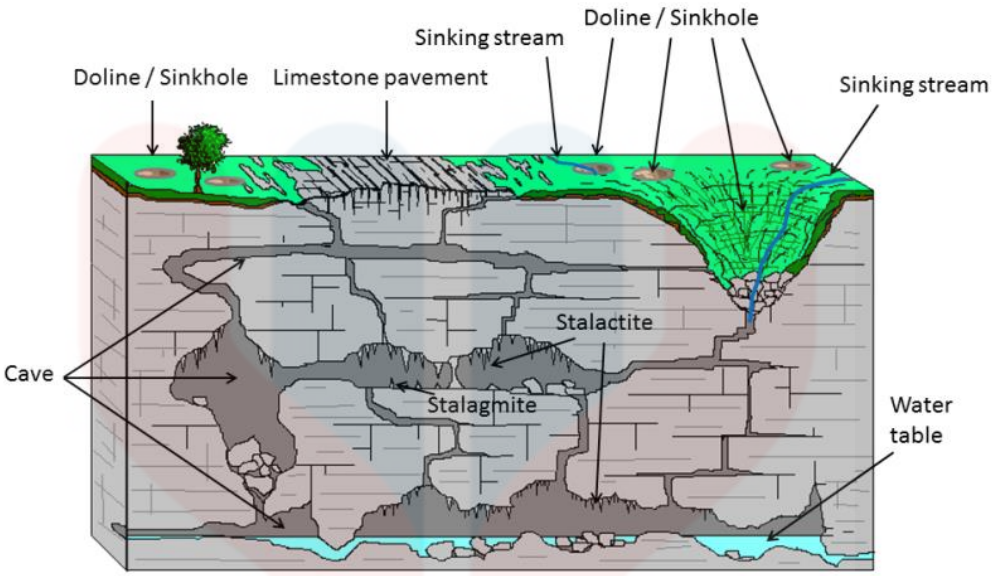


Figure 5.1: Typical Karst Landscape

(Geological Survey Ireland is a Division of Department of Communications, Climate Action and Environment © 2018)

5.1.1 Condition contribute to the Development of Karst

There are conditions that contribute to the development and formation of the Karst such as, dense rock, high hydraulic gradient, high rainfall, high biological activity, warm temperatures, pressure and mixing of carbonate waters. The development of karst topography requires water and soft rocks, most often limestone, but can also be dolomite, lime, marble, or gypsum. The environment must be one in which there is enough precipitation and runoff to dissolve the rocks. It must also be an environment that is easily dissolved in rocks.

The dense rock should have highly jointed. The solution is facilitated by the concentration of groundwater along the joints. If the rock is too porous flow is not locally concentrated and karst development is inhibited. The high hydraulic gradient

will be produced by steep topography rivers. Water that is moving will corrode much faster than standing water.

High rainfall distribution will supply more water thus more solution to occur. Rainfall becomes carbonate by absorbing CO_2 atmospheric. In addition, rainfall encourages the growth of the decomposing plant as an additional source of CO_2 to the flowing water. In dry areas, the development of karst landscapes is inhibited. High biological activity occurs when there is a present of algae, plants and lichen. This will increase the amount of carbonic acid that enters the groundwater system.

Warm temperatures divided into two types that are high temperature and low temperature. Biochemical activity will increase if the temperature is higher and will form CO_2 and organic acids. In low temperature, the dissolution decrease when there is less CO_2 dissolve in water due to the low biochemical activity.

When water is under pressure, it can dissolve more CO_2 that holding more $CaCO_3$ in solution. $CaCO_3$ will deposited into travertine when the pressure is released. Mixing of carbonate water is a nonlinear relationship exists between Ca^{2+} and CO_2, an under saturated, aggressive body of water is produced by the mixing of two saturated water bodies.

5.1.2 Climate and Karst

Development of Karst is strongly influenced by the climate change which is both directly through the moisture balance and the temperature regime and also indirectly. The climate is divided into polar regions, cold humid mid-latitudes, subhumid and semiarid steppe and savana grasslands and tropical forest. The tropical rainforest is the climate that is categorized in Malaysia. The climate in Malaysia is the best developed of karst formations where the amount of the rainfall is very high. The

warm temperature and thick vegetation in Malaysia also result in high concentration of organic acids and carbon dioxide. Apart from that, the groundwater flows in a tropical forest is in large quantities and very aggressive.

5.2 Different types of Karst Formation/Landform

5.2.1 On the surface

Figure 5.2: Limestone Karts along the study area

Karst topography is likely to occur in the area of the humid and wet environment. Humid climate is the area that has a very large amount of flowing water. There are two types of humid climate which are humid temperature and humid tropical. Hills are the most dominant topography in humid tropical climates.

Figure 5.3 3D landform of study area

a) Mogote hills

Figure 5.4: Mogote hill at the study area

Mogote hill is a form of karstic morphology that is developed mainly in the in low latitude. It is a hill that isolated surrounded nearly by flat area. Mogote is formed from remnants of limestone sediment layers deposited at a certain time over a long period of time. Mogote has a unique formation which is rounded, tower-like form, steep-sided hills and undercutting from surrounded alluvial plains. It is composed of either limestone, marble or dolomite rock. They are the remains of limestone that have been deposited and eroded. Figure 5.3 shows the formation of mogote hill at the study area.

Figure 5.5: Mogote hill by using Google Earth

b) Conical hill

Figure 5.6: Conical hills at the study area

Conical Hill is a landform with a distinctly conical shape. The shape is hollow surrounded by steep and rounded hills or dollines at the feet of many steep-sided cone-shaped hills. It is usually isolated or rises above other surrounding foothills, and is often, but not always, of volcanic origin. The conical hill karst landform is the landscape dominated by low conical hills that from in the humid tropical climates. The hills are fully covered with vegetation and there is doline shape lies between them at the feet of hills. Conical hills or mountains occur in different shapes and are not necessarily geometrically and have shaped cones but some are more tower-shaped or have an asymmetric curve on one side. Figure 5.4 shows the conical hill karst that is found in the study area while figure 5.5 is the image of the conical hill from the Google Earth.

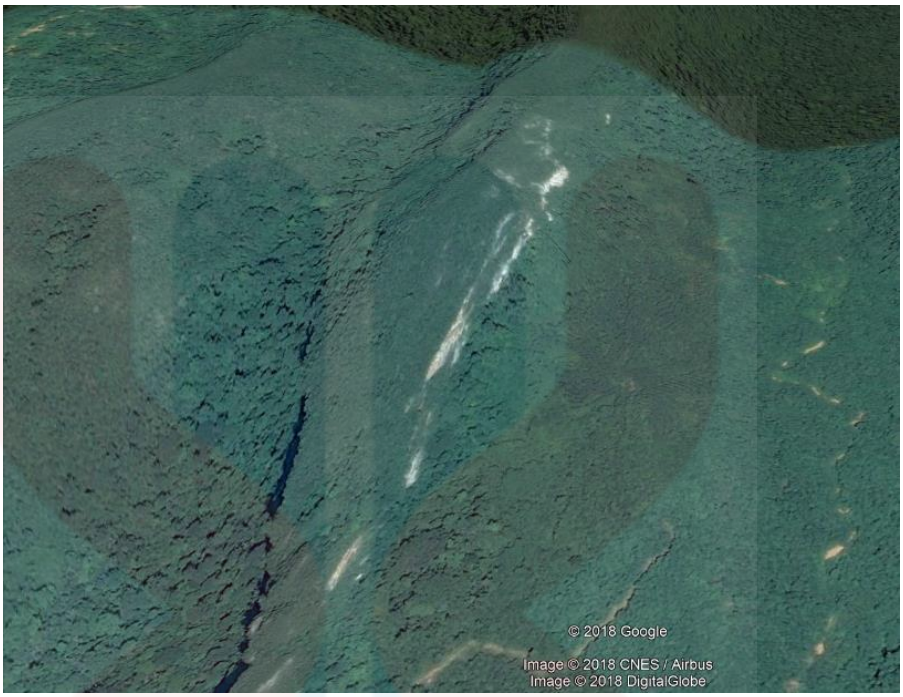


Figure 5.7: Conical Hill by using Google Earth

5.2.2 Subsurface Karst

a) Cave

According to Gunn (2004), the cave is a natural opening which occurs in rocks and large enough for a human to enter. The cave is formed from the dissolution process between acid and surface of the rock that contains calcium carbonate. It is developed from the other processes such as erosion and gravitational breakdown or collapse. A solution of the caves occur in limestone or dolomite are the most common types in Gua Musang area. Limestone rock is the most suitable for the creation of caves. The accumulation of water dissolvent action in certain locations leads to the creation of small cavities caves when they are broadened.

Figure 5.8: The entrance of limestone's cave at the study are

b) Speleothems

Speleothems also referred to as formations or decoration of cave features formed by the deposition of minerals. In the cave, there are many unique speleothems that formed with the help of water. Water will seep out through the joint and crack in the limestone rock. As it passes through the organic materials, it picks up carbon dioxide gas and creating carbonic acid. The acidic water enables to dissolve the carbonate rock which the cave is formed. When the dissolved rock is exposed to the air in the cave, the percolating water degasses due to decreasing of carbon dioxide supply become supersaturated with calcium carbonate and lastly calcite is precipitated on the cave walls, ceilings, and floors. A variety of different types of speleothem can be seen in the cave and majority are composed of calcite. The types of deposit found in the cave of the study area that are columns or pillar, stalactites, and flowstone.

Stalactites

Stalactites are the most common features that can be found in the cave (figure). It is formed due to the accumulation of CaCO3 from mineralized water solution. It is formed downward from the cave ceiling and has a shape like a curtain hanging from the roof to the floor of the cave. In the beginning, the features appeared small in size like a hollow tube form when a drop of water hanging by surface tension. It is formed when a drop on the tip of a growing leaves a deposit until at one time it grows bigger.

Figure 5.9: Stalactites found in the limestone karst

Stalagmites

The corresponding formation of stalactites is a stalagmite. It grows upward from the cave floor. It is undergoing a process in creating the features but more depending on the pH condition within the underground cavern. If stalactites grow long enough to connect with stalagmites on the floor, they form a column.

Columns

The column is an upright pillar formed by the unions of stalagmites and stalactites. It occurs due to the active and constant dripping of water that contains dissolved calcite. This formation took a long time and undergoes rapidly dissolution process until it forms as column liked showed in figure 5.8.

Figure 5.10: Column found in the limestone karst

Flowstone

Flowstones are chemically formed as calcite deposited that build up from the water that moves along through wall or floor of the caves. It is due to active flowing water in which carbon dioxide is lost and carbonate material is deposited. Water that dissolved minerals will deposit and the thin layer will build up each other. As it gets thicker, the rounded shape will be developed at the layer.

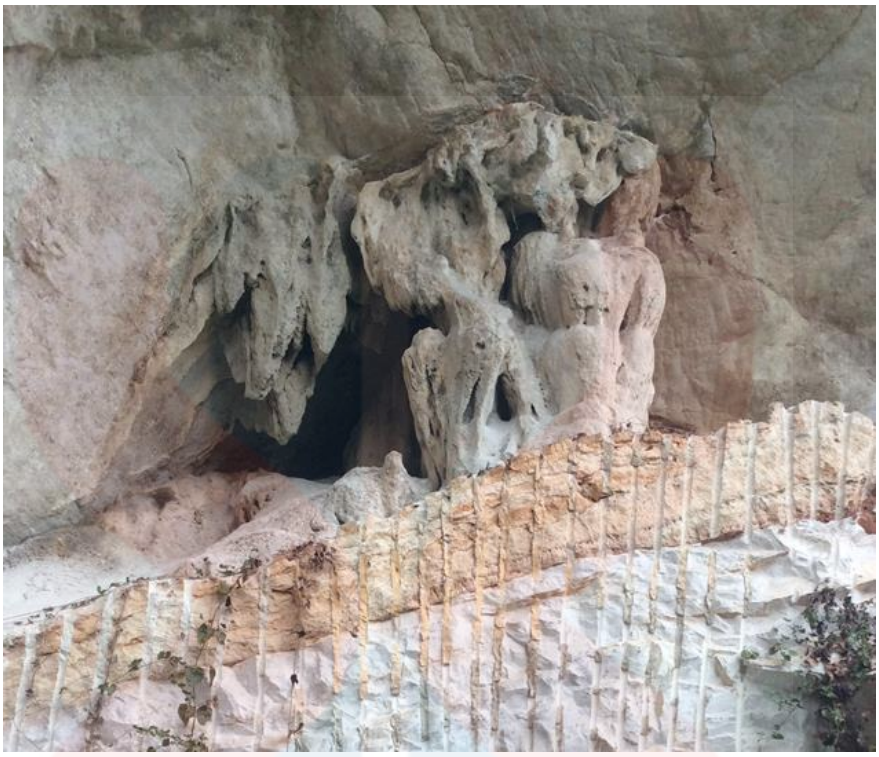


Figure 5.11: Flowstone in the limestone karst

5.2.3 Surficial Landform

Surficial landform is the study of landforms and the unconsolidated sediments that lie beneath them. There are three types of surficial landform which are closed depressions, karst valleys, and minor solution features. For closed depressions, types include dolines, sinkholes and solution collapse (uvalas and poljes). Meanwhile, the Karst valleys are divided into four types that are allogenic valleys, blind valley dry valley and pocket valley. While the minor solution features landforms is karren. In the study area, only karren can be found there.

Karren

Karren is small scale solutional features and sculpturing found on limestone and dolomite surface based on (John, 2007). The karren are created by flowing of water on the slope. When its rain, the rain contains carbon dioxide from the atmosphere are

able to dissolve the limestone rock. It runs down the limestone and sculptures it, the water will dissolving s groove or solution flute into the rock. This karren formation creates the parallel and vertical grooves. Figure 5.10 shows the karren on the limestone rock.

Figure 5.12: Karren found in the study area

5.3 Petrography of the Karst Limestone

The karst limestone in the Gua Musang district is part of a sequence of rock formations that make up the Gua Musang Formation. Gua Musang Formation is evolved from the marine depositional system that closely related to the distribution of carbonate rock nowadays.

Most of the formation in the study area are karst formation which is consist of limestone rock. A petrographic of the Karst limestone in the study area clearly show that the limestone already undergone crystallization process forming the dolomite which modifies their mineral arrangement and eliminates the effect of fossils and microfossils in the rock.

According to (Boggs, 2009), dolomite composes of the crystal of nearly uniform size which is unimodal size distribution and crystals of various sizes which is polymodal size distribution. From the 10 samples of a thin section of the rock observed under a microscope, the crystallization of Gua Musang Karst can be classified into two types of different dolomite texture. There are planar dolomite (idiotopic dolomite) and non-planar dolomite (xenotopic dolomite).

The planar dolomite consists of planar-e (euhedral) and planar-s (subhedral). In the study area, it only shows the planar-s (subhedral) dolomite. The texture of the crystals of dolomite is subhedral to anhedral. It has compromise boundaries with many crystal face junctions. The crystal face junctions are straight boundaries between two crystal met at a distinct angle. The dolomite is low in porosity and low intercrystalline matrix spaces among the crystal.

The non plannar dolomite has closely packed together crystal forming anhedral texture and non-rhombic crystallizes grain. The shape of the crystallize grain is mostly oblate, serrated, curved with an irregular intercrystalline boundaries. The crystal face junctions that preserved are rare and often have an undulatory extinction in the crossed polarized light.

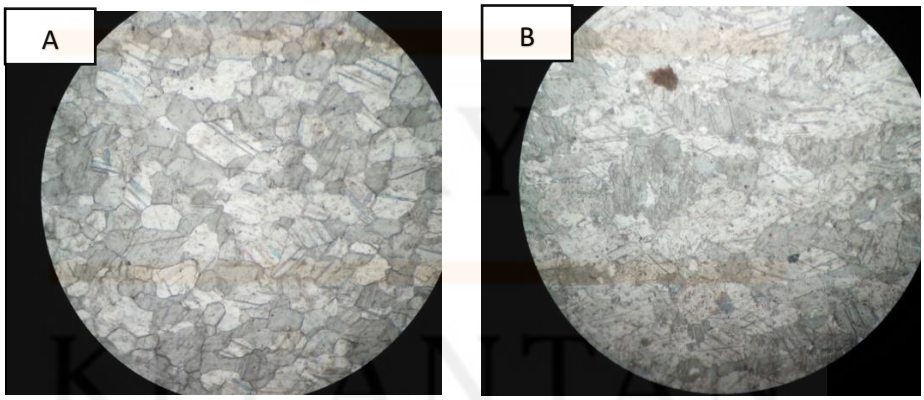


Figure 5.13: Dolomite crystal: **A**. Planar dolomite exhibiting subhedral to anhedral crystal **B.** Non-planar dolomite with curved or irregular faces

The dolominization process by which the limestone is altered into dolomite whereby calcite calcium carbonate ($CaCO_3$) is transformed into magnesium carbonate $CaMg(CO_3)_2$ or dolomite in the rock. To become dolomite, limestone must pass through this exchange several times or longer and stable period. The process can be referred to the increasing proportion of carbonate rock with the increasing of age and the average of the composition of Precambrian carbonate rocks approached the mineral dolomite formation (Garrels and Mackenzie, 1971). Besides, Given and Wilkinson (1987), with a statement that the increasing amount of dolomite formation can be used to correlate the periods of sea level high and continental flooding.

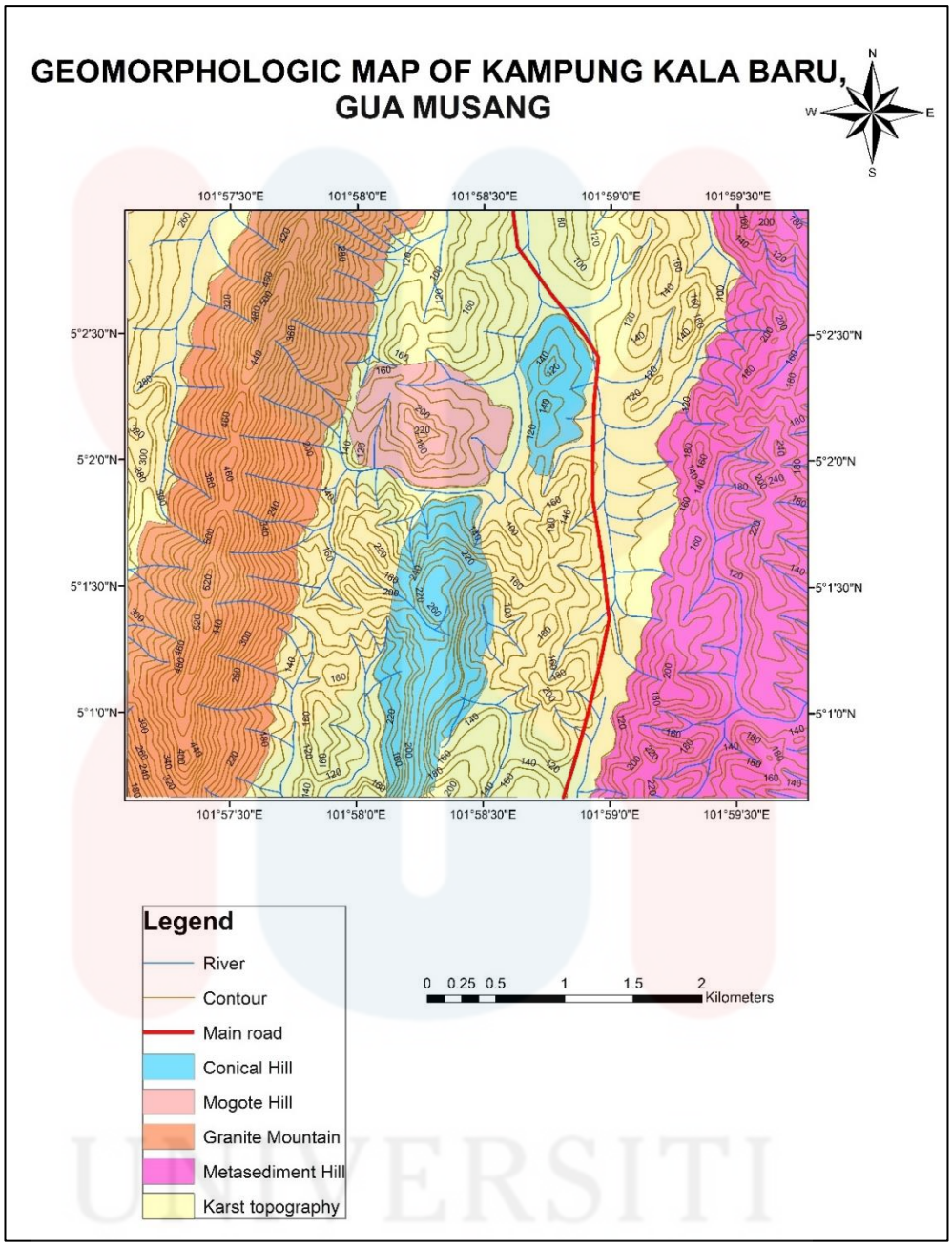


Figure 5.14: Geomorphologic Map of Kampung Kala Baru

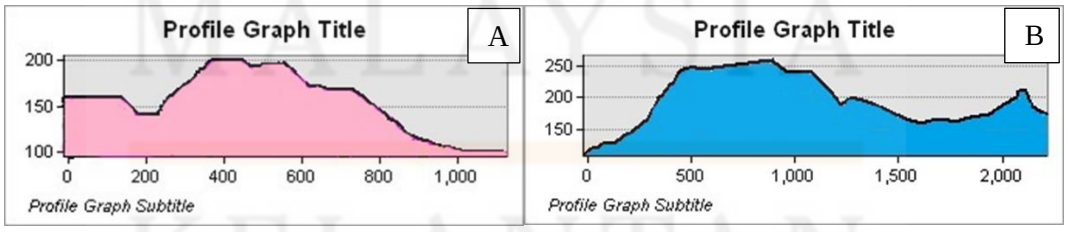


Figure 5.15: The cross section of mogote hill (A) and (B) conical hill

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In conclusion, the objectives of this research have been achieved. For the first objective, to update and produce the geological map of the study area. The geological map was produced with the scale 1:25 000 to highlight the lithology and geomorphology of the study area such as drainage system, lineament, and topography. The map was produced consists of four types of lithologies that provide individual information of their age. Based on the geological mapping, the Gua Musang formation in the study area observed are granite, limestone, tuff and metasediment rock. Granite is the youngest rock which classified as Cretaceous age while metasediment is the oldest rock classified as Permian age.

The second objective is to identify the formation of karst/landform in the Kampung Kala Baru. The interpretation of karst formation was done by relating the information and data from geological mapping with the understanding of the process in the karst. The karst landform in the study area can be divided into surface karst, subsurface karst and surficial landforms. In the identification of surface karst such as mogote hill and conical hill, the use of satellite imagery from the ArcGIS and interpretation of the landform by Google Earth is a really helpful and beneficial method in the study area. The formation of Karst is very beneficial in the tourism sector as it promises a fascinating and exciting view resulted from the water dissolution on the soluble rocks.

The last objective is to produce the karst geomorphologic map of Kampung Kala Baru. The map can be used by the authorities for planning and managing the land

in the study area. The area nearby the karst formation is the best water storage as a source of water for the people. From the geomorphological map, to know the geological hazard such as sinkholes might occur in the future. Sinkholes are one of the hazards that has been categorized in a karst region.

Apart from that, Kampung Kala Baru area is a good area for studying the karst geomorphology as there is a lot of karst formation or landscape that can interpret in this study area. The geomorphologic of Gua Musang area also can be used in the future as a reference to conserve and preserve the karts as a recreational area. Karst formation can have the value of scientific heritage as a challenging adventure site and have a potential monument of nature.

6.2 Recommendation

As the study has been done, some recommendation is being proposed to this research. The study of karst geomorphology in the Gua Musang area needs to be studied continuously because of the high rate of erosion rates and high weathering process. The area of Gua Musang may result in forming a new karst formation/landform which will destroy the unique formation of karst that already present.

Besides, the new method to identify the karst formation should be suggested besides using the only satellite imagery or ArcGIS software. For the karst limestone, the research needed to use an aerial photograph to get the best result for the type of karst formation. The aerial photograph will show the 3D diagram which easier to analyze the boundary of the karst.

The karst limestone in the study area has potential as a geo-tourism place in aspect from the view of the karst and features that have formed in the cave. It can be suggested as a recreational place for people to have a picnic and doing outdoor activities in the area. The area around the karst needs to be clean and reconstruct to attract people to go there to enjoy the new attractive place in Gua Musang.

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