GEOLOGY AND ASSEMBLAGES OF FOSSIL IN BUKIT BUCU, TERENGGANU

by

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APPROVAL

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

Signature	:	…….....
Name of Supervisor I	:	
Date	:	……..

DECLARATION

I declare that this thesis entitled "**GEOLOGY AND ASSEMBLAGES OF FOSSIL IN BUKIT BUCU, TERENGGANU** "is the results of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree

Signature :

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Date :

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Geology and Assemblages of Fossil in Bukit Bucu, Terengganu

ABSTRACT

Bukit Bucu had been acknowledged as one of the fossils abundance site. The aim of this study is to improve the lack of previous research as the objective of this research are to produce geological map of 1:25000 scales, to identify the fossil assemblages and to determine the depositional environment of Bukit Bucu. Therefore, methods for this research are by producing geological 1:25000 map, calculating percentage of fossil in determining the assemblages and based on lithofacies determine the depositional environment.. As result, total fossil per phylum identified are 184 as six phyla (Brachiopoda, Mollusca, Bryozoan, Echinodermata, Trilobita and Plantae) were determined. Correspondingly, the most abundance distribution of fossil is phylum Echinodermata and the most abundance species is phylum Brachiopoda. Thus, based on lithofacies the depositional environment of Bukit Bucu focused on deltaic depositional environment supported by the findings terrestrial plant fossil at the delta top and marine fossil at the delta front and also secondary structures that existed shows the mouth bar facies at delta front.

Geologi dan Taburan Fossil di Bukit Bucu, Terengganu

ABSTRAK

Bukit Bucu telah diiktiraf sebagai salah satu kawasan yang mempunyai taburan fosil yang banyak. Tujuan kajian ini adalah untuk menambah baik kelemahan dalam penyelidikan terdahulu memandangkan objektif penyelidikan ini adalah untuk menghasilkan peta geologi dalam skala 1: 25000, untuk mengenal pasti taburan fosil dan untuk menentukan persekitaran penempatan Bukit Bucu. Oleh itu, kaedah untuk penyelidikan ini adalah dengan menghasilkan peta geologi dalam skala 1: 25000, mengira peratusan fosil dalam menentukan perhimpunan dan berdasarkan kefahaman lithologi bagi menentukan persekitaran deposisi. Hasilnya, jumlah fosil per filum yang dikenalpasti adalah 184 sebagai enam phyla (Brachiopoda, Mollusca, Bryozoan, Echinodermata, Trilobita dan Plantae) telah dikenal pasti. Begitu juga, taburan fosil yang paling banyak adalah filum Echinodermata dan spesies paling banyak adalah filum Brachiopoda. Oleh itu, berdasarkan kefahaman lithologi, persekitaran penempatan Bukit Bucu merupakan persekitaran delta yang disokong oleh penemuan fosil tumbuhan di bahagian atas delta dan fosil marin di hadapan delta dan juga struktur yang wujud menunjukkan facial bar mulut di hadapan delta.

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m	Meter
mm	Milimetres
cm	Centimetres
km	Kilometres
xpl	Cross Polarized Light
ppl	Plain Polarized Light
%	Percentage

LIST OF ABBREVIATIONS

No.		TITLE
1.	GIS	Geographical Information System
2.	GPS	Global Positioning System
3.	XPL	Cross Polarized
4.	PPL	Plane Polarized

CHAPTER 1

INTRODUCTION

1.1 General Background

Assemblages of fossil are groups of organisms that are known to have lived at the same time. Therefore, a fossil assemblage helps to narrow down the possibilities for the age of rock layer. This research will be benefits to educational and tourist site in order to show the natural occurrence of fossil at the field. The title for this research is Geology and Assemblage of Fossil in Bukit Bucu Terengganu. This researched focused on the general geology of the study area and the assemblages of and also the depositional environment of fossils in Bukit Bucu, Terengganu.

1.2 Study Area

Kuala Terengganu has a distribution of rocks uncovered along the East drift from scope. The coordinate of Kuala Terengganu is 5.3296° N, 103.1370° E. Rocks dissemination of the Eastern Belt as partitioned by Yin (1985) fall into four groups, for instance Carboniferous-Permian meta-sedimentary rocks ,Triassic Volcanic rocks, Jurassic-Cretaceous mainland rocks and also from Quaternary period. In Terengganu there are many districts known as Marang, Kuala Terengganu, Dungun,

Besut, Setiu and Hulu Terengganu. However my studies area is located in Kuala Terengganu, specifically at Bukit Bucu, Batu Rakit Kuala Terengganu state.

Bukit Bucu is situated in the town of Batu Rakit, Kuala Terengganu, in residential park well-known as Taman Atikah. In the light of current discoveries, a more positive age is found out. Bukit Bucu elevation is in 100 m above ocean level, on the northern bank of Terengganu, near Batu Rakit town. The coordinate of Bukit Bucu is N 05’ 26’ 27.5’ E 103’02.47’04’. The fossils were found in sediment rock precisely on a shale rock on the north-eastern face of the slope. Also, in the study area stated the location of the study area, demography, accessibility, land use and also the social economic of the residents’ area. Above all, this research focused on Geology and the Assemblages of Fossil in Bukit Bucu, Terengganu.

a) Location

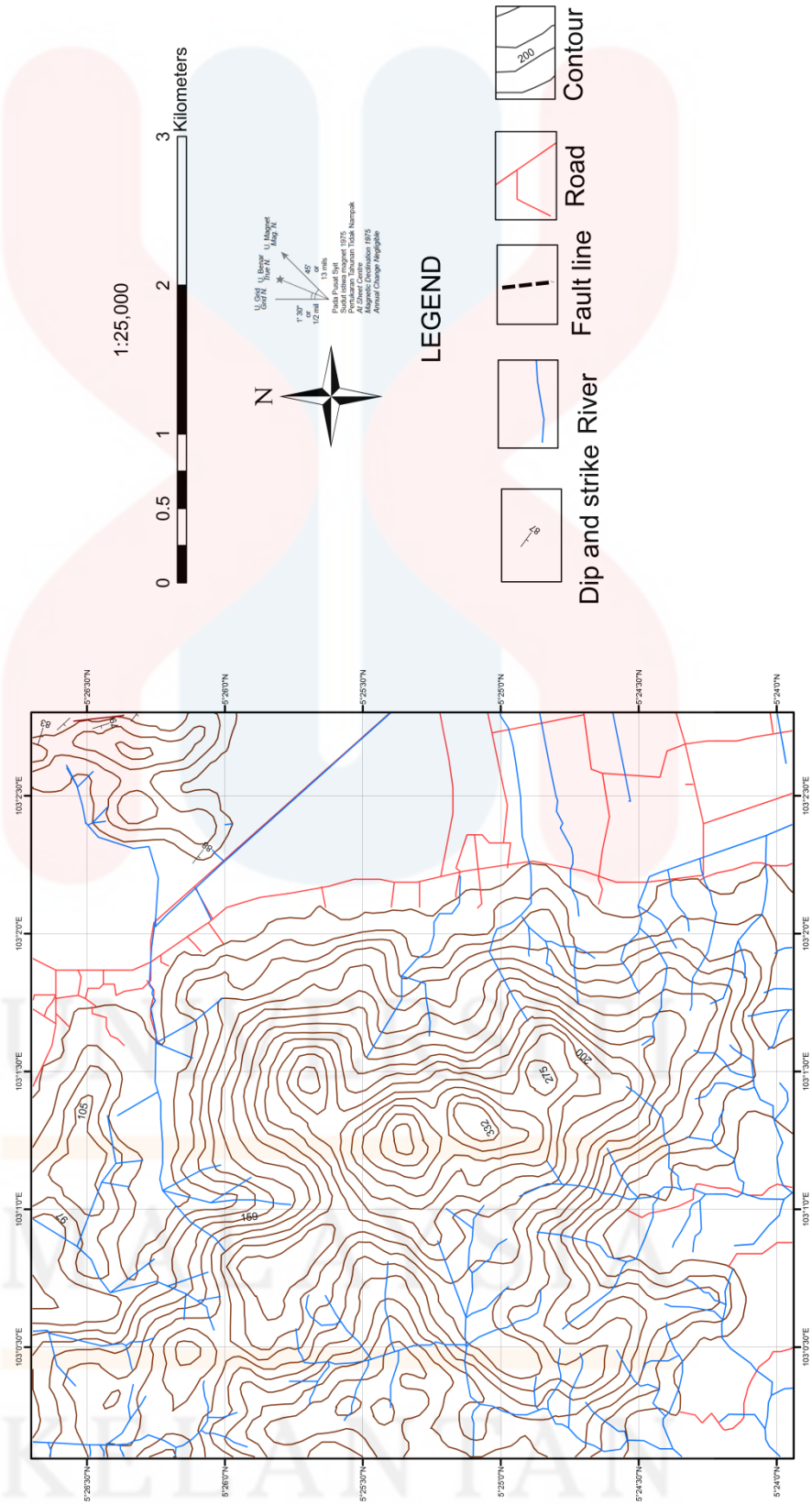


Figure 1.1: Base map (Study area) of Bukit Bucu, Kuala Terengganu

Figure 1.1 shows the base map of the location explicitly the study area which located in Bukit Bucu, Kuala Terengganu district in the state of Terengganu. The perimeter of the box is 5x5 kilometre. In addition, the base map had shown the geological features at the study area such as the river. Besides, the highest elevation of the study area is 332 metre while the highest elevation for Bukit Bucu is 100m above from sea level. Moreover, there are also stated road such as main road and the residential road. The main road that include in the box is namely as Jalan Tok Jembal Bandar Permaisuri. Also, in the study area there also several residential areas those consist of Kampung Hilir, Taman Desa Kayangan that located at the top of the base map. Other than that, there are also Kampung Bukit Wan and Kampung Gong Langai. Legend also provided as the reference for the features in the base map. For example, the red colour is symbolize to main road, the black with thin layer of line is indicate to residential road, the colour of nubuck tan is referred to contour whereas the blue colour referred

b) Accessibility

Figure 1.2: Accessibility of Bukit Bucu, Kuala Terengganu

Additionally, Figure 1.2 shows the accessibility of the study area of Bukit Bucu, Kuala Terengganu. (A) is paved road and (B) is unpaved road in palm oil tree. In order to access the study area there are two ways or roads that applicable to access. For example, from the main road such as Jalan Tok Jembal Bandar Permaisuri and there are also residential road that can be accessed through several residential namely as Kampung Hilir, Taman Desa Kayangan, Kampung Bukit Wan and also from Kampung Gong Langai. Moreover, there are also residential road that connected from Jalan Tali Air, Jalan Bonggor, Jalan Kampung Wakaf Mesira Batu Rakit, Jalan Tanjung ke Depan and also Jalan Kampung Padang Marang Kg. Teliput.

c) Demography

Table 1.1 shows the distribution of population of Kuala Terengganu 2010 the population for Kuala Terengganu include Kuala Nerus state is increasing from 898,825 to 1,035,977 within 2000 to 2010-07-06. Since the study area is in Kuala Terengganu, therefore the distribution population of Kuala Terengganu including Kuala Nerus district are also increasing from 304,181 to 343,284.

Table 1.1: The distribution of population of Kuala Terengganu include Kuala Nerus 2010

Name	Status	Population Census 2000-07-05	Population Census 2010-07-06
Terengganu	State	898,825	1,035,977
Besut	District	122,744	140,952
Dungun	District	131,585	154,932
Hulu Terengganu	District	63,631	72,052
Kemaman	District	140,319	171,383
Kuala Terengganu (include Kuala Nerus)	District	304,181	343,284
Marang	District	84,938	97,857
Setiu	District	51,427	55,517

Source: Department of Statistics Malaysia

d) Landuse

Another element that is important in study area is land use. The land use is referring to the land that is use by human being either for construction, mining or exploration. Thus, the land used in the study area is for the residential area. Other than that, the land use also consist of construction site, paddy field, school and also farm. This land use covered the residential area including the Kampung Hilir, Taman Desa Kayangan, Kampung Gong Langai and also Kampung Bukit Wan.

d) Social economic

The social economic for people that lives in the study area mainly composed of teacher since there are three school that involved in the study area. Also the land use at there being exposed as construction site and there are also farms. Thus, it shows that the people living in the area are also a breeder and also a construction worker. Moreover, there are also paddy field which means some of the people tendency to work as farmer.

1.3 Problem Statement

There are several problem statements able to improve from previous researcher such as are lack of research and details in the study area of Bukit Bucu, Terengganu. The only updated research related to Bukit Bucu is on 1986 by Idris and Zaki in their paper. “A carboniferous shallow marine fauna from Bukit Bucu, Batu Rakit”, Terengganu. Moreover, there is none researched about the assemblages of fossil occurrence in the study area. This is said so because previous researcher such as researcher (Ibrahim Abdullah, 2006) focused on the presence of pre-carboniferous metasediments in the eastern belt. Other than that, this study is conduct because to acknowledge the depositional environment of Bukit Bucu. This is because referring to previous study Bukit Bucu was acknowledge as shallow in depositional environment however Bukit Bucu also have potencies in having flora fossils which to be exact Plantae phylum.

1.3 Objective

This research is going to be conduct based on these objectives such as:

- To produce the geological map of the study area in 1:25000 scales. This geological map consists of lithology units of rock, stratigraphy of rocks, the geomorphology of the study area, the structural geology such as primary or secondary structure, vegetation and also the accessibility of the study area.
- To determine the assemblages of fossil Bukit Bucu, Terengganu.
- To determine the depositional environment of the study area of Bukit Bucu, Terengganu.

1.5 Scope of the Study

Research in Bukit Bucu is focused on Geology and the Assemblages of Fossils in Bukit Bucu, Kuala Terengganu. Thus, for the scope of the study, firstly this research is to produce the geological map of the study area. Produced the geological map fieldwork strictly include the geological features such as structural, lithology, palaeontology, geomorphology and stratigraphy of the study area. Basic geological mapping such as compass, GPS, field book are used during mapping as a method in gathered the data from the sites. Next, the data that has collected transformed into digital map by using certain software such as ArcGIS when produced the map.

While, the Georose software application used when to show the direction of the force exerted. The force might exerted from many side such top, down, left or right since it depended on the ancient history that distracted the structural geology until it able changed from original shape to the presence shape. In interpreting the the assemblages of fossil and the depositional environment at the study area literature review has been used.

1.6 Significance of study

The significance of this study is to produce the geological map of the study area with the scale of 1:25000. Produced a geological map consist of the geological information regards the study area such as stratigraphy, lithology unit and the structural geology of the area. Other than that, this research to update the assemblages of fossils and to fulfill the problem statement as stated in the research. With fossil assemblage, it helps to narrow down the possibilities for the age of rock layer. These researches to give the benefits towards the educational sector and tourist site while to show the natural occurrence of fossil naturally at the field. This occurrence of fossils, allowed the visitors to fell by themselves through allowed them to see and touch the fossils with naked eyes.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is the reviewed of books studied, research paper, encyclopaedia, magazine, website and also from various sources. This literature review is important since it supports the content as it provided the sources from the citation with necessary format.

2.2 Regional Geology

Regional geology categorized as the investigation of topographical of extensive scale locales. According to Khoo & Tan, (1983) the peninsular Malaysia involves of three longitudinal belts namely Eastern belt, Central belt and Western belt. For the Eastern, Central and Western belt categorized based on distinctive differences in geophysical, magmatism, stratigraphy, geological evolution and structure. Between Central belts and Western belts there is a boundary that was drawn in connecting the serpentinites bodies mainly found in Bentong Raub area, Negeri Sembilan and Kuala Pilah area and Pahang known as Bentong Raub Line by Hutchinson (1975, 1977). Part of Sibumasu Terrane formed from Western Belt as it derived from Gondwana plate in late of early Permian which located in North West

Australia. Sukhothai Arc was representing by Eastern and Central belt on margin of the Indochina Block in late of Carboniferous to Early Permian as referring from Metcalfe (2013). Additional, Bukit Bucu is situated in Kg Batu Rakit and the slope is 100m above ocean level on the northern shore of Terengganu Darul Iman, Malaysia. Exposures of sedimentary rocks at Bukit Bucu have been known to yield fossil brachiopods. Notwithstanding, ongoing visits to the zone have additionally yielded trilobites, bryozoans, crinoids, and bivalves. The age of these progressions have been doled out dubiously as 'Permian to Triassic and conceivably some Carboniferous by MacDonald (1967).

2.3 Geomorphology

Geomorphology is the survey of the physical features of the surface of the earth and the connection to its topographical structures. Bukit Bucu is said to contain sedimentary rocks since fossils may be in sedimentary rocks. According to Idris & Zaki, (1986), on the northern coast of Terengganu precisely Bukit Bucu elevation prominently 100 meter above sea level and closed to Batu Rakit.

2.4 Stratigraphy

According to Idris & Zaki, (1986), the sequences lithostratigraphic consist of alternating layered of siltstone, sandstone and shale. The fossil bearing stratum is at

the layer of 53 meter level and 65 meter thick. At level 45 meter there is also presence of mud clasts in a shale horizon.

Those rocks that suffered from low grade metamorphism are able to be evidenced of slates. MacDonald (1967) states that the age is from Permian to Triassic probably with some carboniferous to an informal arenaceous unit that has been assigned to the strata unit. Moreover, an upper carboniferous fauna of bryozoans, bivalves, crinoids, trilobites and brachiopods abundant at the sedimentary sequence at Bukit Bucu, Batu Rakit, Terengganu. In addition, ripple marks and cross bedding are also well preserved in sandstone Idris & Zaki, (1986).

2.5 Palaeontology

Palaeontology is the analysis of fossil dead creature or plant (widely varied vegetation). Fossils are abundant in previous geologic time, period and ages. Essentially it is begin the time of Pre Cambrian, Cambrian, Paleozoic, Mesozoic and Cenozoic. Amid every time, it have diverse event because of contrast period. For instance, during Devonian period invertebrates animal namely as brachiopod have greatest population even though it is in the Paleozioc era. This geologic time scale is vital to recognize the fossil because of their name, trademark, origination and their history geography. Sedimentary rocks expose at Bukit Bucu known as yield fossil brachiopods. Other than that, the area contains variety of bivalves, bryozoans, crinoids and trilobites by MacDonald (1967) the age is Permian to Triassic and possibly some carboniferous.

According to Idris & Zaki (1986), rich fossils in the study area are well preserved. Those fossils are known as trilobites identified as *Paladin ophistops*, bivalves recognized as *Edmondia* sp., crinoid recognized as *'Potecrinus'* (stems), Bryozoa identified as *Fenestella retiformes* and brachiopods identified as *Brackythyria strangwayst Chonetinella* sp.. In addition, according to T.Ohano *et al.* (1971) there were three distinct forms of plant fossil were found in Tajung Mat Amin, Terengganu such as *Rhacopteris* sp., *Sphenopteridium* sp. and *Sphenopteris* sp.

2.6 Lithology

Lithology is the description regarding description of physical properties of rock unit or rock formation. Referring to Singh (1985), northern part of Eastern belt consists of igneous rocks, Jurassic Cretaceous continental deposits and Carboniferous meta-sediments. The continental deposits occur in a number of small isolated area and the meta- sediments are dominants. In Eastern belt, meta-sediments as Carboniferous were map based on fossils found in Ulu Paka, Terengganu by (Chand, 1978) and some other places in Batu Rakit (Idris & Zaki, 1986) also known Sungai Perlis bed (Chand,1978) and some in north Terengganu and Pahang (Jennings & Lee, 1985; Metcalfe et al., 1980). In addition, (Chung, 1973) geological map of peninsular Malaysia shows Triassic to Jurassic sedimentary rocks in the belt. Since the study area is located near to Batu Rakit, Kuala Terengganu therefore rocks in Bukit Bucu correlated to Batu Rakit.

CHAPTER 3

MATERIAL AND METHOD

3.1 Introduction

This chapter briefly explained about the materials and methods throughout the research. Materials that were needed before conduct a geological mapping. Common used material for mapping are hand lens, sample bag, measuring tape, and a bottle of hydrochloric acid, global positioning system, suunto compass and also geological hammer. Other than that, methods or methodology are the processed that occurs before, during and after the process of geological mapping.

3.2 Materials

Hand lens, sample bag, measuring tape, hydrochloric acid solution (HCL), global positioning system (GPS), compass (Suunto) and geological hammer are the several example of material and equipment's that need and used when conduct the preliminary studies. Hand lens are used in identifying the mineral such as biotite, hornblende, quartz and muscovite in a better recognition. Sample bag in A4 size are used to keep the sample with labelling important details such as the location in term of coordinate, vegetation, climate, geomorphology of the location. Measuring tape in metre unit is a measuring tool that used in measuring the outcrop and act as scale in order measured the depth, length, high of an outcrop or geological structure.

Hydrochloric acids solution (HCL) used in order when clarified either it is calcite or vice versa. Once, hydrochloric acid react bubble will form. A global positioning system is a navigation device.

Global Positioning System or GPS act as receiver and capable of received information from GPS satellites and then calculate the geographical position of the device. In all weather conditions, anywhere on or near the Earth, GPS is a device that able to retrieve the location and time information from the GPS system. Geologists used a number of different magnetic compasses when measured the geological structure orientation as they map in the field when analyzed the geometry of bedding planes, joints, and metamorphic foliations and lineations. The most common device used to date in this aspect is the analog compass. The analog compass that usually been used are the Suunto and Brunton. Suunto and Brunton compass used when calculate the slope reading, dip strike angle and direction. However, Sunto compass is used in this research.

A geological hammer is used when take out the rock sample in palm size. The chisel-tip rock hammer consist a hammer head on one finish and a slightly curved chisel-shaped blade on the opposite. The flat of this hammer is employed for breaking rocks and light-weight chisel work. The chisel hammer used for separate the layers of sedimentary rocks, trimming rocks, and dig in soils and sediments. This hammer usually is used by geologists and also fossil hunters. The soft grip is intended to be comfy in hand and to scale back the vibrations of impact. In addition, a single part of steel formed the handle and head of the hammer.

3.3 Methodology

3.3.1 Preliminary studies

Preliminary studies are the pre studies and it also the first stage before conduct a research. A preliminary study is the process of gathered data from variety of sources such from literature review and also from geological information system (GIS). For literature review, the data that can be gathered as referred to regional geology, geomorphology, structure geology, lithology about the study area and related to the title of the research. Literature reviews are obtained from journal, website such as Google scholar, Mendeley software and also from encyclopaedia. From GIS there are several maps were produce by using ArcGIS software such as topography, drainage pattern, and contour pattern map are reviewed.

Topographic map exposed the shape of a landscape of a study area. This consists of elevations that specified the height above the sea level and the contour lines are lines of equal elevation. Drainage pattern map is a pattern shaped by stream erosion over time that exposed the characteristics of the geological structures and type of rocks in a landscape region. Drainage pattern is the pattern formed by lakes, streams and rivers in a specific drainage basin. Slope map is a contour Lines slope that is calculates in a topographic map. Slope is the measure the degree of inclination of a characteristic relative to the horizontal plane. A lineament map is a linear characteristic in a landscape that is an expression of such a fault as an underlying

geological structure. A lineament will typically appear as a fault-aligned valley, a straight coastline, a series of fold-aligned hills or fault or indeed a combination of these topographies. A contour map is a map showed with contour lines, such as a topographic map that shows hills and valleys and the gentleness of slopes or the steepness.

3.3.2 Field studies for data collection

Next method in conducted a research is field study in data collection. For field studies, the data collected from the field and mapped by used traverse method. During research, interpreting and observing the geological features is important when gathered the data. The interpreted and observed about the study area are related to geomorphology, lithology and stratigraphy of the study area. Moreover, the common material for mapped such as compass Sunto, Geological Hammer, Hydrochloric acid solution hand lens, sample bag, measuring tape, global positioning system (GPS) need in accomplishment data collection.

In addition, field note books and smart phone are important when gathered the data from fieldwork. The field note book is used in write down the raw data of the geological features that consists at the study area such as dip and strike, drew the outcrops, lithology and any other data that related. A smartphone also important at field studies when at the fieldwork. The smartphone is used for captured the outcrop in panorama mood, recorded the data of the study area and also applicable in gained

the data such as the coordinate or directions of any outcrops. Importantly, a smartphone is important as sources of security. By smartphone, phone called can be made and also applicable for sent coordinates in seeking helps.

Furthermore, method for fossil sampling is the process taking out fossil from rock. Next, the fossil sampling were bring to laboratory to identify the fossil and from that analysis and interpretation were made up and lastly determine the assemblages and the depositional environment in details.

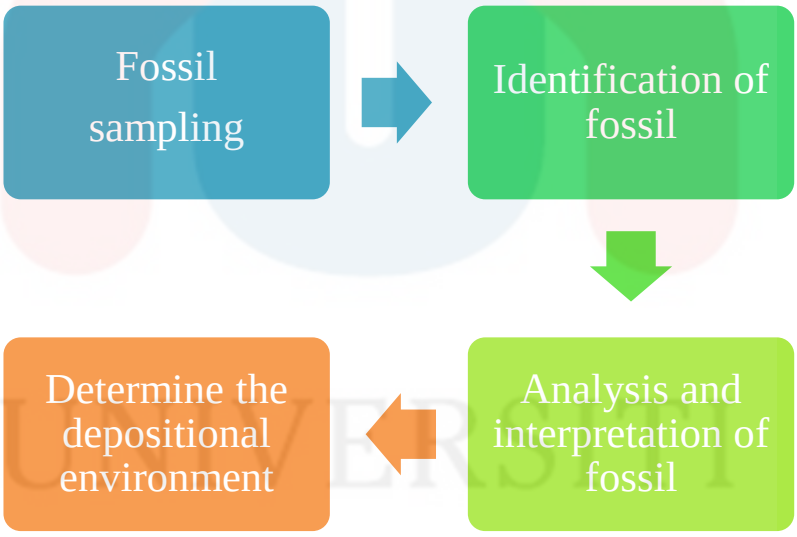


Figure 3.1: Research Flow chart of fossil sampling

3.3.3 Laboratory Work

After gathered data from fieldwork the next method is laboratory works. Laboratory works is carried out for gained further explanation and commonly laboratory works is done after completed gathered data from field. The analysis or interpretation is settled in lab. In laboratory works, analyses of thin section took placed.

Generally, thin section is a process of identified the optical properties of the minerals precisely from rocks through analysis of thin section for further interpretations and analysis for petrographic microscope that need to reveal the origin of parent rock. Other than that, the optical properties regarding the minerals in the rock able to investigate through thin section process. Data Processing is the collected data's from the preliminary and field studied with laboratory work. All of this data need when process the data in data processing. For data processing there are a few software that are used such as GeoRose software for Rose diagram, ArcGIS software for Cross Section and produce map. Next, in data processing also provided the GIS laboratory for data input that involve of geomorphological map, geology map, traverse map, topography map and stratigraphic column and lithological section.

3.3.5 Data Analysis and Interpretation

Data analysis and interpretation are conducted when the data processing has completed. On this part the specimen's result from thin section processed need to interpret and analysis. Other than that, for the analysis and interpretation, data from structural geology, lithology, stratigraphy, petrology and palaeontology and sedimentary from field has been analyse and the result are known after the analysis processed settled. The data gathered from the analysis and interpretation has been formed in statistic form.

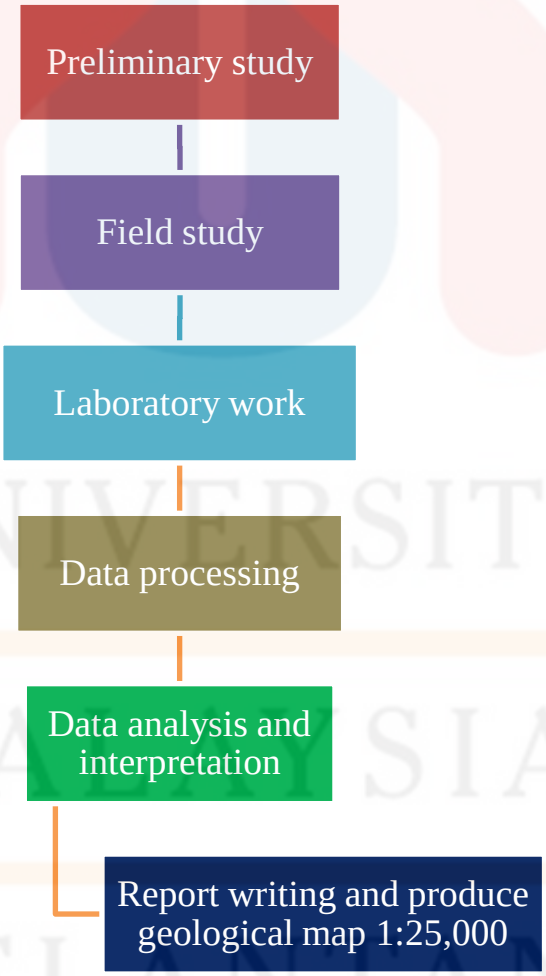


Figure 3.1.1: Research Flow chart

CHAPTER 4

GEOLOGY OF THE STUDY AREA

4.1 Introduction

This chapter discussed regarding the general geology of the study area such as geomorphology, lithostratigraphy, historical geology and also the structural geology based on data collected at field throughout mapping. For instance, also discussed in this chapter are the vegetation, settlement, traverses map and the accessibility of the study area.

4.1.2 Accessibility of the study area

The area in study area that can be access is limited. This is said so because there are little road than can be accessed through riding a vehicle or walking. The main road used daily by the people is Jalan Kampung Wakaf Mesira Batu Rakit, Jalan Kampung Padang Maras – Kg Telipot, Jalan Tanjung ke Depan and Jalan Banggol. Also, there is Jalan Tali Air at the study area.

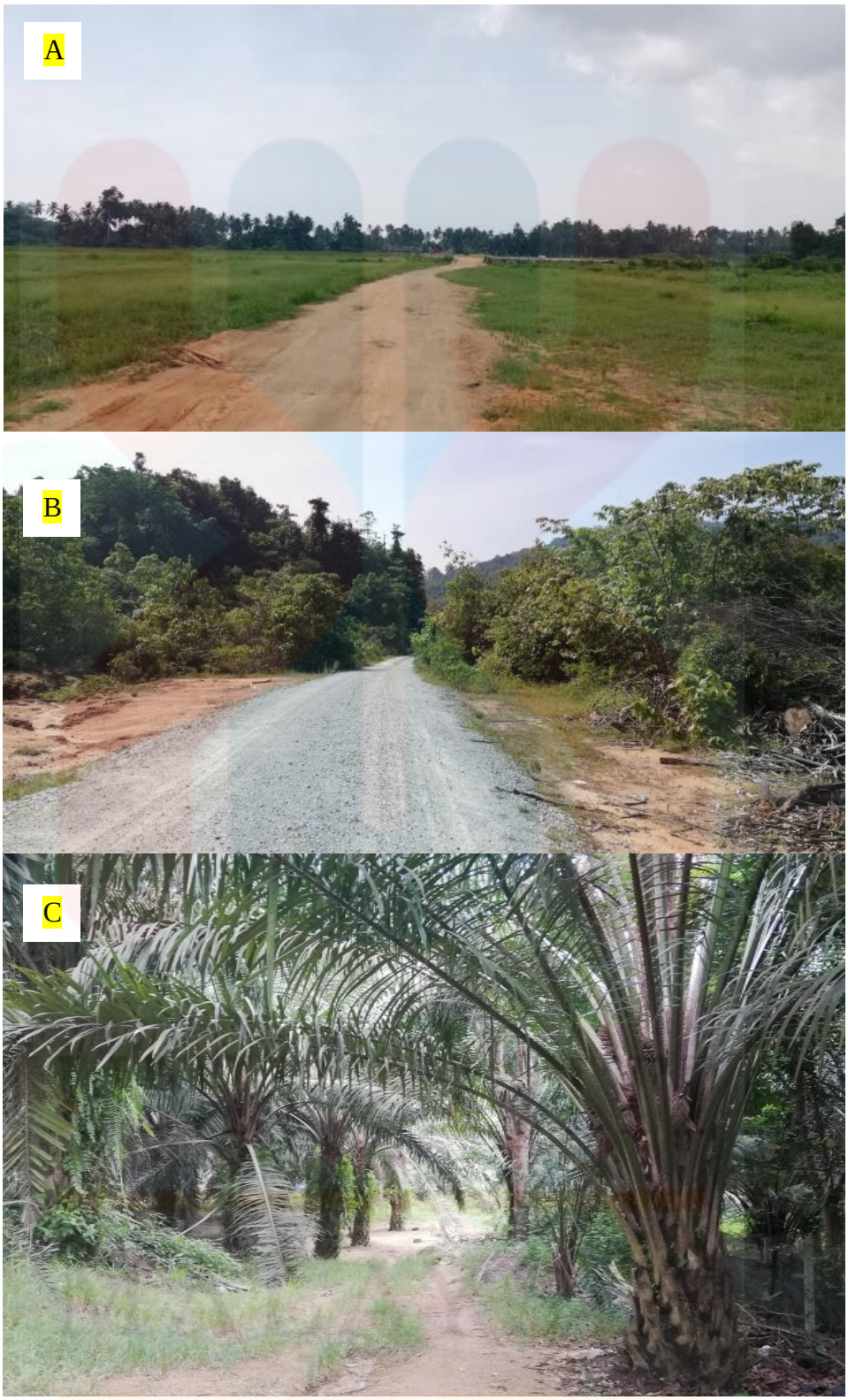


Figure 4.1: A) The unpaved road at paddy field, B) The paved road in plantation and C) The unpaved road in oil palm plantation. This road can be access by man power and

4.13 Settlement

Settlement is a someplace earlier been unpeopled are establish by those live in the area. For Kuala Terengganu settlement, the community consist of palm oil planters, rubber tree planters, teachers, breeders and also farmers.

4.1.4 Forestry

Forestry is in what way land is used and how people are able to the land as a source of life. Forestry also can be allocated into several types such as forest, land, recreation, soil, water and many more. However, in the study area there are some types of forestry as stated earlier.

Figure 4.2: Paddy field and other vegetation in the study area

Forestry or vegetation are related to each other and this is because land and soil are essential to grow plants and crop. Several types of tress and plant that grows

in the study area are banana, paddy and coconut trees. Vegetation in the study area supplies food source to the villagers and also as a source of income. The type of forest in the study area is tropical forest. The forest was in medium thick with trees and bushes.

4.1.5 Traverse and observation

Traverse is path of travel in the study area. It is done through mapping the study area. While observe is a process of geological observation that is made through traverse the study area. As shown in Figure 4.3 traverse map of the study area. Traversing and observation of the study area been done within ten days for hundred and seventy- six location (176). Out of hundred and seventy-six locations, the description for the location are fossil station, observation and sampling location, observation location, geomorphology station and thin section location. Fossil location is the specification location from site at Bukit Bucu.

While observation and sampling location is where observation is conducted and there were fifteen samples is took from. Besides, the observation station is where only the observation was conducted and geomorphology station is when geomorphology observation was completed. Moreover, thin section station is the station where petrography analysis was conduct. There are six samples and were label as F 09, F 10, F 12, F 15, F 16 and F 17. Those samples are from different textures and grain size of granite and also rock that composed of fossil.

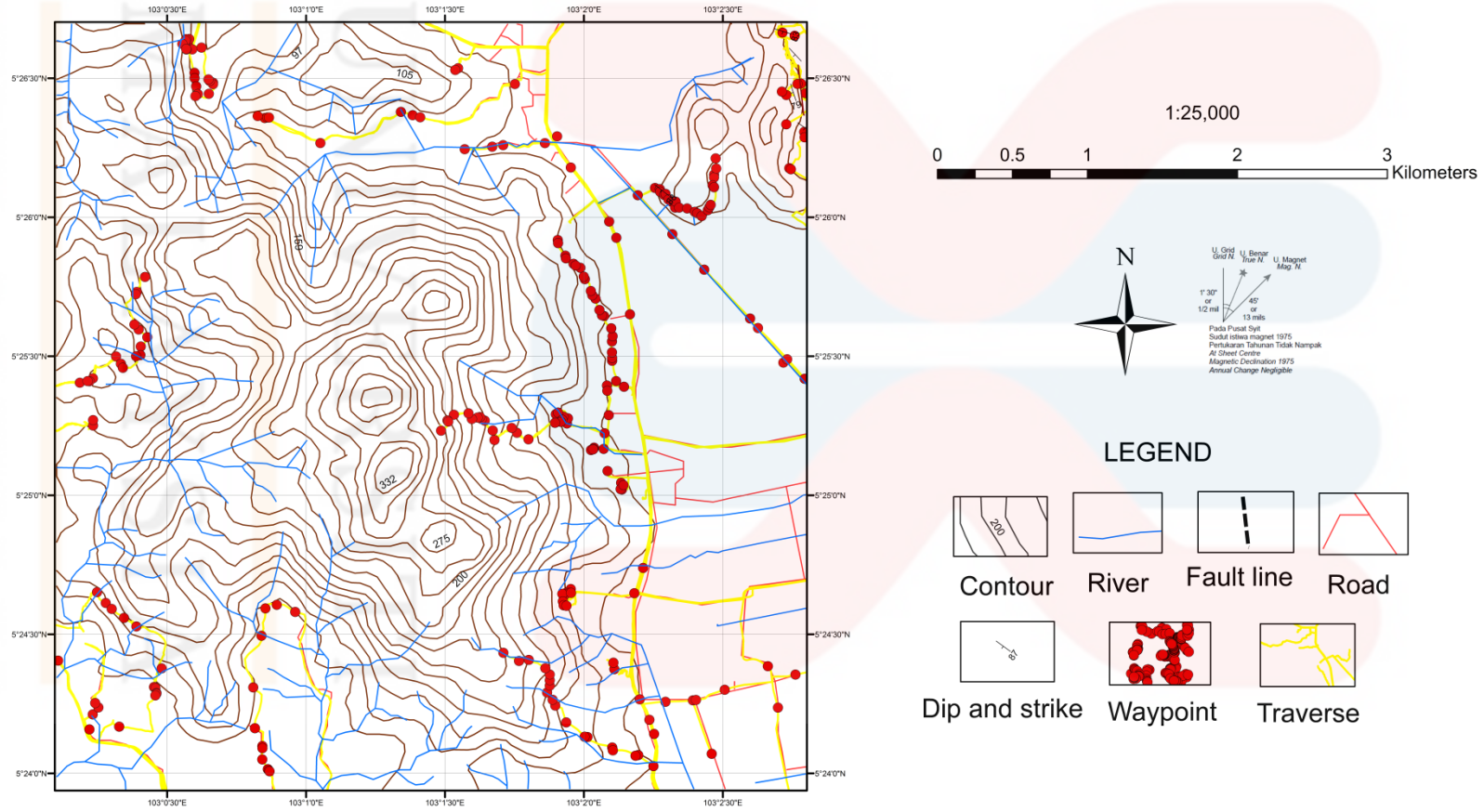


Figure 4.3: Traverse map of study area

4.2 Geomorphology

Scientifically, geomorphology is focused on earth's topographic features such as the study of the surface of the earth, the process behind the formation, the landscape and landform of the earth topography. Additionally, geomorphology also involved erosion, weathering and deposition of the resulting rock through stream, glacial and wind. As well in geomorphology there are several parts that included such as topography, weathering process, drainage pattern, watershed and variety of landform that can be observed.

4.2.1 Topography

Referring to the table above the classification for relief elevation by Van Zuidam (1985) stated that geomorphology is the study of relationship between lanfrom process in spatial arrangement, the process and the geomorphological landform. Also, certain factors such as study area, landscape, type of lithology influenced the tectonic or the geological structure. Thus, parameters used to clarify the relief are determined by numerical in elevation as above. Hence for the study area there are three reliefs determined such as low relief for low lying plain, medium relief for low hill and hill as the elevation in the study area is between 5-330 meters from the sea as shown at Figure 4.3.

Table 4.1: Classification for Relief Elevation, Sources: Van Zuidam (1985)

Relief/ Landform	**Elevation (Meters)**
(1)	(2)
Low Land	<5
Low Lying plain	5-100
Low Hill	100-200
Hill	200-500
High Hill	500-1500
Mountain	1500-3000
High Mountain	>3000

4.2.2 Landform

Landform is a part of terrain topographies on the earth's surface and there are also four major categories of landforms such as plateaus, mountain, hills and plains. Canyons, buttles, basins and valleys is the example of minor landform. Additions, landforms are created due to plate tectonic movement that occurred beneath the earth surface by pushing hills and mountains.

Low relief morphology unit landform consist characteristic of low topographic with elevation of 5 to 100 in from sea level for low laying plain. As shown in Figure 4.4 the low laying plain morphology. Rock distribution at the relief mainly composed of granite in form of boulder and also mainly metasandstone with interbeded shale and minor in slate. Commonly it also composed of sand, clay and silt as it widely spread in flat river valleys. These distributions of rock can be seen at paddy field, lake and also at residential area near by the ocean.

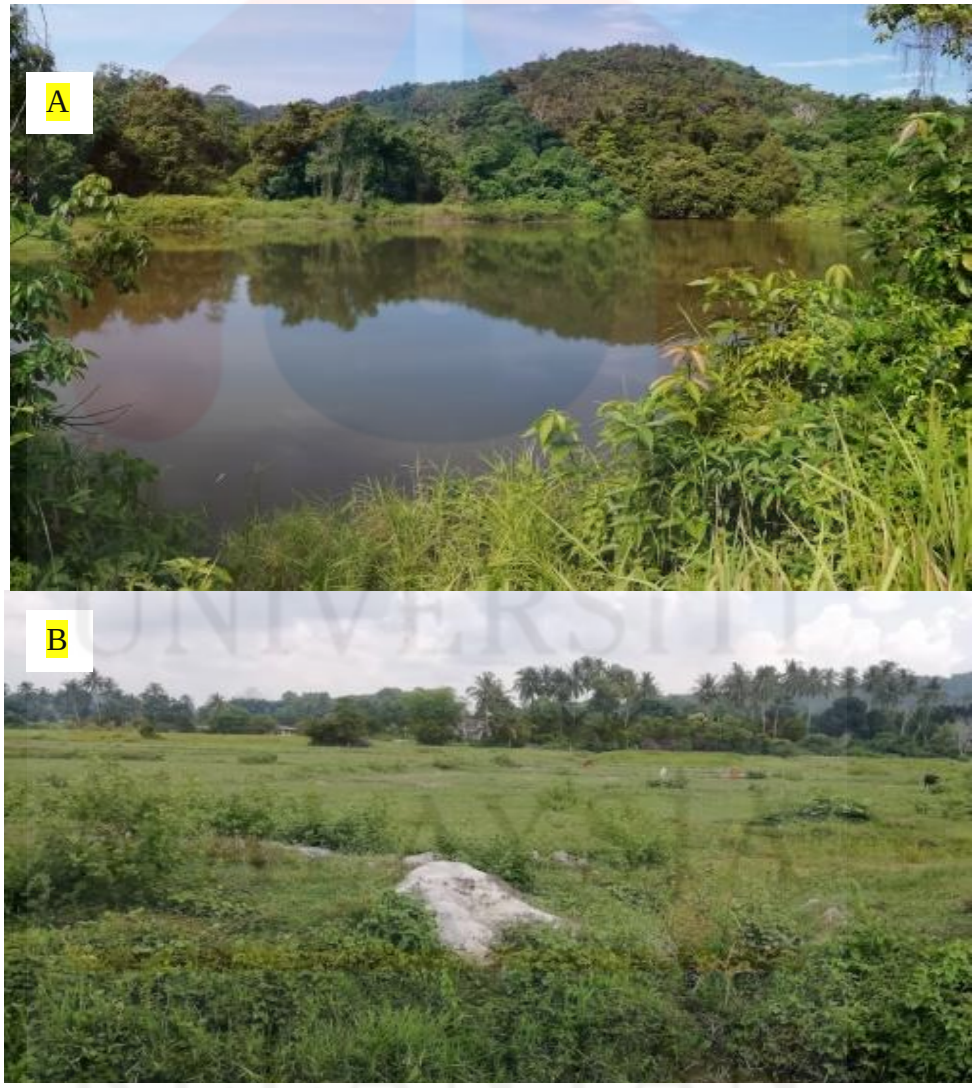


Figure 4.4: shows the low laying plain morphology of the study area and the distribution of rock can be seen at (A) lake, (B) paddy field.

Medium relief morphology consists of low hill and hill. This topographic texture is from medium to coarse grain and consists of slope where more to moderately steep. Figure 4.5 shows view from Bukit Maras showed the medium relief. This said so because the hill is granite in rock and the vegetation is high. The example of medium relief morphology is Bukit Maras which located in Kuala Nerus, Terengganu where the elevation is 320 metres from the sea level. Bukit Maras is tourist spots in Terengganu for hiking and fantastic view of Kuala Terengganu. At top of Bukit Maras, which is at 320 metres from sea level one able to see three cities in a Kuala Terengganu district.

Figure 4.5: View from Bukit Maras, showed the medium relief for low hill and hill with latitude of 5.42158500 and longitude of 103.02641300

4.3 Weathering

Weathering is a process that involves chemical, physical and biological in order to achieve the alteration of rock however the rock mass maintain in situ. Weathering slightly different from erosion as erosion is a process where transportation and degradation process occurred. Therefore, in weathering there are three types such as physical, biological and chemical weathering.

4.3.1 Physical weathering

As shown above in Figure 4.6 shows the example of of physical weathering that occurred in the study area. Physical weathering causes the disintegration of rock by physical process where involved the breakdown of rock into its constituent minerals with any rock forming minerals. Also the contraction of rock and thermal expansion is the principle of physical weathering. In addition physical weathering does not involve any chemical change in rock forming mineral unlike chemical weathering where the alteration of mineral occurred.

Figure 4.6: Physical Weathering

4.3.2 Biological Weathering

Biological weathering is a process of weathering that caused by living things such as animals and plants. As shown in Figure 4.6.1 biological weathering is also known as organic weathering. This is said so because animals and plants release acid forming chemicals that can caused weathering and also able to contribute to the disintegration of landforms and rocks. In addition, there are two types of biological weathering which is organic compounds and chemicals. Moreover, the examples of biological weathering easily can be found when trees put down roots through cracks or joints in the rock to find moisture. Roots gradually hold the rock apart as trees grows.

Figure 4.6.1 Biological weathering

4.3.3 Chemical Weathering

A process where alteration of mineral composition occurred either the mineral composition is redistributed or changed because of the thawing of water between cracks and fissures within rock, growth of plants and living organism in rock or the alternate freezing due to pressure release upon rock by erosion of overlaying materials. Also the rock minerals are exposed to hydration, oxidation, solution and carbonation. As shown above, Figure 4.6.2 shows the exfoliation that occurred on igneous rock. Exfoliation is mutual in area that moderate rainfall as it is the separation of succeeding thin shell from massive rock such as basalt or granite. Likewise, the thickness can be from a few millimetres up to few metres.

Figure 4.6.2: Figure (a) is the exfoliation that occurred on igneous rock.

4.3.4 Mass Wasting

Mass wasting is the geomorphic process where sand, rock, soil and regolith move downslope as a solid whether discontinuous or continues mass. It full fills the characteristic of mudflows and debris flows and it also under the force of gravity. Creeps, flows, falls and slides are the main classes of mass wasting. These classes based on quantity of water and the speed of rock or sediments moves. Slumps and creeps shared the same causes. However the different between slump and creeps is slump causes more drastic changes in terrain and moves faster compared to creep as it moves slowly and gradually. Furthermore, slump able to form at hillside or base of mountain slope when it is eroded away during construction or by water. While, the sliding of rock material down a mountain is a rockslide. Moreover, unstable slopes and steep commonly have mass movement compared to stable slopes

.

Mass movement is different from mass wasting, this is because mass movement is when weathered rock move down to the slope after rain while mass wasting is the movement of weathered material due to gravity force. However, when the friction on a rock is greater than gravity for several type of slopes the rock will stay and otherwise. As shown in Figure 4.6.3 the slump type of mass wasting as it occurred and full fills the characteristics such as it moves downward due to gravity force and also it form at hillside due to construction or cut by water.

Figure 4.6.3: Slump type of mass wasting with coordinate of latitude 5.40511400 and longitude of 103.00763000

4.4 Drainage pattern

Drainage pattern is a pattern that formed by lakes, river or streams in a particular drainage basin. While drainage basin is a topographic region which a stream receive throughflow, groundwater flows and also runoff. Also, there are four main types in drainage pattern such as rectangular, parallel, and dendritic. Thus, rectangular pattern is formed in areas that consist of very little system of bedding plane, faults and fractures that able to form rectangular network. While parallel type of drainage is a system pattern that caused by steep slopes. Streams are straight because of steep slopes. It also formed in areas of parallel and elongate landforms. Though, most common exist is dendritic patterns where unconsolidated rock can be eroded equally in all directions and the streams does not consist of structure. Dendritic pattern easily identified at gneiss, sedimentary rock, granite and volcanic rock. As shown in Figure 4.6.4 it is the type of dendritic patterns in red circle. A dendritic pattern showed a look like branching pattern of tree roots. This dendritic pattern is develops in region that underlain with homogenous material.

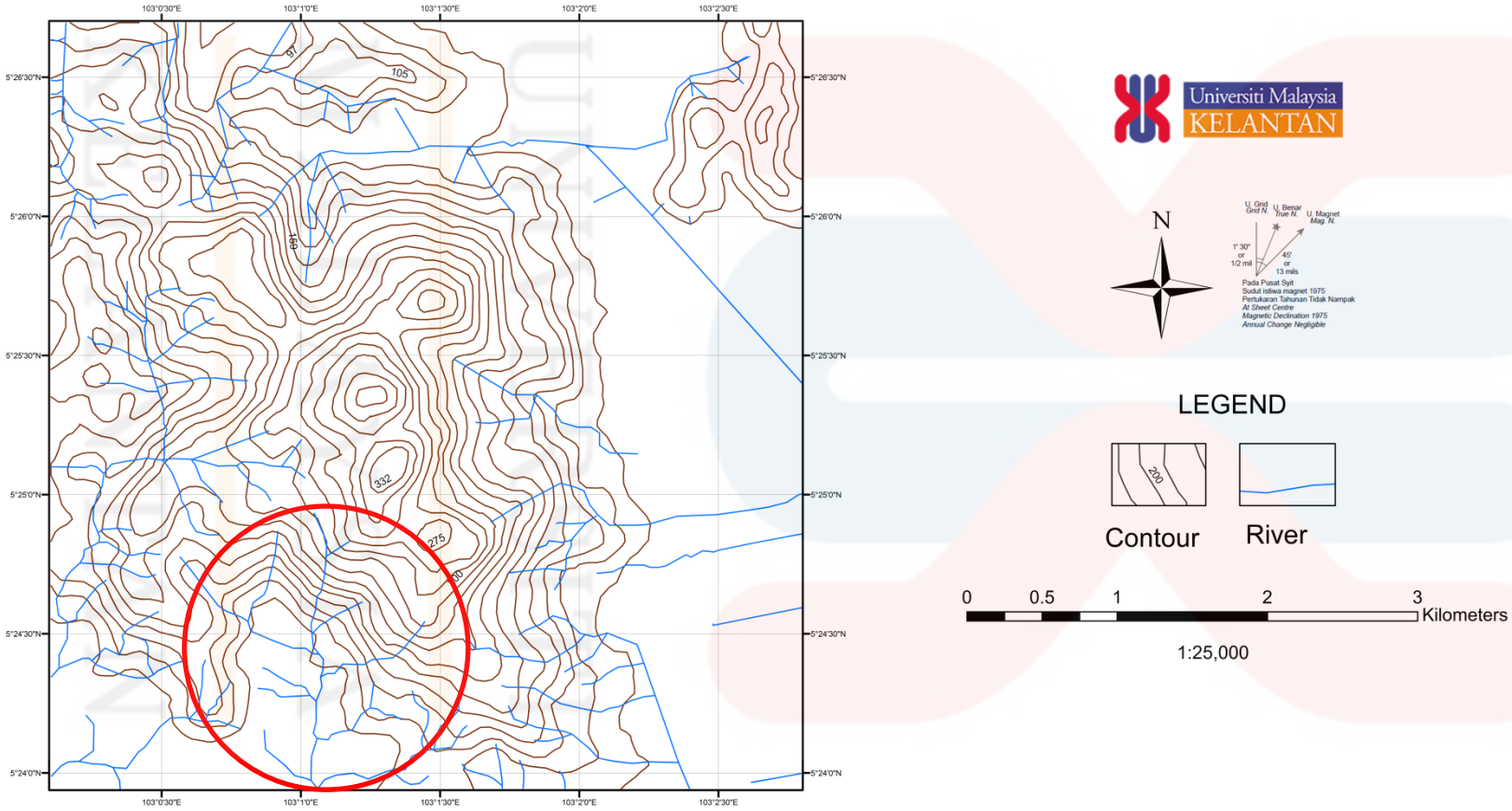


Figure 4.6.4: Drainage Pattern of the study area show dendritic in type (red circle)

4.5 Lithostratigraphy

Lithostratigraphy can be defined as the formation that lithological of stratigraphic unit which are traceable and mappable. Therefore, in my study area there are three type of lithology that consist of mainly metasandstone with interbeded shale and minor slate, minor acid intrusion of igneous and alluvium. Generally, lithology of the study area consist of igneous and sedimentary rocks that can be interpreted through geological map before went to site to collect the rock samples in order to determine the lithology unit and the boundary between igneous and sedimentary rock.

As the study area is in the scale of 1:25 000, lithology of rock unit shown at Figure 4.6.5 The geological map and the cross section of the study area where red colour indicated for igneous rock and sedimentary rock coloured with green colour. Also, Table 4.2 showed the stratigraphy of the study area which consist of three different ages in period where from early carboniferous to late cretaceous to late carboniferous to quaternary as quaternary is the youngest strata and the early carboniferous period is the oldest strata. In addition, the types of rock as the rock sample are showed from Figure 4.6.6 to Figure 4.7.0. These rock samples mainly represent the rock unit in the study area.

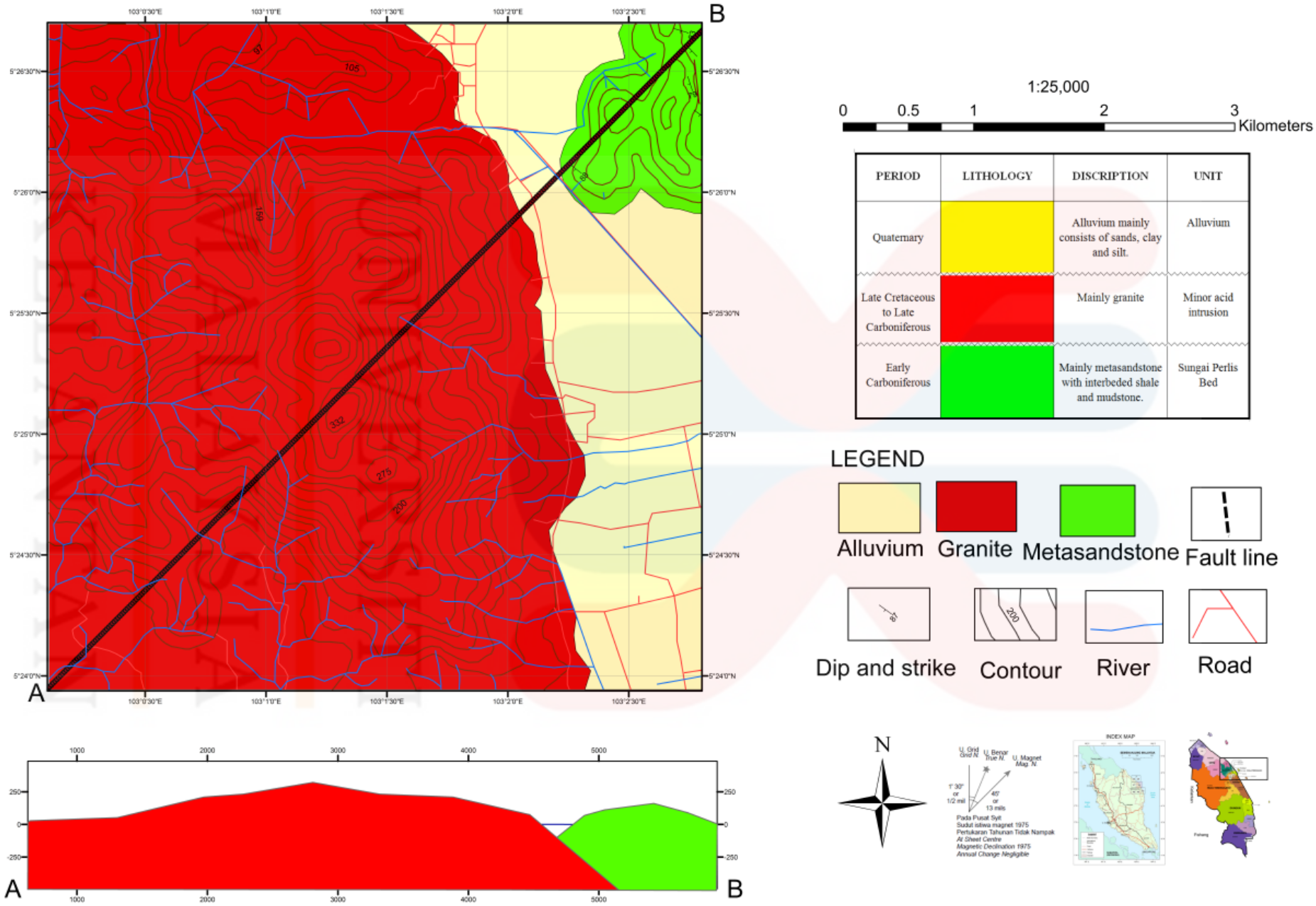


Figure 4.6.5: The geological map and the cross section of the study area

4.5.1 Stratigraphy

PERIOD	LITHOLOGY	DISCRIPTION	UNIT
Quaternary		Alluvium mainly consists of sands, clay and silt.	Alluvium
Late Cretaceous to Late Carboniferous		Mainly granite	Minor acid intrusion
Early Carboniferous		Mainly metasandstone with interbeded shale and mudstone.	Sungai Perlis Bed

Table 4.2: The stratigraphy of the study area

4.5.2 Description of unit

Based on the Figure 4.5 above, there are three units in the interior the study area that able to identify. Those are alluvium, minor acid intrusion and also Sungai Perlis bed. According to (Ellen beger, 1975), Principle Superposition can define as at the time of the formation of one of the highest stratums, the stratum below it had developed a firm consistency. At the time of the formation of any stratum, the superincumbent material was completely liquid. Therefore, at the time of the formation of the lowest stratum, none of the higher strata existed.

Thus, between three units Sungai Perlis Bed is the oldest since it is deposited in the period of Early Carboniferous. This is because Sungai Perlis bed is in the period of early carboniferous as according to (Chand, 1978). The type area is catchment areas of Sungai Perlis, Sungai Angka, Sungai Jengka and Sungai Paka. For the boundaries, the top and base are not exposed and the thickness is probably around 1500 m. The lithology for Sungai Perlis bed is mainly composed of carbonaceous slate, phyllite and schist, argillite together with minor lenses of quartzite, meta-conglomerate and calc- silicate hornfels. Thus in Bukit Bucu area it mainly composed of metasandstone with interbeded shale and minor slate. Moreover, Sungai Perlis bed has correlation with Charu Formation in the age of lower to middle carboniferous.

Thus, for subdivisions it is divided into argillaceous facies, calcareous facies and arenaceous facies. .In addition, the depositional environment is shallow marine and the fossil content are bryozoan such as *Fenestella* sp., brachiopod, crinoid, bivalve and plant such as *Lepidohendron* sp.

Meanwhile, the youngest strata are alluvium unit where it is deposited in the period of quaternary according to Kamaludin *et al.* (1993) , Stauffer (1973), Walker (1955), Ingham and Bradford (1960), Sivam (1969). The lithology are gravel,sand, silt and clay in all possible mixtures, together with peaty sediments, peat and accumulations of partly lignitized wood and logs. Also, in Bukit Bucu area the alluvium mainly consists of sands, clay and silt. It is widespread in flat river valleys. The depositional for alluvium is coastal neither estuarine nor fluvial. The fossil consist are mammals such as Palaeoloxodon namadicus (elephant tooth) palynomorphs (pollen, spores & others), pollen fossil such as *Acanthus* sp, *Aglia* sp and also *Avicennia* sp.

Between the youngest and the oldest deposition in age referring to principle of superposition there is an intrusion occurred in Late Cretaceous to Lower Carboniferous where the intrusion is minor acid intrusion. According to Hutchison (1977) the Late Cretaceous Granite also known along the southern of the Bentong Raub area. It also represent the tectonic disarticulation along the Main Range Belt Rose which virtual to Central Graben since age of Triassic. Besides, granites in Late Cretaceous have high level characteristics and occurred locally. Apparently this

granite were lacking of tin mineralization. The style of mineralization is different in the Main Range and Eastern Belts. This can be described due to their aluminium-rich and silicon- rich rocks of the earth's continental upper crust, the most abundant individual rock being granite and also from tectonic history.

Figure 4.6.6: Granite (Igneous rock)

The name of rock is granite, the colour is grey and consists of white colour. The grain size is course to fine grain and the composition of mineral mainly composed of quartz and the type of rock is Igneous rock.

Figure 4.6.7 Granite (Igneous rock)

The name of rock is granite, the colour is grey and consists of white and light colour. The grain size is course grain and the composition of mineral mainly composed of quartz and the type of rock is igneous rock.

Figure 4.6.9: Shale (Sedimentary rock)

The name of rock is shale, the colour is grey and consists of white and black colour. The grain size is fine grain and the composition of mineral mainly composed of quartz and the texture is clastic rock. Thus, the type of rock is Sedimentary rock.

Figure 4.7.0: Meta- mudstone (Sedimentary rock)

The name of rock is meta- mudstone, the colour is brown, red, white and black. The grain size is medium to coarse grain and it consists fossil.

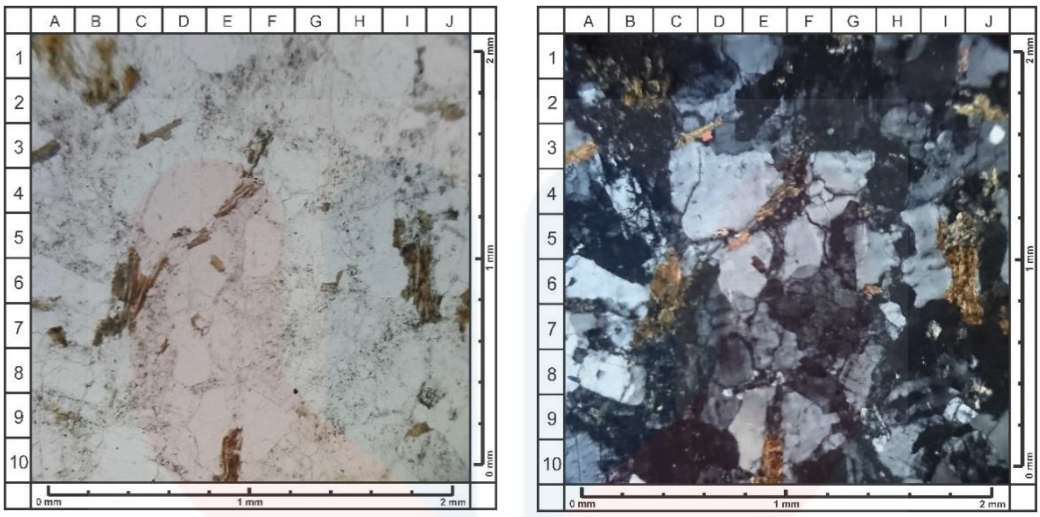


Figure 4.7.1: Petrography analysis of sample F09

From Figure 4.7.1 shows the petrography analysis of sample F09 at latitude of 5.44134700 and longitude of 103.04636500. Next, (A) shows the plane polarized light (PPL) while (B) shows cross plane polarized (XPL) and the rock name is Quartz Wacke, (Petijohn, 1975). For mineralogy description, the mineral compositions consist of quartz, biotite, silica clay and opaque mineral. Between all, quartz is the highest content of mineral composition by 65 percent and Quartz can be observed at (D4) the milky white colour at (PPL). The relief is low without cleavage. Pleochroism is low, the shape in anhedral, followed by silica clay for 26 percent and can be seen in (PPL) in milky white colour at (C1) and at (XPL) was in black colour. No relief and no pleochroism and the shape is crystal also the cleavage cannot seen.

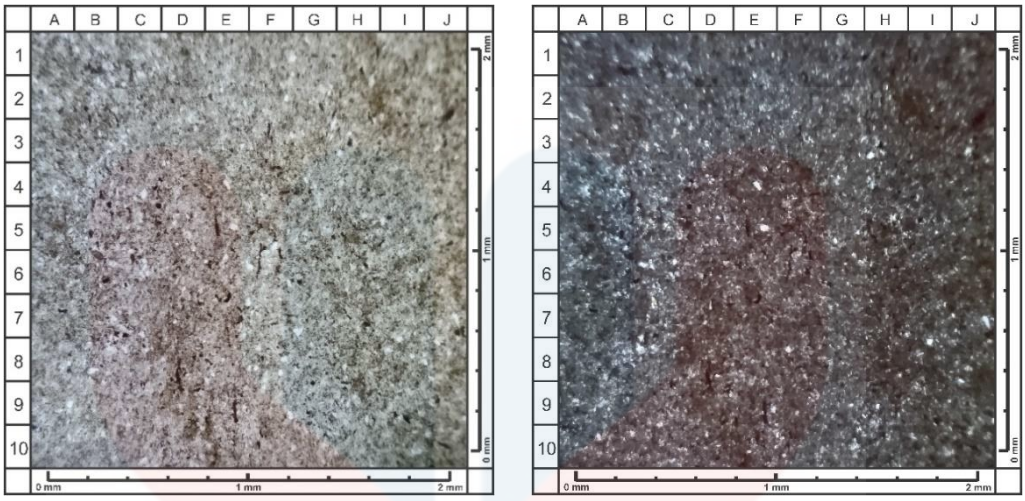


Figure 4.7.2: Petrography analysis of sample F10

Next, Figure 4.7.2 shows the petrography analysis of sample F10 at latitude of 5.44440600 and longitude of 103.04524300. Next, (A) shows plane polarized light (PPL) while (B) shows cross plane polarized (XPL) and the name rock name is Meta Mudrock given by Petijohn (1975). For mineral composition, it consists of quartz, silica clay and opaque mineral. Between those minerals silica clay consist of 88 percent where in (PPL) can seen in milky white colour at (A1) and at (XPL) was in black colour. No relief and no pleochroism and the shape is crystal also the cleavage cannot seen.and followed by quartz where consist of 10 percent and the quartz can be observed at (E4) the milky white colour at (PPL). The relief is low without cleavage. Pleochroism is low, the shape in anhedral.

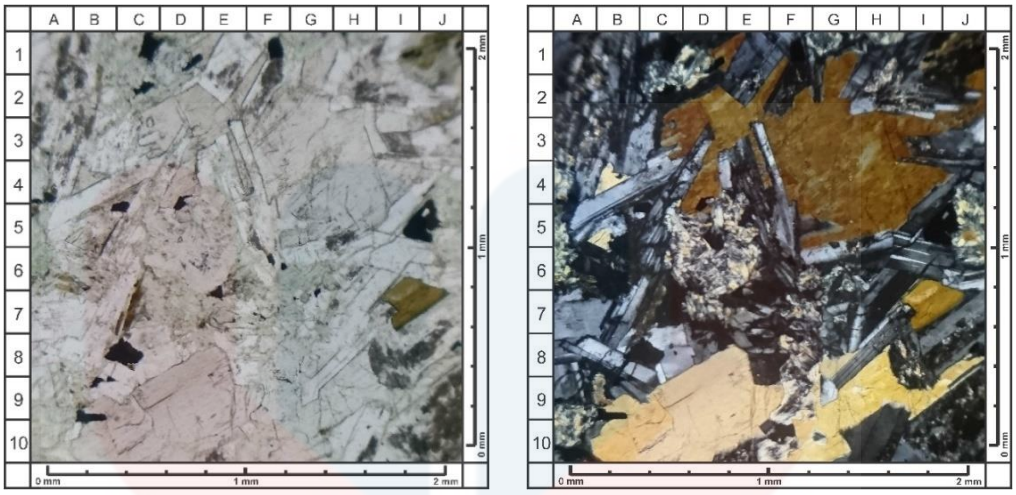


Figure 4.7.3: Petrography analysis of sample F12

Furthermore, from Figure 4.7.3 shows the petrography analysis of sample F12 at latitude of 5.41007200 and longitude of 103.03211800. (A) shows the plane polarized light (PPL) while (B) is Cross Plane Polarized (XPL) thus name of the rock is Meta Andesite referring to O'dunn & Sill (1986). For mineral composition in F12 it consists of pyroxene-orto, sericite clay, amphibole and basic mass. Between those mineral composition, the most abundant percentage basic mass which is 48 percent where Light colour in (PPL) can be seen at (A3) and dark colour in (XPL). Consist of quartz microlites, feldspar microlites and volcanic glass and were spread in existence and it followed by sericite clay by 47 percent where sericite clay shown at (D6), in (PPL) white brown colour while in (XPL) is red brown. Low relief, medium in pleochroism and anhedral crystal in shape.

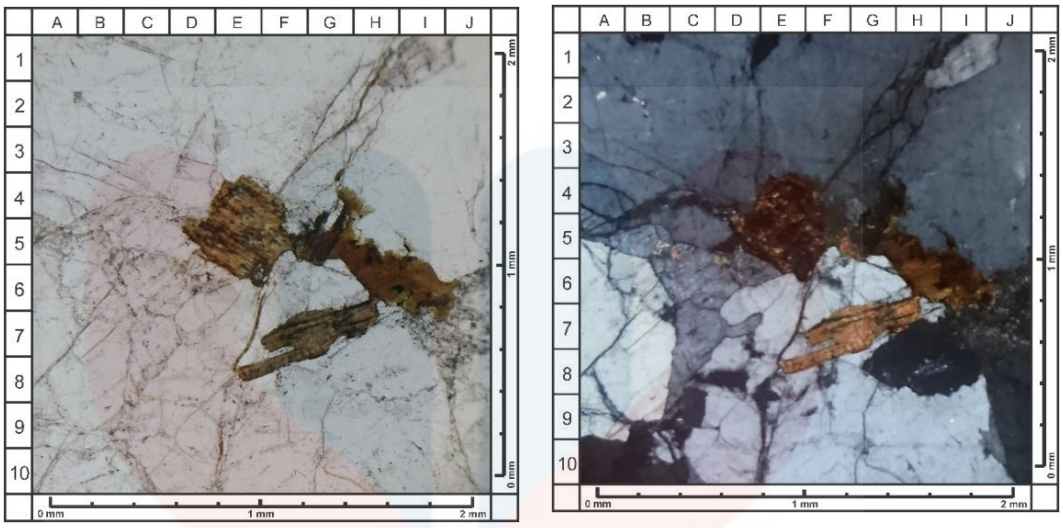


Figure 4.7.4: Petrography analysis of sample F15

Furthermore the next Figure is 4.7.4 where the petrography analysis of the sample F15 is at latitude of 5.44131300 and longitude of 103.01108900. (A) shows the plane polarized light (PPL) while (B) is the cross plane polarized (XPL) and the name of the rock is Quartz Arenite according to Petijohn (1975). For mineral composition, this sample consist of quartz, biotite and silica clay. Thus, the highest content is quartz by 87 percent where quartz can be observed at (A1) the milky white colour at (PPL). The relief is low without cleavage. Pleochroism is low, the shape in crystal anhedral and followed by biotite with 8 percent where biotite can be seen at (G7) where the colour is dark brown in (PPL) while in (XPL) it is in orange to light red brown. It also has high relief and the pleochroism is medium. Also, it is one direction of cleavage and the shape is subhedral.

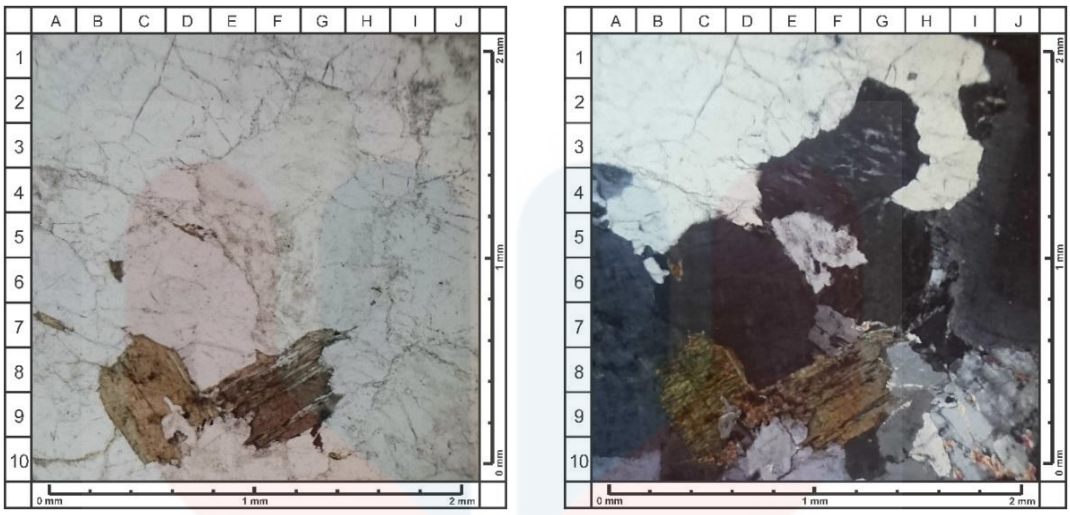


Figure 4.7.5: Petrography analysis of sample F17

Moreover, the Figure 4.7.5 shows the petrography of sample F17at latitude of 5.4489300 and longitude at 103.00946200. Thus, (A) shows the plane polarized light (PPL) while (B) shows the cross plane polarized (XPL) and the rock name is quartz rich Granitoid according to Streckeisen (1976). Therefore, for the mineral composition it consist of plagioclase with 10 percent where Plagioclase shown at (F7) and in (PPL) displayed light colour while in (XPL) light milky red, suvhedral – euhedral in shape, medium pleochroism,one direction in cleavage and were spread existence in thin section as phenocryst and basic mass and quartz with 82 percent which the abundance mineral in mineral composition and biotite consist of 8 percent where Biotite can be seen at (F9) where the colour is dark brown in (PPL) while in (XPL) it is in orange to light red brown. It also has high relief and the pleochroism is medium. Also, it is one direction of cleavage and the shape is subhedral.

4.6 Structural geology

Structural geology is a part of geology that discussed about the primary and secondary structure that involves in an area. Primary structure geology is the structure that formed during or after deposition of sedimentary rock or formation of igneous rock. Additionally, the example of primary structure is due to occurrence of tectonic such as faulting and folding. While the secondary structure is a structure that formed after or later than primary structure such as mud crack, slump structure, lamination and others. This is because from the structure that occurred stress and strain can be calculated and determines in order to determine the direction of biggest force that has being applied. Other than that, structural geology also can determine the sources of petroleum and mineral sources which is importance in economic geology.

Discussion of structural geology in study area counted in of geological structure that were found in field such as regional stratigraphy, type of structure and the interpretation of the geological structure. Those are sated as follows:

- Slump structure
- Mud crack
- Lamination
- Systematic and non-systematics joint
- Faulting (Reverse fault)

As shows in Figure 4.7.6 where secondary structure geology known as slump structure is a soft sediment deformation structures that develop at deposition during the first stage of sediment consolidation. Also, the structures commonly can be found at places such as at shallow marine, turbidity current, deltas and rivers. This said so because those environments consist of high rate in deposition where sediments are allowed to pack loosely. Other than that, slump structure mainly found in mudstone and in sandy shale. Slump structures indicated the result of movement and the displacement of unconsolidated sediments. Technically, this structure can be seen at the area of steep slope and it often faulted.

Figure 4.7.6: Secondary structure geology (Slump structure)

Second structure is mud crack or known as desiccation crack. Theoretically mud crack is a sedimentary structure that formed as muddy sediment and the formation also occurred in clay bearing soils as result of reduction in water content because of the exposed towards high temperature and pressure. Hence the environments can be tidal flat or flood plain. Moreover, this mud crack indicated and environment where sediment went dried and wet. Mud crack are showed in Figure 4.7.7 that was found in the study area.

Figure 4.7.7: Secondary structure geology (Mud crack)

Lamination or lamina can be defined as a fine thin layer with a scale of 1 millimetre thick and normally can be found at fine grained sedimentary rock such as sandstone, siltstone and shale. Furthermore, lamination cultivates when fine grained particles settled where it only occurred in coastal environment. This is said so because the separation between grains of different size are caused by wave energy. Figure 4.7.8 showed the lamination of sedimentary rock that occurred at shale at Bukit Bucu, Terengganu area.

Figure 4.7.8: Lamination of sedimentary rock

Joint frequently found in most each exposure of rock and joint is a fracture that occurred naturally in rock body or layer that caused by tensional forces. The difference between joint and faulting is joint does not have movement while faults have lateral movement that caused displacement.

As well, joint are formed when rocks are overextended to the breaking point where faults are shaped due to the constant of tectonic movement. Moreover, joint can be classified into three major types such as systematic joints, columnar joints or non-systematic joints. Systematic joints can be categorised as parallel or planar that occurred regularly as they formed as a group of joint sets. While columnar joint is a group of joint at triple junctions approximately 120° angles and they split the rock body into columns, prisms or long. Columnar joints type of jointing is a typical shallow dikes, sill and thick lava flows. Furthermore, non-systematics joints are joints that in irregular orientation. Thus, the example for non-systematics joints is conjugate joint.

Therefore, in the study area there are two types of joints which is systematic and non-systematic joint. This proved by through Figure 4.7.9 and 4.8.0. Figure 4.7.9 showed the systematic joint while Figure 4.8.0 is the combination of systematic and non-systematic joint. The result of systematic and non-systematic joint are showed in Figure 4.8.1 and 4.8.2 through rose diagram application. Rose diagram is an application that is used to display the orientation of joints or paleocurrent data in sedimentary structure geology.

Figure 4.7.9: Systematic joint

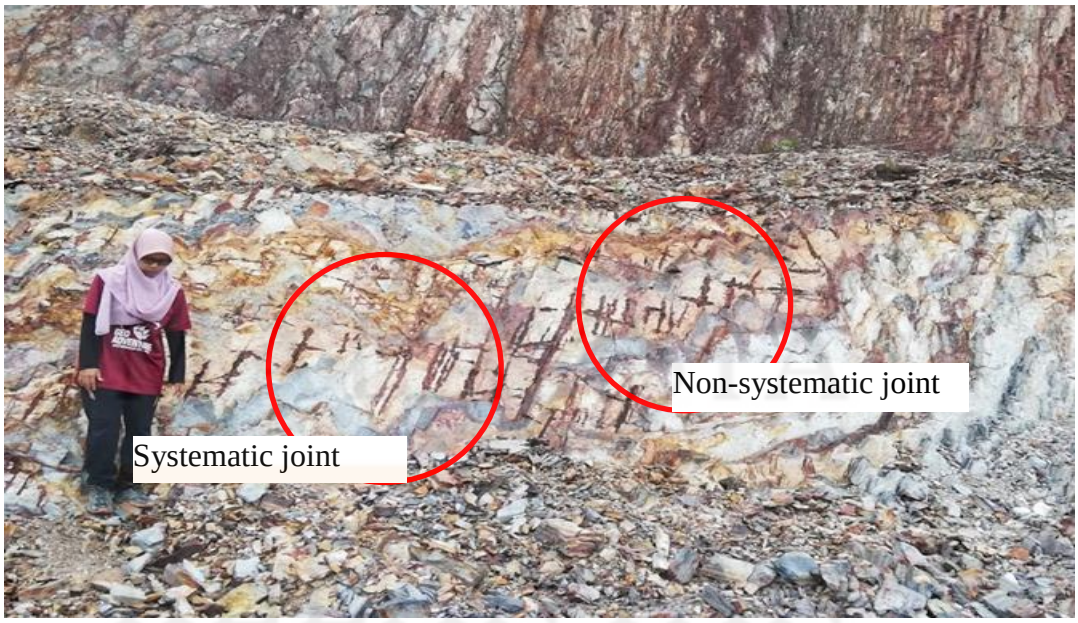


Figure 4.8.0: Systematic and non-systematic Joint

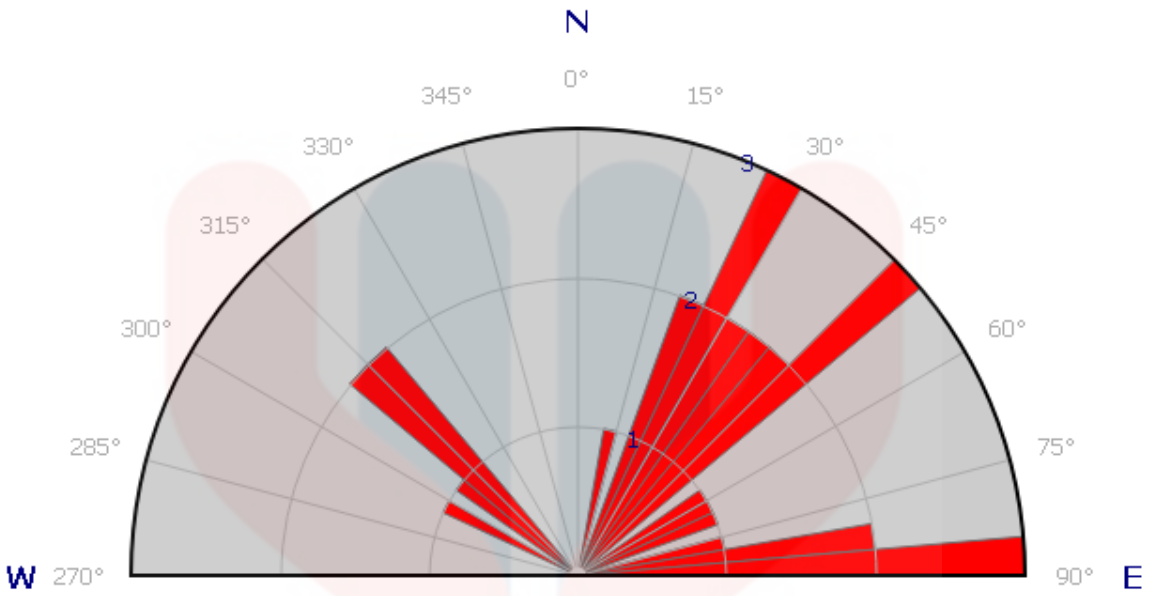


Figure 4.8.1: Direction of systematic joint

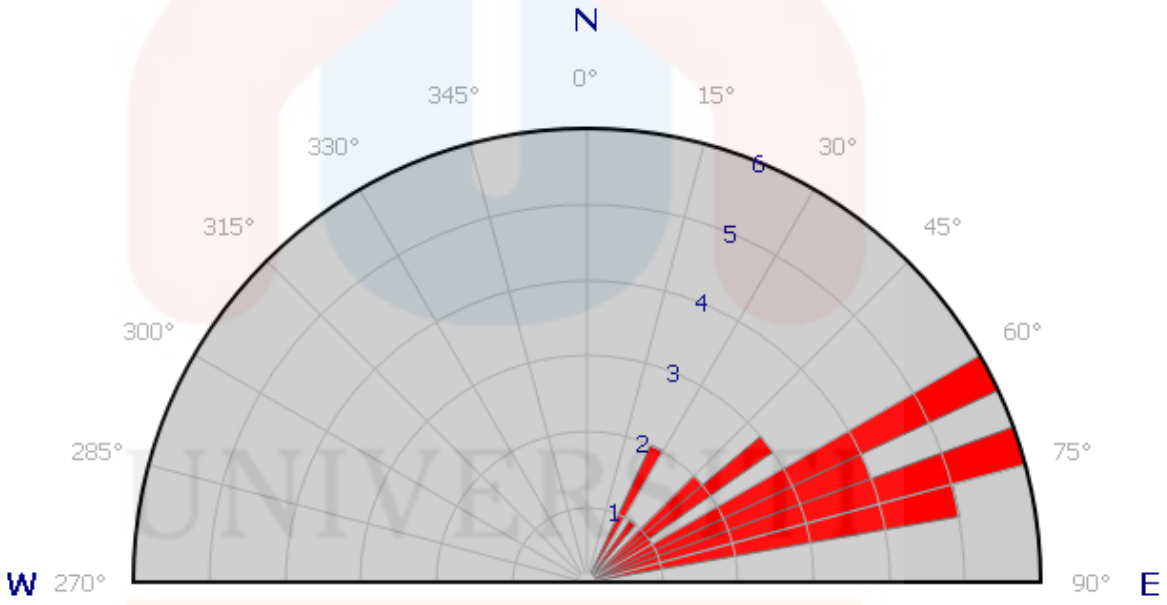


Figure 4.8.2: Direction of non-systematic joint

Previously as mention in joint subtopic, fault is fracture of rock that consist of displacement that caused by tectonic movement. Technically, fault is an example of brittle that response toward stress while fold is ductile that response towards shear strength. In faulting, there are three different types of fault that categorised through hanging wall and footwall displacement and also the degree of displacement. Those three types are normal fault, reverse fault and strike slip fault. A normal fault can be identified when hanging wall is move towards downward as reverse fault is when hanging wall is move upwards and strike slip is when those wall move sideways by meaning not moving up or down. Therefore as shown in Figure 4.8.3 as the hanging wall is move upward thus it is a reverse fault in type.

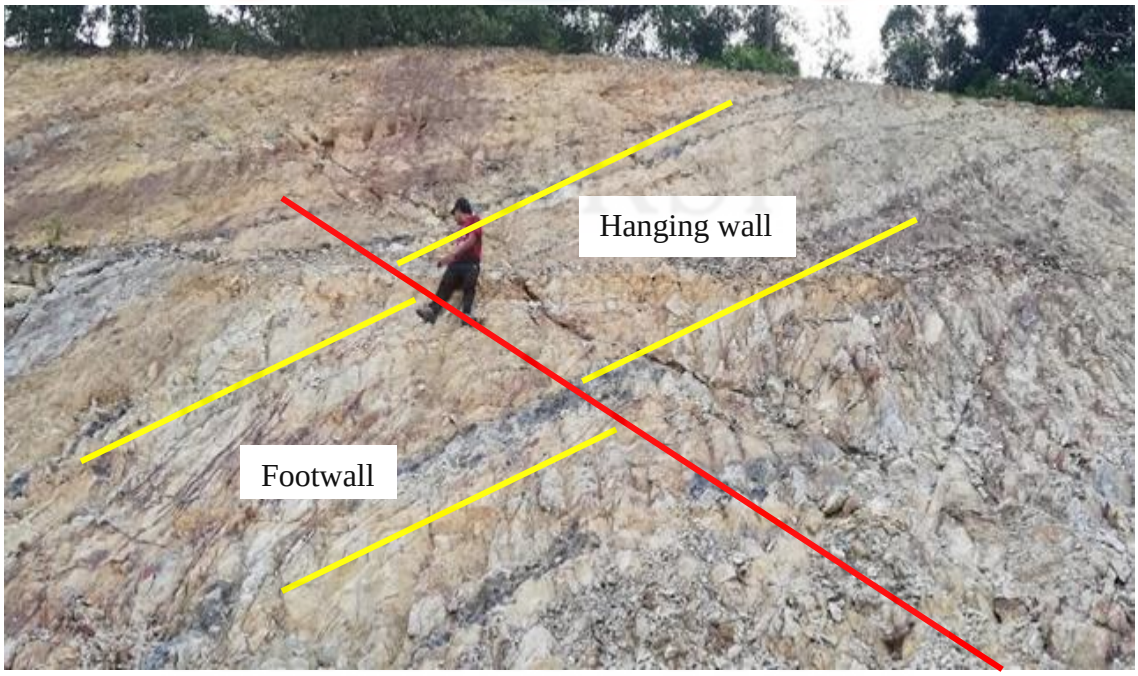


Figure 4.8.3: The Faulting (Reverse fault)

4.7 Historical Geology

Historical geology is to explain the historical of the geological process that occur in an area. In historical geology, it discusses about the tectonic setting and the formation that influence or affluence the geology of an area. Since, the study area is located in Bukit Bucu, Terengganu therefore it has correlation with several formation that related such as Sungai Perlis Bed, Charu Formation, Semantan Fromation of Raub suture. This correlation between those formation prove that Bukit Bucu, Terengganu is in in the period of early carboniferous based on the fossil founds in the area where consist of phylum Brachiopoda, Echinodermata, Mollusca, Trilobita, Bryozoan and Plantae. Lithology in Bukit Bucu area mainly composed of metasandstone with interbeded shale and mudstone and also granite. Also, consists of sands, clay and silt. It is widespread in flat river valleys. Moreover, the depositional of Bukit Bucu study area is shallow marine.

CHAPTER 5

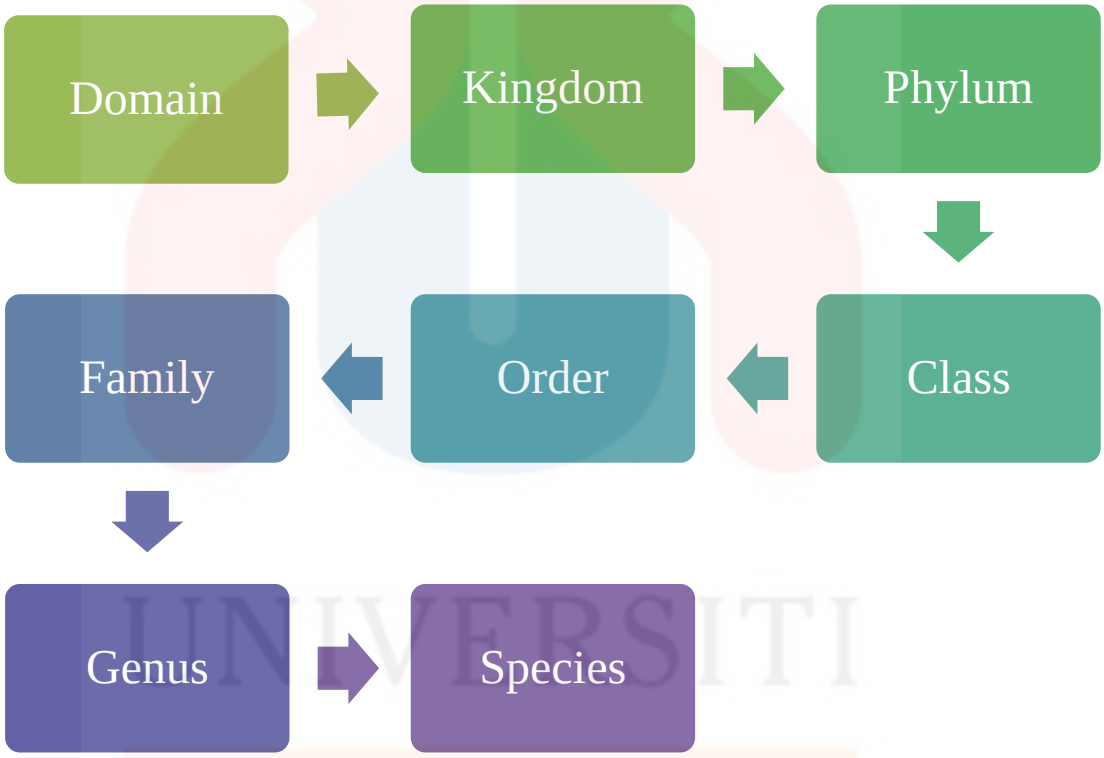
ASSEMBLAGES OF FOSSIL IN BUKIT BUCU

5.1 Introduction

Fossil can be well-defined as naturally preserved body or trace of any once living such as animals or plants from a past geological age. Imprints of the organisms that preserved in sedimentary rocks from earlier geological periods known as fossil record. Fossil record is important because it consist of physical evidence of history of the earth and also the evidence of pre-existing organisms either animal or plants. Also, geoscientist or geologist able to determine the paleo climate of pre-existing organism deposited.

Fossil sampling were done at two different site where the first site is located at N 05’26’27.5’ E 103’02.47’04’ and the second site located at N 05’26’2.68’ E 103’02’38.07’ as shown in Figure 5.21 The fossil location. Those fossil sampling were brought to lab for further identification of fossil then analysis the fossil assemblages and determine the depositional environment. Both locations mention above found at Bukit Bucu, Terengganu that labelled as Locality 1 and Locality 2 as shown in map as Figure 5.1 Subsequent, identification of fossil were based on taxonomy classification of fossil. Taxonomy classification is a ranked system used to

classifying and naming the extinct organisms to the species level based on their shared similarity characteristics as shown in the smart chart below. Additionally, fossils classified based on their similar geometry. In naming organism had to follow the scientific names of entirely organisms based on their genus and specific description according to Linnaean taxonomic rank. Furthermore, the scientific name need to written in italics underlined.



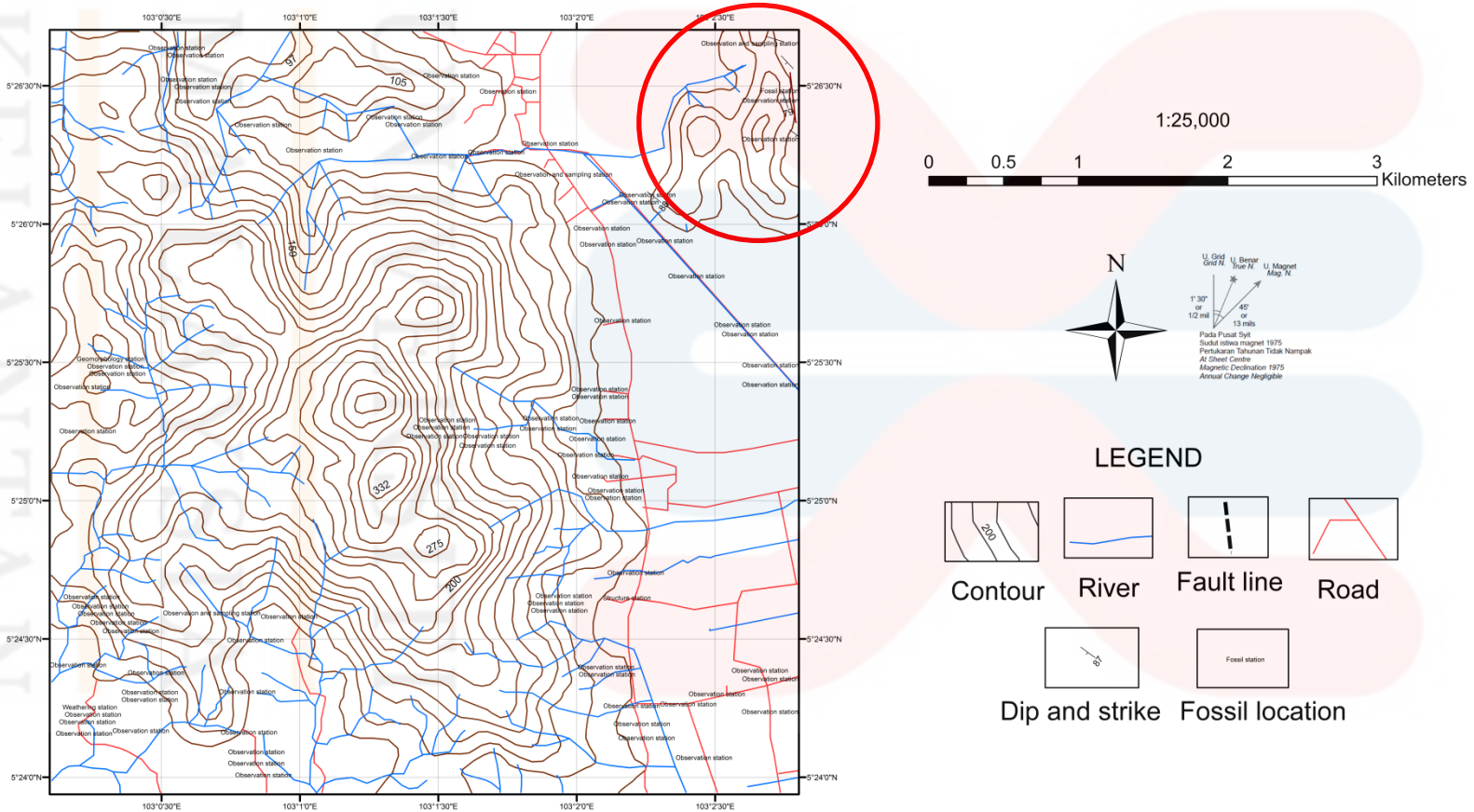


Figure 5.10: Fossil location (red circle**)**

5.2 Fossil Identification

Previously discussed, fossils been identified through their taxonomy rank with their individual characteristic recognized. Numerous sources and reference are used to recognize each and every species. In addition, Figure 5.10 shows fossil location of Bukit Bucu, Terengganu. Therefore, in Bukit Bucu area there are a number of species were found and able to acknowledged as they composed of phylum Brachiopod, Mollusca, Echinoderms, Bryozoans, Trilobite and plant fossils. Those identified fossils found shown as follows in Table 5.1 findings between previous study and this study.

Table 5.1: Findings between previous study and this study

Previous study by Idris & Zaki, (1986)	This study
Brachythyrina strangwaysi	
Chonetinella sp.	
Paladin ophistops	
Paladin veeravurursi	
Edmondia sp.	
Fenestilla retiformes	
'Poterocrinus' sp.	
	Derbyia sp.
	Antiquatonia sp.
	Avonia sp.
	Dictyoclostus sp.

	Buxtonia sp.
	Chonetes sp.
	Euomphalus sp.
	Posidonia sp.
	Myalina sp.
	Aviculopecten sp.
	Fistulipora sp.
	Fenestella sp.
	Fenestella pahangensis Sakagami
	Fenestella plebia
	Fenestella cf. tenax Ulrich
	Batosyoma Jamesi
	Cyathocrinus sp.
	Asterias rubens sp.
	Crinoid stem and stalks
	Phillipsia sp.
	Cryrtosymbole? sp.
	Annularia Stellata
	Lepidodendron sp.
	Calamites
	Cordaites
	Lepidophylloides sp.
	Cordaites principalis

	Stigmaria sp.

Phylum Brachiopoda Class Articulata

Antiquatonia sp. (Plate I, A, B)

Kingdom: Animalia

Phylum: Brachiopoda

Class: Articulata

Genus: Antiquatonia

Species: *Antiquatonia* sp.

Phylum Brachiopoda Unidentified Class

Avonia sp. (Plate I, H)

Kingdom: Animalia

Phylum: Brachiopoda

Family: Portulacaceae

Genus: Avonia

Species: *Avonia* sp.

Brachythyrina strangweaysi (Plate I, E)

Kingdom: Animalia

Phylum: Brachiopoda

Genus: Brachythyrina

Species: Brachythyrina strangweaysi

Dictyoclostus sp. (Plate I, I)

Kingdom: Animalia

Phylum: Brachiopoda

Genus: Dictyoclostus

Species: *Dictyoclostus* sp.

Description of shape:

Dictyoclostus sp. shape consist of concave to convex lamp shell shape and highly ornamented with grooves, lines and were common invertebrate forms in shallow sea.

<u>Phylum Brachiopoda Class Strophomenata</u>

Buxtonia sp. (Plate I, K)

Kingdom: Animalia

Phylum: Brachiopoda

Class: Strophomenata

Order: Strophomenata

Genus: Buxtonia

Species: *Buxtonia* sp.

Chonetes sp. (Plate I, J)

Kingdom: Animalia

Phylum: Brachiopoda

Class: Strophomenata

Order: Strophomenida

Genus: Chonetes

Species: *Chonetes* sp.

Description of shape:

The shell of *Chonetes* sp.is small, one half concave in form and the other is moderately in convex shape.

Derbyia sp. (Plate I, F, G)

Kingdom: Animalia

Phylum: Brachiopoda

Class: Strophomenata

Order: Rhynchonellida

Family: Wellerellidae

Genus: Derbyia

Species: *Derbyia* sp.

Phylum Brachiopoda Class Chondrichtyes

Chonetinella sp. (Plate I, C, D)

Kingdom: Animalia

Phylum: Brachiopoda

Class: Chondrichthyes

Order: Captorhinida

Family: Captorhinidae

Genus: Chonetinella

Species: *Chonetinella* sp.

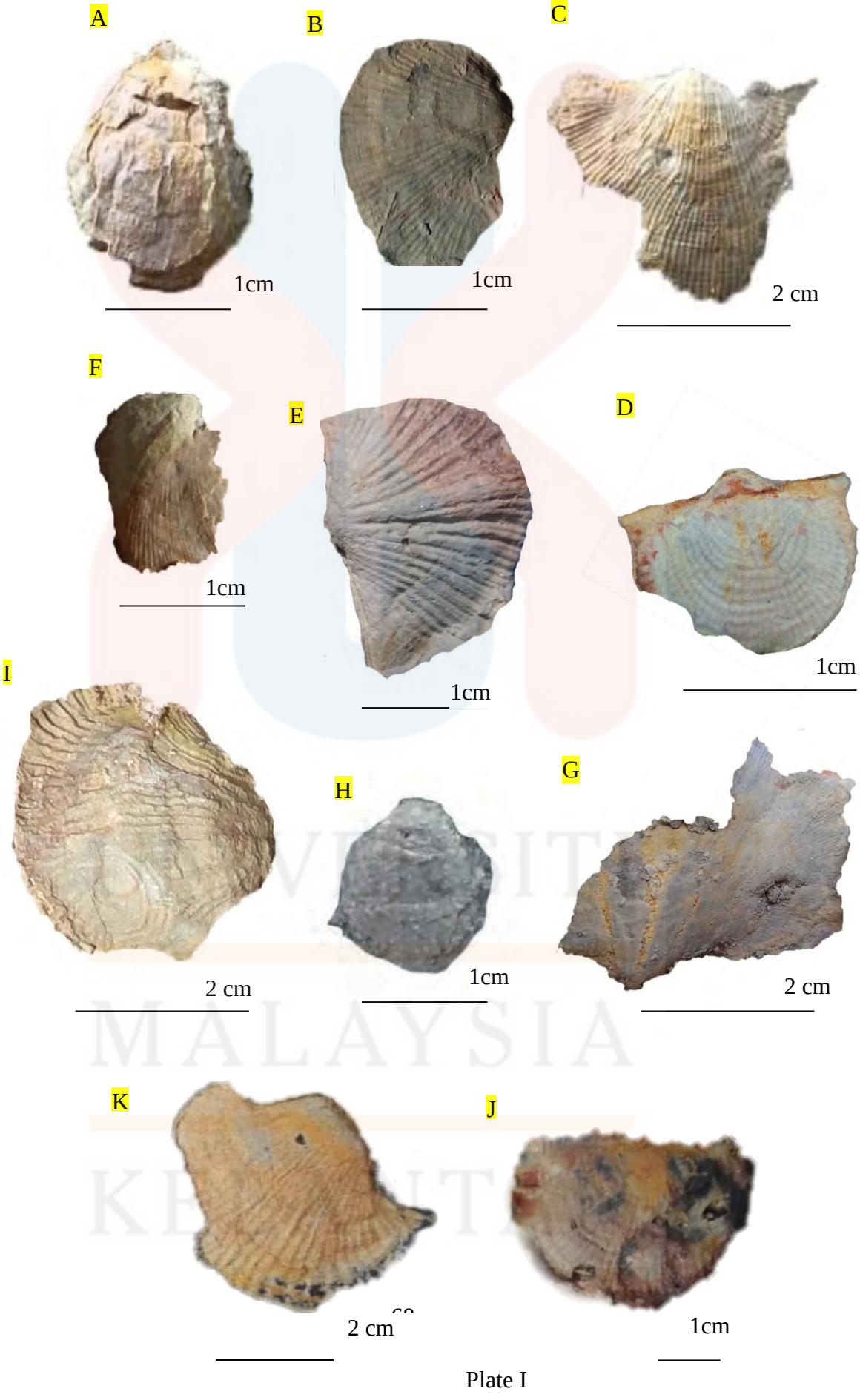


Plate I

Phylum Mollusca, Class Bivalvia

Aviculopecten sp. (Plate II, G)

Kingdom: Animalia

Phylum: Mollusca

Class: Bivalvia

Genus: Aviculopecten

Species: *Aviculopecten* sp.

Myalina sp. (Plate II, A)

Kingdom: Animalia

Phylum: Mollusca

Class: Bivalvia

Genus: Myalina

Species: *Myalina* sp.

Posidonia sp. (Plate II, B)

Kingdom: Animalia

Phylum: Mollusca

Class: Bivalvia

Order: Alismatales

Family: Posidoniaceae

Genus: Posidonia

Species: *Posidonia* sp.

Unidentified sp. (Plate II, C, D, F, H, I)

Kingdom: Animalia

Phylum: Mollusca

Class: Bivalvia

Species: Unidentified sp.

Phylum Mollusca, Class Gastropoda

Euomphalus sp. (Plate II, I,J)

Kingdom: Animalia

Phylum: Mollusca

Class: Gastropoda

Order: Eumphalina

Family: Euomphalidae

Genus: Euomphalus

Species: *Euomphalus* sp.

Description of shape:

Euomphalus is categorized by a closely coiled shell with a slightly preeminent spire and a channel-bearing angulation on the upper surface of the whorls. The lower surface of the whorls is rounded to angular.

Phylum Mollusca, Class Cephalopoda

Edmondia sp. (Plate II, K, L)

Kingdom: Animalia

Phylum: Mollusca

Class: Cephalopoda

Order: Ammonite

Family: Ammonite

Genus: Edmondia

Species: *Edmondia* sp.

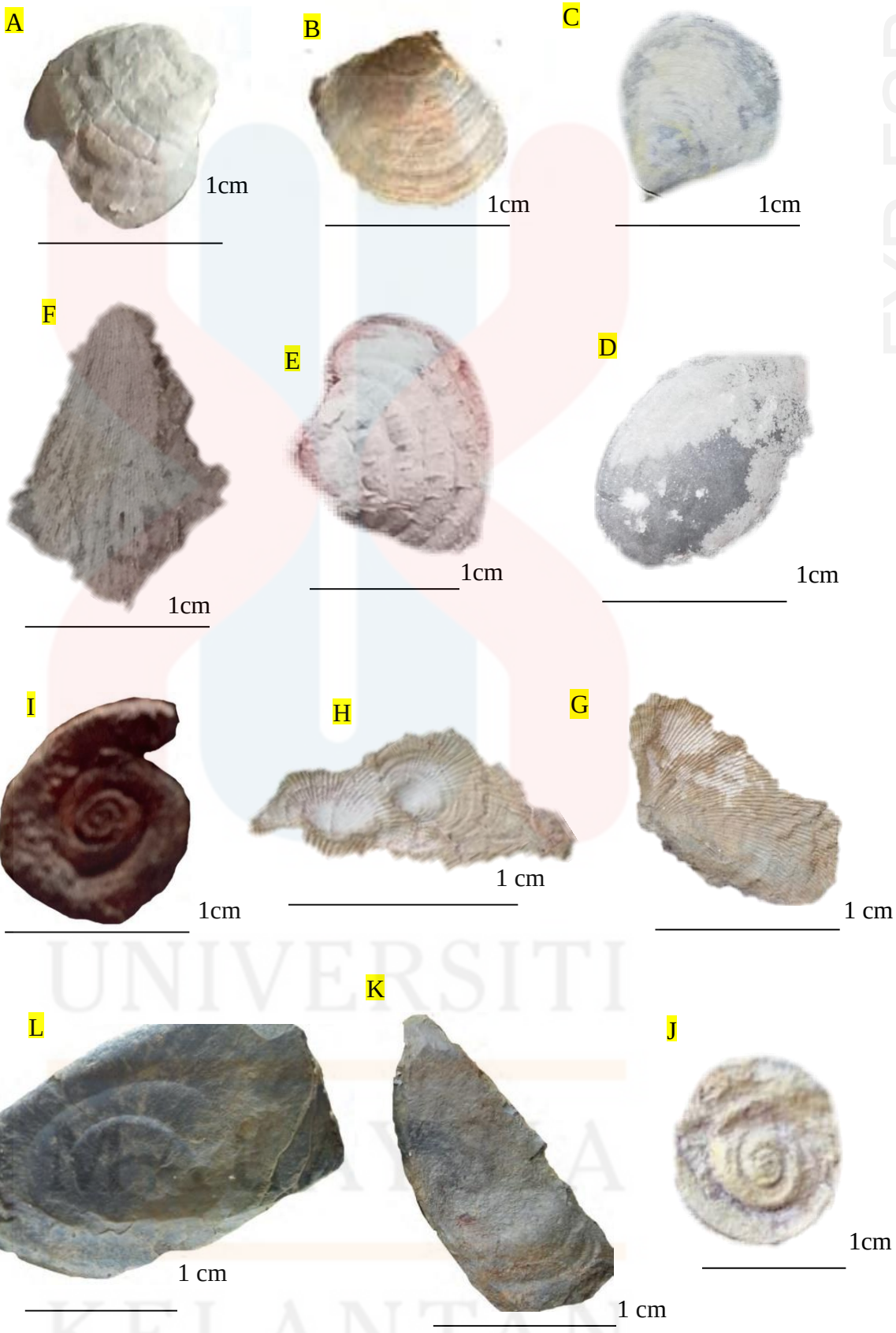


Plate II

Phylum Mollusca, Class Stenolaemata

Batostoma Jamesi (Plate III, E)

Kingdom: Animalia

Phylum: Bryozoa

Class: Stenolaemata

Order: Trepostomatida

Family: Trematoporidae

Genus: Batostoma

Species: Batostoma Jamesi

Description of shape:

The nodules diameter is between 5mm to 10 mm and the nodules is circular to oval where in between of 2mm density also there are numerous nodules can be seen.

Fenestella sp. (Plate III, A, H, I, J, K)

Kingdom: Animalia

Phylum: Bryozoa

Class: Stenolaemata

Order: Fenestrida

Family: Fenestellidae

Genus: Fenestella

Species: *Fenestella* sp.

Fenestella pahangensis Sakagami (Plate III, B)

Kingdom: Animalia

Phylum: Bryozoa

Class: Stenolaemata

Order: Fenestrida

Family: Fenestellidae

Genus: Fenestella

Species: Fenestella pahangensis Sakagami

Fenestella plebia (Plate III, C)

Kingdom: Animalia

Phylum: Bryozoa

Class: Stenolaemata

Order: Fenestrida

Family: Fenestellidae

Genus: Fenestella

Species: Fenestella plebia

Description of shape:

Fenestellidae is a family of Bryozoans having order of Fenestrida. The skeleton of its settlements comprises of solid branches that are interconnected by narrower crossbars. Zooids inhabit one side of the branches in two parallel columns or two at the branch base and at least three lines further up. Zooids can be identifying as small rimmed pores and in well-preserves sample. The front of the branches conveys small nodes in zigzag line between the apertures.

Fenestella cf. tenax Ulrich (Plate III, D)

Kingdom: Animalia

Phylum: Bryozoa

Class: Stenolaemata

Order: Fenestrida

Family: Fenestellidae

Genus: Fenestella

Species: Fenestella cf. tenax Ulrich

Fistulipora sp. (Plate III, F)

Kingdom: Animalia

Phylum: Bryozoa

Class: Stenolaemata

Order: Cystoporida

Family: Fistuliporidae

Genus: Fistulipora

Species: *Fistulipora* sp.

Fenestella retiformes (Plate III, G)

Kingdom: Animalia

Phylum: Bryozoa

Class: Stenolaemata

Order: Fenestrida

Family: Fenestellidae

Genus: Fenestella

Species: Fenestella retiformes

Description of shape:

Fenestella retiformes can be identified by the netting shape that forms on Fenestella.

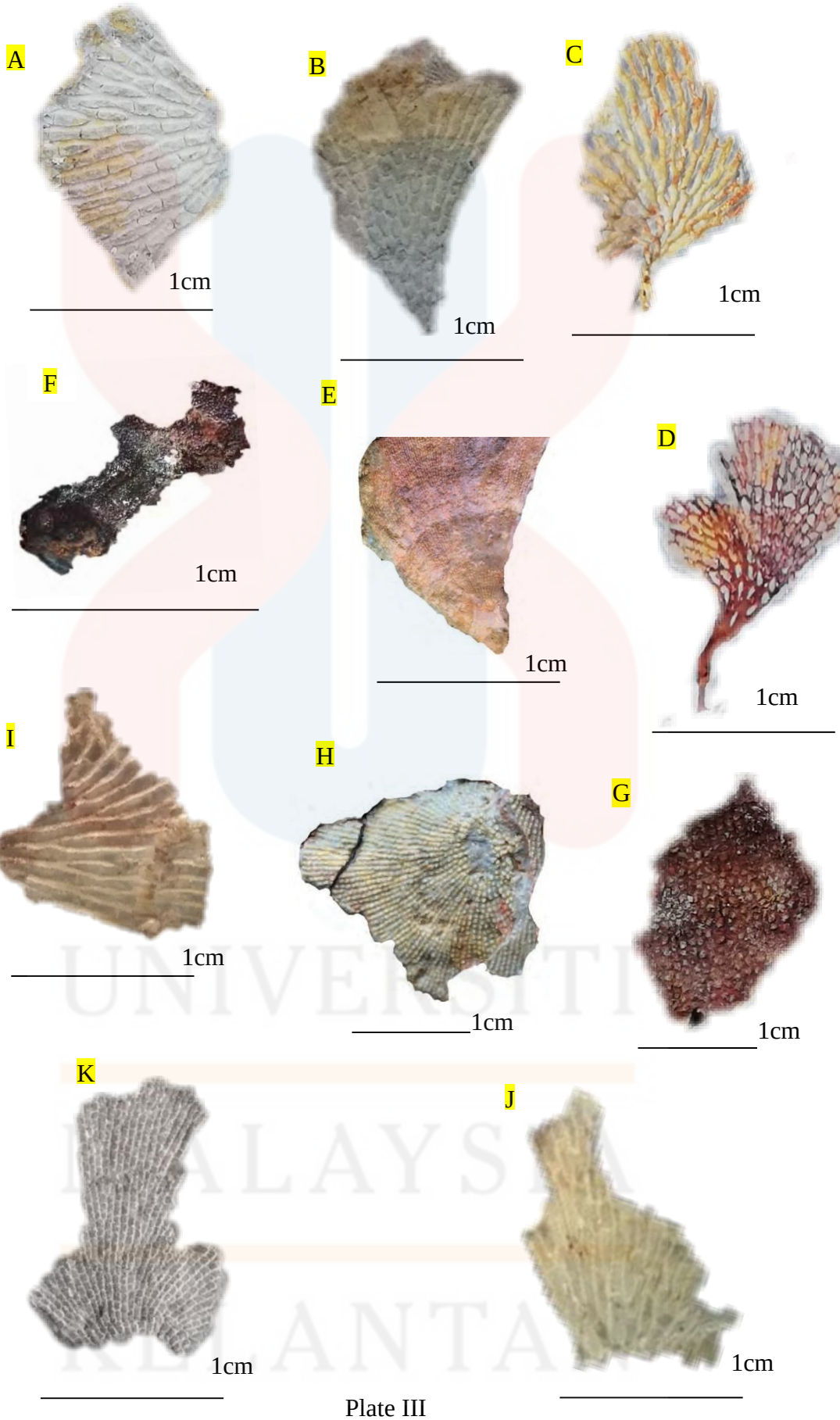


Plate III

Phylum Echinodermata, Class Crinoidea

Cyathocrinus sp. (IV, A)

Kingdom: Animalia

Phylum: Echinodermata

Class: Crinoidea

Order: Cladida

Family: Cyathocrinitidae

Genus: Cyathocrinus

Species: *Cyathocrinus* sp.

Poterocrinus sp. (IV, B)

Kingdom: Animalia

Phylum: Echinodermata

Class: Crinoidea

Species: *Poterocrinus* sp.

Phylum Echinodermata, Class Asteroidea

Asterias rubens (IV, C)

Kingdom: Animalia

Phylum: Echinodermata

Class: Asteroidea

Order: Forcipulatida

Family: Asteriidae

Genus: Asterias

Species: Asterias rubens

Description of shape:

In order to identify Asterias rubens there are several features such as the central row of white spines along each arm, there are also several papulae in each space between spine, the soft floppy texture and beige colouring in each space between spines.

Phylum Echinodermata, Class Unidentified

Crinoids stem and stalk (IV, D)

Kingdom: Animalia

Phylum: Echinodermata

Species: Crinoids stem and stalk

Description of shape:

Columnals forms the crinoid stem or stalk. Most columnals round in shape, but may be pentagonal, elliptical, oval, or square shape.

A

1cm

B

1cm

C

1cm

F

1cm

Plate IV

Phylum Arthropoda, Class Trilobita

Paladin veeravurusi (V, A)

Kingdom: Animalia

Phylum: Arthropoda

Class: Trilobita

Order: Proetida

Family: Protidae

Genus: Paladin

Species: Paladin veeravurusi

Crystosymbole? sp. (V, B)

Kingdom: Animalia

Phylum: Arthropoda

Class: Trilobita

Order: Proetida

Family: Protidae

Genus: Cyrtosymbole?

Species: *Crystosymbole?* sp.

Phillipsia sp. (V, C)

Kingdom: Animalia

Phylum: Arthropoda

Class: Trilobita

Order: Proetida

Family: Phillipsidae

Genus: Phillipsia

Species: *Phillipsia* sp.

Description of shape:

The genus Phillipsia is categorized by sub-stipitate apothecia, sub-operculate asci, bright-coloured, large and asymmetrical ascospores with longitudinal striations.

Paladin ophistops (V, D)

Kingdom: Animalia

Phylum: Arthropoda

Class: Trilobita

Genus: Paladin

Species: Paladin ophistops

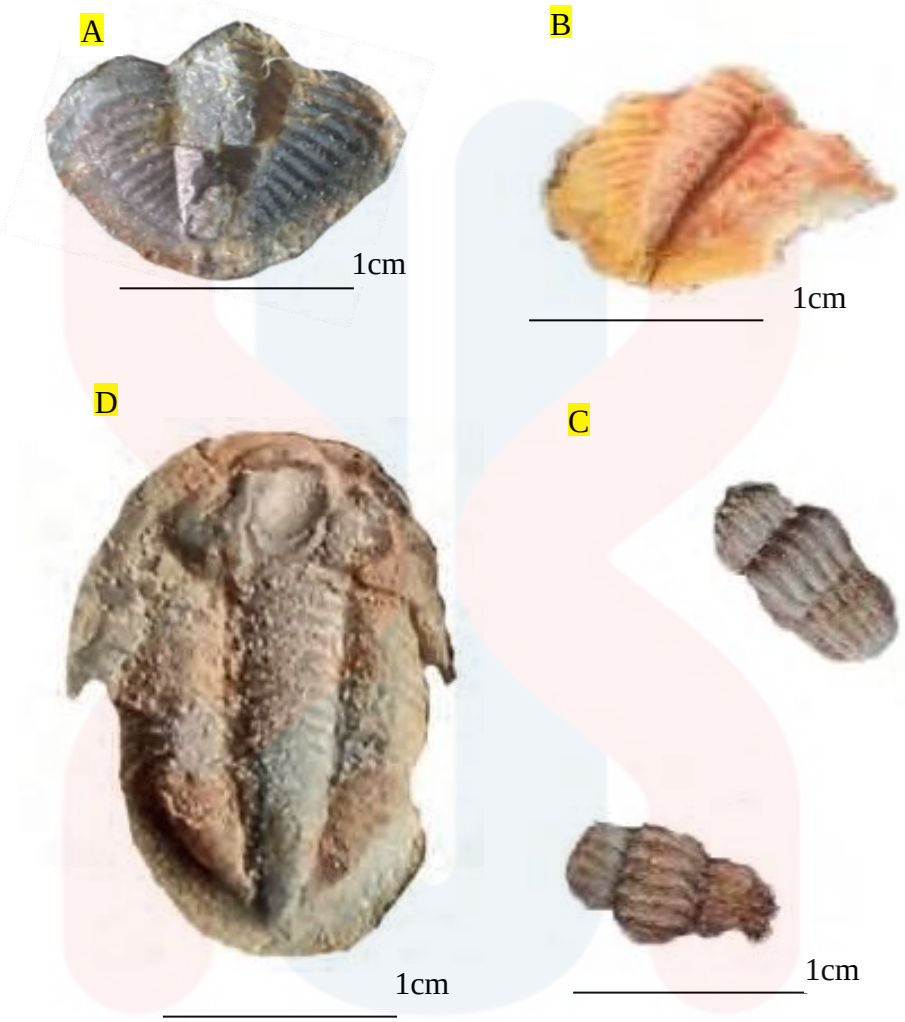


Plate V

Phylum Plantae, Class Polypodiopsida

Annularia Stellata (VI, A)

Kingdom: Plantae

Phylum: Plantae

Class: Polypodiopsida

Order: Equisetales

Family: Calamitaceae

Genus: Annularia

Species: Annularia Stellata

Description of shape:

Annularia leaves are set in spirals of between 8 to 13 leaves. The shape is variable, being oval in Annularia sphenophylloides and between linear and lanceolate in Annularia radiata, but they are always flat and of varying lengths.

Calamites sp. (VI, C)

Kingdom: Plantae

Phylum: Plantae

Class: Polypodiopsida

Order: Equisetales

Family: Calamitaceae

Genus: Calamites

Species: *Calamites* sp.

Description of shape:

Calamite fossils range from pit casts, roots, twigs and leaves to strobili. The s tem is known as Calamities, the leafy twig is called Annularia, and the fructification is known as Calamostachys. The plant body of the Calamites was a tall tree rising at a height of 20-30 metres.

Phylum Plantae, Class Lycopodiopsida

Lepidodenron sp. (VI, B)

Kingdom: Plantae

Phylum: Plantae

Class: Lycopodiopsida

Order: Lepidodendrales

Family: Plantae

Genus: Lepidodenron, Sternberg

Species: *Lepidodenron* sp.

Description of shape:

Lepidodendron is an extinct genus of primitive, vascular, tree-like plants related to lycopsids which is club mosses and the quillworts. They were part of the coal forest flora.

Stigmaria sp. (VI, G)

Kingdom: Plantae

Phylum: Plantae

Class: Lycopodiopsida

Order: Lepidodendrales

Genus: Stigmaria

Species: *Stigmaria* sp.

Description of shape:

The shape of the leaf bases and the arrangement of their vascular strands disti nguish the different genera within the arborescent lycopsid group.

<u>Phylum Plantae, Class Pinopsida</u>

Cordaites (VI, D)

Kingdom: Plantae

Phylum: Plantae

Class: Pinopsida

Order: Cordaitales

Family: Cordaitaceae

Genus: Cordaites, Unger

Species: Cordaites

Description of shape:

Cordaites is a fossil leaves that consist of several features such as long, strap like leaves with almost straight edges. Numerous, closely spaced veins (many more t han eight) extend along the length of the vein; none of them are more prominent than others (no midvein). Cordaites are so long that they are rarely found to be complete.

Cordaites (VI, F)

Kingdom: Plantae

Phylum: Plantae

Class: Pinopsida

Order: Cordaitales

Family: Cordaitaceae

Genus: Cordaites, Unger

Species: Cordaites principalis

Description of shape:

A whole leaf of the not unusual species Cordaites principalis varies in length between 20 and 70 cm and in width among 3 and seven cm. It is strap-shaped and has an entire margin. The leaves of Cordaites principalis possess fine, parallel veins and between the ones veins there is from 2 to 5 false rib which lack xylem.

Phylum Plantae, Class Unidentified

Lepidophylloides sp. (IV, E)

Kingdom: Animalia

Phylum: Echinodermata

Genus: Lepidophylloides

Species: *Lepidophylloides* sp.

A

1cm

B

1cm

C

1cm

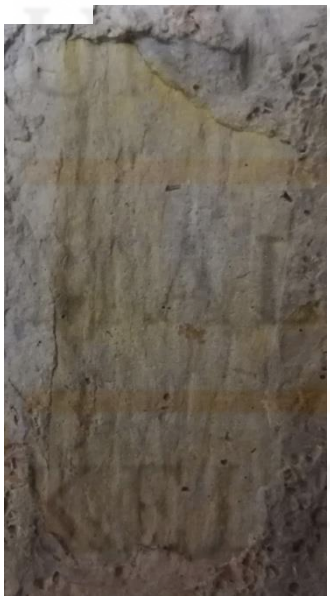
E

1cm

D

1cm

G



1cm

F

1cm

Plate VI

5.3 Fossil Distribution

In Bukit Bucu, Kuala Terengganu the fossils are distribute in two locations as in perimeter of 5km x 5km area. Therefore the locations are acknowledged by location 1 and location 2. The latitude and longitude for location 1 is 5.44134700 103.04636500 and for second location the latitude is 5.43169700 and the longitude is 103.04808900. Referring to Table 5.2 Details of fossils by location shows at variety phylum of fossils were found such as phylum Brachiopoda, Mollusca, Echinodermata, Trilobita, Plantae and bryozoan were found at location 1 and at location 2 only echinoderms and several effects of chemical and physical weathering was found. Also shown from the table is the abundance of fossil determine via phylum.

Table 5.2: Details of Fossils by Location

Location	Fossils found (Phylum)	Total fossil per (Phylum)	Abundance (%)
Location 1 Latitude: 5.44134700 Longitude: 103.04636500	Brachiopoda	37/153	24.18
	Mollusca	32/153	20.92
	Bryozoan	32/153	20.92
	Echinodermata	40/153	26.14
	Trilobita	5/153	3.27
	Plantae	7/153	4.58
Location 2 Latitude: 5.43169700 Longitude: 103.04808900	Echinodermata	34/34	100

5.4 Fossil site analysis

Fossils found had been calculated according to total fossil per (Phylum) and the abundance (%) in order for analyses and identify the distribution of phylum and the abundance of species within two different localities. Thus, the result for site was shown below by referring to Figure 5.2 and Figure 5.21. Figure 5.2: Abundance (%) of fossils for Location 1 and Location 2. Location 1 was stated with coordinate of latitude of 5.44134700 and longitude of 103.04636500. Also in location 1 it consist of six phylum with their abundance of percentage such as phylum of brachiopoda is (24.18%), mollusca (20.92%), bryozoan (20.92%), echinodermata (26.14%), trilobita (3.27%) and plantae (4.58%) while location 2 only consist one phylum which is echinodermata (100%). In mollusc phylum it contains of three different class such as class of bivalve, class of gastropod and also class of ammonite.

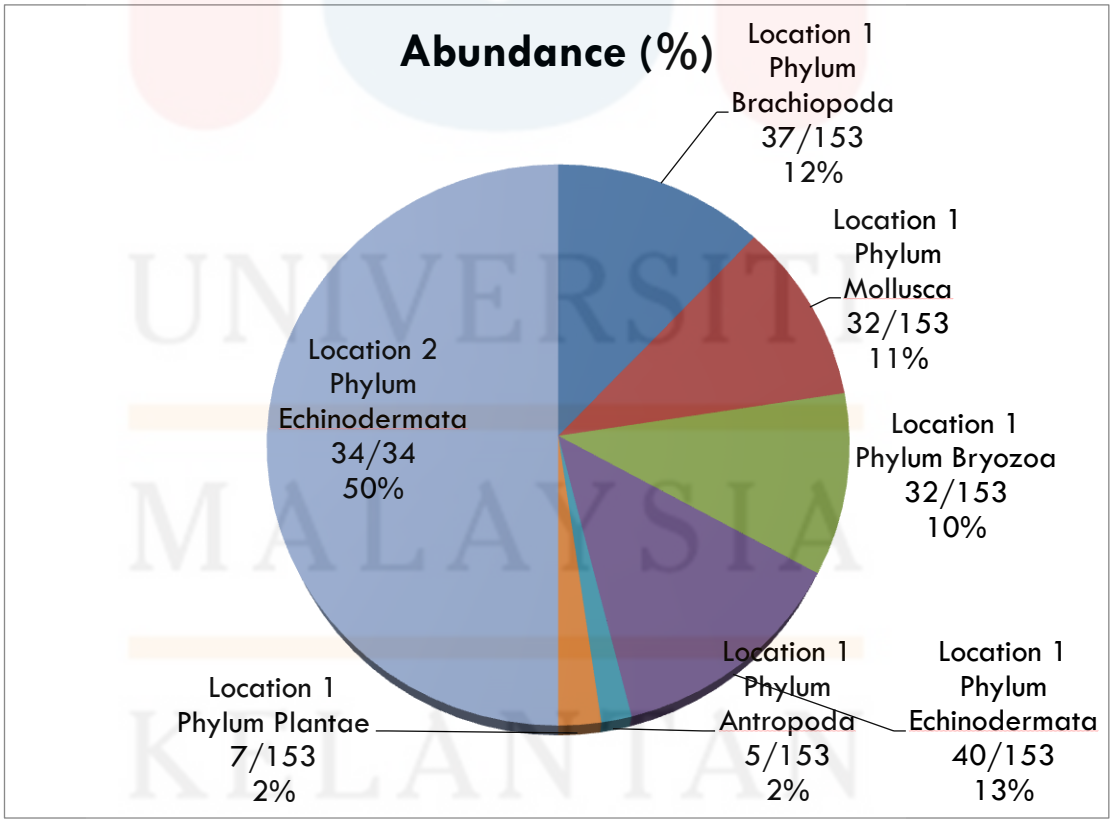


Figure 5.2: Abundance (%) of fossils for Location 1 and Location 2

Furthermore Figure 5.21: Abundance (%) of fossil of Location 1 only shown for location 1 that consists of six different phyla. This figure is differentiating the fossil found within their phylum. However, for the location 2 there is no figure present because the only fossil content were echinoderm. For the location 1 the total fossil found per phylum is 153 total. While for location 2 the total number phylum echinodermata that was found is 34 in total. Thus from the abundance percentage, there are two results were obtain. Consequently, the abundance fossil found per phylum among the six different phyla which conquer the highest total found is phylum brachiopod with eleven species and the abundance of distribution of fossil at both locations is echinodermata.

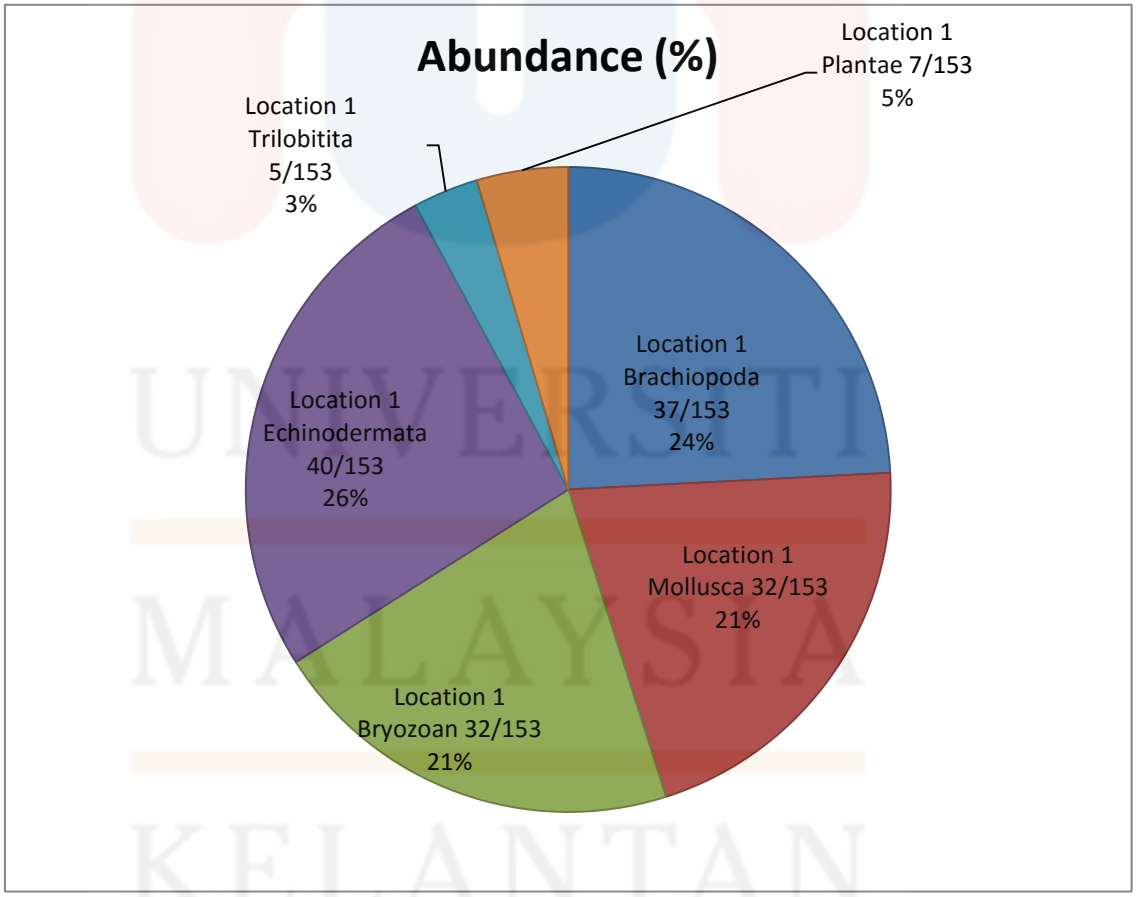


Figure 5.21: Abundance (%) of fossil at Location 1

5.5 Interpretation and discussion

Previously as mention in the main there are phyla of brachiopoda, mollusca, bryozoan, echinodermata, trilobita and plantae that can be found at the study area of Bukit Bucu. Referring to Figure 5.3 lithology of the Bukit Bucu, all of the phylum except for phylum of plantae was found at the strata which at 10m and 30m while phylum of plantae found at 45m. Thus there were eight species that found in phylum of brachiopod for example *Antiquatonia* sp., *Chonetinella* sp., Brachythyrina strangwaysi, *Derbyis* sp. *Avonia* sp. *Dictyoclostus* sp. *Chonetes* sp. and *Buxtonia* sp. Next for phylum of Mollusca in class of bivalvia there are three identified species for instance *Myalina* sp. *Posidonia* sp. *Aviculopecten* sp. and there are also unidentified species of bivalve. Other class of bivalvia is gastropod and cephalopod in phylum of mollusc. For class of gastropod the identified species known as *Eumphalus* sp. while the identified species for the cephalopod is *Edmondia* sp.

While for phylum of bryozoan there are seven identified species such as *Fenestella* sp. Feenestella pahangensis sakagami, Fenestella plebia, Fenestella cf. Tenax Ulrich, Batostoma Jamesi, *Fistulipora* sp. and Fenestella retiform, In addition there are four identified species for phylum of echinoderm for instance *Cyathocrinus* sp. *Potecrinus* sp. *Asterias rubens* sp. and crinoid stem and stalks. Phylum of trilobita consist of four identified species namely as Paladin veeravurusi, Crystombole? Paladin ophistops and *Phillipsia* sp.

Furthermore for phylum of plantae there are seven identified species known as Annularia stellate, *Lepidodenron* sp. *Calamites* sp. Cordaites sp.,*Lepidophylloidae* sp. Cordaites principalia and *Stigmaria* sp. As the results that obtained before, basically there are two results where the first result is the most abundant species of fossil distribution that found is brachiopoda followed by bryozoan and plantae fossil. However, the most abundance distribution of fossil is phylum of echinodermata as it well distributes and easily found at the study area. Moreover, as phylum of mollusca consists of bivalvia, cephalopoda and gastropoda. Therefore between the trios, the abundance of distribution that was found is class of bivalvia compared to cephalopoda and gastropoda.

5.6 Depositional Environment

In a nutshell, Bukit Bucu study area is a shallow marine depositional environment based on previous study referring to Idris & Zaki, (1986) as they found fauna species in the age of carboniferous. Thus, based on this research of the assemblages of fossil in order to determine and acknowledge the depositional environment of the study area hence Bukit Bucu is a shallow marine depositional environment precisely in delta front at mouth bar. This is said so because of the fact that present on the lithology as referring to Figure 5.3 Lithology of the study area. From the lithology simply seen the geological structure that exposed for example cross bedding, slump structure, truncated bed, planar lamination and the existence of marine and plant fossil.

It is further convincing with the features of deltaic deposit referring to Nichols, G. (2009) states that the lithology is mainly composed of sandstone and mudstone. This is suitable with the study area since fossils were found at shale in mudstone and there also sandstone. Not to forget, the secondary structure that existed also proves the mouth bar facies at the delta front in the deltaic environment. Also, the existence of terrestrial plants fossil of the delta top and marine fauna fossil at the delta front and it is true as the features states that for colour characteristics the delta top deposit oxidised. Thus, this clearly seen at Figure 5.4 the depositional environment of the study area.

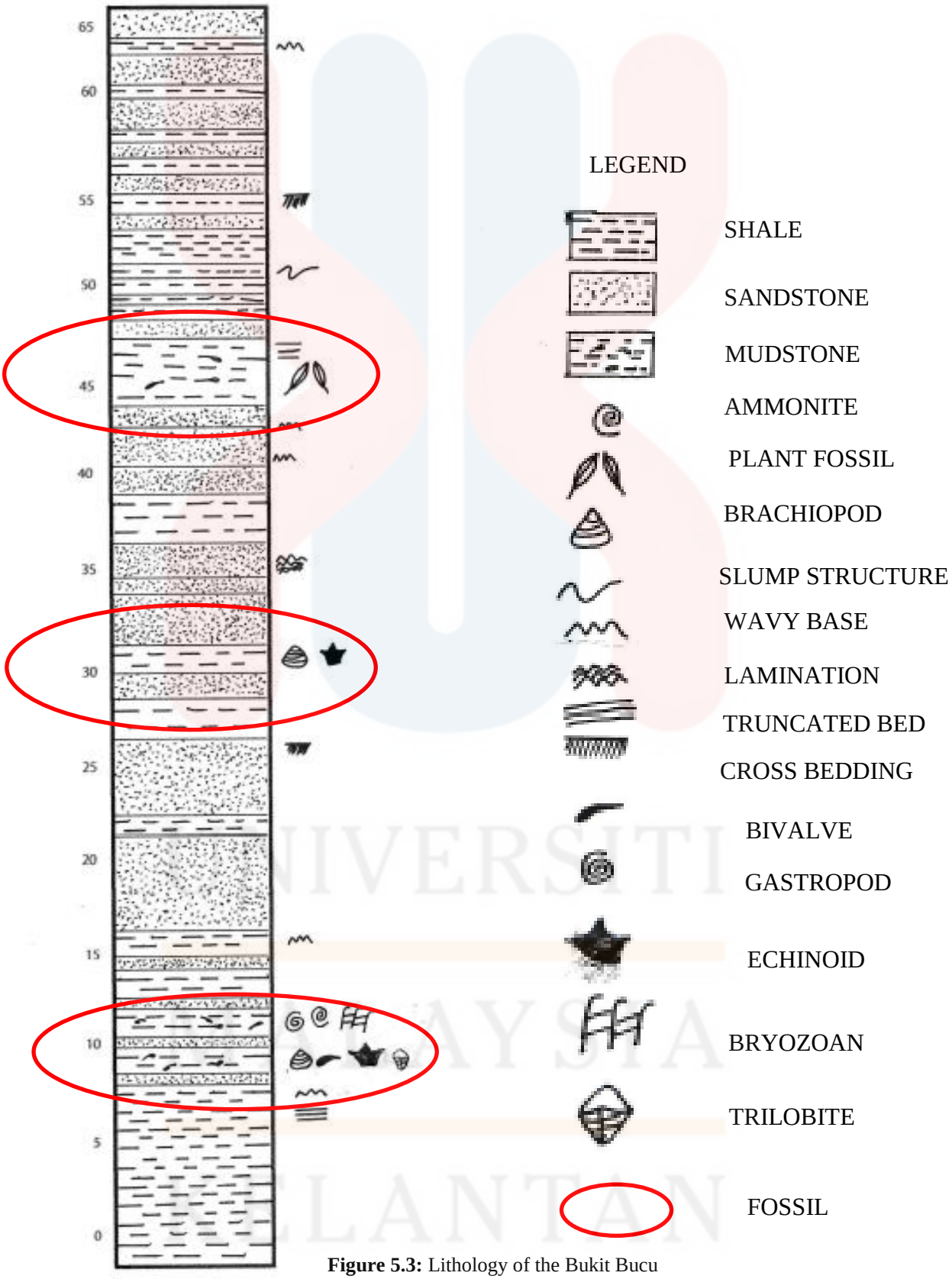


Figure 5.3: Lithology of the Bukit Bucu

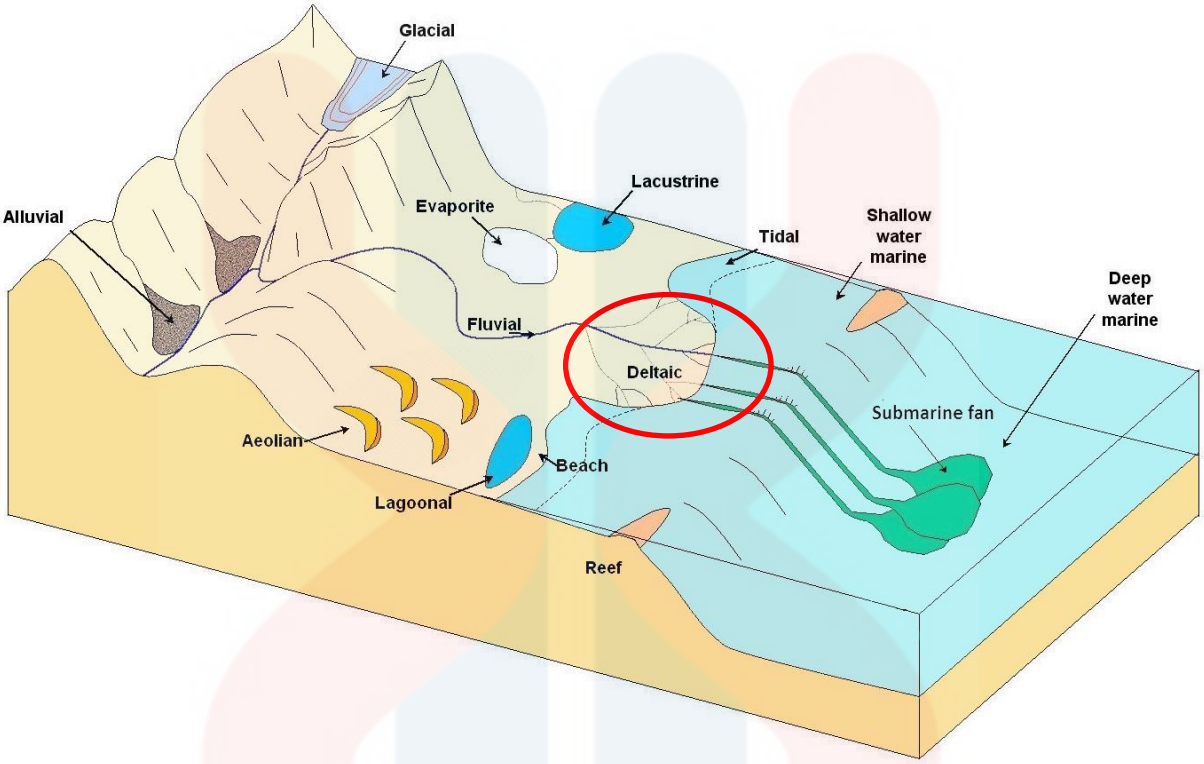


Figure 5.4: The depositional environment of the study area (red circle)

Sources: Earle, S. (2019, September 23). Physical Geology – 2nd Edition

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This chapter determine the findings and the result based on discussion throughout this research. Thus, this research been conducted due to three objective producing a geological map within the scale of 1:25,000 of the study area, determine the assemblage of fossil via pie chart and percentage abundance and determine the depositional environment of the study area. Thus, a geological map of the study area was produce in Chapter 4 and the lithology are composed of metasandstone with interbeded shale with mainly granite and also granodiorite and there are also sand, clay and silts while for the assemblages of fossil there are two results where phylum brachiopod is the highest abundance of fossil in percentage per phylum while for the abundance of percentage for distribution of fossil is phylum echinoderm.

Next, from the result obtain and the geological features of the study area, Bukit Bucu is determining as deltaic environment precisely in delta front at mouth bar of shallow marine. This being supported by the lithology referring to Figure 5.3 Lithology of the study area and it also previously mention in subtopic of 5.6 Depositional environments. The flora fossil known as plantae in phylum and for the fauna fossil known as phylum of brachiopod, mollusc, echinoderm, bryozoan, and

trilobite and also the geological structure that occurred strongly supported the deltaic depositional environment.

6.2 Recommendation

From this research there is little recommendation that can be suggested for future researcher and for better out coming data. First and foremost the mapping for the study area is limited to 5 km x 5 km which allow producing a geological map for a small area in perimeter of 25km area. Thus, for future researcher are recommend to expands out the study area therefore more geological data can be obtained and able to produce a better geological map for the study area.

Following, this recommend is for government highlighted focused on agencies that involve in conservation of Geo Park. Since Bukit Bucu is being taken over by Malaysian Geological Society thus more conservation is needed in make sure fossils is not being disrupted or broken due by any construction or development of the houses or the area. Bukit Bucu is not only composed of fossils but also structure geology that important in geological features that allows palaeontologist, fossil hunter and students such as from Universiti Malaysia Kelantan coarsely in Geosciences to learn about fossils and conserving the fossil for future generation.

REFERENCES

Abdullah, I. (2006). On The Presence Of Pre-Carboniferous Metasediments In The Eastern Belt: A Structural View.

Birks, H. J. (1968). The Identification Of Betula Nana Pollen. New Phytologist, 67(2), 309-314.

Chand, F. 1978. The Geology And Mineral Resources Of The Ulu Paka Area (Sheet 61), Trengganu. District Memoir 16, Geological Survey Malaysia.

Chandra, S., Srivastava, A. K., & Singh, K. J. (1989). Palaeobotany And Climate Around Marhwas Area, Sidhi District, South Rewa Gondwana Basin During Upper Permian.

Chung, S.K., 1973. Geological Map Of West Malaysia. 7th Edition. Geological Survey Of Malaysia.

Earle, S. (2019, September 23). Physical Geology – 2nd Edition. Retrieved From Https://Opentextbc.Ca/Physicalgeology2ed/Chapter/6-3-Depositional-Environments-And-Sedimentary-Basins/.

Ellenberger, F. (1975). Histoire De La Géologie, Vol. 1: Technique Et Documentation.

Fontaine, H., & Khoo, H. P. (1990). Palaeontological Research In Terengganu State, Peninsular Malaysia. Ten Years Of Ccop Research On The Pre-Tertiary Of East Asia, (20), 97.

Gobbett, D. J. (1966). The Brachiopod Genus Stringocephalus From Malaya. Journal Of Paleontology, 1345-1348.

Hussain, Z., Zakaria, M. R., & Leman, M. S. (2008). Geoheritage Of Malaysia. Geoheritage Of East And Southeast Asia, Eds Ms Leman, A. Reedman, And C. S. Pei (Bangi: Lestari), 151-184.

Henri, F., & Amnan, I. B. (1995). Biostratigraphy Of The Kinta Valley, Perak.

Hutchison, C.S., 1975. Ophiolite In Southeast Asia. Bull.Geol. Soc. America 86: 797-806.

Hutchison, C.S., 1977. Granite Emplacement And Tectonic Subdivision Of Peninsular Malaysia. Bull. Geol. Soc. Malaysia 9: 187-207.

Idris, M. B., & Zaki, S. M. (1986). A Carboniferous Shallow Marine Fauna From Bukit Bucu, Batu Rakit, Terengganu.

Khoo, T. T., & Tan, B. K. (1983). Geological Evolution Of Peninsular Malaysia.

Khoo, T. T., Yaw, B. S., Kimura, T., & Kim, J. H. (1988). Geology And Palaeontology Of The Redang Islands, Trengganu, Peninsular Malaysia. Journal Of Southeast Asian Earth Sciences, 2(3-4), 123-130.

Macdonald, S., 1967. The Geology And Mineral Rersources Of North Kelantan And North Terengganu. Geol. Surv.

Mem. 10, 202p.Metcalfe, I. (2013). Tectonic Evolution Of The Malay Peninsula. Journal Of Asian Earth Sciences, 76, 195-213.

Nichols, G. (2009). Sedimentology And Stratigraphy. John Wiley & Sons.

Ohana, T., Kimura, T., & Khoo, T. T. (1991). Further Discovery Of Some Carboniferous Plant Fossils From Tanjung Mat Amin, Trengganu, Peninsular Malaysia. Journal Of Southeast Asian Earth Sciences, 6(2), 93-101.

Rajah, S. S. (1979). The Kinta Tinfield, Malaysia.

Shuib, M. K. (2003). Transpression In The Strata Of Pulau Kapas, Terengganu.

Singh, D.S., 1985. Geological Map Of West Malaysia. 8th Edition. Geological Survey Of Malaysia

Stauffer, P. H. (1974). Malaya And Southeast Asia In The Pattern Of Continental Drift.

Jennings, J.R., &B Lee, C.P., 1985. Preliminary Note On Theoccurrence Of Carboniferous Age Coal And In Situ Plant Fossils In The Eastern Peninsular Malaysia. Newsletter Of The Geol. Soc Of Malaysia 11(3): 117-121.

Lee, C. P.; Leman, M. S.; Hassan, K.; Nasbib, B. M.; Karim, R., (2004). Stratigraphic Lexicon Of Malaysia; Geological Society Of Malaysia: Kuala Lumpur, Malaysia., 21-28.

Yang, X., Damen, M. C. J., & Van Zuidam §, R. A. (1999). Use Of Thematic Mapper Imagery With A Geographic Information System For Geomorphologic Mapping In A Large Deltaic Lowland Environment. International Journal Of Remote Sensing, 20(4), 659-681.