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FYP FSB

**GENERAL GEOLOGY AND DEPOSITIONAL ENVIRONMENT
AT CHIKU, PALOH, GUA MUSANG, KELANTAN**

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E19B0094**

**A reported submitted in fulfilment of the requirements for the
degree of Bachelor of Applied Science (Geoscience) with Honours**

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2023

APPROVAL

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

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DECLARATION

I declare that this thesis entitled “Geology and Depositional Environment at Chiku, Paloh, Gua Musang, Kelantan” is the result of my own research except as cited in the references. The thesis has not been accepted for my degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

Abstract: This research study entitled general geology and depositional environment was carried out at Chiku, Paloh. The research area is located at Gua Musang district. The research site is in Peninsular Malaysia's central belt. It's between the longitude and latitude of the mapping area from 102o15°32'E to 102o18°14'E. The study is believed part of the Aring Formation, since the main river in the area is Sungai Relai. From the base map and the field mapping, the geomorphology of the area consists of two types of landforms and erosion. Thus, the age range for the study area is Mesozoic which is from late Carboniferous to the early Triassic. From that, we can predict the Facies study for determine the depositional environment based on the geomorphology, structural geology, lithology, grain size and fossil content. To achieve the objective, different materials and equipment such as hammer, compass and gps was used to collect and record sample. From geological mapping and analysis, the study area shows few structures such as fault, vein and joint. The purpose of the research is to produce the geological map of the study area with scale of 1:25,000. Besides the objective of this study to determine the depositional environment of the study area. The depositional environment could be tidal flat environment based on fine grain of metasedimentary rock and volcanic sandstone fragments found. Generally, this study area consists of sedimentary rock which is volcanic sandstone. Based on all the evidence elaborates, the depositional environment of the study area at the shallow marine environment setting. This study produces geological map which is useful for detail observation and give significantly to industrial, construction and economic activity.

Keywords: Geological map, depositional environment, shallow marine, lithology

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ABSTRAK

Abstrak: Kajian penyelidikan bertajuk geologi am dan persekitaran mendapan ini telah dijalankan di Chiku, Paloh Kawasan kajian terletak di daerah Gua Musang. Tapak kajian adalah di kawasan tengah Semenanjung Malaysia. Ia berada di antara longitud dan latitud kawasan pemetaan dari $102^{\circ}15'32''\text{E}$ hingga $102^{\circ}18'14''\text{E}$. Kajian itu dipercayai sebahagian daripada Formasi Aring, memandangkan sungai utama di kawasan itu ialah Sungai Relai. Daripada peta asas dan pemetaan lapangan, geomorfologi kawasan terdiri daripada dua jenis bentuk muka bumi dan hakisan. Oleh itu, julat umur bagi kawasan kajian ialah Mesozoik iaitu daripada Karbonifer lewat hingga Trias awal. Daripada itu, kita boleh meramalkan kajian Facies untuk menentukan persekitaran pemendapan berdasarkan geomorfologi, geologi struktur, litologi, saiz butiran dan kandungan fosil. Untuk mencapai objektif, bahan dan peralatan yang berbeza seperti tukul, kompas dan gps digunakan untuk mengumpul dan merekod sampel. Daripada pemetaan dan analisis geologi, kawasan kajian menunjukkan beberapa struktur seperti sesar, urat dan sendi. Tujuan penyelidikan adalah untuk menghasilkan peta geologi kawasan kajian dengan skala 1:25,000. Selain itu objektif kajian ini untuk menentukan persekitaran mendapan kawasan kajian. Persekitaran mendapan boleh menjadi persekitaran rata pasang surut berdasarkan butiran halus batu metasedimen dan serpihan batu pasir gunung berapi yang ditemui. Secara amnya, kawasan kajian ini terdiri daripada batuan sedimen iaitu batu pasir gunung berapi. Berdasarkan semua keterangan yang diuraikan, persekitaran mendapan kawasan kajian di persekitaran marin cetek. Kajian ini menghasilkan peta geologi yang berguna untuk pemerhatian terperinci dan memberi secara signifikan kepada aktiviti perindustrian, pembinaan dan ekonomi.

Kata kunci: Peta geologi, persekitaran mendapan, marin cetek, litologi

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CHAPTER 1

INTRODUCTION

1.1 General Background

The science of geology is described as the study of the Earth's surface and subsurface processes. In historical geology, the origins and evolution of Earth's continents, seas, atmosphere, and species across time are studied. Geology has also played an important role in the history and culture of humankind (James et al., 2007). Geographical information may be used to learn about Earth's past and present as well as possible natural resource uses.

A depositional environment is a place where sediments collected and were influenced by physical, biological, and chemical processes. The Earth, as is commonly known, is a very dynamic environment that changes throughout time due to mechanisms that lead animals to circle. To better understand Earth's history and how it connects to changes in both internal and external processes and cycles, this research investigates the rock record.

What constitutes the depositional environment is the fundamental factor in determining sedimentary rocks' textures and structures as well as bedding features and stratigraphic characteristics (Sam, 2012). Sedimentology and stratigraphy are important to establish the depositional environment.

In the southern section of the Gua Musang District, this is a rural area. In the Paloh region, oil palm is a common crop (Fauzi Hussin & Hussin Abdullah,2012). The main objective or the purpose is general geology and depositional environment aged dating at Chiku, Paloh, Gua musang, Kelantan. The lithologies, stratigraphy, and geomorphology are all poorly shown on this small-scale map. There is also a lack of information about the paloh's depositional environment.

Consequently, this study is aimed to create a thorough topographic map of Paloh region at a scale of 1:25,000 to assess the sedimentary sequence. The Paloh district geology and depositional environment may be studied by geological mapping, laboratory investigations, and the construction of sedimentary logs. The study's findings may prove valuable in future geological investigations.

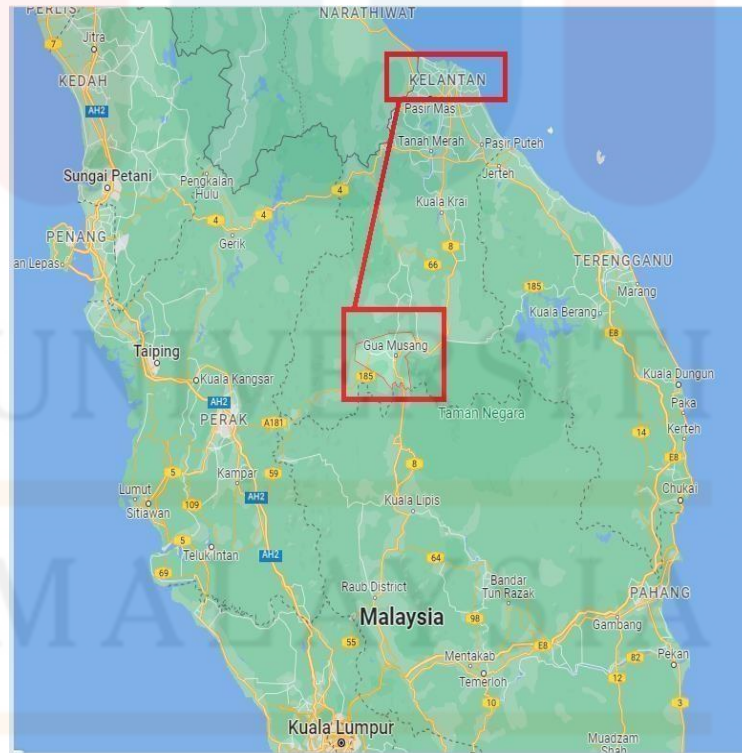
1.1.1 Geology of Chiku

In the eastern section of Gua Musang, Kelantan, there is a development district and town called Chiku. Felda Settlers make up the majority of the population. It serves as the entry point to Kuala Koh National Park. Our geological investigation will be conducted in or near residential areas in Chiku, Gua Musang.

1.2 Study Area

1.2.1 Location

At Chiku, Paloh Gua musang region, the study will be carried out (Figure 1.1). Gua Musang District is located on the district's southernmost boundary. On the order of 25 square miles, the entire land area is (5 km x 5 km). Research takes place in Peninsular Malaysia's heartland. The research site is in Peninsular Malaysia's central belt. This map shows the location of longitude and latitude from $102^{\circ}15'32''\text{E}$ to $102^{\circ}18'14''\text{E}$, as well as the coordinates of longitude and latitude, respectively in (Figure 1.2). While its lowest elevation is 80 metres below, the research area is 320 metres above sea level at its highest point.



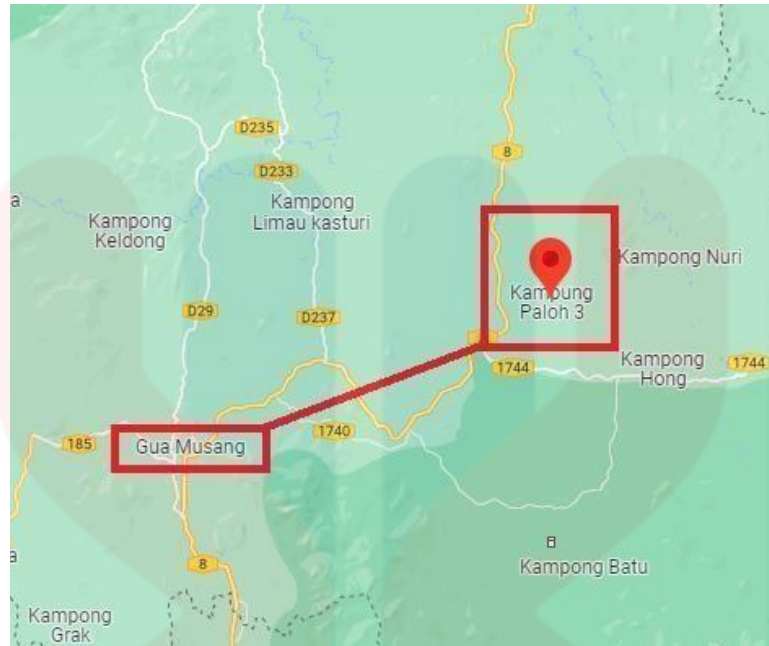
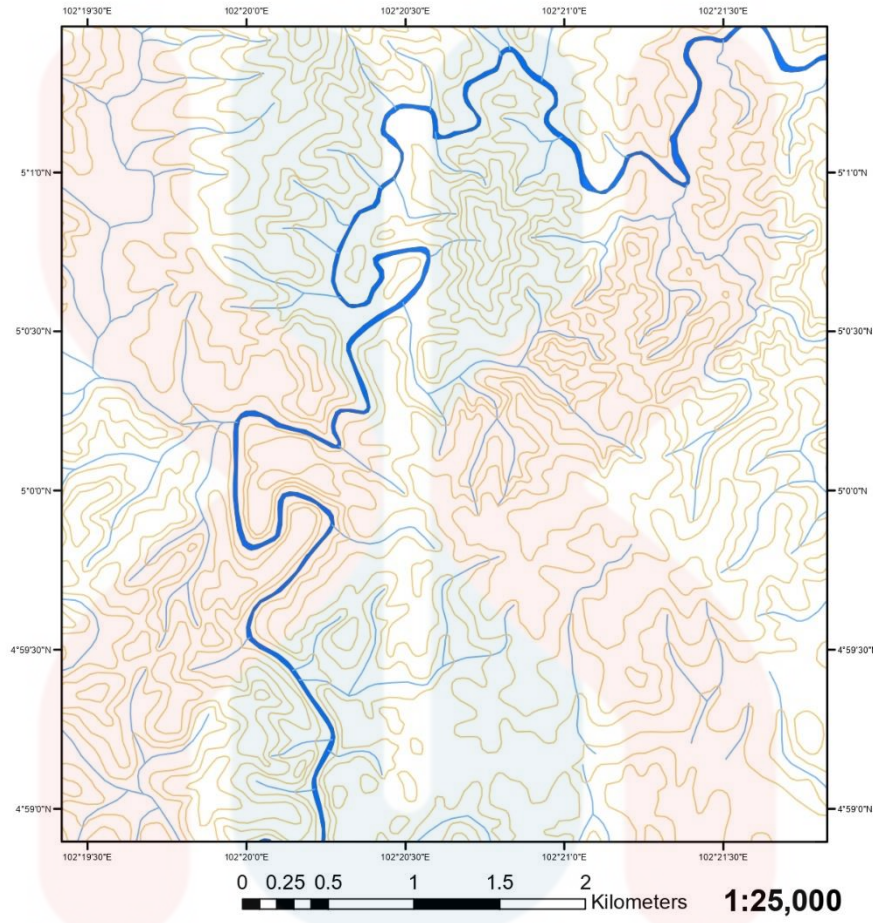


Figure 1.1: Location map

1.2.2 Road Accessibility

From Gua Musang and Kuala Krai, there are two methods to go to the Paloh region (Figure 1.3). The radius between Gua Musang to Paloh area is approximately 58.1 kilometres. Kuala Krai and Paloh are 79.4 kilometres apart, but Kuala Musang and Paloh are just 79.4 kilometres apart. The only way to reach Paloh is through Lebuhraya Kota Bharu - Gua Musang.

Basemap of Study Area



Legend

- Contour
- Sungai
- Sungai Utama

Figure 1.2: Base Map of Study Area.

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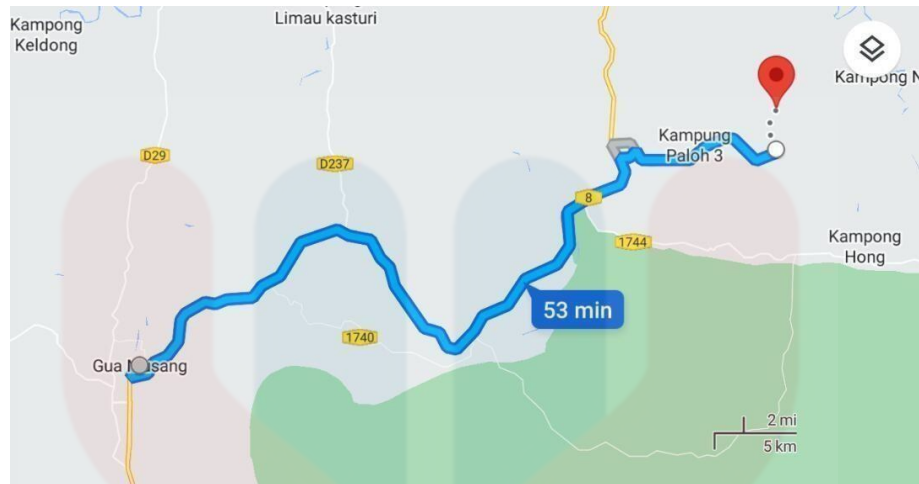


Figure 1.3: Road Accessibility Map

1.2.3 Demography

The number of populations in Gua Musang is increasing over decades. The number of residents is rising to 90,677 people in the year 2010. However, there is a tiny village in the study region which homeresidence to a paloh population called Kubang Sepat. There are 1581 individuals living in Paloh, Gua Musang, Kelantan based on the research area's population density of 317 houses and 338 families. They have property and orchards of their own.

1.2.4 Land Use

There are a wide variety of land uses in Kelantan, however the limited forest still occupies a large portion of the state. Figure 1.4 shows that the research region comprises of oil palm, rubber, and forest, however the study area is dominated by forest (M Hashim et.,al 2017). Three systems are used to describe it: Paloh 1, Paloh 2, and Paloh 3. Paloh 3 is the location of the research area. Rubber and oil palm plantations comprise 1420.14 and 942.86 hectares, respectively. Reserved woodland covers the rest (Fauzi Hussin & Hussin Abdullah, 2012).

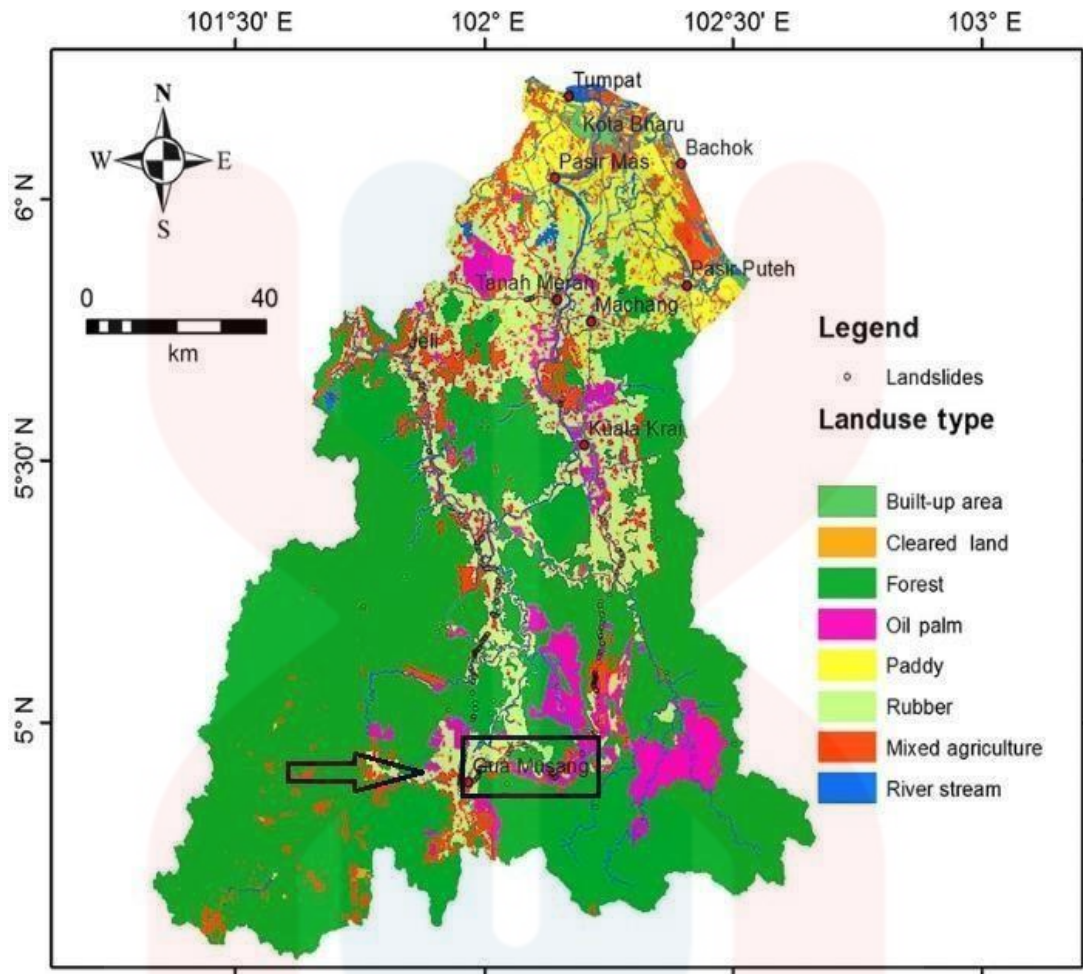


Figure 1.4: land use map of Kelantan state

1.2.5 Social Economic

The palm, rubber, and forest products that are planted in Gua Musang are the main economic drivers there. Oil and wood goods are the major sources of the social economy in the Kelantan areas. Because there are palm tree plantations in the Chiku region that are under the supervision of a government body, the Chiku area relies heavily on palm products. According to Hussin & Abdullah (2012), the rural population relied on both subsistence agriculture and traditional farming to generate revenue.

1.3 Problem Statement

The study area is a part of Gua Musang district in developing area. Peninsular Malaysia's newest geological map, created by the Jabatan Mineral dan Geosains (JMG) Malaysia in 2014, does not include enough geological data, such as precise lithology, to accurately depict the region. Besides that, that map does not focus on the small scale of the study of paloh area and does not contain enough detailed geological data.

There has been no previous research that explains the depositional environment information that reveals the environmental history of the paloh chiku Gua Musang Formation in the examined region.

There has never been research that explains and demonstrates the depositional environment information and Paloh Gua Musang's environmental history in the examined region.

1.4 Objectives

- i. To produce a geological map of Paloh area in the scale of 1: 25,000.
- ii. To determine the depositional environment of Chiku Paloh area, Gua Musang.

1.5 Scope of Study

The Paloh topographical map was developed by analysing the Paloh geology, including landforms, stratigraphy, geological, and history of geoscience. Depositional records may also be used to estimate a region's depositional environment based on the soil type, biodiversity, and architectural of exposed sedimentary strata.

1.6 Significant of Study

A regional geological map can benefit from the findings of this research. An additional study objective is to identify Paloh's depositional environment. In the Paloh region, there is no detailed map of the area's geology. Geological surveying will be done at a 1:25,000 scale because of the study. Will be using this map to update all geomorphic information. People's quality of life may be improved using these resources. After discovering the age and fossils of the study region, will be more aware of the area's historical significance and to protect it for future generations.

Landslide prevention and flood mitigation are both made possible by geological maps and the depositional environment, which supply sedimentation data. Engineers are more aware of the importance of building in a safe environment as a result. Aside from natural resources, economic, industrial, and construction activity are all considered in the geological map.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter focused on earlier research that is relevant to the current study. A literature review is essential since it helps to identify and fill in the gaps in the literature review. The evaluation is predicated on the study's title, goals, problem statements, and research design. Geology, stratigraphy, and sedimentology all fall under this category, as do regional and tectonic geology, fossils, historical geology, and the environment in which sediments were deposited.

2.2 Regional Geology and Tectonic Setting.

Figure 2.1 shows that Peninsular Malaysia is separated into three major geological regions: the northwestern, central, and eastern zones. There are three major geological areas in Peninsular Malaysia, which are the northwestern central, and eastern zones. These regions can be distinguished based on rock properties, age, geological processes, features, and paleogeography, among other factors. Gua Musang was situated in the Peninsular's Central Belt.

Malaysia. Peninsular Malaysia, which is generally referred to as East Malaya, is divided from the Sibumasu and Indochina blocks by the N–S Palaeo-Tethys Bentong-Raub suture. "Tin islands" of Sumatra and western Siam formed as the East Malayan crust expanded due to Sibumasu and Indosinian Orogeny, according to Hutchison (2014). S-type gneisses make up the Peninsular Central Ridge. Southeast Asia region has a new mechanism evolution that is known as escape or extrusive tectonics.

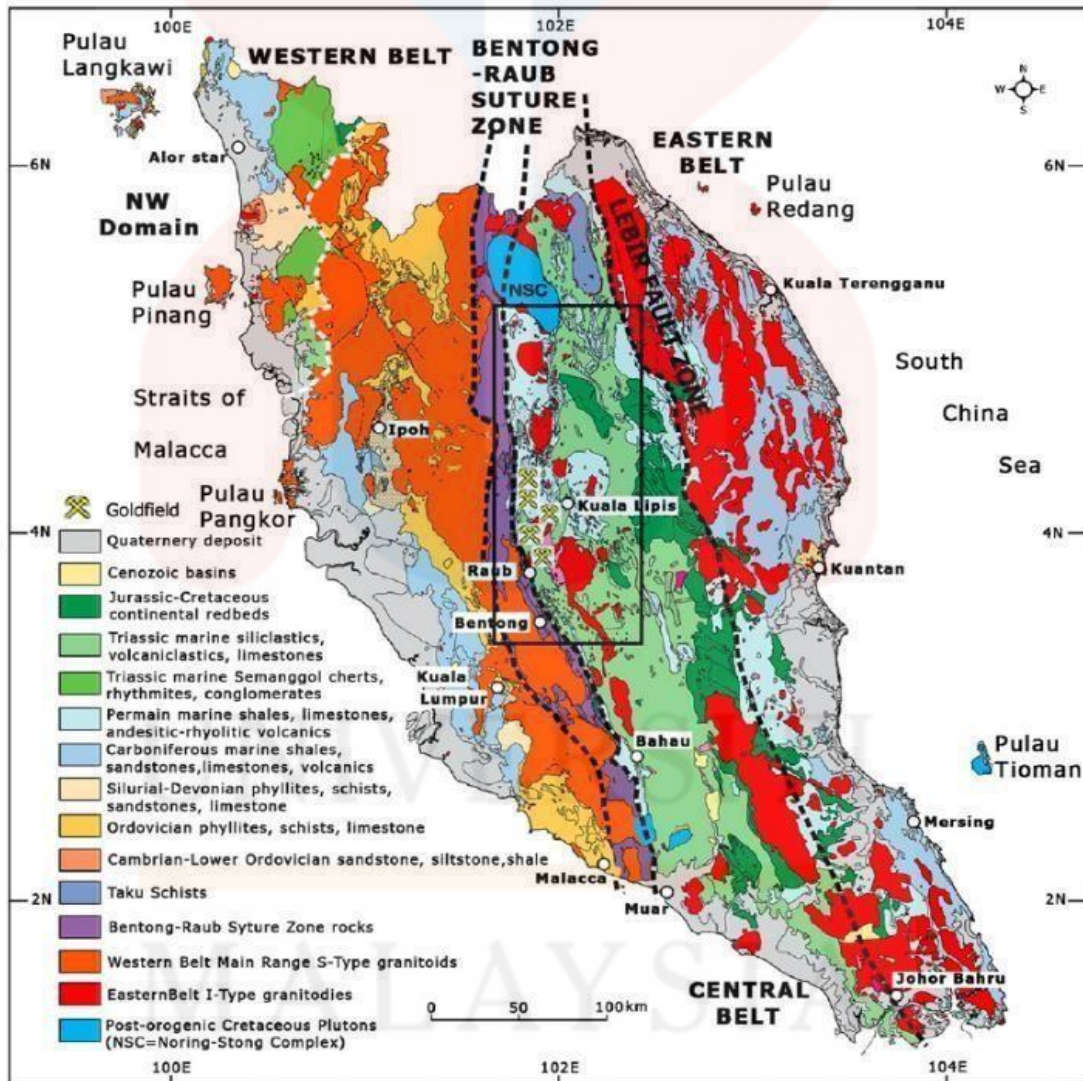


Figure 2.1: Geological map of Peninsular Malaysia (Amin Beiranvand Pour, 2015)

Sedimentary and metasedimentary rocks dominate the central zone of Kelantan, which is flanked by the Continental Slope on the western and eastern (Titiwangsa Range)

and the Boundary Range, according to Heng et al. (2006). There are three granite intrusions in the Central Zone: Senting batholith, Kemahang sedimentary layer, and Stong Igneous Formation. Alluvial plains of Sungai Kelantan cover bedrock marble to Barrier Line (south in Kelantan), while the stone strips of northern and southwestern Kelantan reach north toward the southwest Thai province.

Igneous rock, metamorphic rock, and sedimentary rock are among the several types of rock found in Kelantan, which lies in Peninsular Malaysia's central belt. Although this line is really a portion of Peninsular Malaysia's line, seem to align into a line from north- east (Rahman,1998). The Carboniferous-Permian "Calcareous series," the Triassic "Arenaceous Series," and Mesozoic Granite are the main geological features in Malaysia's west.

Peninsular Malaysia's Central Zone sedimentation is linked to plate tectonics. When oceanic crust was subducted into the continental crust and two tectonic blocks collided in Triassic time, the western and eastern parts of the peninsula were brought closer together (Harbury et al., 1990). Due to a lack of deformational events in the Middle Jurassic, western Malaya, northwestern Siam, and Burman really cannot join with the rest of central and eastern Southeast Asia and Indo.

2.3 Stratigraphy & Sedimentology

Triassic and Jurassic to Early Cretaceous strata are found in the Central Belt of Peninsular Malaysia, with 1.5 to 2 km of continental sediments following. There are many rivers in Kelantan with Permian deposits, including the Sungai Lebir, Aring, Sungai Rela, Paloh, and Badong (Fontaine, 2002). Kelantan's oldest granites are those from the Cretaceous and Jurassic continents. Gunung region and Gunung Perlis and Gunung Pemumpu areas are covered by the Boundary Range Granite and Triassic deposits. There are conglomerate and sandstone layers with occasional volcanic interspersions throughout the sequences.

The eras of Kelantan's geological history may be split into three broad groups which is Lower Paleozoic, Mesozoic, and Quaternary.

Central Belt, north of Gua Musang-Semantan resource-limited, and southeast of both the Bentong-Raub Suture, maybe found by Gua Musang formation. Gua Musang Formation is related mostly of interspersed which is shale, volcanic and sedimentary rocks, including chert nodules. The final result displays forming characteristics including layering and inter. (Hutchison & Tan, 2009). With arenite, lava, and volcanic outbursts, the Gua Musang Formation is mostly composed of magnesium rocks for Yin.

The Aring Formation is responsible for the formation of the Gua Musang Formation, and the part of south-eastern, Malaysia. Volcanic rock from the Aring Formation is mostly composed of pyroclastic, dolomitic marble, and argillite.

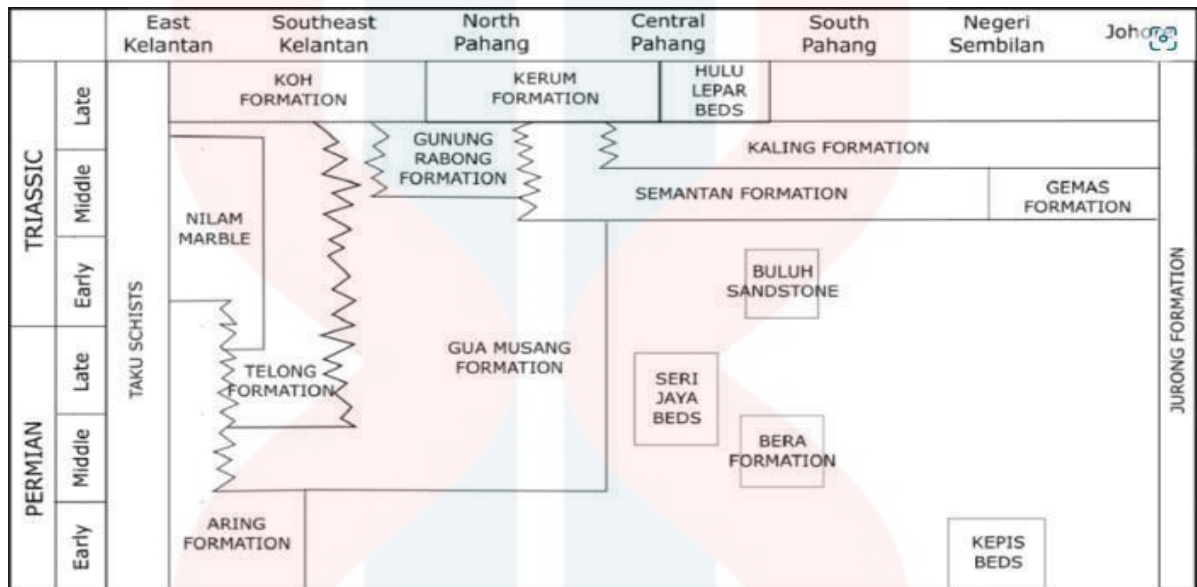


Figure 2.3: Central Belt Peninsular Malaysia's Permo-Triassic stratigraphic correlation

(Sources: Kamal et al., 2016)

2.4 Structural Geology

Tectonic activity in Peninsular Malaysia throughout the Paleozoic and Mesozoic eras had a major impact on the land followed by production of fold and fault, as demonstrated by Dony et al., (2015). Sedimentary and igneous rock exhibits folding, jointing, and faulting as a localized structural characteristic.

Along coastal areas, island arcs, and inside landmass, target faults also produce localised pressure or development. Whenever strike-slip fault kinematics departs from the plate vector, a sedimentary basin develops as its name implies (Noda, 2013). Fault termination basins are defined as basins that are located at or near the end of a fault. At the tip of a strike-slip fault, it forms under transnational stress. As a result of the strike-

slip fault, river silt is the primary source of sediment for the basin's basin. The basin's sinking has been caused by both tectonic depressions and excessive surface heat flow.

The Land of the Continental United States the Bentong-Raub Line and the Lebir tectonic region encircle Malaysia's Southern Delta, extensional findings are also supported. It is possible that the Bentong-Raub Line and the Lebir Zone saw major normal faulting during the Triassic, which led to a rock formation (Metcalf, 1989).

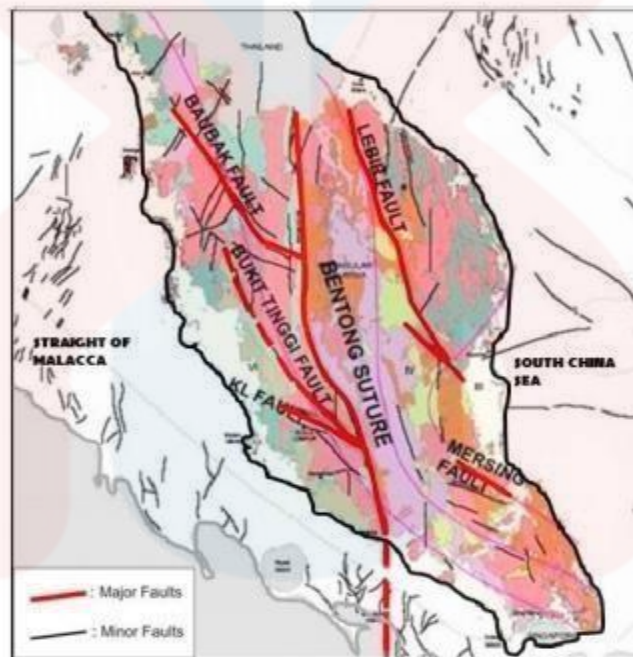


Figure 2.4 : Shows map of peninsular Malaysia major and minor faults. (Metcalf, 1989).

2.5 Fossils

Fossils are a priceless geological resource that may be used to learn about past environments, research Earth's history. It can be further split into chemical, trace fossils.

Research by Kamal et al. (2016) revealed microfossils such as bivalves, ammonia, and brachiopods in Gua Musang as well as microscopic fossilised and foraminiferal species. Researchers Dony and Rosli claim to have found many specimens

of tiny zooplankton in the Aring area. Included in this category are mollusks and brachiopods, amongst others.

2.6 Historical Geology

Kelantan has the youngest rocks since it is in the Central Basin. Most of the marine Permian strata which happen in linear bands bordering Mesozoic deposits in the Central Belt (Farhafiezah, 2017). Sediment from the Triassic epoch began to build up in the basin.

The Main Range Granite was formed between 200 and 230 million years ago, according to Malaysia's Department of Minerals and Geoscience (2003). Volcanic extrusion rocks, granite, sedimentary and metasedimentary rocks comprise Kelantan's geological units. Grass in Kelantan is divided into Main Range and Boundary Range types. Furthermore, Paloh's Triassic argillo-tuffaceous limestone unit, according to Hutchison & Tan (2009), the component is strongly suggesting.

2.7 Depositional Environment

Sedimentary processes impact the depositional environment, which is a location where sediments can be deposited. There are three primary depositional environments: continental, transitional, and marine. Gua Musang formations were developed in a mild, contained environment during the Permo-Triassic era in the Cenozoic Seaway of the Central Belt, according to Kamal (2016) based on sedimentological and paleontological data.

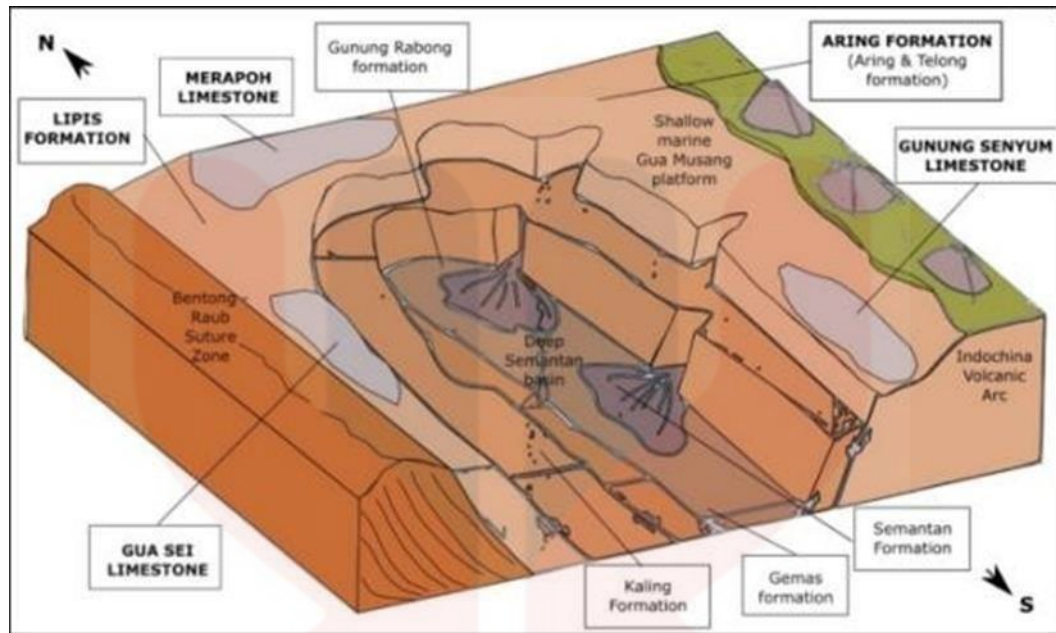


Figure 2.5: Central Belt Peninsular Malaysia's Middle Triassic depositional context.

(Sources: Kamal et al., 2016)

Facies features can be used to infer information about the depositional environment, according to Hashmie et al. (2016). Mineral composition and energy index categorization are only few of the characteristics that make it unique. According to Abouessa et al. (2015), the Sirt Basin, Libya, is a Fluvial floodplain, as evidenced by the cylindrical burrow trace fossils found there. Kepferle (2017) interpreted the geology, lithology, with bedding structures of the Kensington Sedimentary rock Part in the United States as proof of a deltaic environment.

A depositional habitat is a location where particular sedimentary processes are required in order to deposit the material. Continental (land), marginal-marine (transitional), and marine are the three main depositional environments. A facies model compiles the attributes of a certain depositional environment from earlier studies (Boggs, 2014).

Sedimentary logs depict the facies features of a deposit. According to Trujillo & John (2015), stratigraphic columns are significant because they let geoscientists better

comprehend and communicate with one other. The bed number, rock type, major lithology, grain size, and color are all included in a stratigraphic column. To demonstrate the paleotidal range depositional environment, the facies' bedding level, geomorphic, particle shape, and geological form are displayed.

It's possible to convert a comprehensive section's worth of facial features data into a digital format using the Corel Draw programmer. In Western Maryland, Dolezal (2004) utilized this approach to create visual logs to analyses the depositional environment of the Rockwell-PriceFormation.

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

This section outlines how the sources used and how its analysis is carried out before, during, and after the fieldwork. A topographic map, a geologist's hammer, a solution of sulphuric acid (HCl), stationary, a photography, a travel notebook, trying to measure meters are necessary for fieldwork.

It involves six steps, which is, methodology of the study, observational, sample preparation, data preparation and interpretation, and data analysis and interpretation. These stages outline the entire research process, which demonstrates in (Figure 3.1).

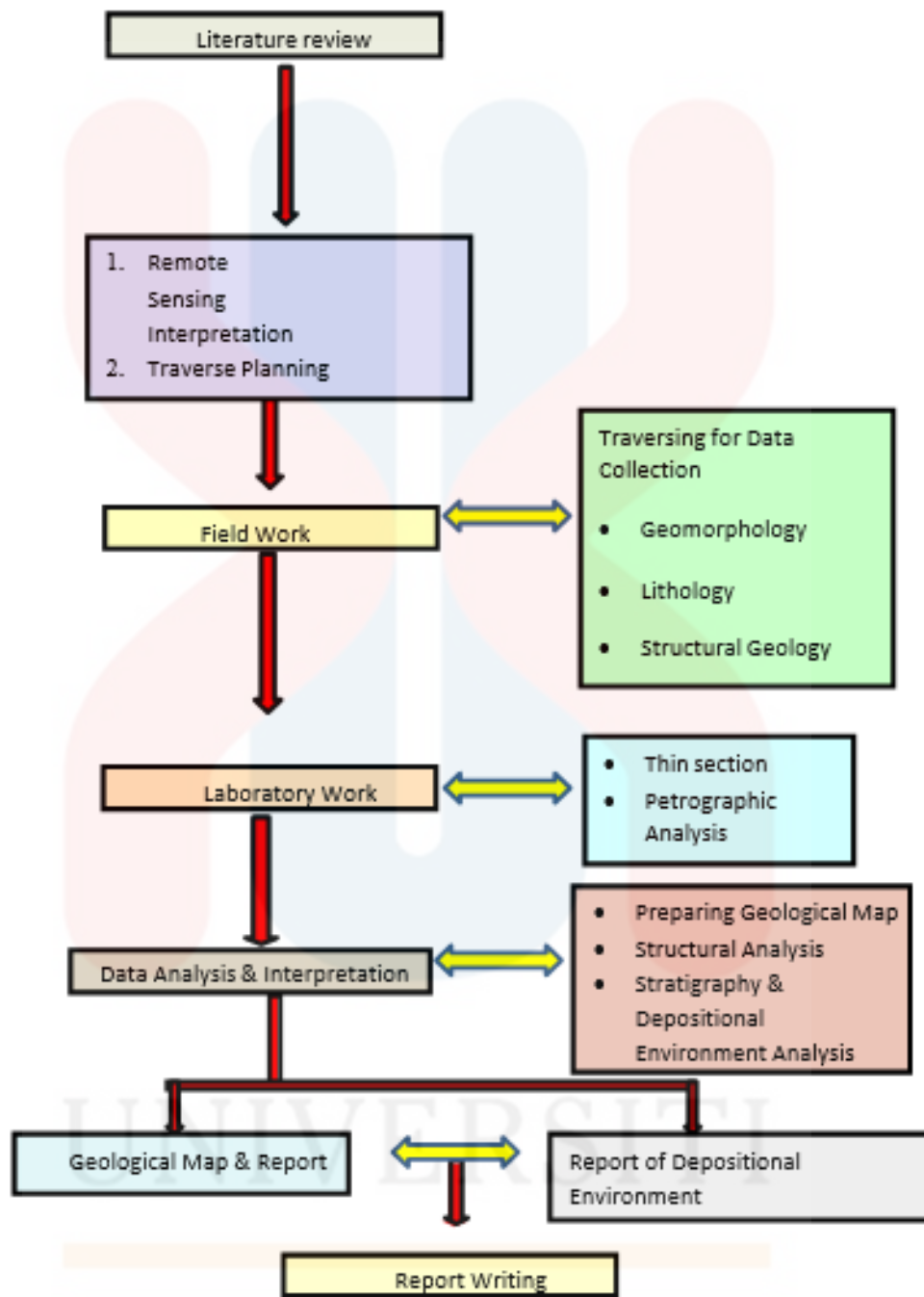













Figure 3.1: Flowchart of the methodology.

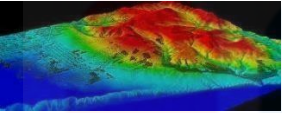

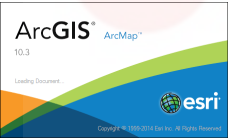
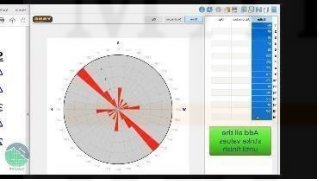
3.2 Methods

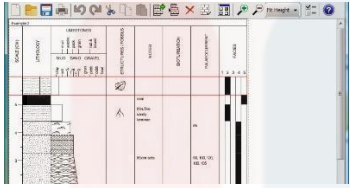
Table 3.1: The images of material and the description.

Material	Uses
<p data-bbox="360 548 587 584">Topographic map</p> 	<p data-bbox="930 548 1409 801">Geological mapping can begin with a known location of the contour, river direction, coordinates, scale bar, and magnetic declination data.</p>
<p data-bbox="360 983 839 1019">GPS - Global Position System (GPS)</p> 	<p data-bbox="930 983 1369 1236">Earth-surface position and time information is provided by GPS, a space-based satellite navigation system.</p>
<p data-bbox="360 1426 480 1462">Compass</p> 	<p data-bbox="930 1426 1433 1753">One of the most important tools in this process is an accurate compass, which is used to accurately measure outcrop orientations as well as the positions of sedimentary strata.</p>

<p>Geological hammer</p> 	<p>A hammer is a standard outcrop sample collection tool. While the hammer's pointed end is used for prospecting in soil and loose rock debris, its flat end is utilized to crush rocks.</p>
<p>Hydrochloric acid (HCl) solution</p> 	<p>Carbonate minerals can be determined by using HCl solution.</p>
<p>Stationary</p> 	<p>A variety of stationary, are ready for use when mapping.</p>
<p>Digital camera</p> 	<p>A high-resolution camera with a geological information.</p>

<p>Field Notebook</p> 	<p>The data and information gathered in the field will be recorded in a field notebook.</p>
<p>Measuring Tape</p> 	<p>The length of the measuring tape to determine the sedimentary strata.</p>
<p>Hand Lens</p> 	<p>We can easily view microfossils and minerals in rock using a hand lens, which can't be seen with the naked eye.</p>
<p>Sample Bags</p> 	<p>To keep the field samples safe, sample bags are required.</p>

<p>Remote Sensing Image</p> 	<p>The satellite's remote sensing picture is a depiction of Earth's surface.</p>
<p>Microscope</p> 	<p>In the laboratory, the microscope is used to identify rocks and minerals.</p>
<p>ArcGIS 10.3 Software</p> 	<p>A programmed that is used to produce, modify, analyze, and distribute information to build a map.</p>
<p>GeoRose Software</p> 	<p>Analyses the joint's position and force direction using computer software Data about the structure's orientation has been uploaded to the software's database.</p>

<p data-bbox="359 226 576 259">Sedlog Software</p> 	<p data-bbox="930 226 1414 551">Drawing a sedimentary log requires the usage of Sedlog 3.1. Sedimentary features and fossils can be seen together with the thickness of the bed and lithology.</p>
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3.3 Methodology

3.3.1 Preliminary Studies

Preliminary research is done to learn about the subject area's regional geology. Study of the topographical map and literature review are part of this phase. The research area's geomorphology is depicted on a topographic map. Analysis of the topographic map can help determine where the lineament is in relation to the study region's historical geology, which can be extrapolated from the existence of lineament as evidence of structural faults in the area. Consequently, geomorphology of the research region maybe analysed using Google Earth. Traversing is scheduled once the maps are analysed to conduct the field research. A well-planned traverse will yield important information about the area.

In addition, a thorough assessment of the relevant literature must be completed before any fieldwork will proceed. Previous researchers' knowledge and geological data are necessary for this inquiry. Preliminary research can be done using books, journals, articles, the Internet, and maps of Malaysia.

The University of Kelantan's library Kampus Jeli is a valuable source for the literature review since it contains important study papers. The library has a collection of books that outline the best practices for collecting geological and environmental data.

3.3.2 Field Studies

The traversal technique will be used to capture and collect data from the field through geological mapping. Gather rock samples from the locations where the area is located so that the geological settings may be classified. Collect the outcrop sample and investigate it. The outcrop that will be in place is sedimentary rock and minimum 5 outcrops can be found in the research area. At first glance, it's an excellent approach to gain a sense of the geological landscape in the region of study.

Secondly, Traversing will be done to carry out a comprehensive mapping. Observing, measuring, and sampling are three of the most important parts of geological mapping. All these factors are critical in gathering data for geological maps and depositional environments. In structural geology secondary structure are have their direction will be evaluated and documented in this study. The compass is used to determine the bed's position after the direction has been established. Overall alignment of a joints and the fractures that make up the joints are both measured as part of the joint and fault analysis.

Lithology, sedimentary structure, and fossil content were used to gather information on the depositional environment. For the age of the rock, the lithology and fossil collecting data must be combined. Because petrography requires calculating the proportion of the mineral in the rock sample, new samples are obtained for examination. The geological structure and Sedimentary structure that developed in the course of a suitable indicator for the analysis for the study. When determine, relative

age of the rock and depositional environment, it is helpful to observe the fossil content or rock in sedimentary rocks. To depict how the facies relate to one another, stratigraphic columns are drawn. A sample of both, a rock and a fossil, is taken for laboratory examination.

Pigment, texture, and particle size distribution will all be taken into consideration while analysing rocks in lithostratigraphy. Samples of the rock are required for further investigation of the rock name through petrographic analysis and also will be identify the fossil name and see if there are any micro fossil in the outcrop, a microscope is a good tool.

The depositional environment's characteristics can be deduced via careful observation. Lithology, sedimentary structure, and the presence of fossils are only a few of these characteristics. The surrounding region should be scoured for rock samples so that the structure and minerals may be identified. Grain size, shape, sorting, and orientation are all aspects of the sedimentary rock's lithology that may be examined. With the use of a measuring tape, the mattress thickness is determined.

The outcrop is sketched and will capture in an acceptable scale during the field study. We can see where to take the taking measurements and samples by looking at the base map. In the sample bags, all the samples have been labelled and put away.

3.3.3 Laboratory Work

The rock samples taken in the field will be sliced into a thin piece for laboratory analysis. Non-deformational diamond saws will initially be used to cut the rock into smaller pieces. It will be necessary to flatten the little sawn rock piece by hand or grinding equipment. After that, epoxy or mounting material is used to attach the flat surface to the slides. Once the glue has dried, the sample is cut into 2 mm slices. The thin section

sample is mounted on the other side of the cover glass. Microscopical petrographic examination can now begin on the thin section. The minerals, pieces, and their covering percentage in the rocks may be recognized by a petrographic analysis. Thus, a rock identification chart may be used to identify the correct rock name.

3.3.4 Data Processing

All the data are very well analysing and evaluate it. Preliminary data from lab work and field studies must be analysed first before they can be understood. Researchers will start by compiling the geological map using remote sensing geomorphology data. It is planned to collect and document geological data in the field on geomorphology, mineralogy, structural geology, and stratigraphy. Petrographic data will be collected in the lab using a microscope by merging and integrating all this data, we will construct a comprehensive geological map.

Fieldwork provides information on lithology, sedimentary formations, bed thickness, and fossils that help determine the depositional environment. There is a way to get the facies' petrography in the lab. As with a geological map, data from both fieldwork and the lab will be incorporated.

The collected and compared data comes from several stages of the project. There are certain data sets that are excluded from the analysis because they exhibit a significant degree of variability compared to others.

3.3.5 Data Analysis and Interpretation

A geological map with a scale of 1:25, 000 will be created using GPS data and field data gathered during fieldwork and laboratory work.

The sedimentary log is shown using data from detailed sections are collected in study area. To create, sedimentary log, we will use Sedlog software. The Paloh area's depositional environment will be interpreted using the features of the sedimentary log plotted. In a report, the conclusions of the research are laid down clearly and concisely for future use.

Structural geology rose diagrams, equal area stereonet diagrams, and equal angle stereonet diagrams may all be plotted using the rose diagram and stereonet plotting application GeoRose. Generate equal area and equal angle stereonet diagrams, as well as strike, dip direction, and dip rose diagrams.

A multi-platform programme called SedLog may be used to create visual sediment logs. It offers a simple, graphical user interface that anybody may use with no difficulty. CSV files may be imported and exported with log data. On a bed-by-bed basis, the data set for a series of rocks is assembled. The goal to provide the user as much flexibility as possible in the output's look was a key factor in the creation of SedLog, while there are certain restrictions. For instance, the total number of columns accessible is set, and symbols can only be added into particular columns. By clicking and dragging the column borders on the screen, you may change the width of the columns. Once a layout is finished, it may be stored and used as a template for various data sets. The "Age" and "Formation" columns should be put on the left side of the log, with text oriented vertically and stratigraphic unit borders recorded.

CHAPTER 4

GEOLOGY

4.1 Introduction

The geology and details regarding the research region were covered in greater depth in this chapter. For the purpose of understanding the general geology of the research region, all geological information was presented together with the data and findings. It covers the research area's accessibility, habitation, forestry, and vegetation. Plantations and a forest reserve are present across the research region. The FELDA organisation manages oil palm and rubber plantations, which make up the bulk of the vegetative cover. The majority of the residents are FELDA employees or policemen. Since the region is covered in flora or a forest, getting to it might be difficult, particularly on a wet day. For the convenience of the task, 4x4 vehicles were necessary. Due to the abundance of flora, the rocks and soils in the research region demonstrate their suitability for a plantation. Along with sampling and data analysis, the research area's geology information included geomorphology, lithostratigraphy, petrology, and the geological structure that was seen. The historical geology of the Paloh region was then explained using the knowledge that had been gathered. The drainage map and the geomorphological map were supplied in the geomorphology section to help with a better understanding of the research area's features. In order to accomplish the goal of the study, it is crucial to have all the geological knowledge about the Paloh region. Geological maps with a scale of 1: 25 000 were created

using the geological data. Additionally, in accordance with the study requirements, the geological information gathered was utilised and further detailed in the next chapter

4.1.1 Accessibility

The ability of the research area to be accessed or acquired readily that benefits the communities in the study region is referred to as accessibility. Road networks are the primary means of access in the Paloh region. This is due to the fact that the road network becomes a result of the socioeconomics of the research area's transportation operations. The accessibility information may be used to estimate the socioeconomic status of the Paloh region. Two paved roads may be located in the south and east of the study area. Gua Musang-Kuala Lumpur highways is the name of the paved road that runs across the study area's southernmost region. Felda Chiku 1 and Felda chiku 2 are all connected by this road. In particular, the upper and eastern areas of the study region, this highway serves as the crucial major road for access. The Jalan chiku 1, which links the Felda Chiku paloh, and Gua Musang-Kuala Lumpur highways, provides access to the study area's southern and western regions. Jalan Chiku serves as a crucial road for getting to different regions of the study area, particularly at the bottom. Two hills in a study area are connected by an old rural highway in the northern section. Since the research area's core is inaccessible due to a road that is not use and has forested areas, there are few options for walking and riding a motorbike there. A 44 rhinoceros, a tiger, a leopard, an elephant, a bear, and a lot of other wild creatures live in the deep, protected forest that covers the majority of the research area's centre, making it dangerous for people to live there.

Figure 4.1 shows the map of accessibility in the study area that consist of Highway of Gua Musang-Kuala Lumpur, the main road of Felda chiku, and former logging road.

Basemap of Study Area

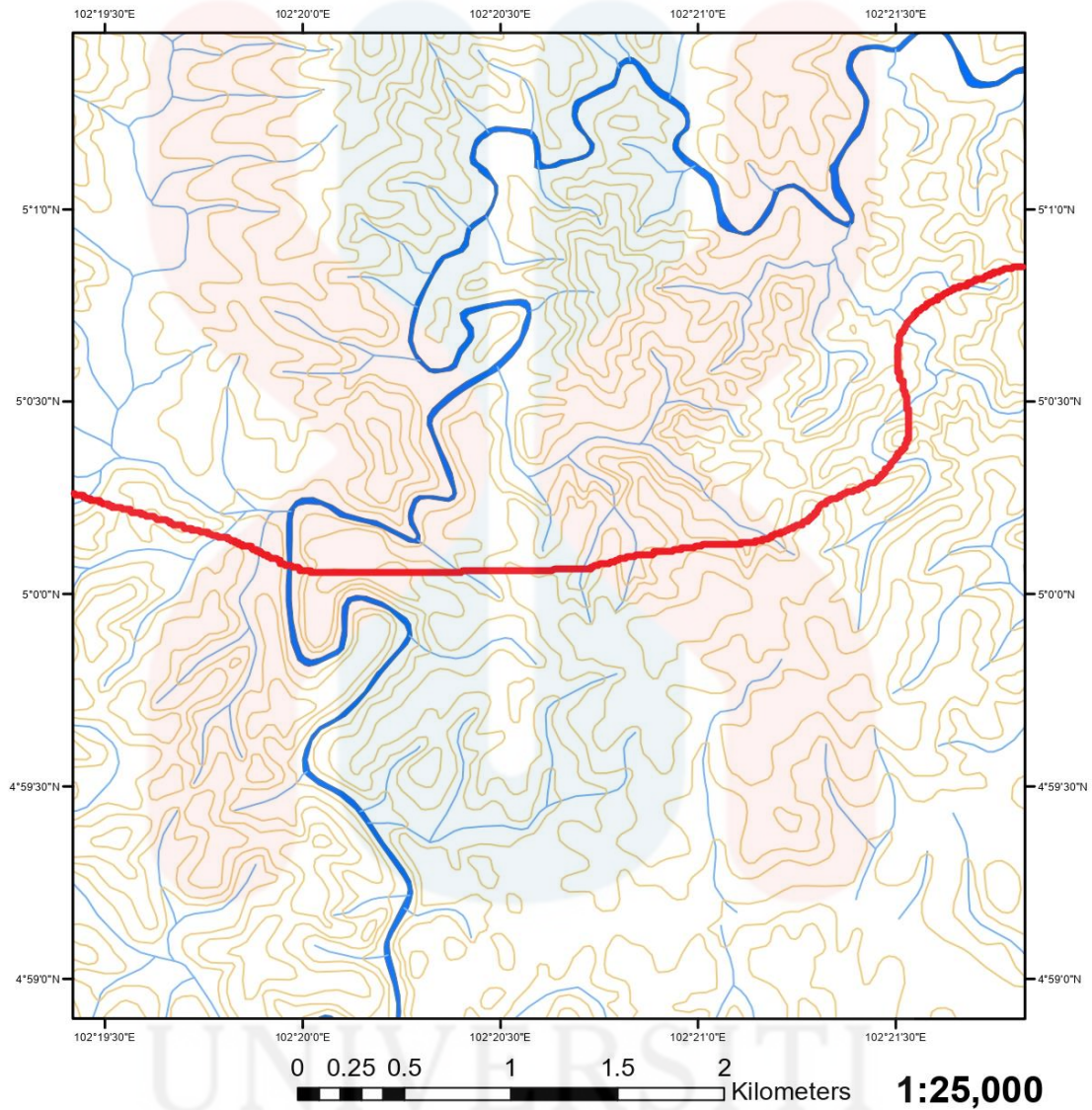


Figure 4.1: Accessibility Map of the Study Area.



Figure 4.2: Shows the Google Earth of Accessibility Map of Study area.



Figure 4.3: Shows Footpath.

According to Figure 4.3, because the footpath is the primary route through the villages and provides some access for motorbikes, the majority of residents use it to stroll. Therefore, doing geological mapping in the research region is simple. This aids in minimising the time and transportation expenses associated with geological mapping. Footpath and major roads make up the bulk of the road network utilised for geological mapping. The river is the primary area of emphasis for data collecting in the research region. Rivers may thus be quickly and readily reached by utilising pedestrian roads.

4.1.2 Vegetation

Depending on the location and kind of soils, the vegetation in the research region is variable. However, there is a minor in forestry and a lot of greenery in the study region. This is due to the fact that the people used the space for vegetation, which is their primary socioeconomic activity in the Chiku region. It also turns into the primary means of support.

The majority of the vegetation in the research area is composed of paddy fields and teak trees, which were planted in various locations depending on the types of soils. Paddy fields are common in volcanic locations, where the volcanic material is well suited for growing rice. Consequently, the study area's use of its land and natural resources was maximised.

4.1.3 Land – Use

Oil palm plantations, rubber tree plantations, and designated forest cover the study area (Figures 4.4). The oil palm and rubber tree plantations are administered by FELDA. The mature trees have already produced new oil palms and rubber. In comparison to the oil palm plantation area, the size of the unpaved road is substantially less in the rubber plantation area. This was done so that the employees could collect the rubber using a motorcycle and the oil palm using a Hilux, which was used for that purpose every day. Compared to the soil in the rubber tree plantation area, the soil in the oil palm plantation area has a deeper brown colour. In the plantation region, the majority of the outcrops are severely worn and have been converted to soil. The study area's southern region is dominated by oil palm plantations, while its southern-eastern and southern-western regions are home to rubber plantations. While oil palm plantations were located in plain areas, the bulk of rubber plantations were located on high hilly areas. The research

area's forest is an established one that is densely forested. The leaves are a deeper shade than the plantation. The distribution of land use is shown on a map in Figure 4.4 Forest reserves are the most prevalent land use in the study region, followed by oil palm plantations and rubber tree plantations.



Figure 4.4: The oil palm and rubber plantation area.

4.1.4 Traverses and Observation

In order to get the geological data in the research region, the basic approach for completing geological mapping is via travelling and observation. The creation of a geological map with a scale of 1: 25000 will benefit from all the knowledge gathered via geological mapping.

Five days were spent mapping the research region in order to create the geological map and analyse the parameters. 5 days were dedicated to geological mapping, while the remaining 2 days were spent defining the scope of the study. In the research region, traversing was mostly done along the rivers. This is because to the less worn and vegetated outcrop found in waterways. As a result, the geological structure and the outcrops were both new and extensively exposed. Figure 4.5 depicts the traverse path

where observation sites were placed to cover roughly 90% of the research area. A comprehensive geological map was produced using the data gathered.

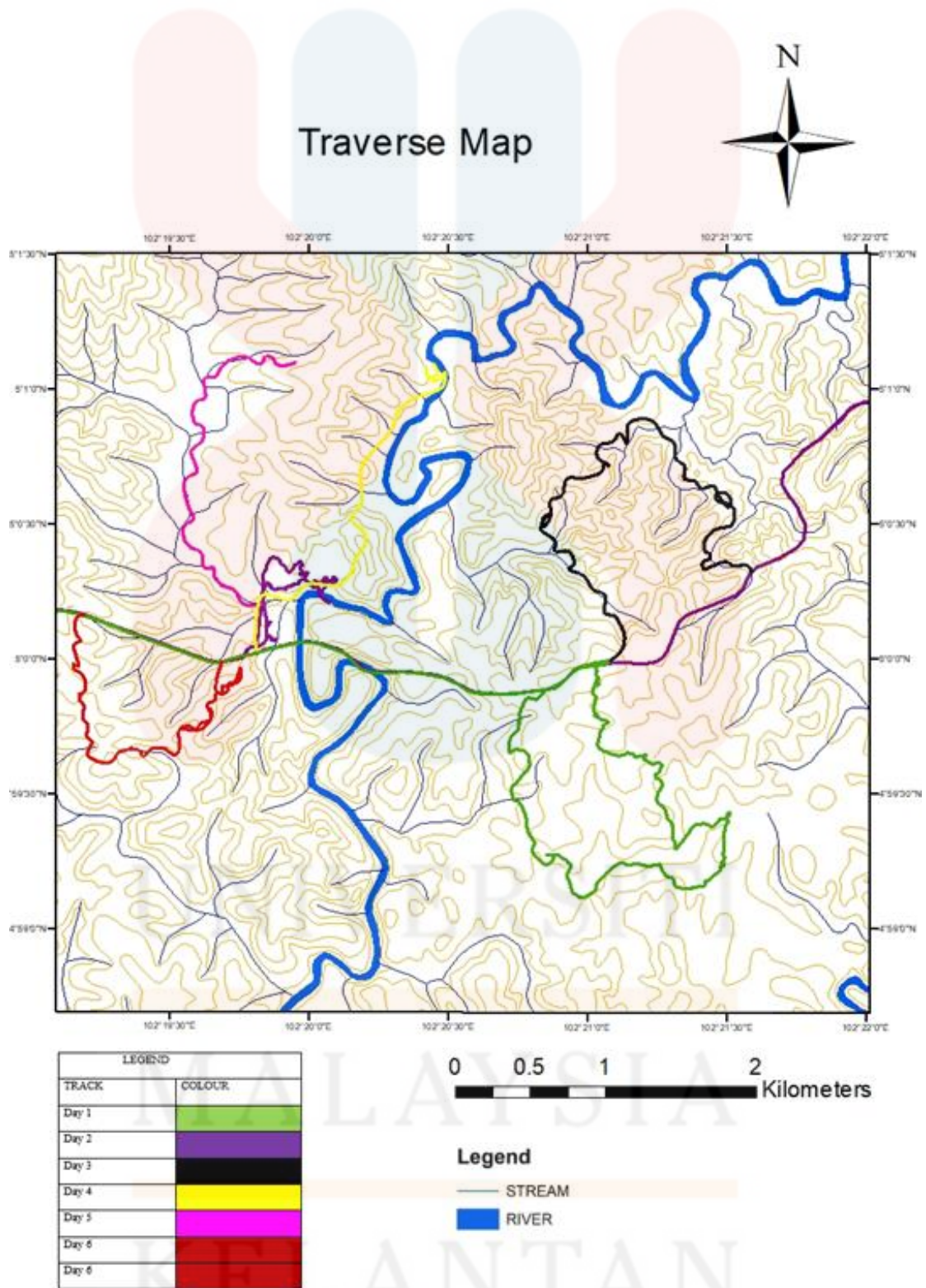


Figure 4.5: Shows the traverse route of my study area

4.2 Geomorphology

The field of geomorphology focuses on and describes the physical characteristics of the earth's surface as well as its landforms, including how they have changed through time since their inception. The geomorphological map, which depicts the distribution of the landform based on elevation, will be used in this study to describe the geomorphological categorization, the weathering process, and the drainage pattern of the studied region. The evolution and qualities of the studied region may be understood by understanding its morphology, making it a useful tool for many planning and development operations. The wearing away of the earth's surface by water, wind, or ice is referred to as an erosional process. On the other hand, the process by which materials and particles left behind after erosion settle down is known as a depositional process. Geomorphology site observation and consideration are essential and useful for environmental and sustainable management. There are other benefits to studying geomorphology, such as its use as a tool for managing natural resources and as a support for different planning and development initiatives.

4.2.1 Geomorphologic Classification

The surface landform in the research region is primarily impacted by complicated structures, forces, and outcomes of many landforms. The study area's morphology is divided between a hilly and flat landscape. The shape of the hill was studied at the mountain's summit, and it was then classified using drawings and the rock type's degree of resistance.

Table 4.1: Classification of topographic unit based on mean elevations.

Topographic Unit	Mean Elevation (m above 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

(Source: Hutchison, 2009)

According to C. S. Hutchison (2009), landforms may be divided into five separate topographic units based on how their mean elevations vary (Table 4.1). The research region's maximum height, 387.5 metres above sea level, is situated in the eastern and southern portions of the study area. As a result, it fits the description of a hilly terrain in the research area. Hilly terrain makes up the majority of the research area's topography, which is also undulating, hilly, and mountainous. The portion of the research region with an undulating and hilly topography is shown in Figure 4.6. In the research region, the red line covers the undulating area, while the yellow line denotes the hilly area. The geomorphologic classification, which is divided into three categories based on the topographic unit classification, may be found. the flat terrain, valley of the escarpment, and undulating hills. Most of the study area's undulating hilly terrain is found in its southernmost region.

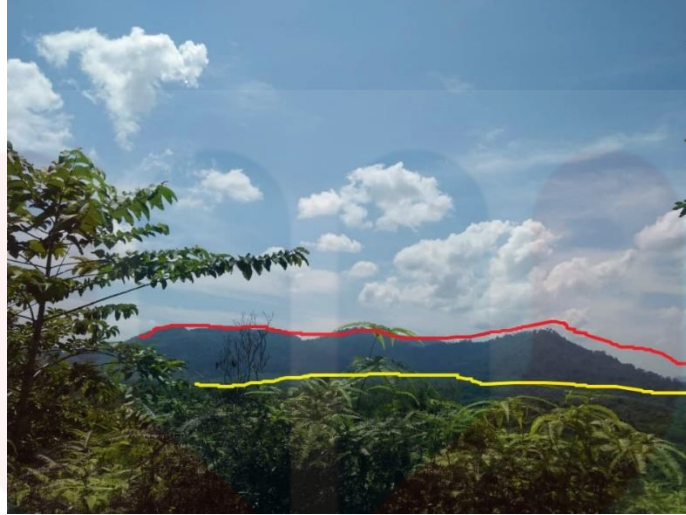


Figure 4.6: The undulating and hilly topographic in 3D view

The geomorphologic classification, which consists of three categories, may be determined based on the topographic unit classification. the flat area, escarpment valley, and undulating hills. The southernmost portion of the research region is where the undulating hills scenery is mostly found. The effects of rock resistance are what produce the various contour patterns. A tight pattern of contour indicates that the rock is extremely resistant, whereas a loose pattern of contour indicates that the rock is poor in resistance.

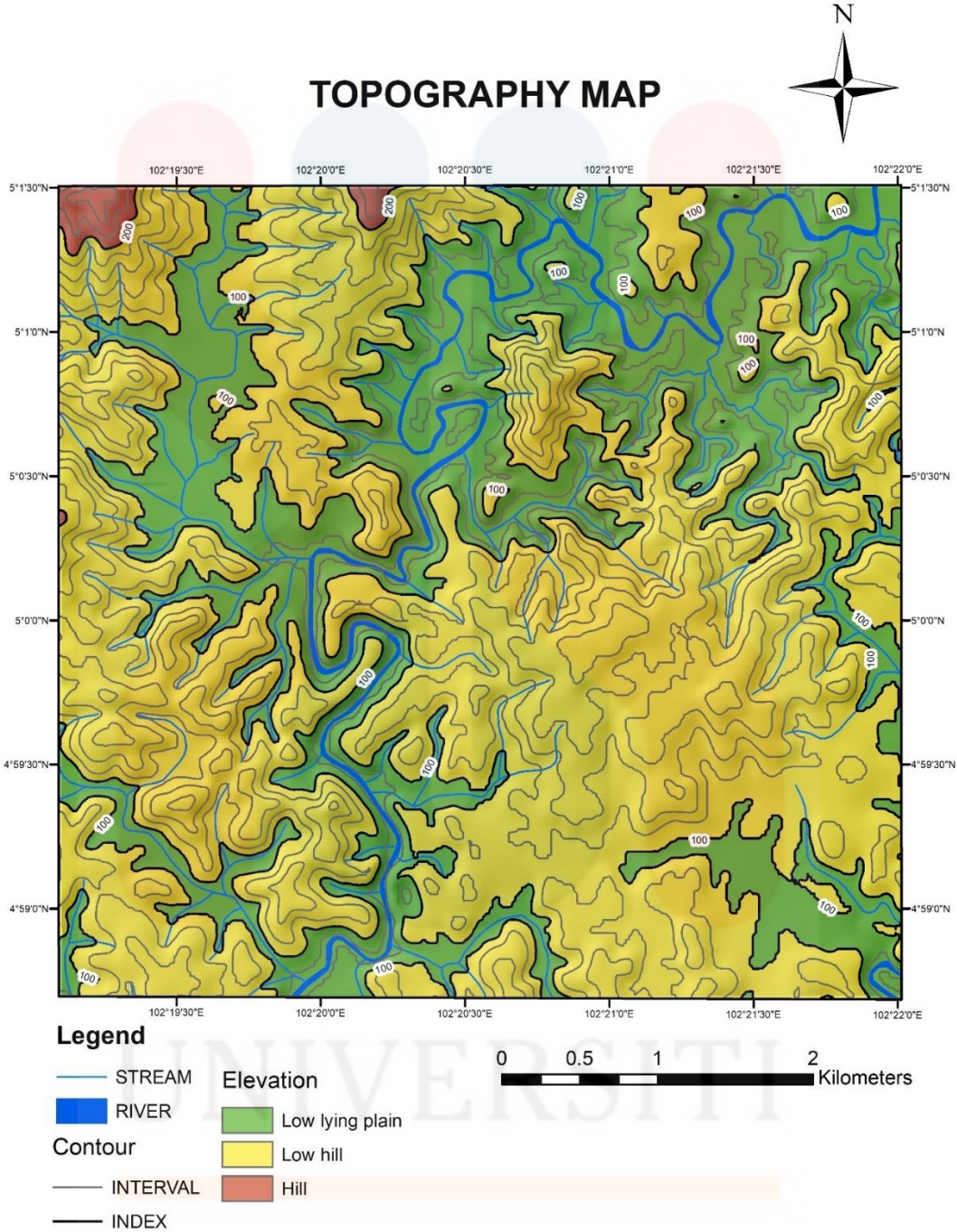


Figure 4.7: Shows topography map.

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4.2.2 Weathering

Table 4.2: Scale of Rock Mass Weathering

Term	Grade	Description
Unweathered (fresh rock)	I	Rock mass shows no loss of strength, discolouration or other effects due to weathering. There may be slight discolouration on major rock mass defect surfaces or on clasts.
Slightly Weathered	II	The rock mass is not significantly weaker than when fresh. Rock may be discoloured along defects, some of which may have been opened slightly.
Moderately Weathered	III	The rock mass is significantly weaker than the fresh rock and part of the rock mass may have been changed to a soil. Rock material may be discoloured and defect and clast surfaces will have a greater discolouration, which also penetrated slightly into the rock material. Increase in density of defects due to physical disintegration.
Highly Weathered	IV	Most of the original rock mass strength is lost. Material is discoloured and more than half the mass is changed to a soil by chemical decomposition or disintegration (increase in density of defects/fractures). Decomposition adjacent to defects and at the surface of clast penetrates deeply into the rock material. Lithorelicts or corestones of unweathered or slightly weathered rock may be present.
Completely Weathered	V	Original rock strength is lost and the rock mass changed to a soil either by decomposition (with some rock fabric preserved) or by physical disintegration.
Residual Soil	VI	Rock is completely changed to a soil with the original fabric destroyed (pedological soil)

Weathering is the collective term for physical, chemical, and biological processes. This whole weathering was found in the study area. Every outcrop in the research area is being physically weathered to a great extent (Figure 4.8). Rocks' colours, hardness, and sizes vary as a result of physical weathering. While the research area's northeast and northwest also experience chemical weathering. In comparison to chemical weathering, which involves the creation of iron oxide or calcite minerals, physical weathering is defined as the mechanical process that causes rock to shatter. While biological weathering refers to plant roots that seep through the rock or algae that produce

compounds that help in the breakdown of the rock, iron oxide refers to the reaction of iron with oxygen, which changes the composition of rocks.



Figure 4.8: The physical weathering in study area.

The outcrop in the southernmost portion of the country is weathered mostly as a result of physical and biological weathering, a process that may result from the presence of flora. Our outcome could be impacted, and it would be challenging to locate any buildings there. Rainfall may have an impact on biological weathering, which focuses more on living things like plant roots on the surface of rocks and causes them to deteriorate more quickly than physical weathering.



Figure 4.9: Biological weathering of plant roots.

For example, the fissures or gaps between the rocks brought on by expanding roots lead the rock to become increasingly fractured or deformed. The rock may fracture as a result of the chemical weathering process that the weathered plant or other organic material will undergo. It happens as a result of the release of carbon dioxide from the breakdown, which, in the presence of carbonic acid, causes the chemical dissolution of rock into soil.

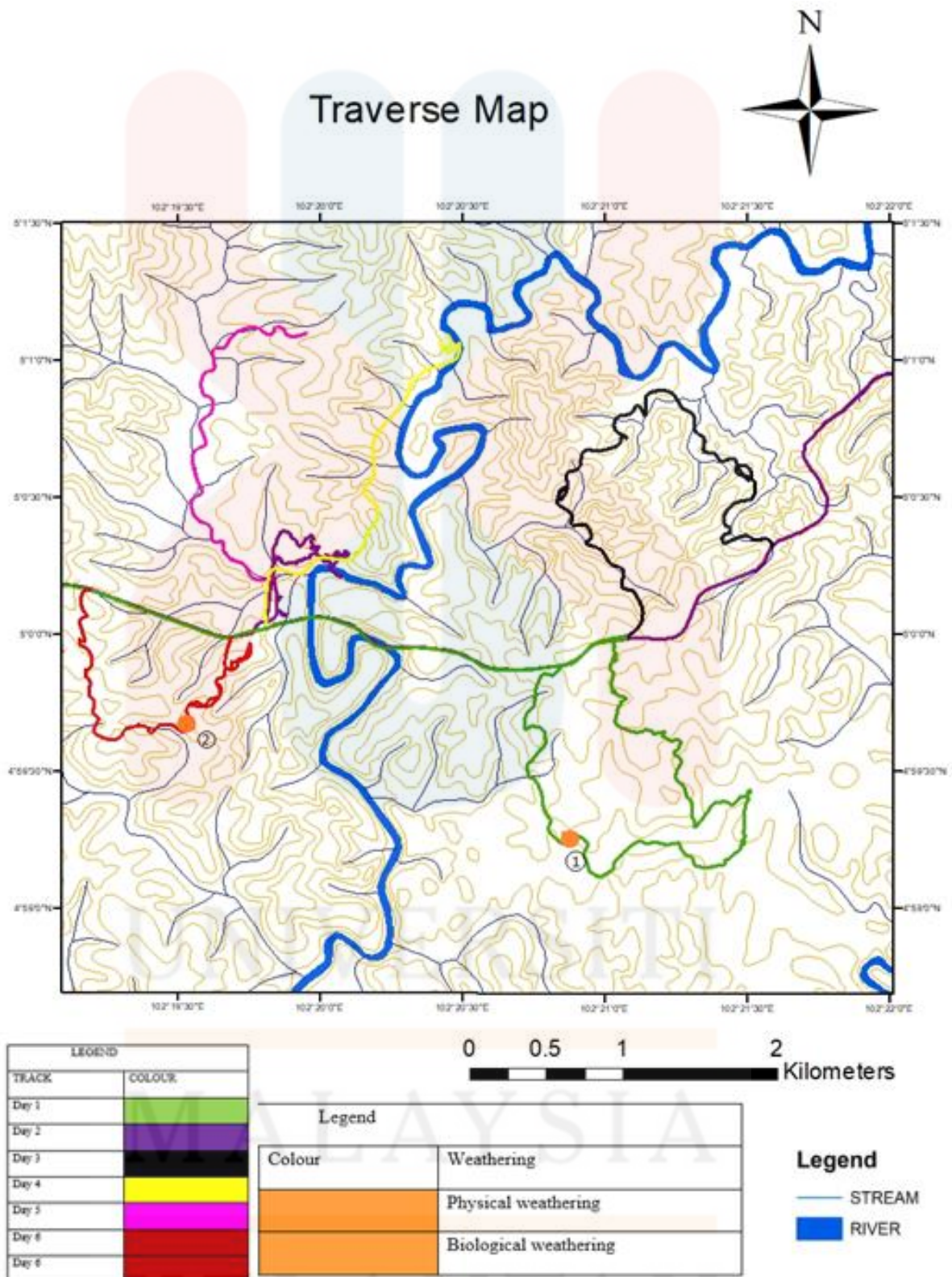


Figure 4.10: Shows the physical and biological weathering location.

4.2.3 Drainage Pattern

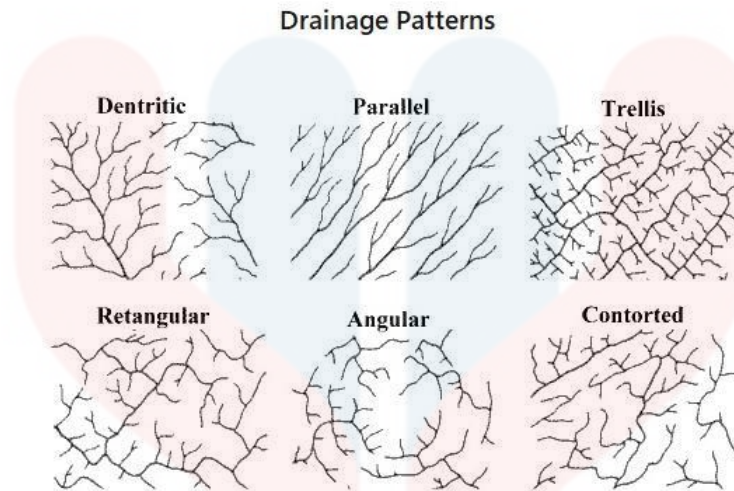


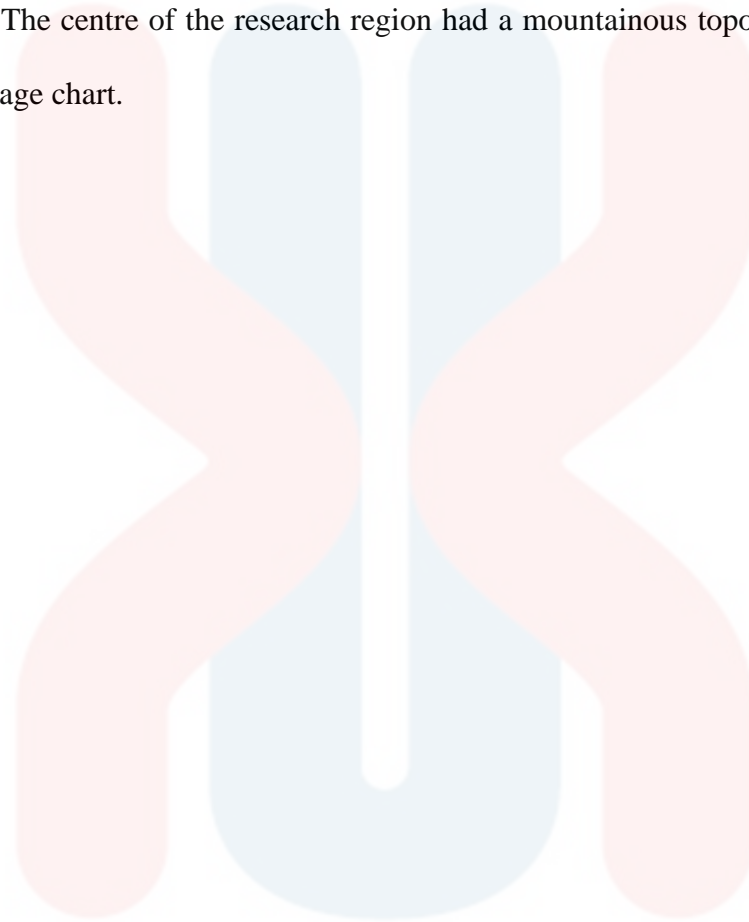
Figure 4.11: Type of drainage pattern.

(Sources: Hanson, 2007)

A drainage system that is scratched into the ground arranges streams in a planimetric pattern (K. Guru Rajesh, 2007). The drainage pattern may be utilised to locate and study the underlying geology features, including topography, slope, structure, and history. There are more than six different types of drainage patterns in the globe, and each has its own distinctive characteristics (Figure 4.11). The drainage map in Figure 4.12 depicts the dendritic, parallel, and distorted drainage pattern of the study region.

Dendritic drainage patterns include unequal branching that mimics tree branches coming from all directions. Particularly common in homogenous rocks that are resistant to water erosion are dendritic patterns. Large crystalline rock, soft rock, and flat-lying strata are the characteristics of a dendritic pattern. There is no structural control coming from geology in a dendritic arrangement. There are two steps involved in the formation of a dendritic pattern. Early on, the stream's rock erosion progresses downward and there are several tributaries. A greater valley gradually engulfed a smaller valley. Rain, relief, and lithological elements all had a role in the development of dendritic patterns. The place where the steep slope has some relief shows the parallel pattern drainage of the river. The

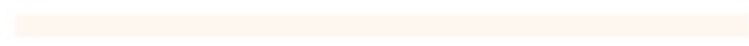
steep slope pouring into the main river in the same direction made the stream's course straight. It developed from a hilly terrain to a flat one, producing a small number of tributaries. The centre of the research region had a mountainous topography, according to the drainage chart.



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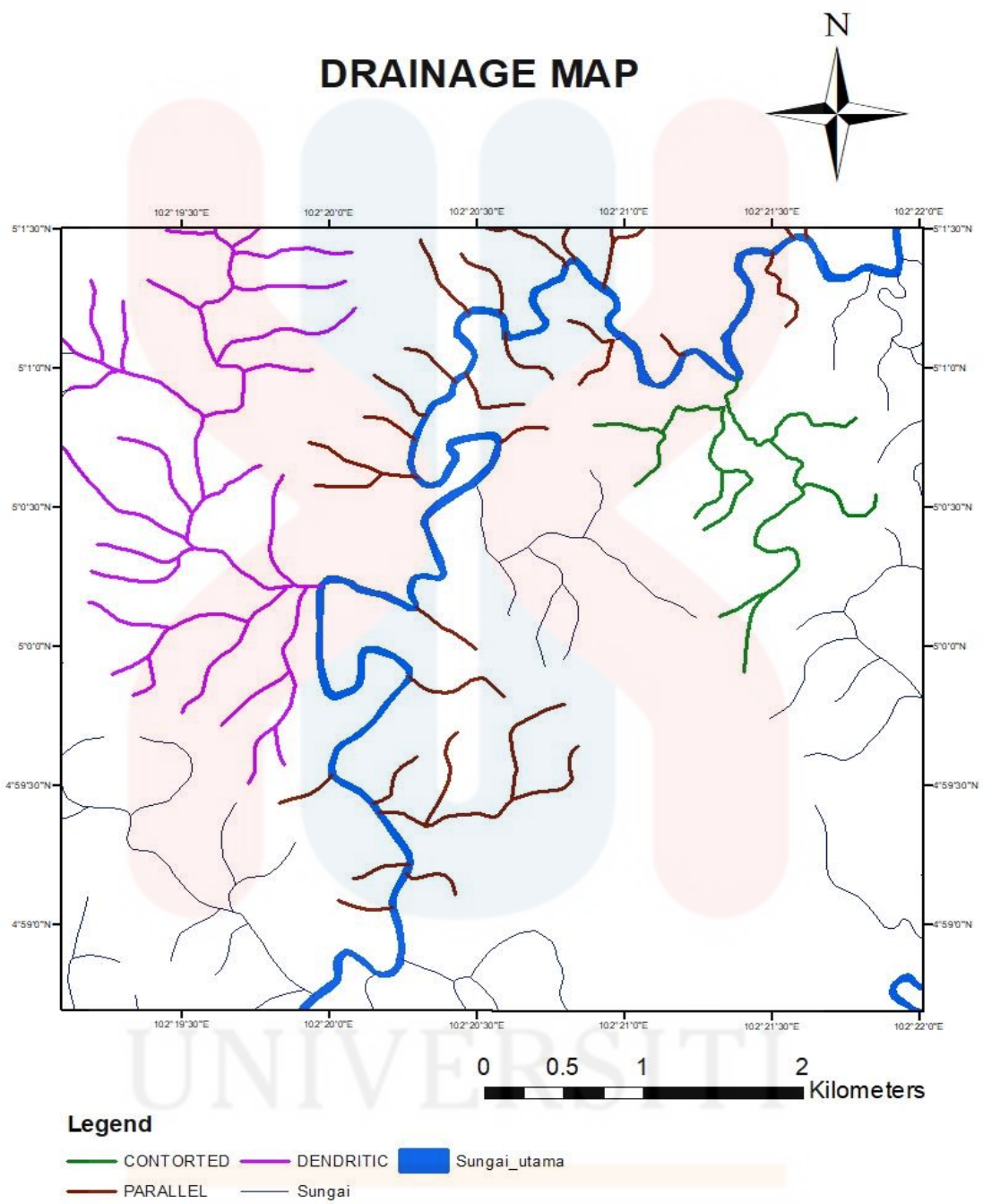


Figure 4.12: Shows the drainage map of study area

4.3 Lithostratigraphy

The distinctions between rocks were seen and noted throughout the traversing procedure to ascertain the lithology unit of the studied region. The lithology-traverse map in Figure 4.14 displayed the outcome. The map will assist in locating the main rock distribution in the research region. The research area's various types of rock are then categorised into lithology units. As a result, the lithology unit and the borders of the various lithology units in the research region may be identified. Sandstone, shale, and phyllite are the three types of meta-sedimentary rock that are most prevalent in the study region. The geological map documented and separated each major lithology unit.

4.3.1 Stratigraphic Position

In sedimentary or layered volcanic rocks, stratigraphy is the categorization of several strata or stacking of sedimentary deposits. The categorization of rocks into well defined, easily mappable units is based on this field, which is crucial to comprehending the geological past. A ring in the Gua Musang Formation Kelantan's Upper Paleozoic rock is compensated for by formations in the south and north. The produced material exhibits forming characteristics like as bedding and cross-lamination (Hutchison & Tan, 2009). The Paloh member, a 1000-meter-thick Tuffaceous limestone unit near the formation's top. Lithology of the aring formation is dominant by pyroclastic facies with beds of argillate and carbonate. The age range of aring formation late carboniferous to late Triassic. These two sub-units were deposited in a forearc basin during the Late Permian and the Late Triassic, which supports easterly-directed subduction, according to stratigraphic and fossil research.

Current Rock Unit		Lithology	Proposed Formation	Age Range	Explanation
Aring Formation		Dominant pyroclastic facies with beds of argillite and carbonate	Aring formation	Late Carboniferous to Late Triassic	Argillite – andesitic (basic – intermediate) volcanic across Aring-Telong area. Includes minor occurrence of arenite and carbonate, and subordinate rudite
Telong formation		Dominant argillite with beds of carbonate and tuff			
Gua Musang formation (including isolated limestone hills)	Low-lying argillo-volcanic	Dominant argillite, prominent carbonate with volcanic interbeds	Lipis formation	Middle Permian to Late Triassic	Argillite - rhyolitic (acidic – intermediate) volcanic across Lipis district – Gua Musang. Includes minor occurrence of arenite and carbonate, and subordinate rudite
	Gunung Senyum limestone	Limestone body in Jengka-Jerantut	Gunung Senyum limestone	?Permian – Late Triassic	Limestone bodies in Jengka – Jerantut vicinity. Occasional presence of intraclasts and brecciated limestone. Non-tuffaceous.

Figure 4.13: Shows the stratigraphic position.

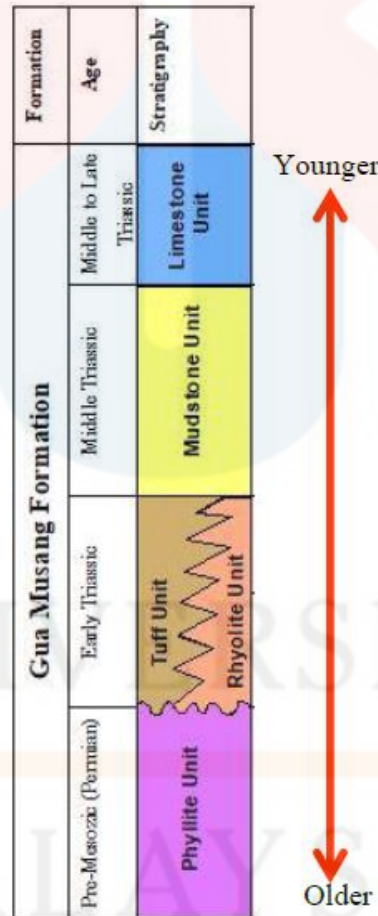


Figure 4.14: Stratigraphic column of the study area.

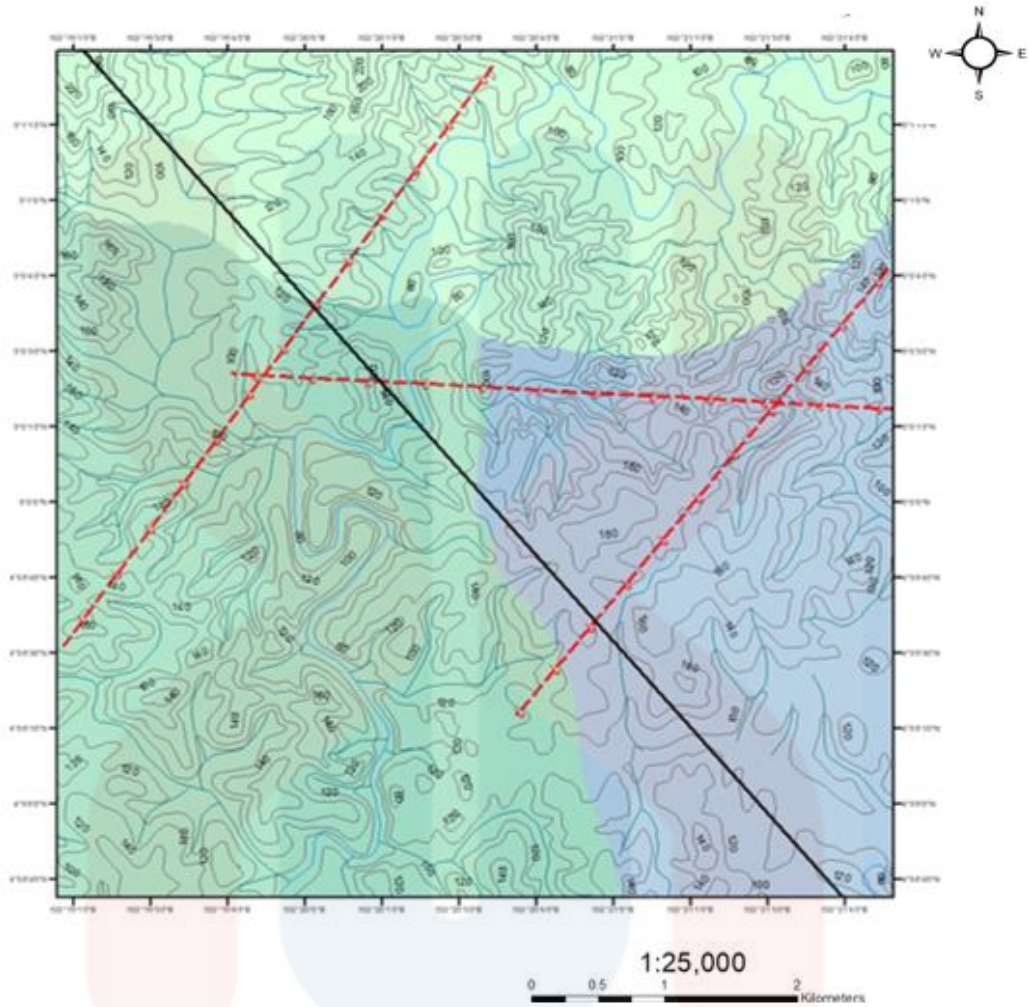


Figure 4.15: shows the Geological map of the study area

Figure 4.14 displays the geological map of the study area. A geological map with a 1:25,000 scale may be found in Appendix A. The study area is made up of three units: phyllite, tuff, sandstone, and shale. While the tuff unit and rhyolite unit are located in the north-west of the study area, the phyllite unit may be found from north to east of it. Sediment units are widely dispersed across the study area. Metasediment, which is a phyllite unit, is the earliest unit. A volcanic rock called a tuff unit is overlaid on top of it as an unconformity.

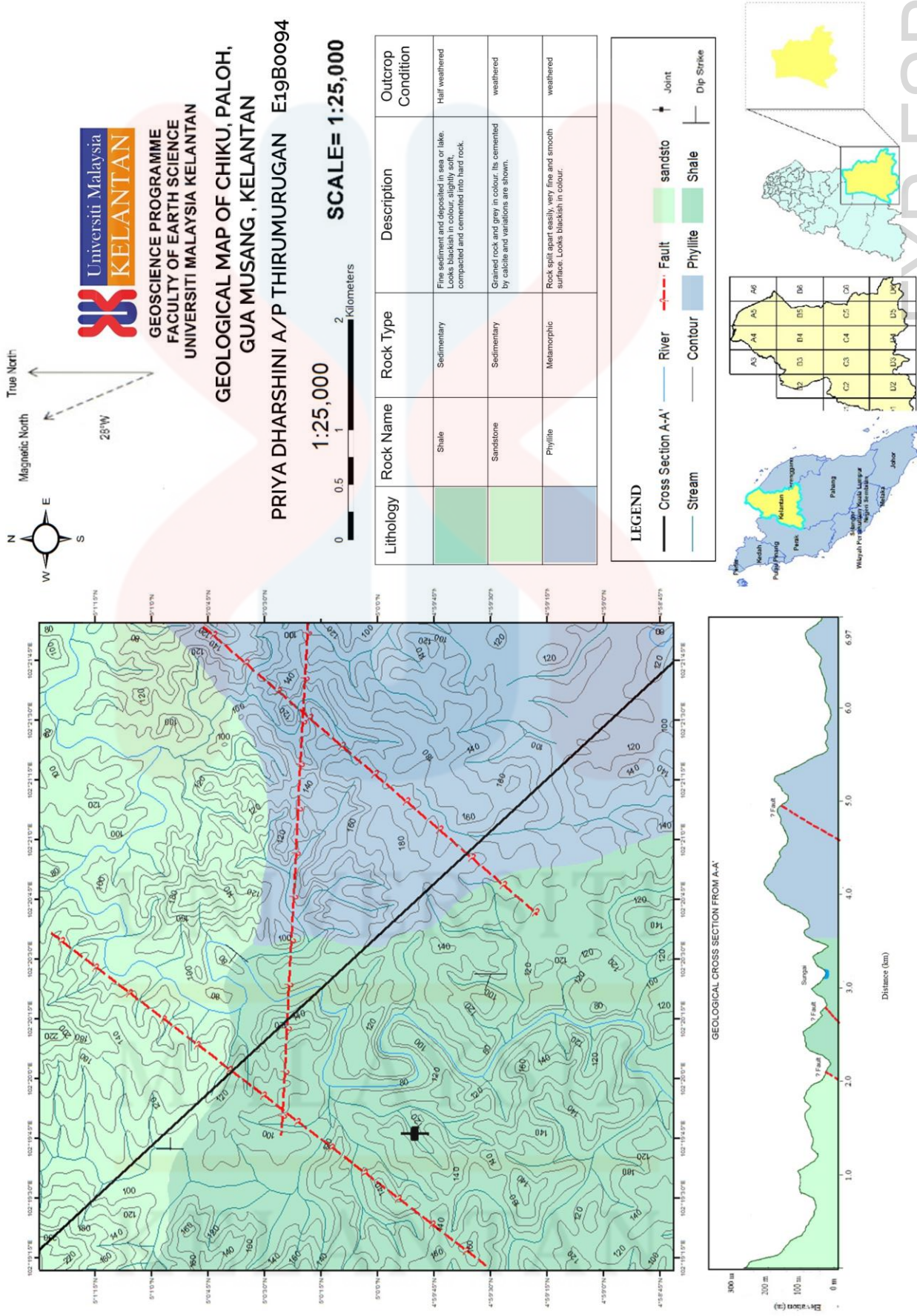


Figure 4.16: Shows the Geological map of my study area.

The geological map of the research region is shown in Figure 4.14. The 1:25,000 scale geological map can be seen in Appendix A. Three units make up the research area: a shale unit, a phyllite unit, and a volcanic sandstone unit. The sandstone unit is located in the south-west of the study area, as opposed to the phyllite unit, which is spread from north to east of the area. In comparison to the metasediment unit, the distribution of shale units in the study area is substantially less. The first unit in a metasediment is called a phyllite. The unconformity is covered by volcanic rock composed of tuff and sandstone units.

4.3.2 Rock Unit Explanation

a) Limestone

Limestone is the region of study's youngest rock type. Although inorganic CaCO_3 precipitation from saltwater also occurs, limestone is the end product of biological and metabolic processes. The study area's limestone is a dark-white hue. As the grain cannot be seen with the naked eye, it is a fine grain. initial mud-limestone component that wasn't bonded together during deposition. The outcrop cannot be taken as a sample because of the roughness. Limestone's smooth surface changes to a rough one when touched. Due to its higher mineral content in carbonates, limestone reacts with hydrochloric acid by producing large bubbles (HCl). Because of the extensive bedding, limestone bedding cannot be detected. Limestone in the studied region is categorised as mudstone using thin section analysis because it is mud supported with less than 10% grain. The Limestone's initial constituents are not connected during deposition.

b) Mudstone

Mudstone rock is dispersed across the study area at low elevations, where it is poorly exposed and covered in vegetation. The mudstone outcrop is dark grey and medium weathered. It is soft and powdering. When mudstone reacts with water, the mud particles easily eroded, and the color and particles of mud easily stick to hand. It is non-fissile and blocky rock. The grey color of mudstone is an indicator whether mudstone is origin from marine or the deltaic environment. The sample cannot be collected because of the outcrop placement is under water.

c) Rhyolite

The research area's northern rhyolite features fine-grained rhyolite with light white and light green colours. The spherical, black, fine siltstone in the rock body of the rhyolite in the study region gives it a distinctive quality. An igneous rock having an aphanitic structure and felsic extrusion is rhyolite. Because of a high gas concentration during an eruption, the rhyolite body quickly cools and develops scoria characteristics. It is visible with the unaided eye that the rock is mostly composed of quartz minerals and contains minimal biotite. The rhyolite sample cannot be collected because of the weathering. The outcrop fully weathered and collapse.

d) Phyllite

Phyllite outcrop is found at the hill with high weathering rate that with the brown and grey surface (Figure 4.15). From the outcrop, bedding structure may be seen and documented. The surface of the hand specimen is quite smooth and fairly firm. It has

medium to fine grains and a very smooth surface. When divided in two, phyllite has a surface that is wavy and velvety. This suggest that there have only been minor regionals sedimentary and metamorphism in the outcrop. The metamorphic rock keeps growing in grain size while maintaining the orientation of the platy minerals. At this stage of metamorphism, little porphyroblast start to emerge; they may be seen as minute bumps on otherwise smooth cleavage surfaces (Harvey et al., 2006).



Figure 4.17: Shows outcrop and thin section of phyllite

Table 4.3 mineral composition of phyllite

Mineral	Description of Optical Mineralogy
Plagioclase (Pl)	Light colour under PPL and greyish red under XPL. Crystal system from subhedral to euhedral. The type of twinning found is Albite and

Carlsbad twinning. Moderate level of Pleochroism with one direction of cleavage. Present as phenocryst and matrix in the thin section. The abundance of 5%.

Chlorite

Greenish brown under PPL view and dark green under XPL. Relief and pleochroism are moderate with zero direction of cleavage. The abundance in thin section is 7%.

Matrix

Appear white brownish under PPL and dark greyish under the XPL view. It is in good sortation because the influences

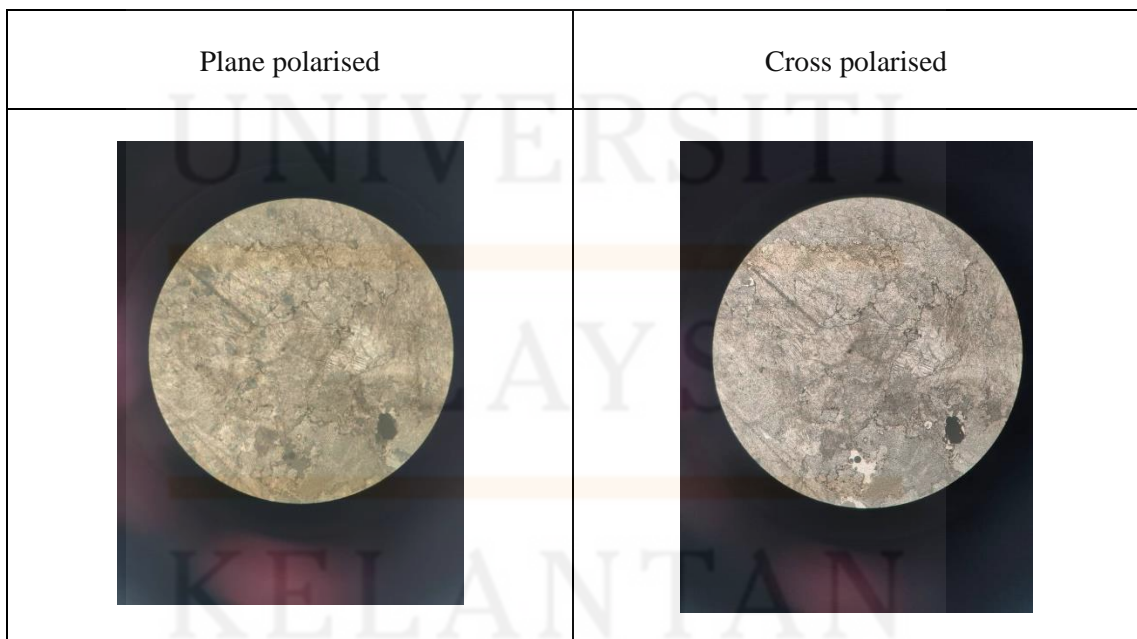


Figure 4.18: Shows plane polarized and cross polarized of phyllite.

e) Tuffaceous Sandstone

There are two places in the research region have tuffaceous sandstone outcrops, however they are not mappable. Two different rock kinds may be seen far away in the same stream. Only a portion of the downstream area has tuffaceous sandstone outcrop. Tuffaceous Sandstone is a light brown hue (Figure 4.17). The study area's sandstone features several laminations. Sandstone develops its parallel lamination by deposition from suspension, slowly moving sediment, or low-density stream. The size or shape of the particle is very spherical and sub-angular. The sandstone has been sorted well. Tuffaceous Sandstone's grain is fine to medium, according to a hand sample. When touched by the hand, the sandstone has a rough texture. A range of mechanisms, including water and wind, are used to carry the clastic grains to the depositional location once they are produced by chemical and physical weathering processes.

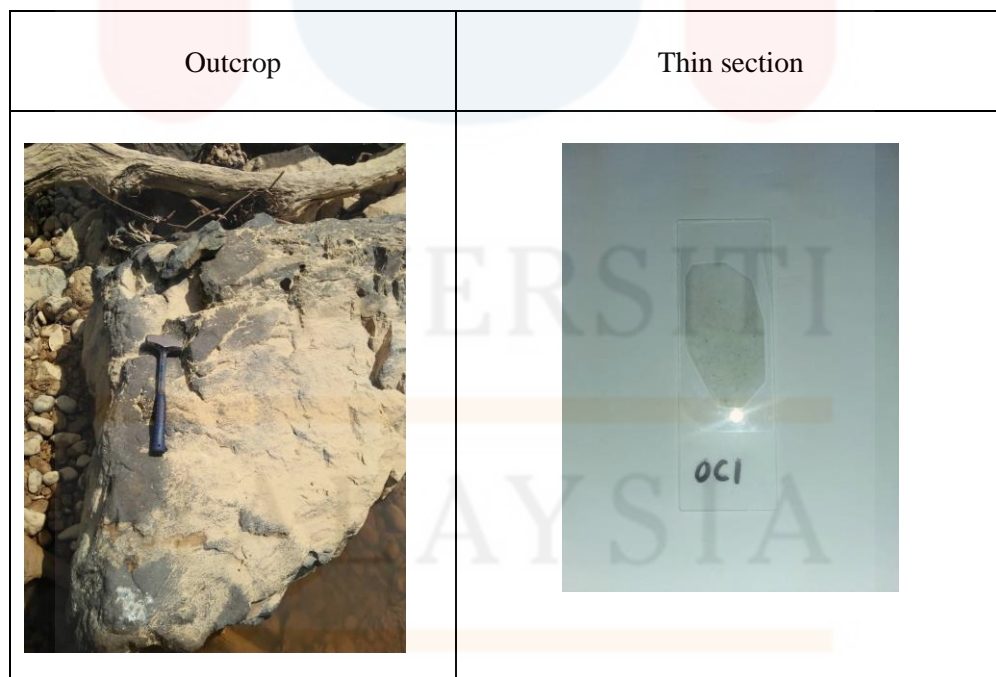


Figure 4.19: shows the outcrop of tuffaceous sandstone and thin section.

Table 4.4 shows mineral composition of tuffaceous sandstone

Mineral	Description of Optical Mineralogy
Lithic Fragment	Brown colour under PPL and dark brown under XPL. Consist of quartz, feldspar, pyroxene, volcanic glass and opaque mineral in the fragment. The fragment abundancy is 20%.
Quartz (Qtz)	More like secondary quartz is known as cement. Under PPL shows white colour and greyish black under XPL. Low relief without cleavage. The pleochrosim is low and the crystal habit is anhedral. Spread in the rock with mineral abundance of 5%.
Feldspar (Fs)	Light colour under PPL and red greyish under XPL. The crystal system is subhedral to euhedral where the crystal is bounded by its characteristic faces. It shows albite twinning with moderate of pleochrosim and cleavage breaks in one direction. The percentage of Feldspar mineral is 30%.

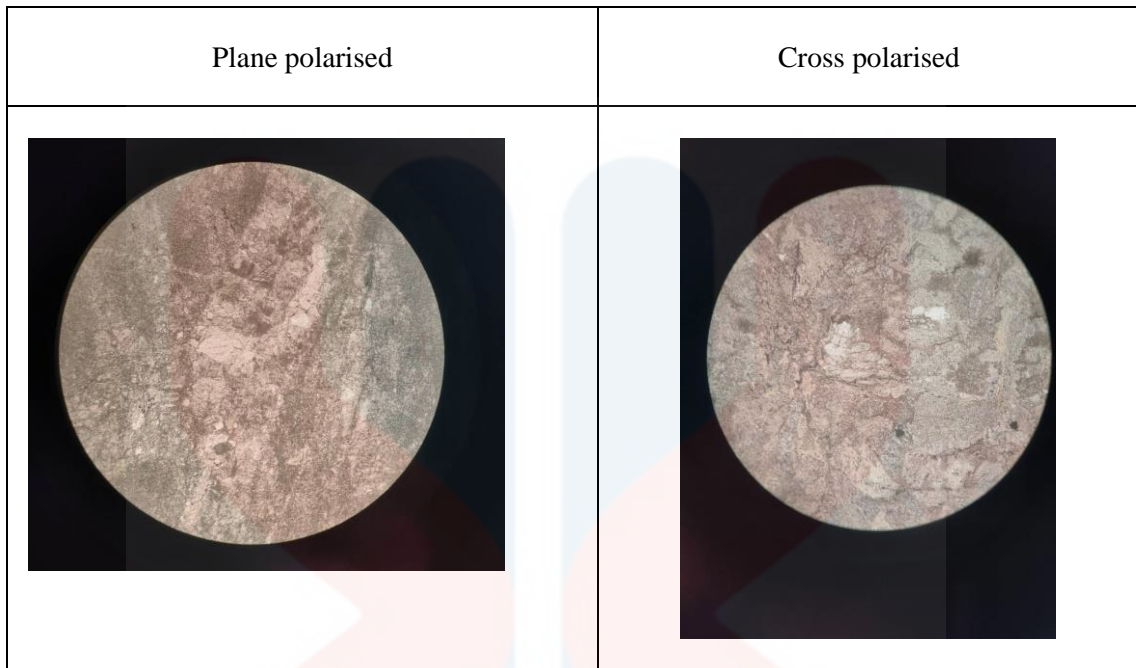


Figure 4.20: Shows the Plane polarized and Cross polarized of tuffaceous sandstone.

There are two places in the research region where sandstone outcrop was discovered, however it cannot be mapped. At a great distance, the same stream has two different types of rocks. When touched by the hand, the sandstone has a coarse texture. By means of physical and chemical weathering processes, clastic grains are liberated, and they are subsequently carried to the depositional location by a variety of mechanisms including water and wind.

f) Shale

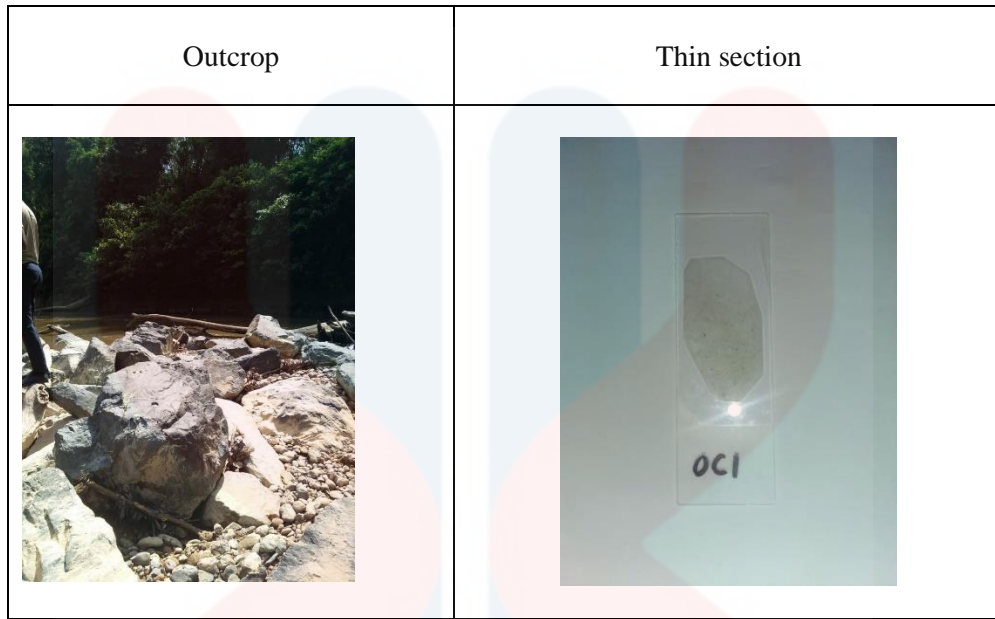


Figure 4.21: Shows the outcrop and thin section of shale.

Table 4.5 mineral composition of shale

Mineral	Description of Optical Mineralogy
Plagioclase (Pl)	<p>Light colour under PPL and greyish red under XPL. Crystal system from subhedral to euhedral. The type of twinning found is Albite and Carlsbad twinning. Moderate level of Pleochrosim with one direction of cleavage. Present as phenocryst and matrix in the thin section. The abundancy of 5%.</p>

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Quartz (Qtz)

Cement is more like secondary quartz.

White appears under PPL while a greyish black appears under XPL.

Without cleavage, low relief the crystal system is anhedral, and the pleochroism is modest. spread throughout the rock with 10% mineral abundance.

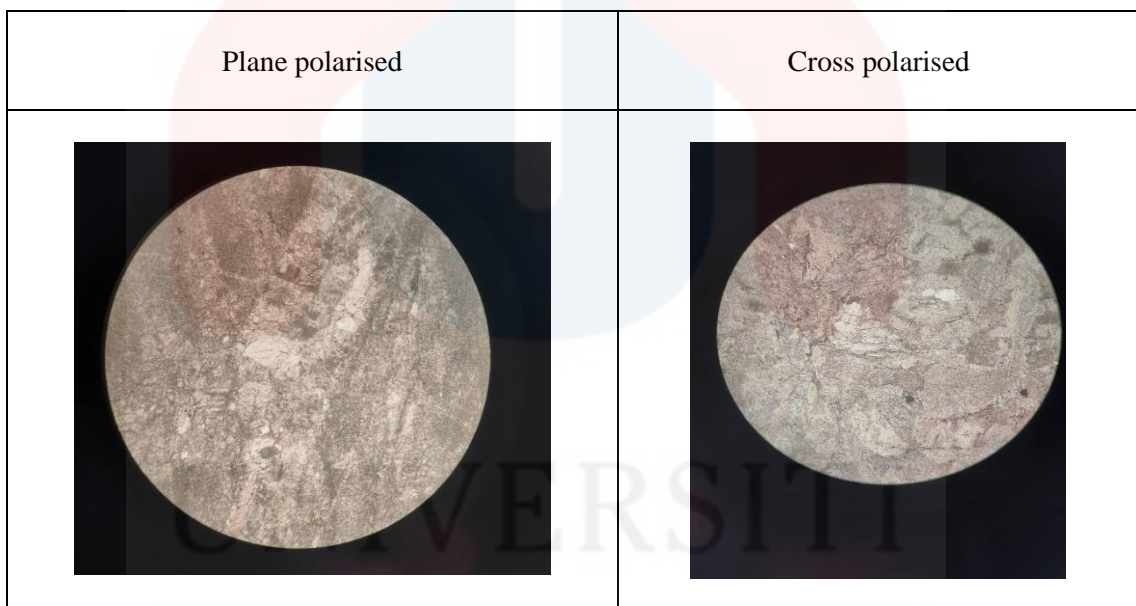


Figure 4.22: Shows the plane polarized and cross polarized of shale.

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4.4 Structural Geology

Secondary structures in structural geology are those where the deformation process takes place after the creation of rock masses. Through the study of structural geology, it is possible to re-enact the deformation process of the earth's surface and subsurface by looking at the local and regional stress in the research area. The study of secondary rock formations and the forces acting on them is known as structural geology. Veins and joints are examples of the secondary structures present in the studied region.

Local structures develop as a result of regional structures, which often have a greater influence on the neighbourhood. Local structures are the little geological formations discovered during mapping. The regional structure may be mapped and shown on the map by first mapping the local structures.

4.4.1 Lineament Analysis

Lineaments are patterns that depict the earth's surface as being linear due to tectonic faults or breaks in the bedrock. It often develops on the earth's surface, and the drainage, topography, and vegetation can be used to identify it. These findings can be drawn from the analysis of data collected remotely. The lineament map of the research region, which was examined during the preliminary study stage, is shown in Figure 4.22. Faults and linear zones can be identified by the interpretation of lineaments.

4.4.2 Vein

A vein is a structure that is created when minerals intrude into a fracture in a rock body. The crack underwent extension fracture with mode I, which does not include displacement but simply involves opening mode that applies tensile stress normal to the

plane, before mineral filled the fracture. The vein may be measured for breadth; it is white dull in tone. High fluid pressure is indicated by veins that are typically mostly composed of the mineralized minerals quartz and calcite. The mineral in vein 84 is quartz rather than calcite since the vein does not react with diluted HCl. The vein is intruded into the phyllite rock, indicating that it is younger than the latter. The vein's presence is connected to a flaw. When a fault forms, the vertical vein that is being displaced pulls apart, and when the displacement grows sufficiently, the phyllite beds are faulted past one another, creating a mineralized fault plane (Peacock, 2004).

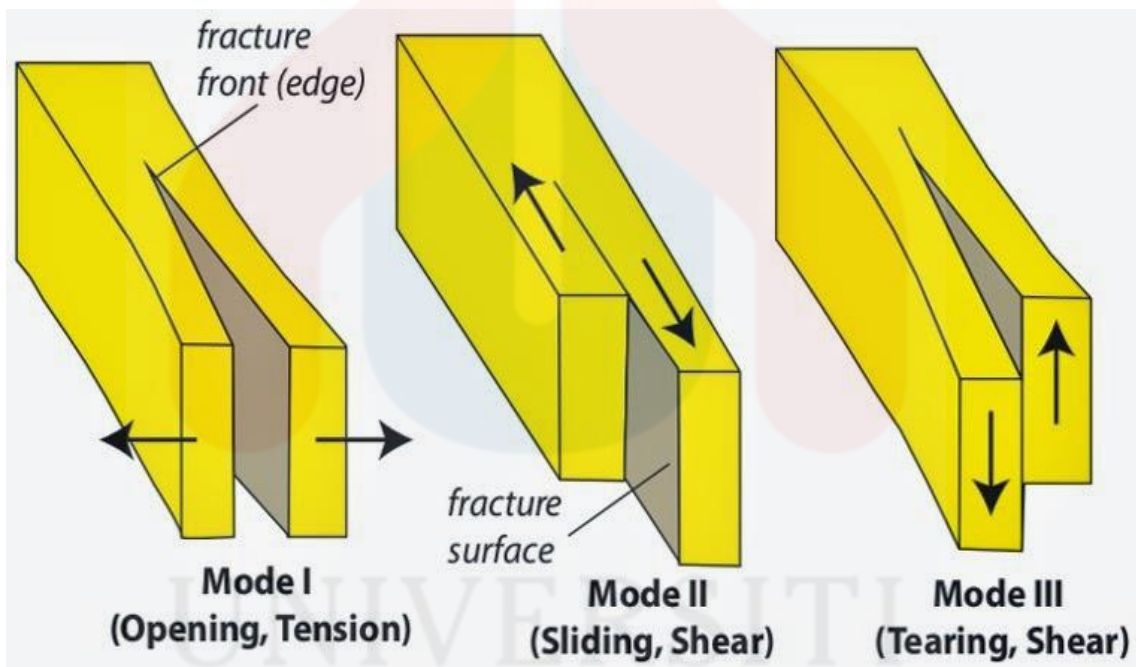


Figure 4.23: Mode of fracture.

(Sources: Lauren, 2015)

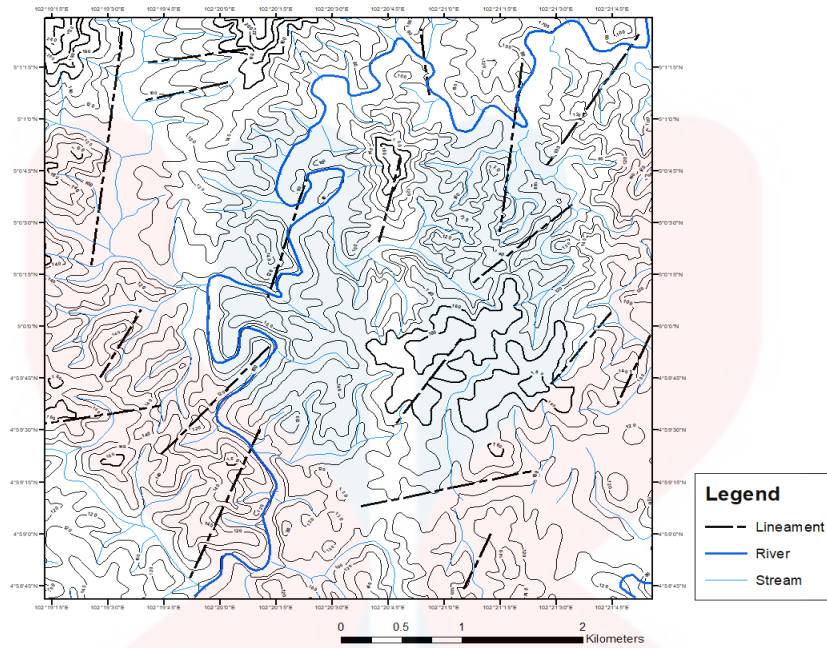


Figure 4.24: Lineament map of study area.

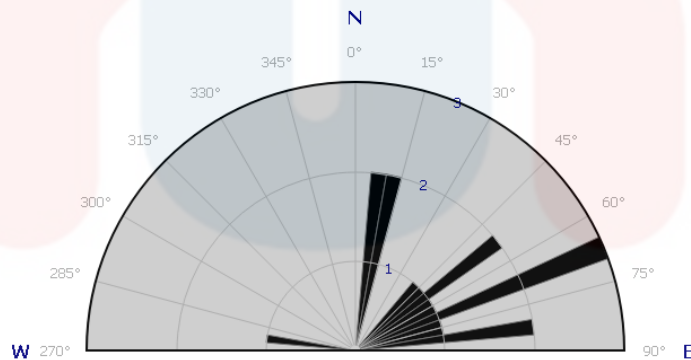


Figure 4.25: The rose diagram of the lineament analysis.

4.4.3 Joint

The majority of the joints in the research area's carbonate rocks. The results of the weathering and erosional processes on the bedrock or outcrop are visible in the joints. The mechanism and joint structure modify the topography and morphology of the earth's surface and have an effect on the form of the land. We discovered two types of joints, called extensional joints and shear joints, at the area. Joints are the most common type of structure at Bunder, and they are typically found on sandstone.

Next, a crack known as a shear joint with an emerging shear plane was created when the rock squeezed. However, the planes of separation where there was no shear displacement were near the extensional joint. In contrast to the extensional fracture, which is not actually straight, the shear fracture has a crisp, straight structure, making it easy to identify the joint.

Table 4.6: Joint reading in sandstone.

Bearing	Frequency	Bearing	Frequency	Bearing	Frequency
0° - 10°		121° - 130°	II	241° - 250°	II
11° - 20°		131° - 140°		251° - 260°	
21° - 30°		141° - 150°		261° - 270°	II
31° - 40°		151° - 160°	II	271° - 280°	
41° - 50°	III	161° - 170°	IIII I	281° - 290°	IIII
51° - 60°		171° - 180°	II	291° - 300°	
61° - 70°		181° - 190°		301° - 310°	IIII
71° - 80°		191° - 200°		311° - 320°	II
81° - 90°		201° - 210°	I	321° - 330°	IIII IIII I
91° - 100°		211° - 220°		331° - 340°	IIII I
101° - 110°		221° - 230°		341° - 350°	IIII IIII IIIIIII
111° - 120°		231° - 240°		351° - 360°	II

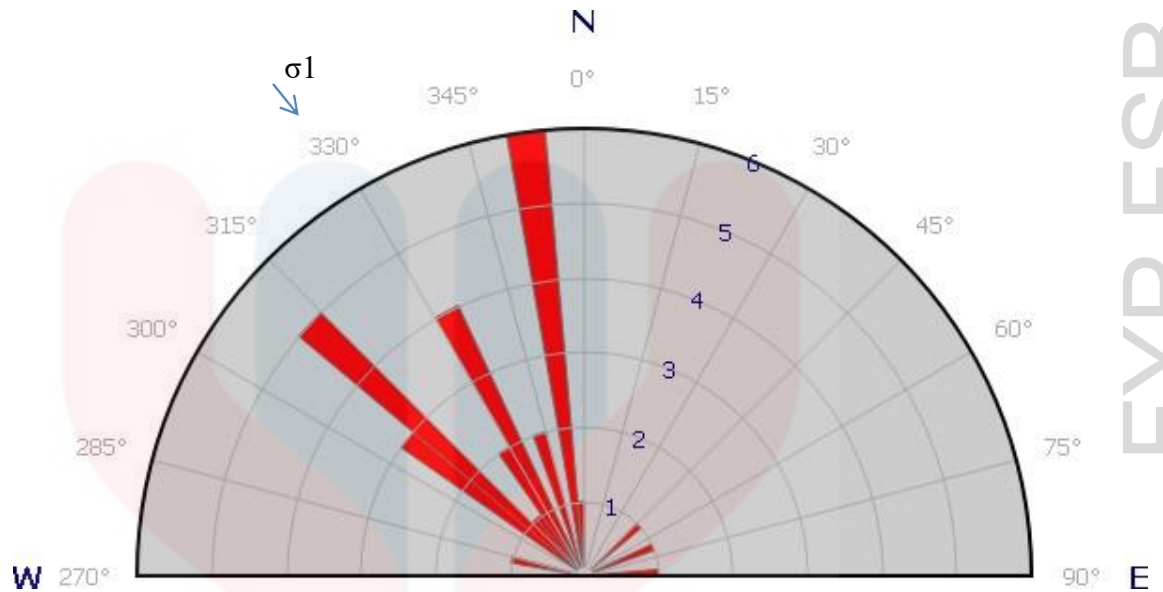


Figure 4.26: Shows the rose diagram from the measurement of frequency of joints.

4.5 Historical Geology

Historical geology of the study area started during the Early Permian and ended during Middle Triassic. The geology of the research region was interpreted during the fieldwork based on the geomorphology, lithostratigraphy, structural geology, and historical geology of the study area. The research area's geography has an impact on its accessibility, habitation, and vegetation. In the Chiku, Paloh area, weathering can take two different forms which is physical weathering and biological weathering. The study area's primary drainage basin is the main river, Sg Relai. Metasediment, then Tuff, Sandstone, and Limestone, are the earliest rock units in my study area. The rock that can be found in my study area is volcanic sandstone, lapilli tuff, phyllite, shale and limestone. The Aring formation, together with the Gua Musang formation, is the only major formation. Different types of depositional habitats, such as shallow marine and submarine settings, are present in every formation.

CHAPTER 5

DEPOSITIONAL ENVIRONMENT OF CHIKU, PALOH

5.1 Introduction

Each unique characteristic of deposited rock reveals a unique background deposition process. The depositional environment is investigated by evaluating facies such lithology, sedimentary structure, fossil content, texture, colour, geometry, paleocurrent, and so on. For petrographic purposes, many samples have been gathered and processed.

The discussed based on depositional environment in Chiku, Paloh Gua Musang. Based on the criteria of bedding thickness, lithology, sedimentary structure, and fossils, it is interpreted. To characterize the depositional environment of Chiku, Paloh in the research region, two lithologies were produced.

At $5^{\circ}0'0''\text{N}$ and $102^{\circ}21'14''\text{E}$, the first site is characterised by a tuff unit that is interbedded with limestone and sandstone. At coordinates $5^{\circ}0'20''\text{N}$ and $102^{\circ}21'30''\text{E}$, limestone is interbedded with phyllite sandstone.

5.2 Location of Detail Litholog

The best outcrop in the research region serves as the basis for the specification requirements. There are no excellent or ideal expose outcrops in the research region for performing lithology. In comparison to other regions, the study area has a much greater rate of weathering. Despite the initial outcrop being severely worn, the bedding may luckily still be seen from a short distance (Figure 5.2). On the first outcrop, the contact between the rocks progressively develops. In the study region, the second outcrop is likewise somewhat worn. Every bedding contact and acute rock-to-rock contact can be seen in the second outcrop (Figure 5.3). The four lithofacies sub-units, A, B, C, and D, are made up of recurrent component lithofacies. The first lithology has sub-units A, B, and C, whereas the second lithology only contains one sub-unit.



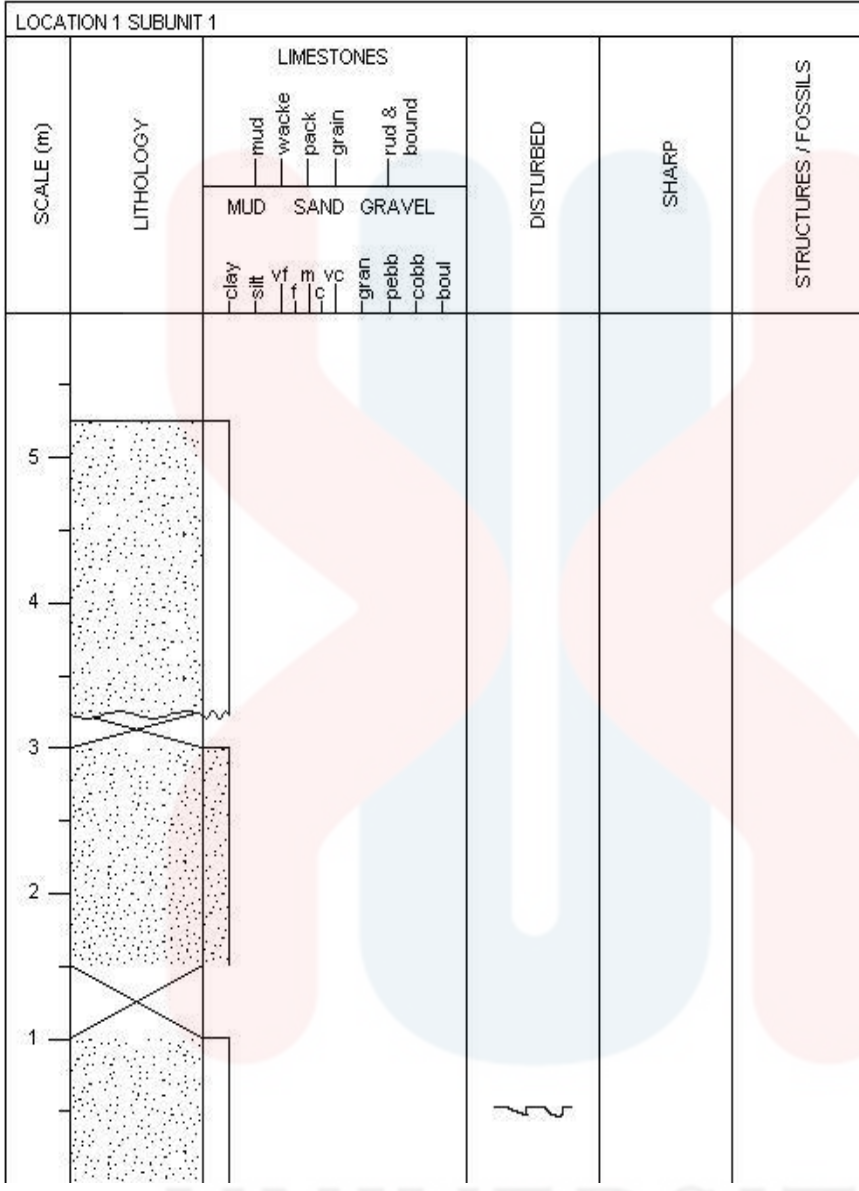
Figure 5.2 shows first outcrop



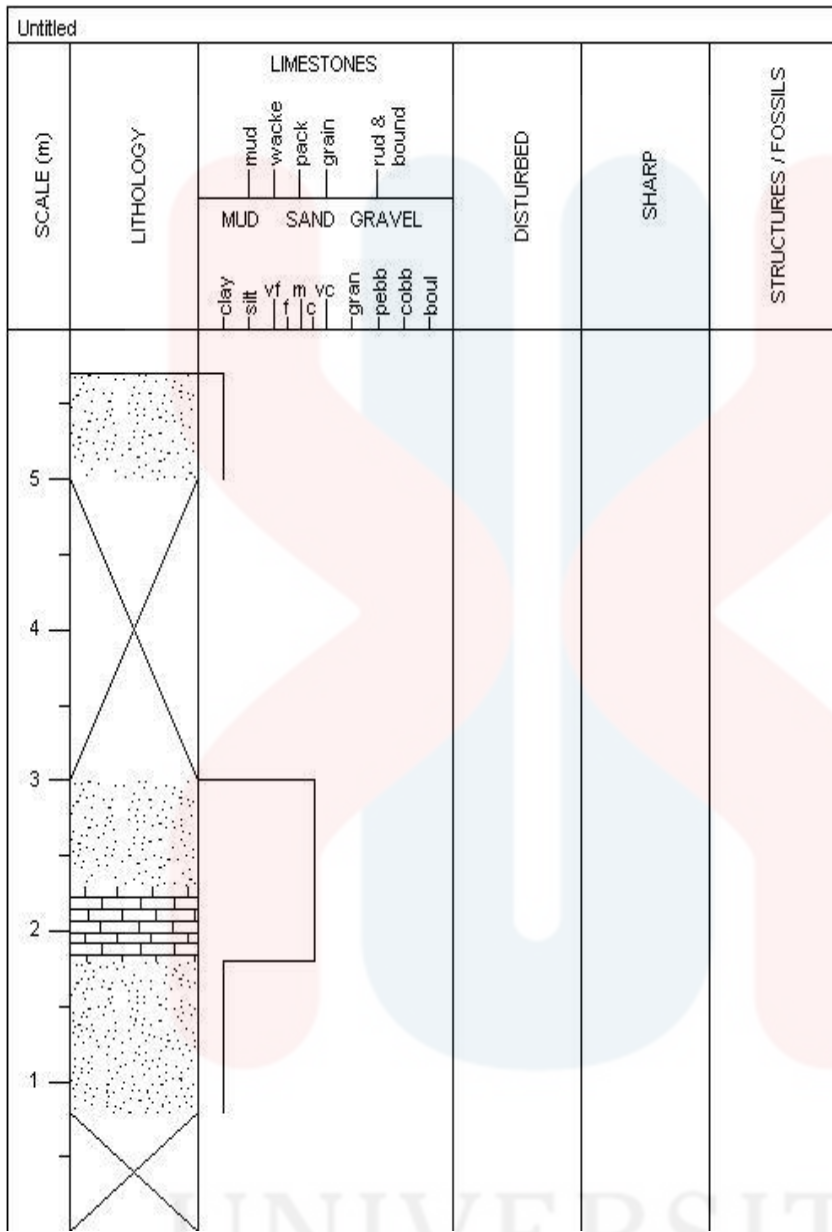
Figure 5.3 Shows second outcrop

5.3 Facies Analysis

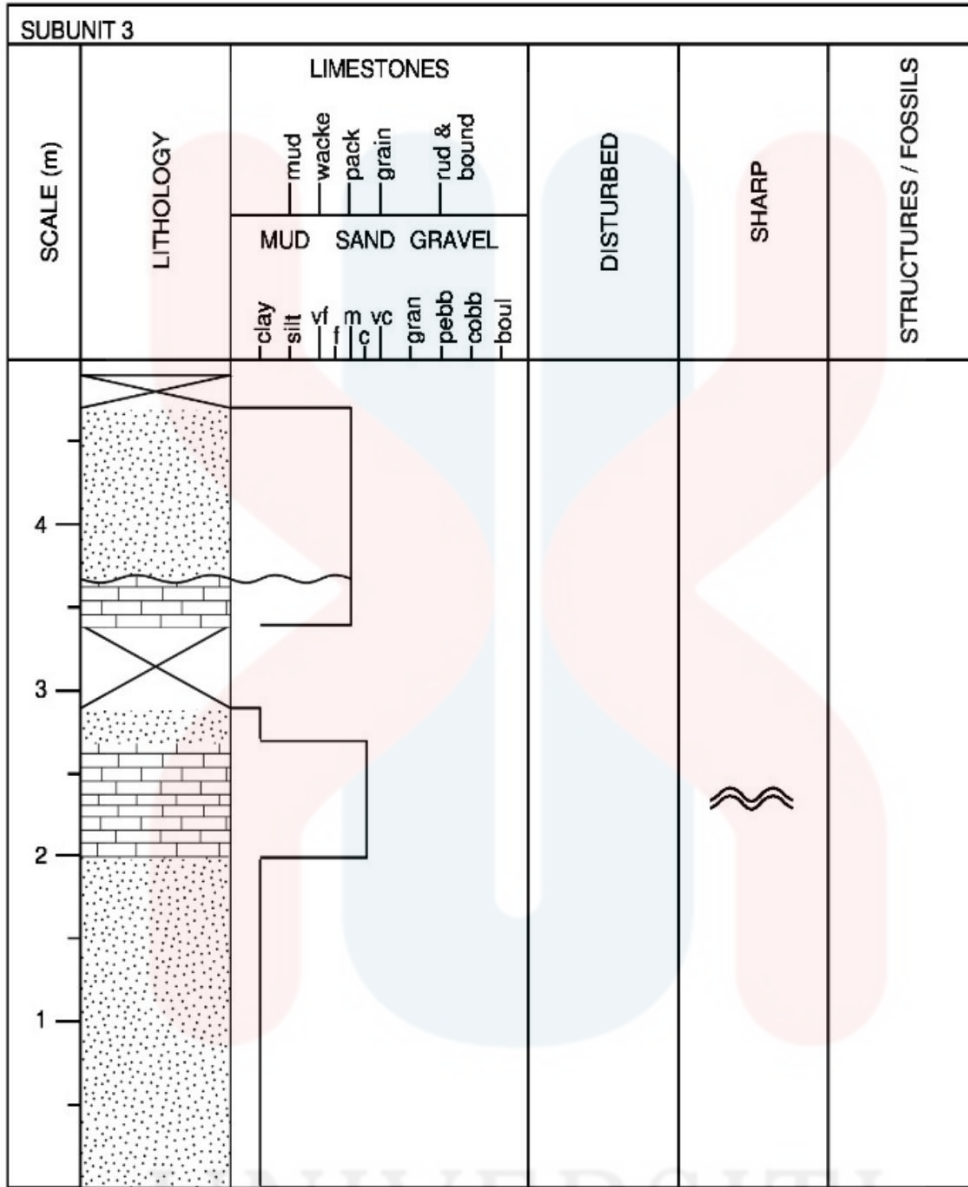
The facies are a kind of rock body that is distinguishable from rock bodies above, below, and laterally adjacent by a particular arrangement of physical, lithological, and biological properties (Hamdani, 2014). The word "facies" refers to all of a sedimentary unit's properties, which often take place on a minute (mm-cm) scale and include lithology, grain size, sedimentary structure, colour, composition, and fossil content. Only lithofacies and biofacies were observed for the interpretation of every sub-unit. The components of an environment may be related to one another and add to its significance. The names of the four distinct facies associations are Sub-unit 1, Sub-Unit 2, Sub-Unit 3, and Sub-Unit 4. Each member of this Sub-unit has unique traits, which are all described in Figure 5.4.



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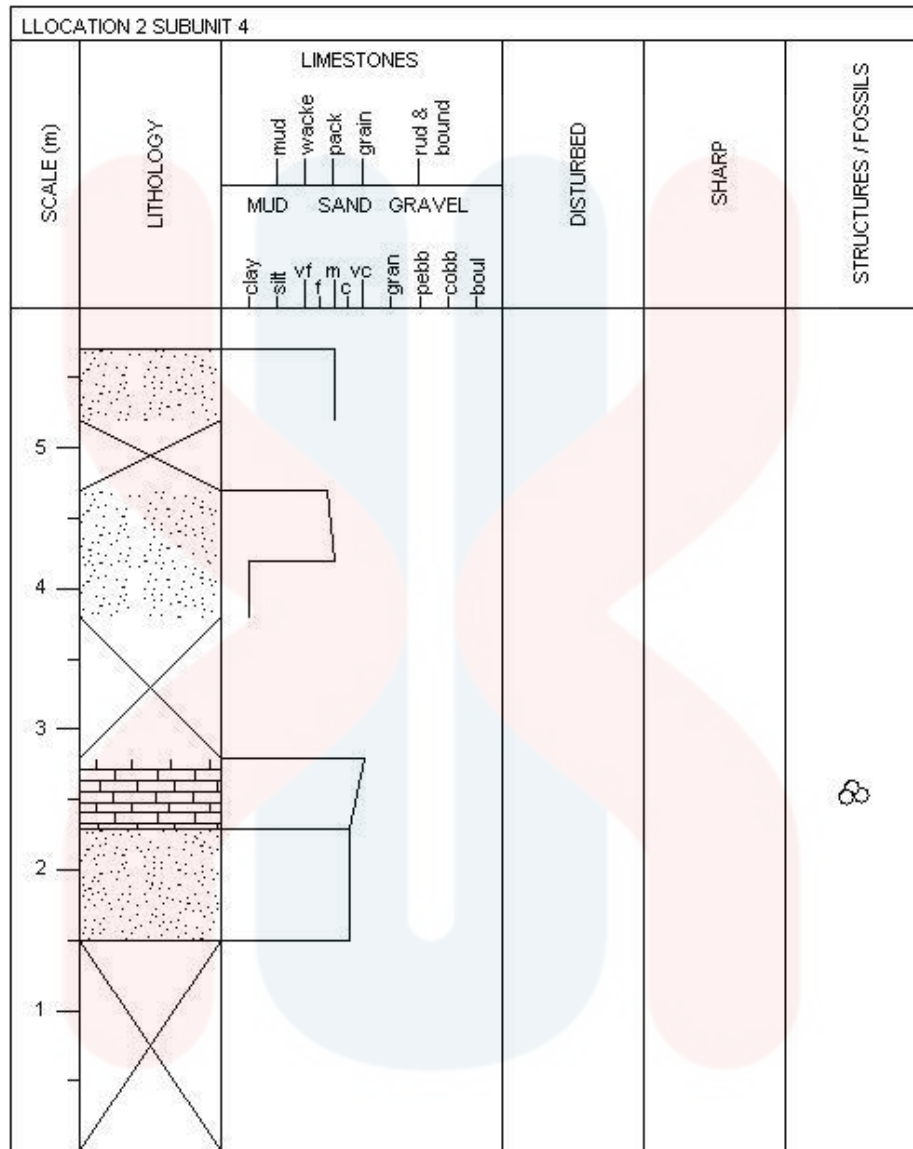


Figure 5.1: Litholog of the locations. Location 1 (Sub-unit A, B and C); Location 2 (Sub-unit D)

5.3.1 Sub-Unit A

This Sub-unit A has a 13-meter length and a 5-meter height. This component's thickness is 5.4 metres. Tuffaceous sandstone and lapilli tuff are the lithologies that may be found in Sub-unit A. The felspathic sandstone that is found here is volcanic in origin, and it ranges in colour from light grey to slightly reddish. Its typical grain size is clay, and it often coexists with tuff. The sandstone from volcanoes is extremely carefully sorted. The tuffaceous sandstone has a thickness that varies from 0.8 metres to 3.0 metres. In contrast, the lapilli tuff discovered in Sub-unit A has a light brown to medium brownish

and pinkish colour, a medium to large mean grain size, is disturbed 9 to 11, and is well sorted. Lapilli tuff ranges in thickness from 0.5 to 1.0 metres. There are displaced bedding and an unidentified rock around 1.9 metres below. Both sedimentary structures and fossils are absent.

5.3.2 Sub-Unit B

Sub-unit B is 6.0 metres thick. Tuff, lapilli tuff, and limestone are the lithologies that may be found in Sub-unit 2. The characteristics of tuffaceous sandstone and lapilli tuff are identical to those of Subunit 1. The discovered tuff is very worn, with coarse grains that range in size from light to reddish brown. The tuff has a thickness that varies from 0.3 to 0.6 metres. Medium-grained and brownish in colour, volcanic sandstone has a coarse texture. The limestone that was discovered is embedded in tuff and cannot be used as a sample. The limestone is quite worn and ranges in thickness from 0.98 to 0.7 metres. Tuffaceous sandstone is rather lightly sorted. Sub-unit B has no sedimentary features or fossils.

5.3.3 Sub-Unit C

Sub-unit C has a 5.92 metre thickness. Tuffaceous Sandstone, lapilli Tuff, and limestone are the lithologies present in Sub-unit C. The tuffaceous sandstone in the first site is often intercalated with tuff and ranges in colour from light grey to slightly reddish. It also has a mean grain size. Separation of the tuffaceous sandstone was done with utmost care. The thickness ranges from 0.6 to 2.0 metres. Limestone may be anywhere from 0.98 metres and 0.7 metres thick. The lapilli tuff discovered in Sub-unit A is well sorted, light grey to medium brown in colour, and the mean grain size is in the middle of the range. Lapilli tuff has a range thickness of around 1.0 metre. White to grey is the colour spectrum

of limestone. Limestone is fine-grained and ranges in thickness from 0.98 metres to 0.7 metres. One can perceive the limestone like a vein. These facies, which is internally dominated by limestone veins, lies in the centre of Sub-unit C. It also features a thin interbedded sandstone layer. Sandstone layers that coexist with limestone erupt when terrigenous clastic debris is scarce (Nichols, 2009). The setting is serene and tranquil as the lithofacies develops.

5.3.4 Sub-Unit D

Tuff lithologies interbedded with tuffaceous sandstone make up the majority of sub-unit D. Sub-unit D has a 5.92 metre thickness. Similar to Subunits A and B, Tuff and Volcanic Mudstone make up Subunit D. Only sub-unit D displays a parallel laminating sedimentary structure along a 6.0-meter outcrop. In clay and tuff, it often produced by deposition from suspension, slow-moving sediment clouds, very shallow water depth, or low-density turbidity currents, according to Sam (2009c). The black tuffaceous sandstone that is present in the area ranges in colour from light grey to black, with an average grain size of clay, and is often intercalated with tuff. The lava sandstone has been extremely carefully separated. The tuffaceous sandstone is between 0.6 metres and 1.0 metres thick.

Although some of the fossils have undergone metamorphism and are thus a stretch, sub-unit D is made up of microfossils that still survive. *Hemigordiellina* sp. is one form of fossil that may be discovered in limestone. *Hemigordiellina* sp., a member of the Fusulinata class, makes up the fossils in Sub-unit D. *Hemigordiellina* sp. provides some extra coiling particles and test form (Jeremie & Daniel, 2007). According to Enzo et al. (2014), the habitat of *Hemigordiellina* sp. occurs in open shallow maritime areas with little current and wave activity. Most *Hemigordiellina* species are Permian to Triassic in age.

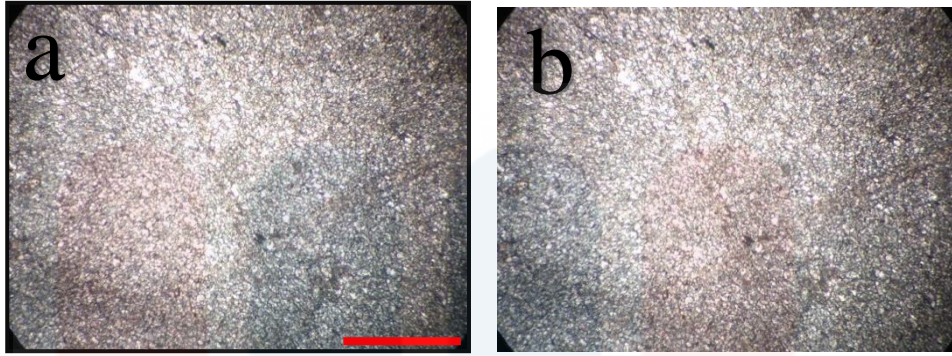


Figure 5.2: Shows the Limestone



Figure 5.3: Shows *Hemigordiellina* sp.,

5.4 Interpretation of Depositional Environment











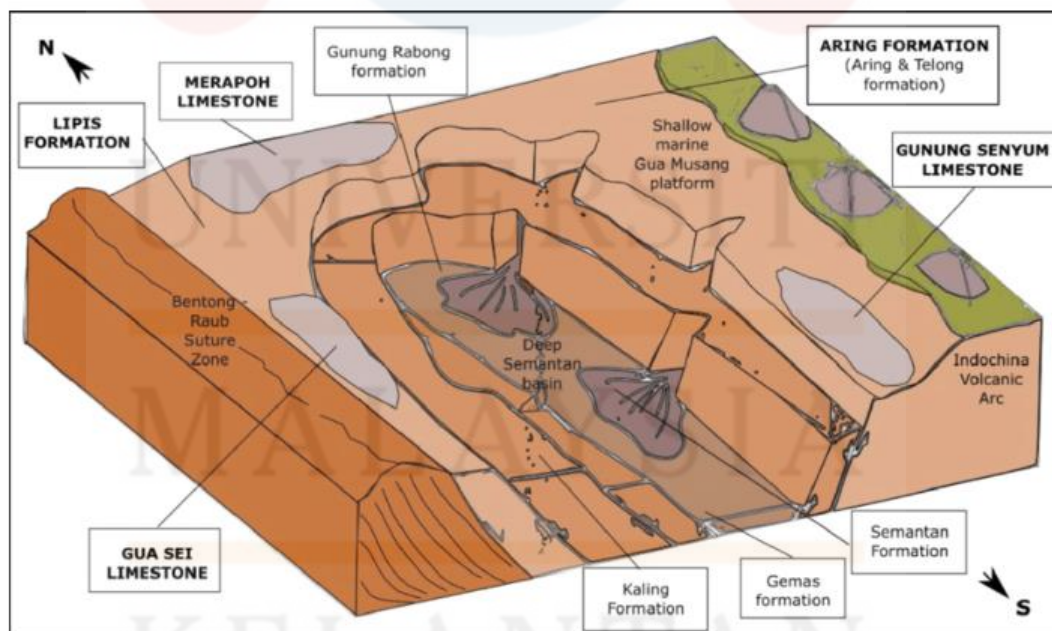
FA	Facies type	Description	Interpretation	Depositional environment
S1	 Gms	Massive to partly crudely stratified pebble-boulder conglomerate, matrix supported, angular-subangular clasts and boulders (> 2m in diameter), poorly sorted (Gms).	Debris flow deposits	Alluvial fan
	 Sm Gm	Massive cobble conglomerate, clast supported, subrounded, poorly-moderately sorted, sandy matrix filled (Gm), massive coarse-medium grained sandstone with fossil plants (Sm), sheet like geometry.	Debris flow deposits, sheet flood deposits	
	 Sm Gm	Massive boulder-cobble conglomerate, subrounded, well-poorly sorted, sandy matrix filled (Gm), lenticular massive coarse grained sandstone (Sm).	Debris flow deposits	
	 Sm Gm Sm	Well sorted, subrounded, sandy filled cobble conglomerate, imbricated, scoured base (Gm), lenticular sandstone with cross-beddings, massive, thick coarse-fine grained sandstone (Sm).	Braided channel fill deposits, sheet flood deposits	
S2	 Gm Gl	Lenticular cobble conglomerate, clast supported, poorly sorted, subrounded-subangular, scoured base (Gl), bedded cobble-pebble conglomerate, well-poorly sorted, imbrication (Gm), normally graded.	Lag deposits, minor channel fills	Fluvial deposits
	 Gm Gm Sp Gm	Gravel-cobble conglomerate, clast supported, subrounded, sandy filled, imbricated, scoured base, lenticular-massive, channel shaped geometry (Gm), coarse-medium grained sandstone, planar cross-bedding (Sp).	Aggradation on longitudinal bar during flood stage, channel fill	
	 Gp Gt Sp	Trough and planar cross-bedded cobble-pebble conglomerate (Gp, Gt), planar cross-bedded medium grained sandstone (Sp), normally graded.	High energy stream-channel flow, linguoid bars	
	 St Gm Sm	Coarse-medium grained sandstone with trough cross-beddings (St), massive pebble conglomerate (Gm) and coarse grained sandstone (Sm), normally graded.	Dunes, minor channel fills	
	 Sp Gl Sw	Coarse-medium grained sandstone with planar and wedge-shaped cross-beddings (Sp, Sw), lenticular pebble-cobble conglomerate (Gl), normally graded.	Linguoid bars	
	 Fm Sp Spl Fm	Coarse-fine grained sandstone with parallel and planar cross-beddings (Spl, Sp), load cast, fine massive mudstone, siltstone (Fm), wormtrails, normally graded.	Linguoid bars, overbank deposits	

Figure 5.4 shows the facies association of my study area. (Huan Xu,2016)

The depositional environment of the Chiku, Paloh Gua musang may be interpreted using the criteria of facies associations, microfacies associations, sedimentary structures, and the presence of fossils in the research region.

Volcaniclastic lithologies, which are the consequence of volcanic material blasted from a vent or fissure as a result of a magmatic explosion, make up the majority of Sub-units A and B. It may be inferred that pyroclastic rock is discharged explosively since it is found in the research area in the form of ash. Volcaniclastic lithologies, the by-product of volcanic debris blasted from a vent or fissures as a consequence of a magmatic explosion, are the prevalent lithologies in Sub-units A and B. Due to the volcaniclastic rock's appearance as ash, it is possible to infer that the volcaniclastic rock in the research region was ejected violently from a vent. Before being transported and dumped, the dust may travel thousands of kilometres and the ash hundreds of kilometres from the vent. According to sub-unit C, it develops as a result of slow-moving sediment clouds, deposition from suspension, and shallow water depth. Tuff and tuffaceous sandstone are interbedded in Sub-unit D. *Hemigordiellina sp.* habitats were located on a low platform. *Hemigordiellina s.*'s ranges from the middle Permian to the Triassic. Therefore, it is assumed that the whole sub-unit has a shallow depositional environment.



Central Belt Peninsular Malaysia's Middle Triassic depositional context.

(Sources: Kamal et al., 2016)

The evidence of cylindrical burrow trace fossils and the interbedding of sand and mud reported by Abouessa et al. (2015) indicates the depositional environment of Sirt Basin, Libya, as Fluvial floodplain. Based on stratigraphy, petrology, and bedding structures, Kepferle (2016) interpreted the United States' Kenwood Siltstone Member as originating in a deltaic setting. The majority of the sediments you may see in your surroundings, such as talus on steep slopes, sand bars in streams, or gravel in road cuts, will never transform into sedimentary rocks since they were very recently deposited. Often times, dense layers of silt from eroding coastal mountains are present in this, which can be several kilometres deep. A forearc basin is generated by friction between the subducting plate and the overriding plate, which drags a portion of the overriding plate down, and is located between the subduction zone and the volcanic arc.

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CHAPTER 6

CONCLUSIONS AND SUGGESTIONS

6.1 Conclusions

By creating a thorough geological map of the research region at a scale of 1:25 000 and determining the depositional environment of the Chiku, Paloh in the study area, all of the aforementioned goals may be achieved.

Throughout the fieldwork, the geomorphology, lithostratigraphy, structural geology, and historical geology of the study area were used to interpret the geology of the research region. There are mountains running across the geomorphology portion of the study area from the west to the east, with hills predominating in other areas. The geographical surface affects the research area's accessibility, habitation, and vegetation. Six days are needed to complete the geological mapping process, of which four days were devoted to the research specification.

There were three geomorphology units according to the topographic geomorphological categorization of the study area. The geomorphological unit is composed of rolling hills, a valley in an escarpment, and a flat area. The whole landscape has a variety of lithological types. The two types of weathering that may occur in the Chiku, Paloh area are physical weathering and biological weathering. There are distinct formation processes for each kind of weathering. In the research region, parallel, dendritic, and contorted patterns make up the primary drainage pattern. The primary

drainage basin for the research region is the Sg Relai river. The parallel pattern and dendritic pattern depict various geomorphologies and serve as structural indicators.

Four lithological units made up the lithology unit that was discovered in the Chiku, Paloh region. Metasediment is the earliest rock unit, followed by Tuff, Sandstone, and Limestone. The Middle Permian through the Late Triassic are the ages of the rocks. The Middle Permian metasediment unit is mostly composed of phyllite, shale, and tuff. Unpredictability is concealed by a sturdy unit. The Early Triassic tuff unit is made mainly of tuff and tuffaceous sandstone. Aring formation, together with Gua musang formation, constitute the major formation. Shallow sea and underwater settings are two examples of the many depositional environments that make up each formation.

The lineament analysis using Rose diagram was used to establish the structure of the mechanism. Strike-slip faults and normal faults are the two primary types of faulting in the research region. Geomorphology was used to define the normal fault, and measurements of identification and lineament were used to compute strike-slip. Sinistral strike-slip predominates in the studied region. A joint-like structure was also discovered.

To understand the depositional environment of the Chiku, paloh, a few factors are considered. The facies associations, the presence of any sedimentary structures, and the presence of any microfossils in the research region are employed as the parameters. All of these parameters contribute to providing details on the formation's energy level and the environment in which and when the sediments are formed. Based on facies relationships, the Aring formation is split into four sub-units. Lapilli tuff is interbedded with tuffaceous sandstone in Sub-unit A, and tuff is interbedded with limestone, lapilli tuff, and tuffaceous mudstone in Sub-unit B. Both Sub-unit C and Sub-unit D consist of tuff interbedded with tuffaceous sandstone. Sub-unit C is characterised by tuffaceous sandstone interbedded with lapilli tuff and limestone. The connections of all the identified

facies and sedimentary structure point to an open, shallow marine environment with little energy flow. Based on the discoveries, it is assumed that Paloh is located in the tidal flat zone given the depositional environment of the Chiku. The occurrence of microfossils, including *Hemigordiellina* sp., which are found in shallow marine environments from the Middle Permian to Triassic age and fulfil the second purpose, lends credence to the interpretation. The primary type of volcano in the studied region is tuffaceous sandstone, whose volcanism activity took place in shallow marine environments with undersea environments serving as the formation depositional environments.

6.2 Suggestions

As a warning, several portions of the Paloh region, Gua Musang, are difficult to access due to the dense flora and woodland. It is suggested to use modern technology, such as drones or unmanned aerial vehicles, to carry out the geological mapping for such difficult parts (UAV). The latest UAV has expanded its capabilities and is now able to evaluate rock facies and examine the geological characteristics of the rock.

In addition, it would be beneficial if UMK could offer a thinning machine for thin section work. That allows us to obtain a narrow segment with a 2mm thickness. My issue is that the thin section I made is rather thick and difficult to view under a microscope.

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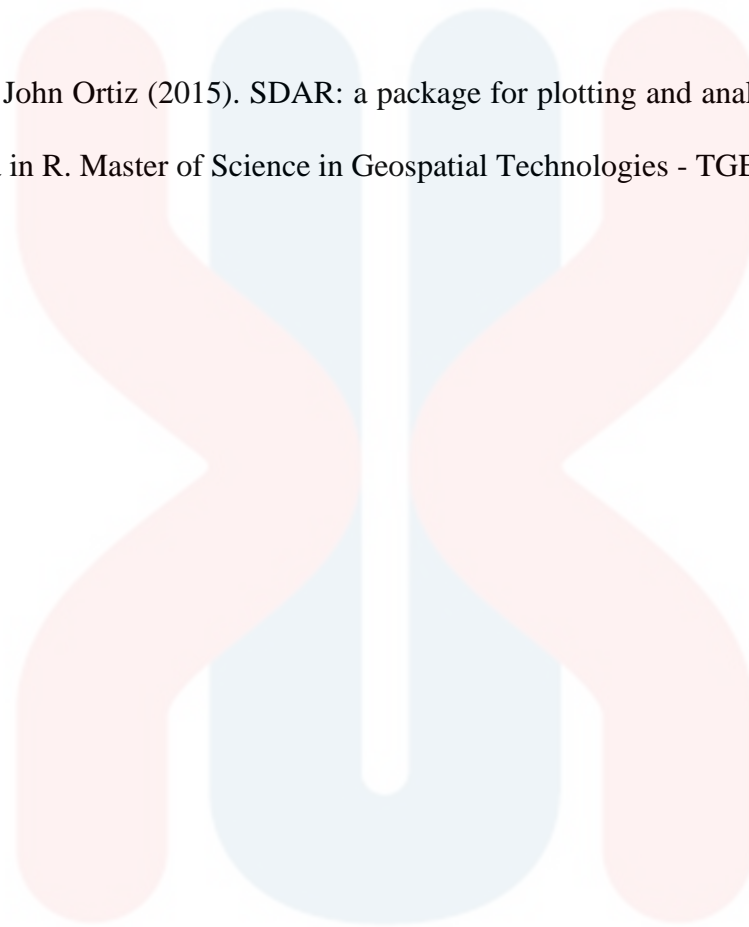
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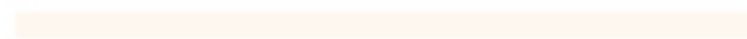
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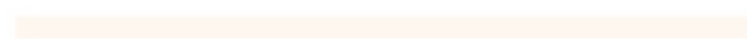
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