GEOLOGY AND GEOHERITAGE ASSESSMENT OF LATA MAWO, KAMPUNG LAWAR, JELI KELANTAN

By

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A report submitted in fulfilment of the requirement for the degree of Bachelor of Applied Science (Geoscience) with Honours

FACULTY OF EARTH SCIENCE UNIVERSITI MALAYSIA KELANTAN

2023

DECLARATION

I declare that this thesis entitled "GEOLOGY AND GEOHERITAGE ASSESSMENT OF LATA MAWO, KAMPUNG LAWAR, JELI KELANTAN" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature:

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Date: 15 January 2023

APPROVAL

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

Signature:

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Date:

ACKNOWLEDGEMENT

I am grateful to Allah for the success of my final year project and for the good health and well-being that allowed me to complete it within the given timeframe. I also wish to express my appreciation to my Geoscience Program head lecturer, Dr. Nursufiah Bte Sulaiman, for her guidance and provision of necessary resources throughout the research process. I am deeply grateful to my friends for their assistance, encouragement, and support while writing my thesis. Their contributions were instrumental in motivating me to produce high-quality work, especially my thesis friends, Wan Ahmad Aqil Fahmi Bin Wan Ahmad Khalil, Muhammad Ibrahim bin Abd Aziz and Siti Nur Adila Binti Yazizul Rahman.

I am taking this opportunity to express my appreciation to my parents, who have been with me throughout the whole process. They provided me with a balanced life, helped me to tie the pieces together, they never abandoned me and always supported me in terms of moral and financial. Their support and motivation have been my driving forces to complete my final year project. I will be forever indebted to their love and care. Lastly, I want to express my deepest and most sincere gratitude to every single individual and organization that have been involved, directly or indirectly, in the completion of this final year project. I am extremely grateful for all the support, guidance and assistance provided by each and every one of them. Their invaluable contributions have played a crucial role in the successful completion of this project and have greatly helped me to achieve my goal. I would not have been able to accomplish this without your support and I thank you all from the bottom of my heart.

GEOLOGY AND GEOHERITAGE ASSESSMENT OF LATA MAWO, KAMPUNG LAWAR, JELI KELANTAN

ABSTRACT

The objective of this study that tittle geology and geoheritage assessment of Lata Mawo, Kampung Lawar Jeli Kelantan is to update geological map of Lata Mawo, Kampung Lawar Jeli with scale of 1: 25 000 and to assess geodiversity value at study area for geoheritage assessment. Lata Mawo basically has unique geological features that can been observed in the nature which included geological structures through the geoheritage values. The study area is within N 05°40'32.72" E101°40'21.04", N 05°40'32.35" E101°43'09.78", N 05°37'57.16" E101°43'09.86", 05°37'57.18" E101°40'20.21" which around 5km x 5km along the area in Jeli, Kelantan. Jeli area is also strategically positioned near the central borders of Kelantan and Perak and the international borders of Malaysia and Thailand. The study area's maximum elevation reaches 760 metres, whereas the minimum at 140 metres. This study concentrates on the overall geology of Lata Mawo. The data of geological mapping been collected by traversing, geomorphology features and sample collections. Throughout this study, ArcGIS Software was utilised to process and create the maps. Following that, DEM data was utilised to build a detailed geological map of the research region by processing, evaluating, and interpreting the data. This study accessed the specific geological characteristics and landforms and conducts research and surveys on them. To do this, a modified version of the Modified Geosite Assessment Model (M-GAM) is employed. The M-GAM model is based on the original Geosite Assessment Model (GAM) and has similar indicators and sub-indicators, with a main and additional value that been assessed by two groups which is that have geology background and who do not have which from the result consists of high in scenic/aesthetic value from the survey that been done. There have been a several kinds of lithology rock units discovered in the research area included alkali feldspar granite, schist, gneiss, phyllite and quartzite.

GEOLOGI DAN PENILAIAN LATA MAWO, KAMPUNG LAWAR, JELI KELANTAN

ABSTRAK

Objektif kajian ini adalah untuk mengemaskini peta geologi Lata Mawo, Kampung Lawar Jeli dengan skala 1: 25 000 dan menilai nilai geodiversiti di kawasan kajian untuk penilaian geowarisan. Lata Mawo pada asasnya mempunyai ciri-ciri geologi yang unik yang boleh diperhatikan dalam alam semula jadi yang merangkumi struktur geologi melalui nilai-nilai geowarisan. Kawasan kajian adalah dalam lingkungan N 05°40'32.72” E101°40'21.04”, N 05°40'32.35” E101°43’09.78”, N 05°37’57.16” E101°43’09.86”, 05°37 '57.18” E101°40'20.21” iaitu sekitar 5km x 5km sepanjang kawasan di Jeli, Kelantan. Kawasan Jeli juga mempunyai kedudukan yang strategik berhampiran sempadan tengah Kelantan dan Perak serta sempadan antarabangsa Malaysia dan Thailand. Ketinggian maksimum kawasan kajian mencapai 760 meter, manakala ketinggian minimum pada 140 meter. Kajian ini menumpukan kepada keseluruhan geologi Lata Mawo. Data pemetaan geologi telah dikumpul dengan merentasi, ciri geomorfologi dan pengumpulan sampel. Sepanjang kajian ini, Perisian ArcGIS telah digunakan untuk memproses dan mencipta peta. Berikutan itu, data DEM telah digunakan untuk membina peta geologi terperinci wilayah penyelidikan dengan memproses, menilai dan mentafsir data. Kajian ini mengakses ciri geologi dan bentuk muka bumi yang khusus dan menjalankan penyelidikan dan tinjauan ke atasnya. Untuk melakukan ini, *Modified Geosite Assessment Model* (M-GAM) digunakan. Model M-GAM adalah berdasarkan Model Penilaian Geosite (GAM) asal dan mempunyai petunjuk dan sub-indikator yang serupa, dengan nilai utama dan tambahan yang dinilai oleh dua kumpulan iaitu yang mempunyai latar belakang geologi dan yang tidak mempunyai hasilnya terdiri daripada nilai pemandangan/estetik yang tinggi daripada tinjauan yang telah dilakukan. Terdapat beberapa jenis unit batuan litologi yang ditemui di kawasan penyelidikan termasuk granit feldspar alkali, schist, gneiss, phyllite dan kuarsit.

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LIST OF SYMBOLS

°	Degrees
‘	Minutes
“	Seconds
^{2}	Per Square
( )	Brackets

LIST OF ABBREVIATION

°	Degrees
‘	Minutes
‘‘	Seconds
^{2}	Per Square
( )	Brackets

LIST OF APPENDICES

°	Degrees
‘	Minutes
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^{2}	Per Square
( )	Brackets

CHAPTER 1

INTRODUCTION

1.1 General background

Jeli district is located in western of Kelantan. It is the backbone of Peninsular Malaysia. It contains rich in natural resources such as gold mines and attractive geological landforms such as hillsides, rivers, waterfalls, and hot springs in around area of the district's area.

In order to keep a 1:25000-scale geological map updated; it seems to be important to look into the overall geology of such studied area as well. Geological mapping with geoheritage mapping could be used to determine overall geology of the study area, and thus to obtain information regarding its geoheritage significance of the geoheritage assessment as well.

Permian sedimentary rock underneath the Gua Musang Formation, which seems largely formed of argillaceous rocks with some calcareous rocks, were found throughout the research area according to a geological map created by the Department of Mineral and Geosciences (2003). Jeli is mostly composed of three kinds of Triassic sedimentary rocks: shales, mudstone, sandstone, as well as limestone, that are all part of the Gunong Rabong Formation. Besides that, this Gua Musang Formation in the Jeli region primarily composed of slate, sandstone, as well as limestone.

The importance geoheritage assessment includes to the community, researchers and others as well. The assessment from study area could be used to help community either from knowledge, economy, and others. Researchers could use the assessment data for their further research about the study area in the future.

As for the background of study it is involves with geological features which become attractions and can be prospective geological heritage. The geological idea centers towards unique, exceptional, especially significant geological features. This consists benefits including educational, aesthetic, environmental, historical, economical as well as ecological aspects of its features of Lata Mawo.

Meanwhile the geoheritage is also known as the geological heritage that is indeed a type of natural heritage equivalent to other types of natural heritage, which including biodiversity. Certain geoheritage locations or geosite are associated with human action, including quarrying, places, and others. Therefore, it may be seen and be considered heritage as well as culture.

Research of geological characteristics that also are connected to legacy that may be conveyed from the past or carried down via tradition generally referred to as geoheritage as well. Sites dedicated to geoheritage are of use to the whole community. As a result, the study area is critical in helping to further understanding of the Earth's ecology and history in general, as well as specific aspects of that environment (such as the genesis of life and mineral and vitality sources).

The study area is suitable for study halls, as it offers a lot of promise for enhancing scientific understanding, providing entertainment, and providing financial help towards the surrounding study area as well.

Geological history generally includes various distinctive locations as well as treasures that seem to be significant towards our knowledge of the earth's origin, which including ecology, rocks, and others as well which are part of the geo-heritage. With the rise into geo-heritage, geo-tourism is becoming ever more popular.

1.2 Study Area

Study area is located at Lata Mawo, Jeli Kelantan. Study would be conduct in Jeli, throughout the Kampung Lawar neighbourhood. The study took place within a 5x5km2 box, which was filled to a density of around 25 kilometres per square metre. In figure 1 shows the location map of Jeli district in Kelantan.

1.2.1 Location

The river and major road may be seen on the base map throughout Figure 1.2 that are included. This study area is bound between a longitude of 101°40'31" E to 101°42'30" and a latitude of 5°38'0" N to 5°40'30". Jeli area is also strategically positioned near the central borders of Kelantan and Perak and the international borders of Malaysia and Thailand. Jeli area has an area of around 129,680.26 acres and thus is divided into three sub-districts: Jeli, Batu Melintang, and Kuala Balah. The study area is situated in Kampung Lawar, Jeli, Kelantan, Malaysia, near Kampung Batu Melintang, around 20 kilometers off Jeli.

The district is abundant in natural resources and has several beautiful geological characteristics. Granitic rock is the dominant rock that formed of Jeli area district. Jeli district seems to have a variety of landforms, including mountain areas, hilly areas, and plain areas. It's also including rich Stong Migmatite which Main Range of schist plus granite in hilly places.

It is located close to Sungai Pergau, which is the main river that indicates a drainage system, as the study area is located in close proximity. That dam's drainage system, which follows the flat alluvium towards the south of the foothills, enhances the surrounding environment. Low and hilly areas can be found throughout the study area. Figure 1.2 indicates the study area's base map.

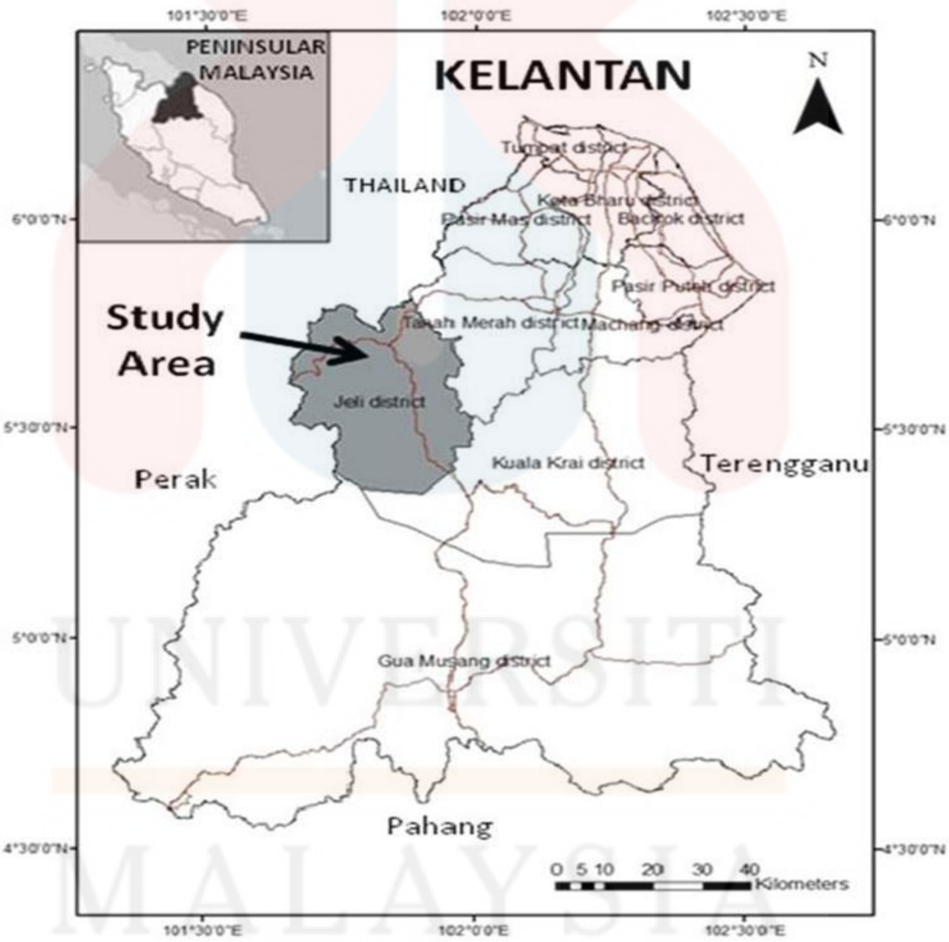


Figure 1.1: shows map district of Kelantan. Study area of Jeli district shown

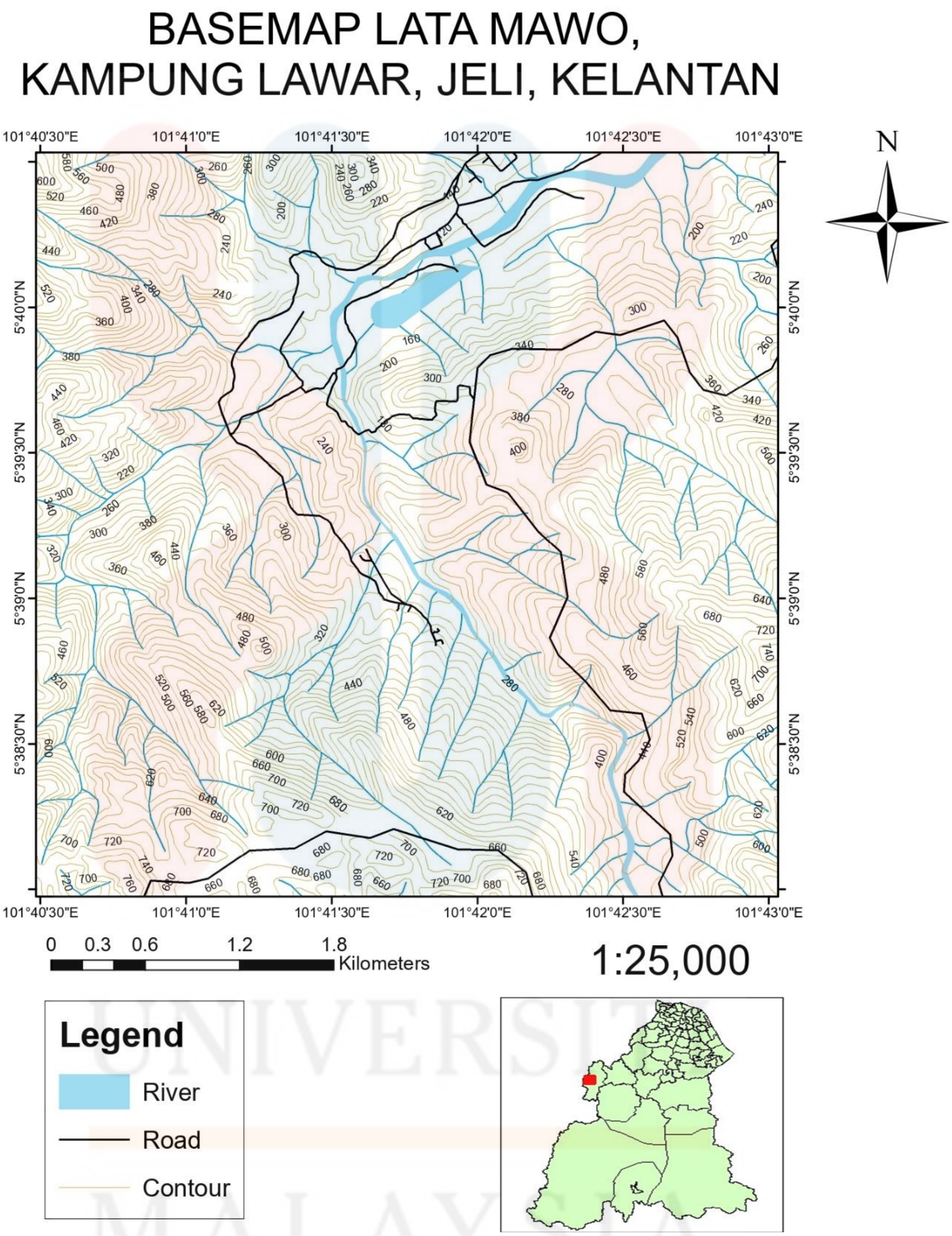


Figure 1.2: shows base map of study area at Lata Mawo, Kampung Lawar Jeli Kelantan

1.2.2 Accessibility

The district of Jeli is in western Kelantan, which is situated near the Malaysian border and the East-West Highway. By route of the Dabong-Gua Musang Highway, the study area may be accessible from Jeli which located nearby the Pergau Dam. This area of study can indeed be reached with help of a good accessibility.

1.2.3 Demography

Kelantan has a total area of approximately 15,0999 km2 and is located in the northeastern part of Malaysia's Peninsular. A section of southern Thailand, Perak towards the west, Pahang towards the south, and Terengganu in southern Malaysia form Kelantan's borders. It is significant to know that Kelantan is divided into ten distinct administrative regions: Kota Bharu; Gua Musang, Machang, Tanah, Merah; Pasir Mas, Pasir Puteh, Bachok, Jeli, Kuala Krai, Tumpat and other smaller places. The Kelantan Hills can be found on the southern side of Kelantan, which includes the Titiwangsa.

On the plains downriver, the rich coastline is what differentiates the regional geology. The river valley is driven here are various elements that influence population distribution in the state of Kelantan, such as the area population, business benefits, and geography. by the cultivation of paddy, rubber plantation, oil palm and others. Table shows total population in Kelantan district.

Table 1.1: Total population in Kelantan district

District	Year				
	2010	**2011**	**2012**	**2013**	**2014**
Bachok	142,100	146,000	149,900	153,800	157,700
Kota Bharu	509,600	522,000	534,500	547,200	560,100
Machang	101,300	103,900	106,400	109,000	111,700
Pasir Mas	212,000	217,300	222,800	228,300	233,800
Pasir Puteh	134,200	137,700	141,100	144,600	148,200
Tanah Merah	133,400	136,700	140,000	143,300	146,700
Tumpat	137,200	177,700	182,200	186,800	191,400
Gua Musang	103,300	106,000	108,800	111,700	114,500
Kuala Krai	120,800	123,700	136,500	129,500	132,400
Jeli	48,000	19,300	50,600	51,900	53,200
TOTAL	**1,641,900**	**1,690,300**	**1,772,800**	**1,806,100**	**1,849,700**

(Source: Jabatan Perangkaan Penduduk Negara, Negeri Kelantan, 2014)

1.2.4 Land Use

Increasingly, land is being used for farming in Jeli, resulting in a severe decrease in Jeli's original forests throughout the years (Muhammad Firdaus Abdul Karim et al., 2020). Jeli's main forest was affected by the study area's coverage of a nearby residential area. Oil palm and rubber plantations have grown substantially during the past few decades. Because Jeli's economic activities are primarily agricultural because of this trend through land usage (Muhammad Firdaus Abdul Karim et al., 2020).

1.2.5 Social Economic

Jeli seems to be at the centre of a phase of significant development and progress. Urbanisation, mostly in Jeli district, has had a positive impact on employment prospects for both residents and visitors alike. Socioeconomic development efforts in the Jeli district depend primarily on agricultural money (Muhammad Firdaus Abdul Karim et al., 2020). Residents can find work on plantations like oil palm and rubber plantations as the plantations grow, creating jobs for those who live there.

1.3 Problem Statement

Literary works on geological maps of the research area hard be found, although consists are old, have insufficient quality, and do not reflect a comprehensive geological map. The Department of Minerals and Geoscience Malaysia developed a comprehensive geological map, but it's not a really precise representation of the current map of the area. The problem is that it has outdated geological information on Lata Mawo which located in Kampung Lawar. There are outdated geological information like map of the study area from time to times which it would create the gap on information. To identify overall changes of geology characteristics through time, an updated geological map was required. This updated geological map might be different from previous geological map of study area as it can be beneficial to any geology-related organisations seeking a greater knowledge.

Next is lack of detailed geoheritage assessment of specifications and a lack of public awareness about the need to preserve natural resources contributed to poor results in this study area. Lata Mawo is suitable for protection through legal means due to its distinctiveness as a natural environment, as well as its emphasis on conservation and public education.

1.4 Objectives

- To update geological map of Lata Mawo, Kampung Lawar Jeli with scale of 1: 25 000
- To assess geodiversity value at study area for geoheritage assessment

1.5 Scope of Study

This study will focus on the geological mapping of Lata Mawo at Kampung Lawar, Jeli Kelantan. This geological mapping is important to update geological map of Lata Mawo with a scale of 1:25 000 and asses geodiversity value at the study area for geoheritage assessment.

On the other hand, this study also focuses on a geoheritage assessment that seems worthy of being conserved, maintained, and passed down to future generations (Reynard, 2016). This study area will indeed be viewed in terms of a certain feature to be assessed. Conservation, scientific and aesthetic value, economic worth, educational value, and added value are some of the criteria used to assess certain aspects.

The preliminary study, mapping, and several quantitative evaluations are included to carry out this study. All of this plays a significant role in informing the citizens about the value of nature and geoheritage assessment that need to be conserve. It would help people to get more knowledge about the Lata Mawo from the aspect of education. Besides that, most commonly acknowledged advantages of natural beauty and landscape are leisure and commerce. Throughout geology, knowledge regarding geologic structures, its existence, especially their origin may be gained from the constantly changing Earth's cycle.

1.6 Significance of Study

The significant of this study is to provide updated geological maps of the study area with a 1:25000 scale and to assess the geoheritage assessment of Lata Mawo in Kampung Lawar, Jeli. Updates towards the geological maps, including recognizing the Lata Mawo community, are essential. It is important to the community in geology features indirection with geoheritage of the study area. This would give more knowledge to the community as some of them do not acknowledge the area of Lata Mawo. In addition, this research area has importance in the fields of science, culture, and even the economy. Using quantitative evaluation throughout this area is beneficial and it has a feature that can be measured. Performing an assessment throughout the research area is significant in raising awareness, give information of the existence Lata Mawo for local government officials and the general public, about the necessity of conserving the region's geological resources. An updated geological map is very important which using the M-gam method to get the data and through the GIS analysis which could become the potential geosite map. This can be used for the tourism, researcher, government and private sector and others as well who are considered interested of the map. Additionally, it might help the public learn more about Lata Mawo.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The literature review is significant to the research study. Many resources including papers, books, internet, journals, web, and perhaps other data sources that would be at fingertips. For better understanding, the study report includes a literature review that identifies theoretical and scientific information. Generally, the preliminary study of geological research relies on desk studies since the data is collected through earlier studies, publications, and other sources. Kelantan's geology becomes easily understood when all the data has been acquired and the survey has been completed.

2.2 Regional Geological and Tectonic Setting

This study focuses on Jeli area which is Peningsular Malaysia. The map shows where Peninsular Malaysia is located mostly on Eurasian plate as well as its relationship to Sundaland, the southernmost section of Asia (Hutchison, 1989).

Throughout Peninsular Malaysia, there seem to be three distinct geological belts that consist of Western, Central, and Eastern. According to Hutchinson (1989), every one of those bands appears to be unique in Malaysian geology and tectonic history. Peninsular Malaysia also has a submerged area that dates back to the Permian and Triassic times (Metcalfe, & Azhar 1994).

This Western belt is the one to be positioned the farthest to the west, whereas the Central belt is the one that is placed the farthest to that same east (Khoo & Tan, 1983). The most elevated portion of the Western belt is located in the northwest part of the region, and it is supported by clastic, limestone, and volcanic rocks of varying sizes. The granite of either the Eastern Province consists largely I-type, with small batholiths and unzone plutons making up the majority of the mass (Hutchison & Tan, 2009). Figure 2.1 shows the map of Peninsular Malaysia showing Western, Central and Eastern Belts (Source: Hutchison & Tan, 2009). Meanwhile, Figure 2.2 below shows regional geology of Kelantan (Source: Minerals and Geoscience Department Malaysia, 2013).

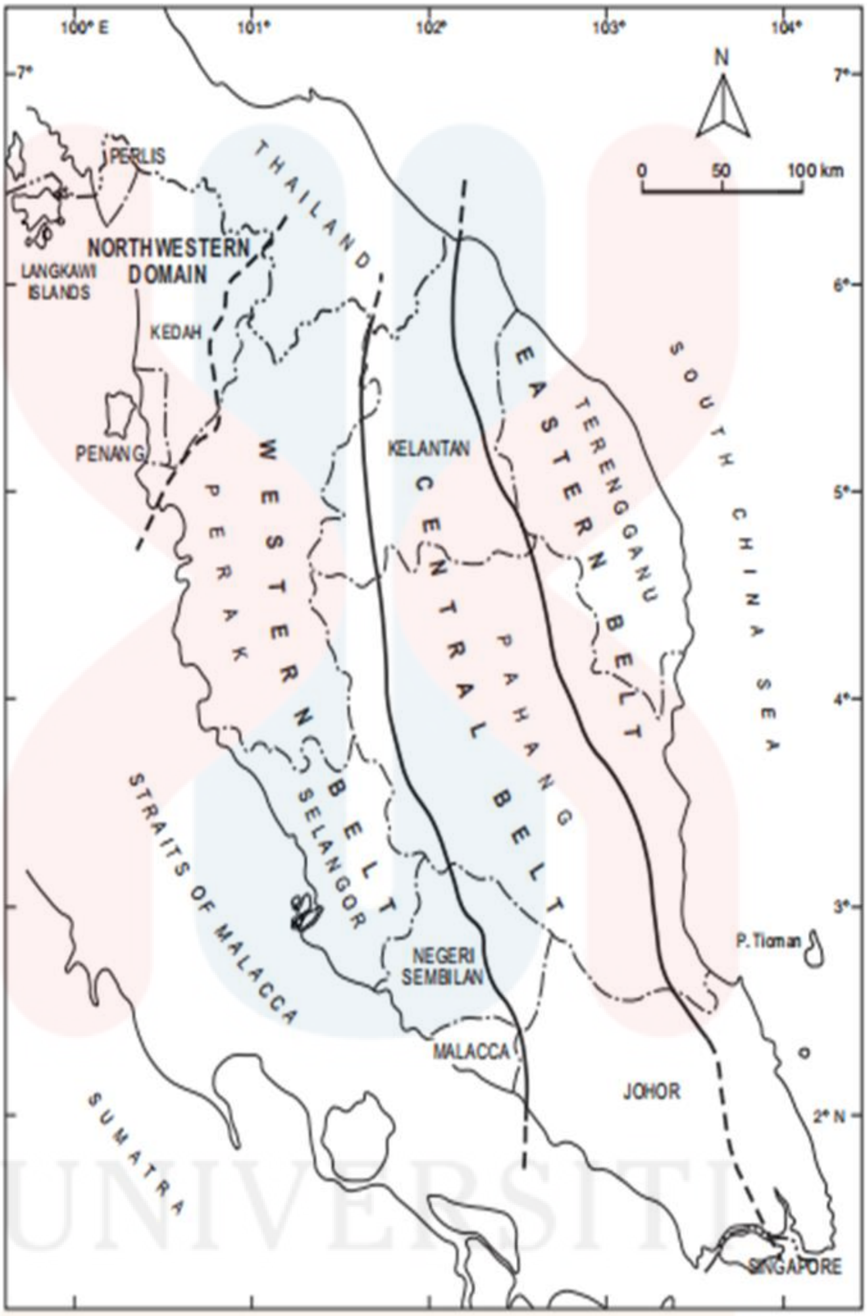


Figure 2.1: Map of Peninsular Malaysia showing Western, Central and Eastern Belts (Source: Hutchison & Tan, 2009).

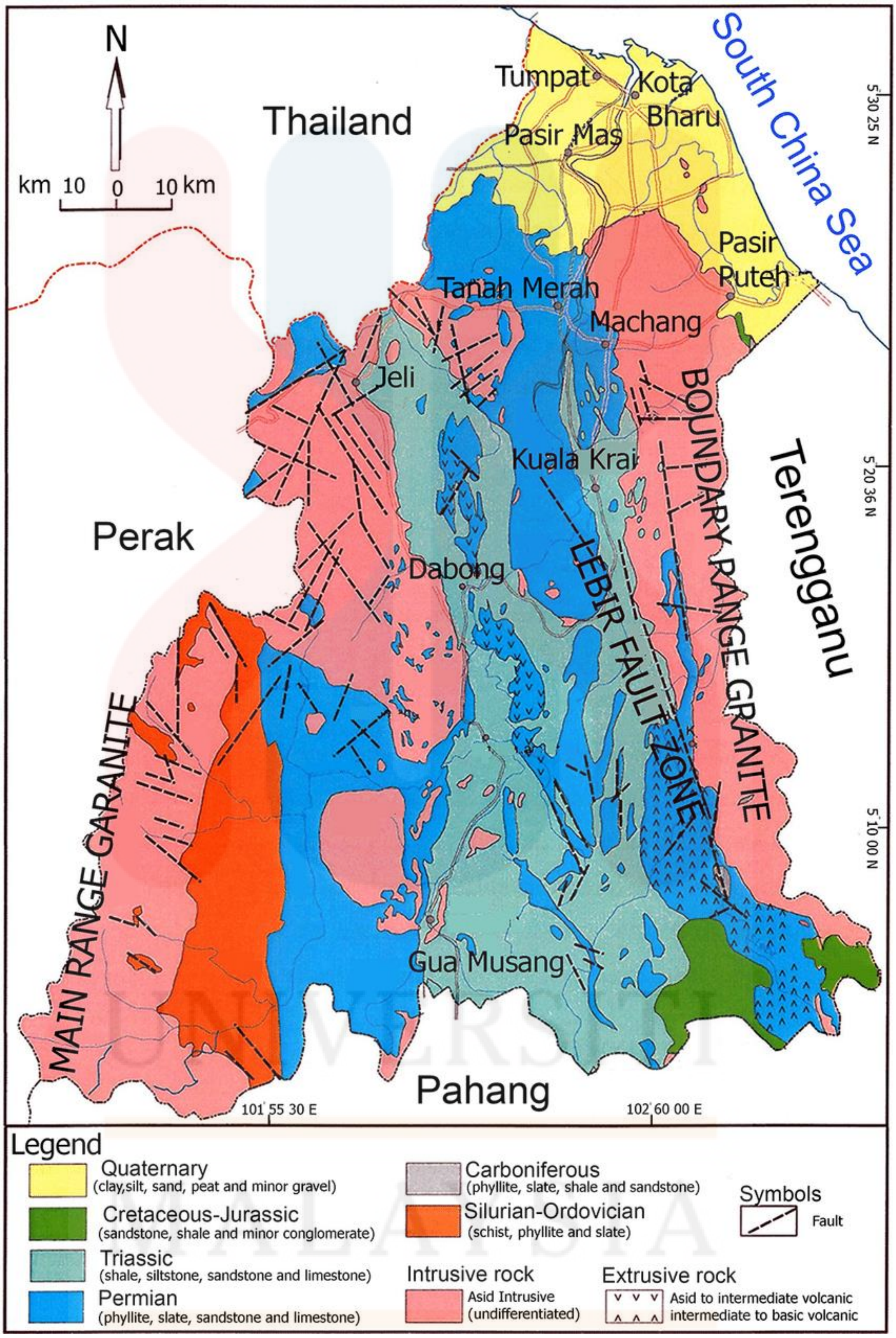


Figure 2.2: Regional Geology of Kelantan (Source: Minerals and Geoscience Department Malaysia, 2013)

Almost the entirety of the state of Kelantan is inside this belt of land. The provinces of Kuala Betis, Gua Musang, Aring, and Gunung Gagau make up the Southern Kelantan area of the Central Belt. The Gua Musang Formation and the Gunung Rabong Formation separate the district of Gua Musang. Granite covers onethird of Peninsular Malaysia, with the Western Belt, the Central Belt, and the Eastern Belt forming three distinct regions (Hutchison and Tan, 2009).

The study been conducted at Lata Mawo, Jeli district, where this area is probably located near the bottom of the Main Range. This Main Range is mostly made up of granitic rocks, and consists of enclaves of sedimentary/metasedimentary rocks thrown in for good measure (Nursufiah Sulaiman et al., 2020). This Main Range granite is generally situated in the southwestern section of Kelantan, running along near Perak as well as Pahang. According to Kelantan's overall area, it seems like Jeli district is made up of three kinds of rocks: Triassic sedimentary rocks from Gunong Rabong Formation, including shale, siltstone, sandstone, as well as limestone (Nursufiah Sulaiman et al., 2020). Figure 2.3 below shows the distribution of granitoids in Peninsular Malaysia (Source: Hussin, 2011).

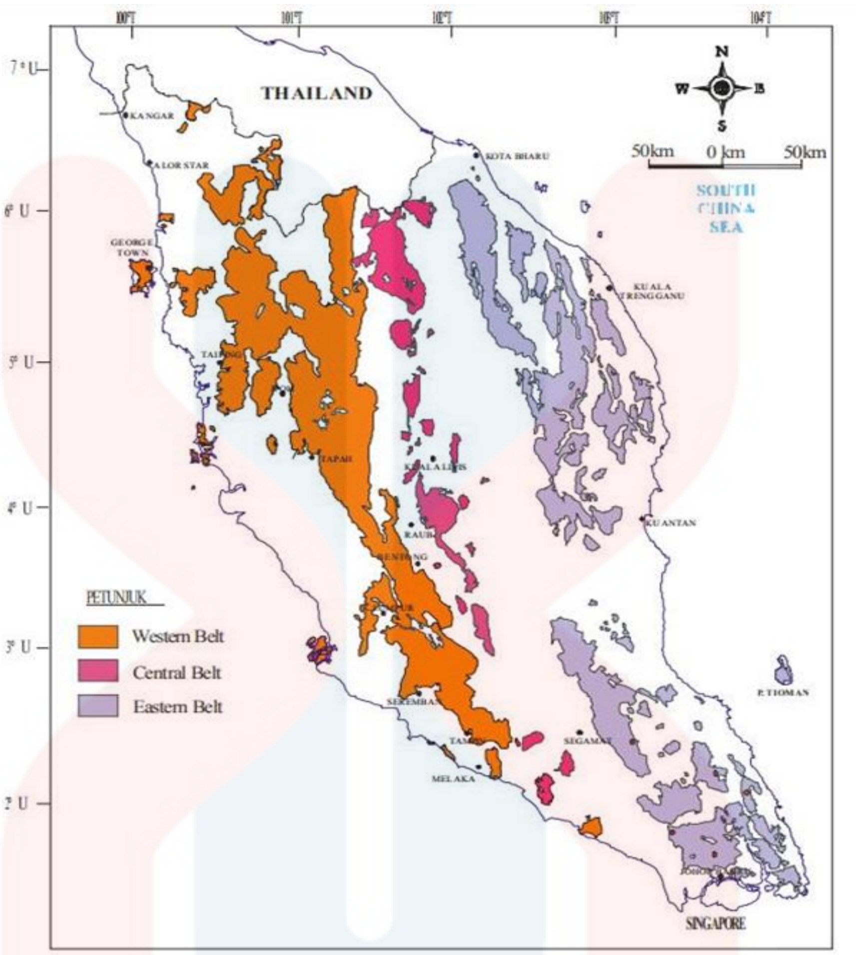


Figure 2.3: The distribution of granitoids in Peninsular Malaysia.

(Source: Hussin, 2011)

2.3 Stratigraphy

The Mangga formation, as per Department of Minerals and Geoscience Malaysia, underlies Kampung Lawar. In Malaysia, the term "mangga formation" is used to identify the low-grade metamorphic sequences of arenaceous, argillaceous, pyroclastic, hornfels, as well as marble. Some argillaceous, arenaceous as well as pyroclastic facies are found in the Mangga formation, which would be a low-grade metamorphic series in Malaysia. Metamorphosed siliceous shale, slate, phyllite, metasiltstone, and hornfels also found in the argillaceous facies.

There seem to be two argillaceous facies layers that can be found at both the bottom and the top with this formation. There are some horn felsic rocks, particularly calc-silicate hornfels, found in the top half of the range. Malaysia's Kampung Lawar-Sungai Kolok Transect area's stratigraphic column is depicted in Table 2.1.

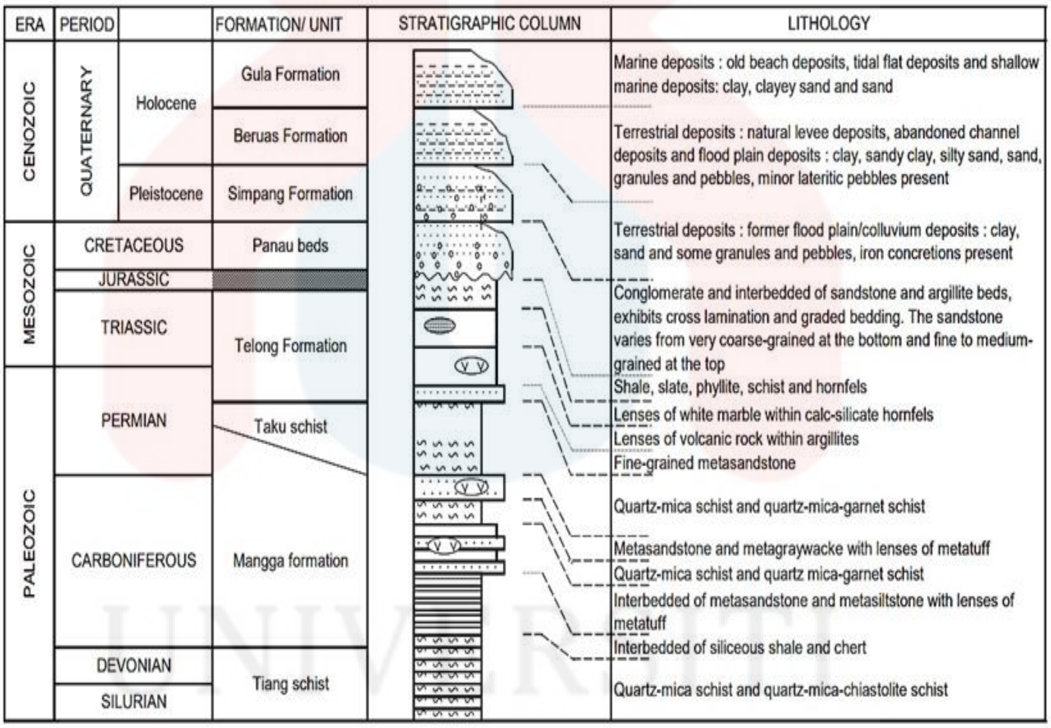


Table 2.1: Schematic stratigraphic column of the Batu Melintang-Sungai Kolok Transect area in Malaysia (Sources: Minerals and Geoscience Department Malaysia and Department of Mineral Resources, Thailand,2006)

2.4 Structural Geology

This state of Kelantan is located in the most north-eastern part of the Malaysian peninsular. As per previous occurrence, these tectonic processes that took place inside Peninsular Malaysia during the Paleozoic and Mesozoic eras had an effect mostly on land area, which resulted in the formation of folding and faulting (Nursufiah Sulaiman et al., 2020). Folding, jointing, as well as faulting are some of the localised features that have been found in sedimentary and granitic rocks. These structures have indeed been identified (Nursufiah Sulaiman et al., 2020).

Through Kelantan, this same pattern of local structures that predominated along the directions of north to the south as well as from the northwest to the southeast seems to have been dominant, whereas in Jeli, the trend of local structures that predominated along the directions of northwest to southeast and northeast to southwest predominated (Dony Adriansyah Nazaruddin, 2015). According to Hamblin, W.K., a joint is formed as a result of the strain that is produced whenever rock being uplifted, folded, either fractured as a direct result of tectonic activity (1994). A joint seems to be a fracture which separates two parts of rock that are moving apart from one another. This concept originates from the field of geology. When the tensile tension in a material surpasses its threshold, a joint will develop even if the shear stress is really not removed first. According to Tjia (1986), the Gemas and Semantan Formations are the primary locations where the dominating strike as well as fold axis of Peninsular Malaysia may be found.

The Bentong-Raub Suture Zone, which is located in Kelantan's central belt within Peninsular Malaysia, seems to be a major structural zone. It is protected by 24 road cuttings along the Karak Highway and BentongRaub Road that run from Gua

Musang to the Cameron Highlands. Schist, phyllite, meta-sedimentary rocks, sandstone, cherts, olistostrome, and melange make up the suture, a 13-kilometer-wide zone of deformed rocks. (Tjia and Almashoor, 1996).

An approximately 20-kilometer-wide suture was predicted by Metcalfe (2000). As part of the Bentong-Raub Suture Zone's geological makeup, find a belt of olistotrome made of interbedded sandstone and claystone, as well as sheared claystone matrix and interbedded chert, quartzite, conglomerate, and tuffaceous claystone in the area. Clasts can be as small as a few centimetres or as large as a few hundred yards. As ocean sedimentary rocks, cherts are regarded as one of the most important clasts or blocks.

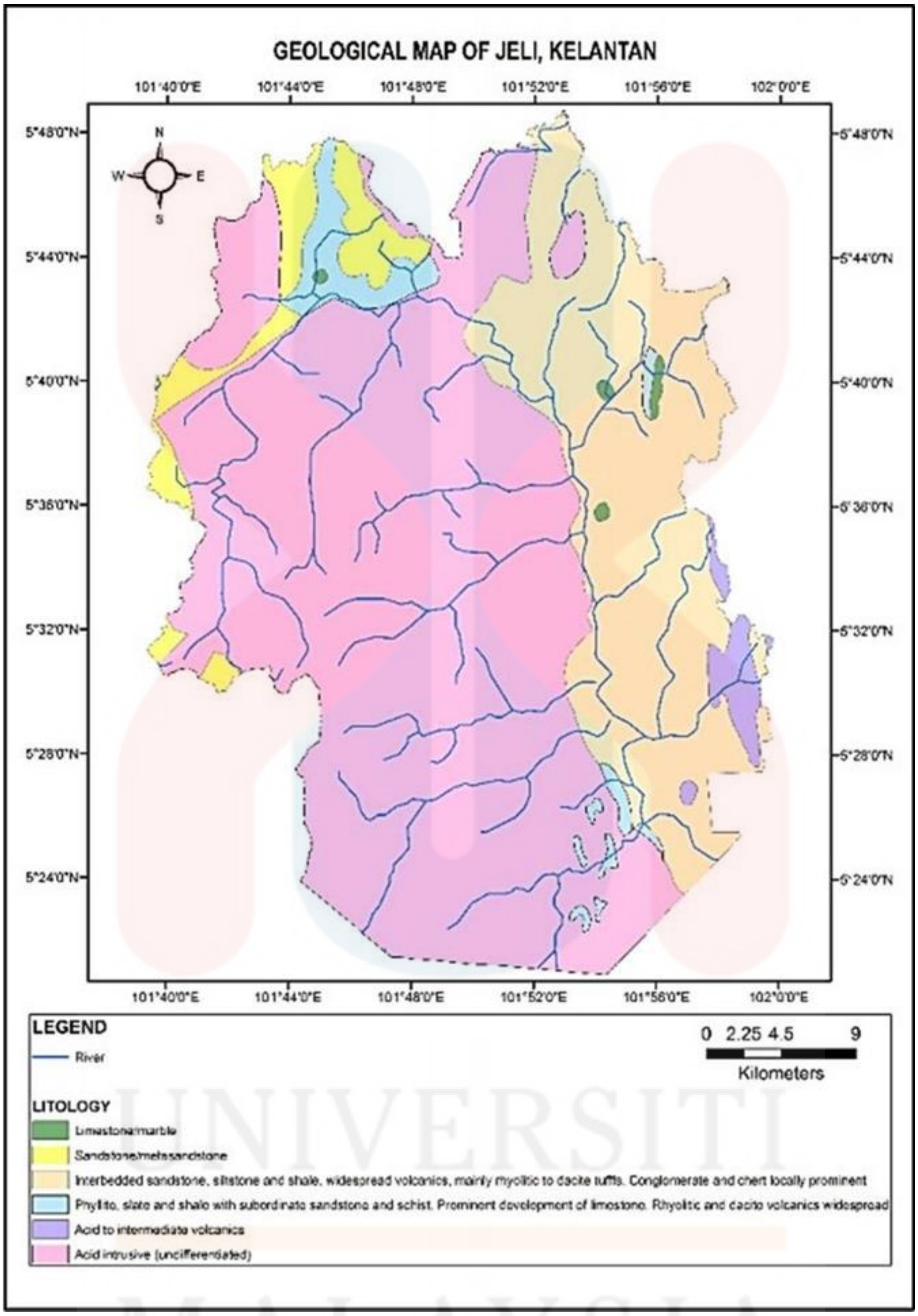


Figure 2.4: General geology of Jeli district (Sources: Department of Minerals and Geoscience of Malaysia, 2003)

2.5 Historical Geology

This formation of the Main Range Granite took place between 200 and 230 million years ago, during the latter half of the Triassic epoch, as stated by the Malaysian Department of Minerals and Geoscience (2003). On a geological scale, the rock units that make up Kelantan can be classified as either unconsolidated sediments or extrusive rocks like granite, but also volcanic rocks, sedimentary or metasedimentary rocks, including sedimentary rocks. The granite that can be found in Kelantan is separated into 2 different masses, which are known as the Main Range and the Boundary Range.

Secondary sedimentation with repositioning from earlier weathered rocks, including solution chemical but also biochemical precipitation, represent examples for unconsolidated sediments. Neither compressed nor lithified are they. Sediments that are not consolidated create the coastal area, that extends along the Thai border to Terengganu's and into Kelantan state. Stone from the Quaternary era stands on top of the flat alluvial plain formed by the sediments.

In the meantime, these extrusive rocks constructed an elongated body extending north to south, mostly in the centre zone but also along the eastern border of the state with Boundary Range granite. According to Kelantan's Geology and Mineral Distribution Map, 2000, they came into existence during the Permian epoch. The Geology and Mineral Distribution Map of Kelantan indicates that sedimentary but also metasedimentary rocks date from the Ordovician to the Cretaceous. These rocks can be dated back as far as the state's history goes. The rocks consisted mainly of the part that runs north to south in the middle of Kelantan.

Dony Adriansyah Nazaruddin et al. (2018) found that the Pergau River drains via a flat alluvial plain towards the south of such a hill mostly in study area, creating it a much more beautiful and interesting scenery for the assessment geoheritage as well.

2.6 Geoheritage and Geodiversity

Some of the area's most stunning landscapes, remarkable geological events, and fascinating geologic features can indeed be tourist attractions, regardless of where they are located. An example of potential geological heritage is still a geological concept which emphasises unique, distinctive, and figurative geological characteristics (ProGEO, 2011) to numerous values, like scientific knowledge, education, aesthetics, recreation, culture, economics, religion, and functional values (Gray, 2004, Gray, 2005; GSA 2012).

Malaysia is among the nations that has been able to successfully preserve its geo-heritage capital while also improving it. According to Komoo (2004), previous efforts to preserve geological resources in Malaysia been done through the Third Malaysian Plan (1976-1980), which provided for the necessity to maintain geological markers and indeed the landscape. In 1996, formal commitments to encourage the conservation of Malaysia's geological heritage marked the beginning of the process that would eventually lead to the foundation of the Malaysian Geological Heritage. Following this, a number of research projects were carried out with the purpose of analysing the geo-heritage in order to locate additional maintenance and development areas.

As a result, geoheritage refers to the long-term economic, environmental, scientific, and cultural value of the earth's natural geological features. It's important to note that geodiversity, that physical setting whereby a life occurs, is indeed a component of abiotic diversity. Soil, water, including geological properties (rocks, minerals, fossils, buildings), as well as their relationship to one another, can all be included when describing the physical landscape. As opposed to geodiversity, which refers to a more general context, geoheritage focuses on the unique cultural heritage and special sites that need to be preserved (ProGEO, 2011).

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 Introduction

Through being able to execute the process of data collection and even the necessary information for geological mapping and thus the potential worth of geoheritage through the Jeli area, only some materials and methods have been required. Research has been made possible through the use of proper tools and techniques.

3.2 Materials

As with the materials and methods employed in this research, some of the materials include maps, photos, and literature that are relevant mostly to the topic being studied and indeed the site of the study itself.

The majority of the materials with this study are components of field equipment, including a Global Positioning System (GPS), geological hammer, Brunton compass, map, and other literary works associated with geoheritage and indeed the study location. The list of the equipment applied in this study could be found in the following table 3.1.

Table 3.1: The function of the equipment.

No	Equipment	Function
1.	Global Positioning System (GPS)	The GPS records and marks the location's coordinates and track as well.
2.	Geological hammer	Rock samples are collected with the aid of these tools, which serve as scale models for the actual samples.
3.	Brunton compass	Brunton Compass is used to determine the strike and dip of geological features such as bedding.
4.	Base map	Before entering into the field, the researchers gather data and information about the study area using a base map.
5.	Hand lens	Using a hand lens, might see the fine details in rock samples, such as fossils, minerals, and other elements.
6.	Sample bags	A sample of rocks is gathered and placed in a sample bag, which is then labelled with the sampling site's coordinates.
7.	Measuring tape	Outcrops usually measured in the field for their length and width.
8.	Fieldwork book	To jot down and record together all information.
9.	Camera	The outcrop photo and geomorphology view are taken with the help of this tool.

3.3 Methodology

There are a few stages to this research's methodological process. Preliminary study is the first approach that could be use in this study. In order to get a basic understanding of the geology as well as to help with the specification, preliminary study is conducted. Preliminary study which is literature, books and others are involve of the study area. The Modified Geosite Assessment Model (M-GAM) model is used to assess the study area based on the values. Another approach that can be use in this study is the data collection through geological mapping as well as geoheritage mapping, which is the second way included in this study. Geological mapping that through traverse is in order to collect data. The global positioning system (GPS) will be used to gather coordinates and traverse data, which will then be imported into ArcGIS. Then, using Georose's programme to enter the joint and strike data.

3.3.1 Preliminary Study

This process began with a preliminary investigation. Desktop study had been used to gather information on the study area. The goal of implementing this strategy is to better comprehend the study's issues and scope. The preceding research study was referred to in order to carry out this procedure. There was no original research done for this study. There are numerous sources of information, such as books, articles, journals, geological maps, and the Internet. When undertaking primary research, this argument be assumed.

3.3.2 Field Studies

In order to gather the data needed for an assessment through a study area, the geological mapping and geoheritage mapping aspects are included in the fieldwork. The study area will be covered by geological mapping which can develop an accurate and updated geological map. Observation with assessment in the field becomes a key component of the geological mapping process. The environment of the study area includes provides assessments needed which demonstrate the area's historical value. The Modified Geosite Assessment Model (M-GAM) model was used and was assessed in Lata Mawo. The requirements were assessed by considering main and additional values in the study area that included as well. According to the M-Gam approach, the questionnaire seems to have been created for geoprofessionals, tourists to evaluate the area of Lata Mawo. GAM model includes the socio-demographic data, indicators and subindicators that have a significant impact. The main and additional values for Lata Mawo have been assessed by geoprofesionals, who were tasked with assessing each subindicator within each. All 27 subindicators were reviewed by geoeprofesional. Meanwhile, though, Geotourist further about Lata Mawo's Additional Values subindicators.

In the questionnaire require them to fill out including education level (high school, diploma or degree and above). The questionnaire covered about the awareness, significance, advantages and others. The survey includes around 50 respondents from many categories ages, gender and others in order to complete the data of surveying. Then data analysis from the data that will get that related to study area. The traverse of the geological map which includes the study area approximately 5 x 5 km.

Data analysis and interpretation is involves creating a geological map of the study area which an updated geological map of the Lata Mawo area with a 5 x 5 km size will be created using the ArcGIS programme that contains geological data. There will be a geological map that includes the study area's immediate strike and dip, lithology and fault lines. As for survey it will be analysis the data that get from the questionnaire that will give to the selected people of community study area.

Table 3.2. Structure of M-GAM model values (Marija Bratić et.al., 2020)

Main values (MV)	
Scientific/educational value (VSE)	
Rarity	Number of closest identical sites
Representativeness	Didactic and exemplary characteristics of the site due to its own quality and general configuration
Knowledge on geoscientific issues	Number of written papers in acknowledged journals, thesis, presentations, and other publications
Level of interpretation	Level of interpretive possibilities on geological and geomorphologic processes, phenomena and shapes and level of scientific knowledge
Scenic/aesthetic (VSA)	
Viewpoints	Number of viewpoints accessible by a pedestrian pathway. Each must present a particular angle of view and be situated less than 1 km from the site.
Surface	Whole surface of the site. Each site is considered in quantitative relation to other sites
Surrounding landscape and nature	Panoramic view quality, presence of water and vegetation, absence of human-induced deterioration, vicinity of urban area, etc.
Environmental fitting of sites	Level of contrast to the nature, contrast of colors, appearance of shapes, etc.
Protection (VPr)	
Current condition	Current state of geosite
Protection level	Protection by local or regional groups, national government, international organizations, etc.
Vulnerability	Vulnerability level of geosite
Suitable number of visitors	Proposed number of visitors on the site at the same time, according to the surface area, vulnerability, and current state of geosite
Additional values (AVs)	
Functional values (VFns)	
Accessibility	Possibilities of approaching to the site
Additional natural values	Number of additional natural values in the radius of 5 km (geosites also included)
Additional anthropogenic values	Number of additional anthropogenic values in the radius of 5 km
Vicinity of emissive centers	Closeness of emissive centers

Vicinity of important road network	Closeness of important road networks in the in radius of 20 km
Additional functional values	Parking lots, gas stations, mechanics, etc.
Touristic values (VTr)	
Promotion	Level and number of promotional resources
Organized visits	Annual number of organized visits to the geosite
Vicinity of visitors centers	Closeness of visitor center to the geosite
Interpretative panels	Interpretative characteristics of text and graphics, material quality, size, fitting to surroundings, etc.
Number of visitors	Annual number of visitors
Tourism infrastructure	Level of additional infrastructure for tourist (pedestrian pathways, resting places, garbage cans, toilets, etc.)
Tour guide service	If exists, expertise level, knowledge of foreign language(s), interpretative skills, etc.
Hostelry services	Hostelry service close to geosite
Restaurant service	Restaurant service close to geosite

3.3.3 Data Processing

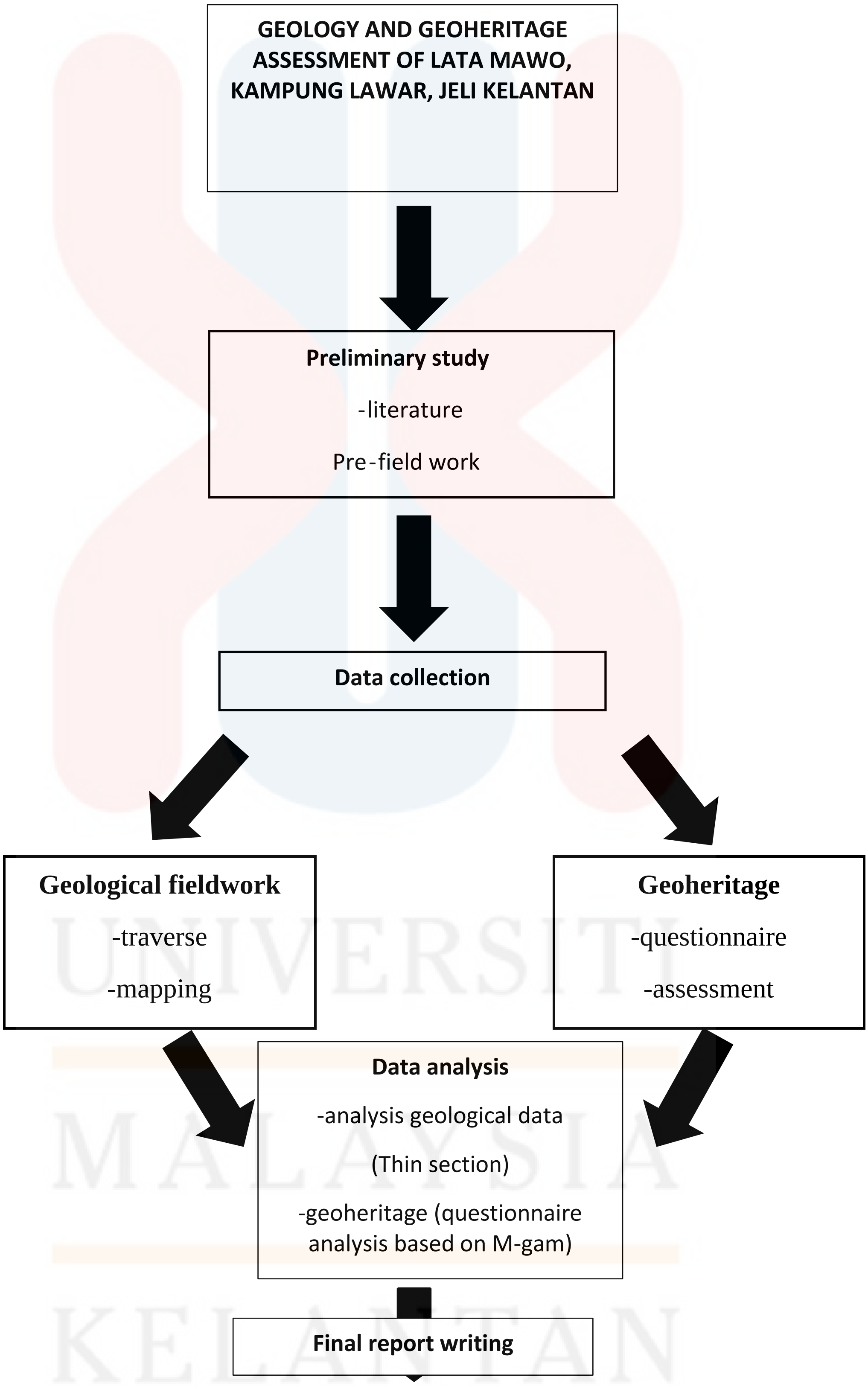
For the data processing, it has most of the information needed about the area's geology, which includes data gathered from the study area. The study area's lithology and stratigraphy, when analysed and interpreted, provide insight into the area's tectonic history, including historical depositional settings. Aspects of geology, geomorphology, and others were all taken into account when determining the degree of geodiversity in the study area. Aspects in geology, geomorphology, and others were all considered for determining the degree of geodiversity of the assessment at the study area.

Geographic mapping has indeed been carried out in order to locate characteristics of recent geological features that exist there. Geological aspects in the study area have been gathered from data obtained by processing, assessing, and interpreting it. Any assessment of both the study area's lithology and stratigraphic data can indicate the geological history and even the metamorphic activities that focused largely before. Furthermore, faults, joints, and others like strike and dip data of Lata Mawo have been taken for analysis and through then used the Georose with Stereonet.

3.3.4 Data Analysis and Interpretation

This data analysis and interpretation includes coordinates, geomorphic, geographical features and others. Geomorphologic aspects define the study area of Lata Mawo. ArcGIS has been used to create a geological map of the study area of Lata Mawo. The M-GAM approach, that was constructed using the M-GAM model, has been utilised in the process of evaluating all of the geodiversity indicators.

3.3.5 Research Flow Chart



CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

The geomorphology, lithostratigraphy, structural geology, and historical geology of the study area will be covered in this chapter. The chapter will also describe the general geology of the area. Jeli district, which seems located in the western part of Kelantan, is where find Kampung Lawar. It serves as Peninsular Malaysia's backbone.

The study of landforms and the processes that create them is called geomorphology. This subfield of geology focuses specifically on development and history. Through the study of geomorphology, it is possible to comprehend the mechanism which related to the changes that have occurred throughout nature. An investigation of rock layers, including their groups, absolute ages, and the relationships between them, is called stratigraphy. The research makes use of lithostratigraphy in order to classify the associations between different strata of it.

The study of the structure of the earth, including the rock forms that help to explain its past of deformation, has been known as structural geology. The information that was gained is essential for providing context for historical happenings. The fields of geomorphology, stratigraphy, and structural geology are all brought together to gain insight on geological occurrences from the past.

4.1.1 Settlement

Kampung Lawar is the local name for the community in the research site. There is a small community of people living in this region because of the plantation, dam, and other it offers. Lata Mawo's presence in the Kampung Lawar draws more people to the area, and residents of the surrounding communities begin to relocate there.

4.1.2 Forestry

The study area is surrounded by plantations, which provide the local community with a significant source of revenue. In the area under study, almost all of the forests have been cleared to make way for like the rubber, most of which are maintained. Sungai Pergau's local economy now benefits greatly from this rubber plantation's expansion. from the dam, sungai Pergau been open this would expose the existance of Lata Mawo that be new attractions of the area for the community.

4.2 Geomorphology

Sedimentation on Earth's surface is studied as part of geomorphology, together with landforms, their processes of formation, kinds, and mechanisms. Understanding the processes, including ice, water, and wind, that shape the Earth's surface is the goal of this research, and it is accomplished by analysing the landscape. The term "landscape" refers to the natural and manmade features of an area, including its landforms (like hills and mountains), land cover (like plants), water features (like lakes, rivers, and the ocean), and human influences (such land use and building structure). The discipline of geomorphology focuses on how and why landforms formed. Qualitative methods have focused on describing landforms, whereas quantitative methods have focused on the processes that bring about landforms including landform change on Earth's surface.

The field of science known as geomorphology investigates how the Earth's topographic and other features formed as a result of physical, chemical, and biological processes. There was a common understanding that the topography, faults, drainage system, as well as weathering processes all had a role in geomorphologic processes. According to Huggett (2007), the Greek terms geo (Earth), morph (shape), and logos (meaning) comprise the word geomorphology (discourse). Geomorphology, then, is the discussion of or research into landforms on Earth. It has close ties to the actual topographical characteristics of the Earth, such as mountains, valleys, and rivers. Around the area of Kampung Lawar that includes Sungai Pergau we can see the geomorphology of its surrounding view of it.

4.2.1 Geomorphologic classification

The classification of landforms according to their nature, how they formed, and how they've changed over time is known as geomorphic classification. The study area's geomorphology at Lata Mawo that located at Kampung Lawar is characterised by many characteristics. Information gathered from a wide variety of sources is processed, analysed, and interpreted to establish the geomorphology of the study area. The geomorphology of the area under study can be characterised by using features such as its topography, the processes of weathering that occurred there, and the drainage pattern that developed there, in addition to the vegetation and the morphology of the water of the study area.

4.2.2 Topography

The study of the structures and characteristics of the earth's land surfaces is referred to as topography. The physical formations and features of a area are sometimes referred to as the "topography" of that area, but topography can also refer to a description of the area or its depiction on maps. The study of the land's surface is referred to as topography. In particular, it establishes the fundamental basis upon which a landscape is built. For instance, the term "topography" might refer to physical features on the surface such as mountains, valleys, rivers, or craters. Table 4.1 below shows classification of topographic units (Jabatan Perancangan Bandar Dan Desa Semenanjung Malaysia)

Absolute altitude (meter)	**Morphology element based on topography**
120-150	Low hills
150-300	Hills
300-1000	High hills
>1000	Mountain

Table 4.1: shows classification of topographic units ((Jabatan Perancangan Bandar Dan Desa Semenanjung Malaysia, 2009)

Most of the area under study is covered by steep mountains, and measurements show that the highest point is at least 720 metres above sea level as find it situated on a hill in the southern side of study area near the Kampung Lawar or on highway of Jeli-Grik. Altitudes in the research area ranged on average from 120 to 360 metres. Figure 4.1 shows Triangular Irregular Networks (TIN) map of the study area. Meanwhile, Figure 4.2 shows geomorphology map of the study area.

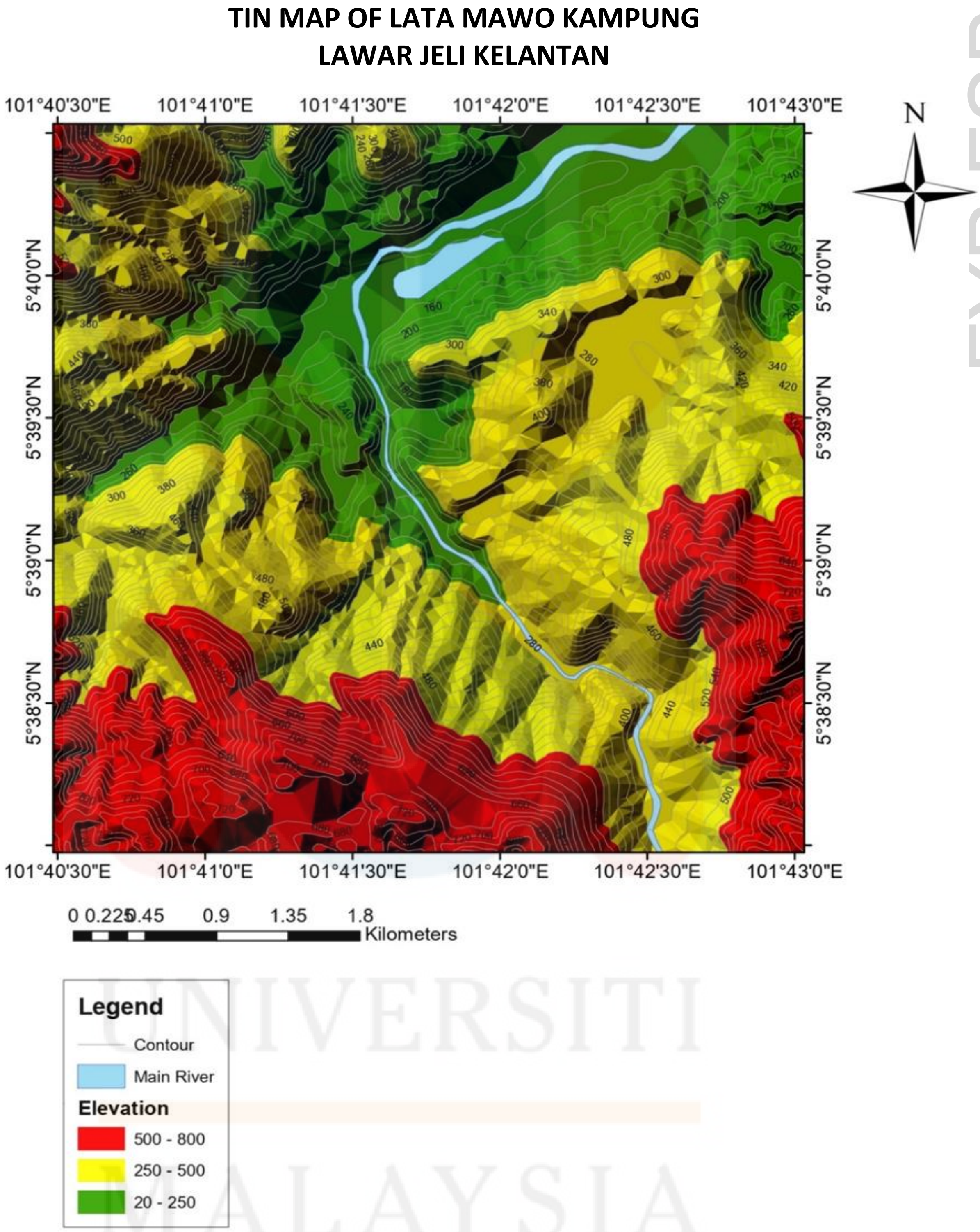


Figure 4.1: Triangular Irregular Networks (TIN) Map of the study area.

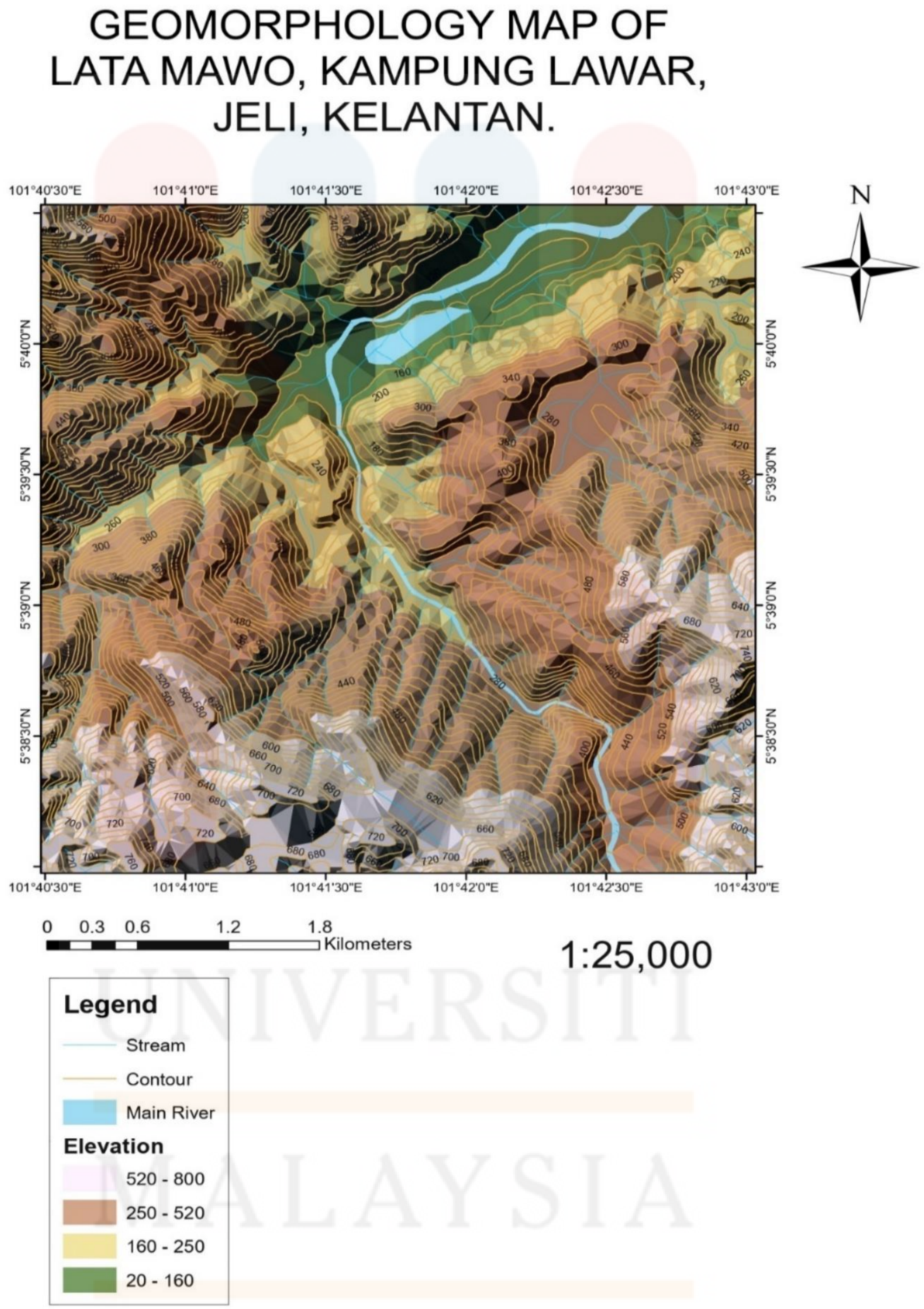


Figure 4.2: Geomorphology Map of the study area.

4.2.3 Drainage Pattern

The drainage pattern of a certain drainage basin is the pattern that is formed either by streams, rivers, and lakes in that drainage basin. The pattern that is left behind after years of erosion by streams provides clues about the types of rocks and geologic formations that are present in an area of the terrain that is drained through streams. The presence of a topographic area which is subject to runoff from either a stream by flow as well as groundwater flow is indicative of a drainage pattern, which is the pattern that displays the movement of water. When precipitation exceeds the soil's capacity to absorb it, it begins to run off and travel across the landscape until it reaches a drainage system, at which point it will begin to destroy the ground. In addition, the stream's flow initiates when surface water is saturated with water from rain or groundwater. The valley's drainage system would eventually take on a new form as a result of the stream's persistent erosion. Figure 4.3 displays the various drainage system types that includes dendritic, parallel, trellis, rectangular, radial, annular, multibasinal and contor

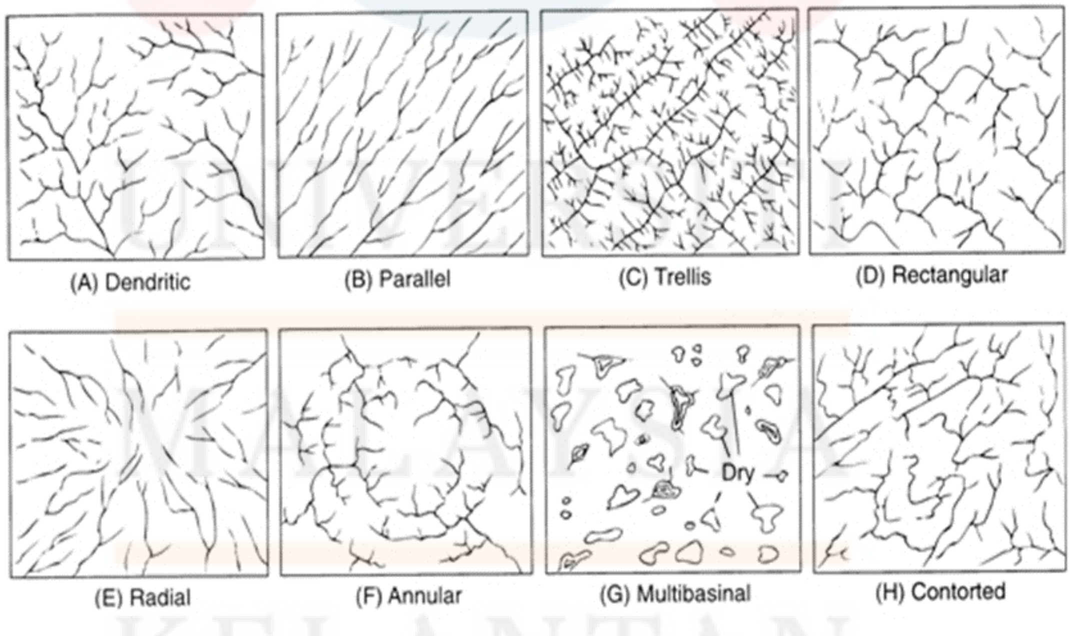


Figure 4.3: shows the types of drainage system

The study area consists a few types if drainage pattern that been identified and shown through Figure 4.4. The types that been identified included dendritic, parallel and rectangular pattern.

i. Dendritic

The most typical kind of drainage system has a structure resembling the branched structure of a tree's roots, and is called dendritic. It appears in places with a uniform subsurface. This means that it is unclear who or what determines the trajectories of these tributaries, given the underlying geology displays similar resistance to weathering. Tributaries include streams that branch off from the main river at an acute angle of less about 90 degree or unite with other streams. They originate in areas where the stream channel is influenced by the slope of the surrounding terrain. The types of rocks that make up this pattern need to be impervious and non-porous in order to have any geological significance of it.

ii. Parallel

A network of rivers called a parallel drainage pattern is one that is generated by steep slopes that have some relief. It develops in areas that have an incline or slope. A region with a consistent gradient is traversed by the tributaries as they flow parallel to one another. Where there is a steep incline to the ground, parallel drainage patterns develop. There is a similar pattern that arises in areas with long, narrow landforms, such as outcropping resistant rock bands. Following the surface's gradient, tributary streams often spread out in parallel configurations.

iii. Rectangular

The main streams and their tributaries exhibit frequent right-angle bends and exhibit sections of nearly the same length, producing a rectangular drainage pattern. It reveals the waterways that run along well-known fault lines or the joint systems that cut the rocks into square or rectangular chunks.

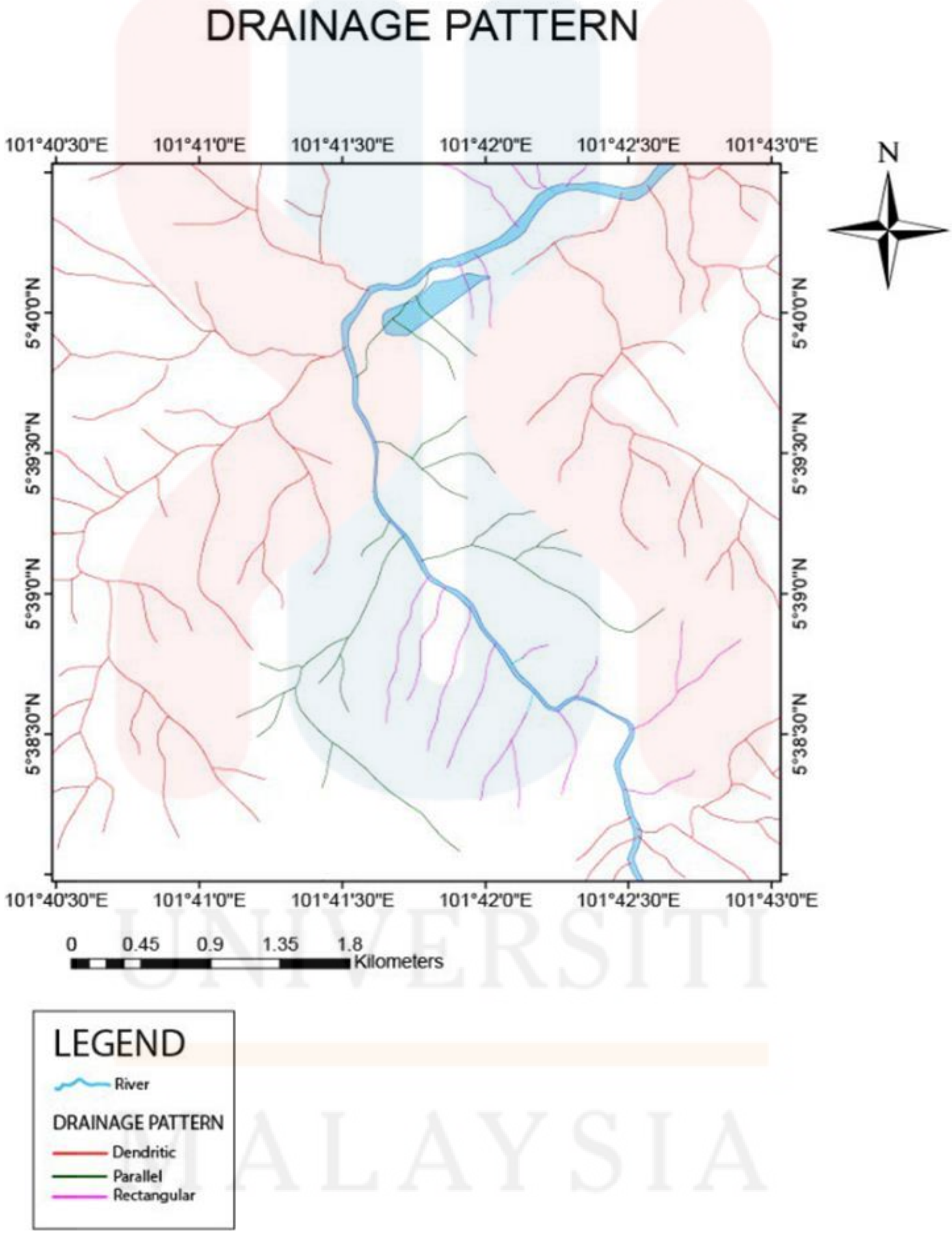


Figure 4.4: Drainage Pattern Map of the study area.

4.3 Lithostratigraphy

The discipline of lithostratigraphy examines various rock units and their stratigraphic attributes to determine how they should be categorized. While lithostratigraphic units are the most essential part of geological features, additional elements include geological structure, bedding orientation, as well as other characteristics. This lithology rock unit can indeed be identified through examination and interpretation of the water system and its relationship to the surrounding terrain and slope gradient of it.

4.3.1 Stratigraphic position

The study of stratigraphy, a subfield of geology, focuses on the relationship between the arrangement and orientation of rock layers and the development of the Earth's geologic history. Analysing the structure of a certain set of strata and the sequence in which archaeological layers are found is essential for relative time sequencing.

STRATIGRAPHY

STRATIGPHY COLUMN

ERA	PERIOD	FORMATION	STARTIGRAPHY COLUMN	LITHOLOGY	DESCRIPTION
Cenozoic	Tertiary	Acid intrusive		Alkali Feldspar granite	Consists of anorthoclase, quartz, biotite and opaque mineral
Mesozoic	Middle-Upper Triassic	Gunung Rabong (argillaceous)	? ? ? ? ? ? ?	Schist	Consists of quartz, chlorite and opaque mineral
				Gneiss	Consists of feldspar, quartz, biotite, base mass and opaque mineral
				Phyllite	Consists of quartz, biotite and opaque mineral
				Quartzite	Consists of quartz and feldspar

LITHOLOGY COLUMN

LITHOLOGY	DESCRIPTION
	Almost entirety of the study area is covered with acid intrusive, which is igneous rock, and is considered as either an intrusion from the Central Belt Granitoid. This would be the primary reason of the hilly landforms found in the study area that been covered.
	The less in the amount of cover up of the study area caused by sedimentation, deposition, solidification and other processes. The lithology of the rocks that have been discovered is referred to as argillaceous.

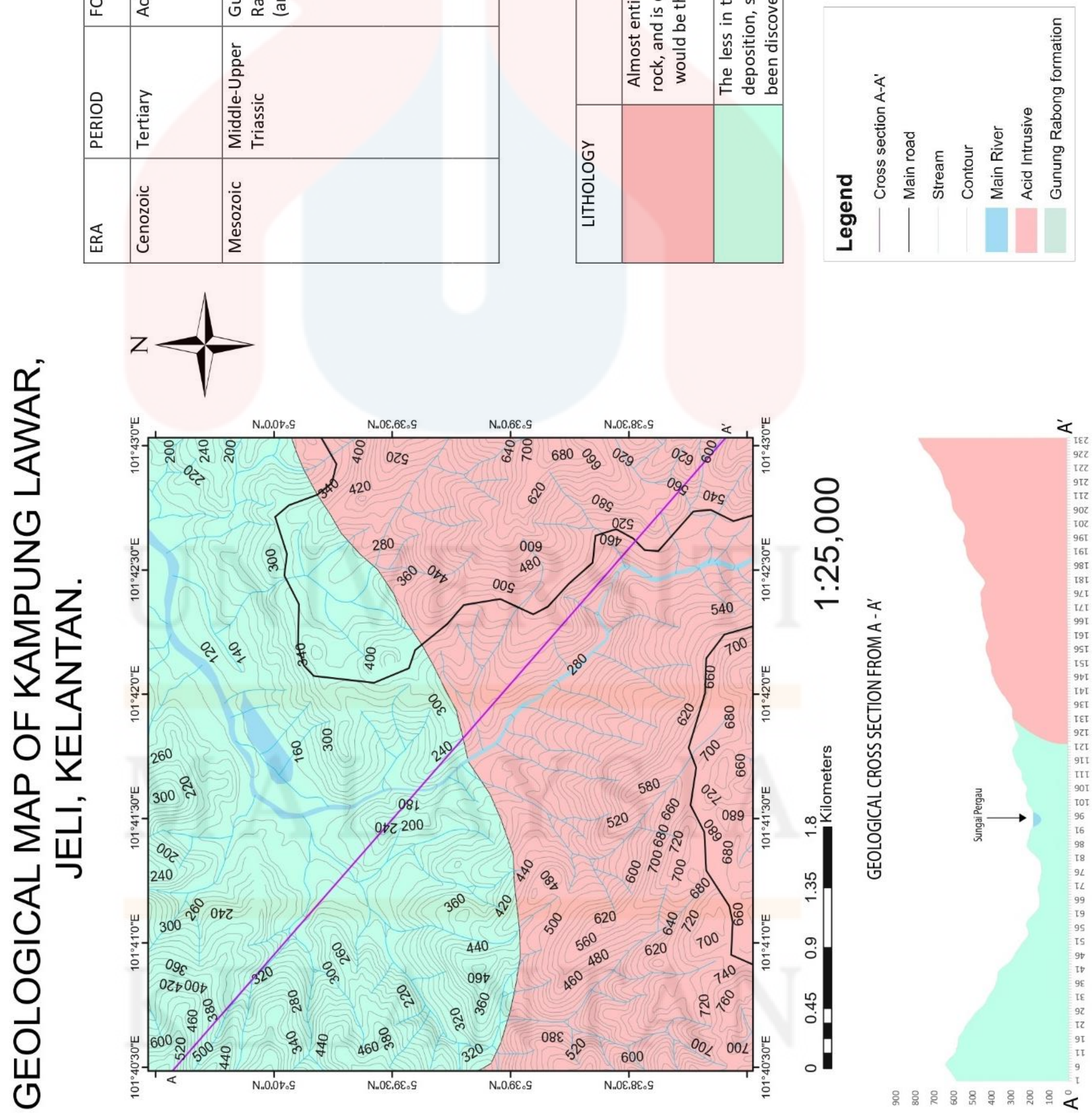


Figure 4.5: shows Geological Map of study area.

ERA	PERIOD	FORMATION	STARTIGRAPHY COLUMN	LITHOLOGY	DESCRIPTION
Cenozoic	Tertiary	Acid intrusive	? ? ? ? ? ? ?	Alkali Feldspar granite	Consists of anorthoclase, quartz, biotite and opaque mineral
Mesozoic	Middle-Upper Triassic	Gunung Rabong (argillaceous)		Schist	Consists of quartz, chlorite and opaque mineral
				Gneiss	Consists of feldspar, quartz, biotite, base mass and opaque mineral
				Phyllite	Consists of quartz, biotite and opaque mineral
				Quartzite	Consists of quartz and feldspar

Table 4.2: Shows stratigraphy column of the study area.

According to the rock layers, or stratigraphy column that shown in the table 4.2 it is from period Carboniferous-Permian of Gunong Rabong of it. This includes the argillaceous. The lithology that been found the study area includes the schist, gneiss, phyllite and quartzite. As for the the Gunung Rabong Sedimentary Formation, it is dates back to the Middle to Upper Triassic.

Geological features of the region were formed as a result of orogenies that occurred in the past. Geological, geophysical, and chemical evidence suggests that Triassic and Permian metasedimentary rocks are the hosts for gold mineralization in Kelantan.

Based on the stratigraphy column above (Table 4.2) shown that as for the acid intrusive in the Tertiary period of it. This particular unit is placed inside the Tertiary period on the geological time scale since it was formed during that time.

4.3.2 Unit Explanation

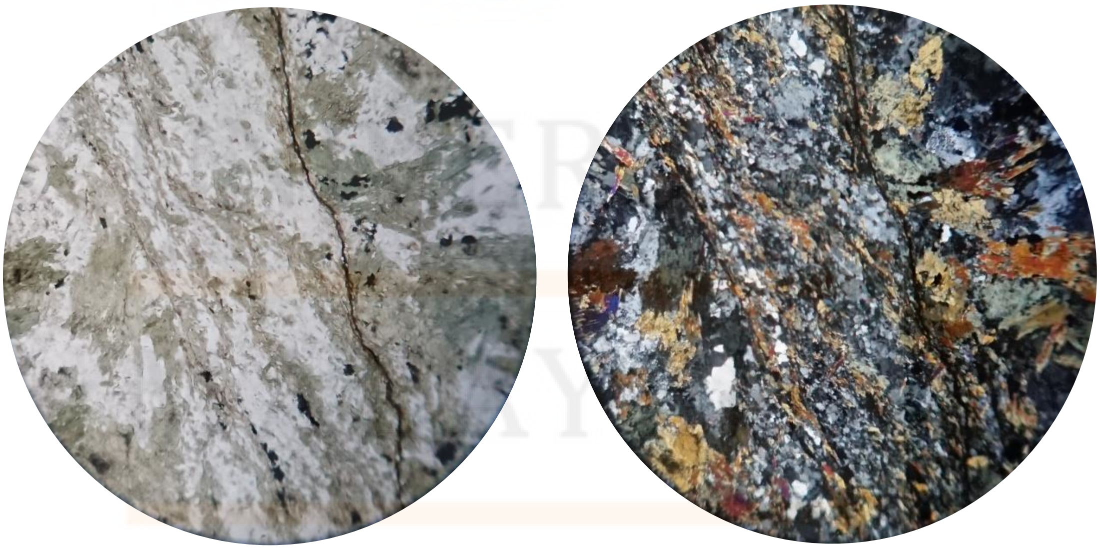
a. Schist unit

Schist is a type of metamorphic rock that has medium-sized grains. This indicates that the rock is made up of mineral grains that can be seen with a hand lens with a low magnification, and that these mineral grains are oriented in such a way that the rock may be easily broken into thin flakes or plates. This texture is a direct result of the presence of a significant amount of platy minerals, which include micas, talc, chlorite, and graphite. These were all frequently found intermixed with minerals that are coarser in texture, such as feldspar or quartz.

Schist often represents a medium degree of metamorphism since it originates during regional metamorphism that occurs in tandem with the mountain-building process (orogeny). In addition to volcanic rocks like tuffs and lava flows, sedimentary rocks like mudstones are also possible precursors to schist. One type of schist, formed by metamorphism from mudstone, is extremely prevalent and typically quite mica-rich (a mica schist). If the protolith can be determined, the schist will typically take on the name of the protolith from which it was formed. For example, a schist that forms from sandstone would be called a "schistose metasandstone." Quartz-felspar-biotite schist is an example of a rock whose name includes the names of its constituent minerals.

Schist is defined as a metamorphic rock with medium grain size and developed schistosity. Metamorphic cleavage (a foliation) results in schistosity, a layering of the rock that makes it easy to break off flakes or slabs less than 5 to 10 millimetres (0.2 to 0.4 in) in thickness. With a 10x hand lens, can see the individual mineral grains in schist, which range in size from 0.25 to 2 millimetres (0.01 to 0.08 in). Over fifty percent of the mineral grains in a schist always lean in one direction. One of the three types of metamorphic rock, schists are distinguished from gneiss and granofels by the degree of schistosity formed within their layered structures.

During microscopic observation at 10x ocular and 5x objective magnification, a foliated structure (schistose) and crystalloblastic (nematoblastic) texture were observed, including grain sizes ranging from <1/256 - 1/3 mm and good sorting. The mineral composition consisted of 58% quartz (A7), which displayed colorless absorption in PPL, low relief, no pleochroism, anhedral crystal form, and no cleavage. In XPL, the interference color was an order 1 gray-white with wavy dark corners. The composition also included 40% chlorite (F1), which had a green absorption color in PPL, low-moderate relief, weak-moderate pleochroism, anhedral-subhedral crystal form, and no 1-way cleavage. Additionally, 2% of the minerals were opaque (J1), displaying black absorption color in PPL, low relief, no pleochroism, and euhedral-anhedral crystal form in XPL with interference color being black order 1 and no twinning. In Figure 4.6 shows plane and cross polarized view of schist in thin section.



Plane polarized (PPL) **Cross polarized (XPL)**

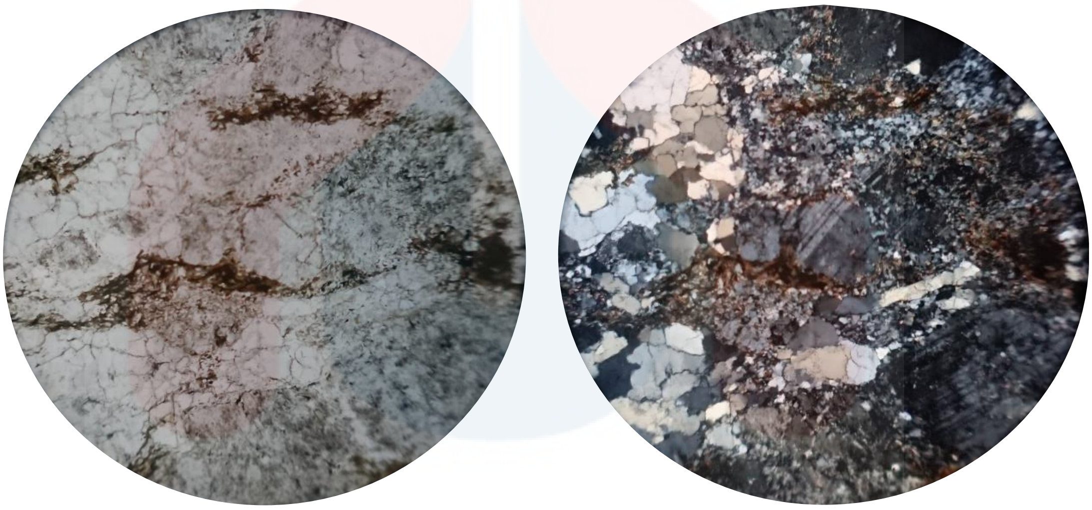
Figure 4.6: PPL and XPL view of schist thin section

b. Gneiss unit

Gneiss is one of several types of metamorphic rock that may be found all over the world. It is the result of metamorphic processes on igneous or sedimentary rock formations at high temperatures and pressures. In comparison to schist, gneiss requires higher temperatures and pressures to develop. Almost always, gneiss has a banded texture with alternating dark and light bands and no clear cleavage.

The compositional banding in gneiss (gneissic banding) is characteristic of this coarse-grained metamorphic rock, but schistosity and cleavage are underdeveloped. In other words, this is a metamorphic rock with a weak tendency to fracture along compositional layers, despite being formed of mineral grains that are visible to the naked eye and that form evident strata. The word has been used more broadly in Europe to describe any high-grade metamorphic rock that is coarse, mica-free, and igneous.

During microscopic observation at 10x ocular and 5x objective magnification, gneissic foliation and porphyroblastic textures were observed, with grain sizes ranging from <1/256 - 1 mm and poor sorting. The mineral composition consisted of 20% feldspar (E5), which displayed colorless absorption in PPL, low relief, no pleochroism, euhedral-anhedral crystal form, and 1-way cleavage. In XPL, the interference color was gray-white order 1 with parallel dark angles, and twinning included albit-kalsbad-kalsbad-albit-polysynthetic twinning. 35% of the minerals were quartz (A10) with colorless absorption in PPL, low relief, no pleochroism, anhedral crystal form, and no cleavage. In XPL, the interference color was order 1 gray-white with wavy dark corners and no twinning. There was 4% biotite (F6) with brown-greenish absorption in PPL, moderate relief, strong pleochroism, subhedral-euhedral crystal form, and 1-way cleavage. In XPL, the interference color was green-orange order 3 and parallel dark angles with no twinning. 39% of the composition was a base mass(C1), which varied from colorless-light gray-brown absorption in PPL, high relief. In XPL, the interference color varied from dark gray-black-brown and consisted of quartz microlite, feldspar microlite and biotite microlite, and 2% of the minerals were opaque (E1), displaying black absorption color in PPL, low relief, no pleochroism, euhedral-anhedral crystal form in XPL with interference color being black order 1 and no twinning. In Figure 4.7 shows plane and cross polarized view of gneiss in thin section.



Plane polarized (PPL) **Cross polarized (XPL)**

Figure 4.7: PPL and cross XPL view of gneiss thin section

c. Phyllite unit

The foliated metamorphic rock known as phyllite forms when slate undergoes additional metamorphism, resulting in the preferred orientation of very fine-grained white mica. Quartz, sericite mica, and chlorite are its main ingredients. Mica flakes in schist are huge and have developed a preferred orientation; in contrast, mica flakes in slate are incredibly fine and are found throughout the rock. It is intermediate in metamorphism between slate and schist and so belongs to the group of foliated metamorphic rocks.

Phyllite's protolith (or parent rock) is either shale, pelite, or slate. Unlike the slate minerals that make up its composition, the platy minerals that make up this rock are too small to be seen with the human eye. The term "phyllitic sheen" is used to describe the lustre of phyllites, and these rocks are typically categorised as having developed under low-grade metamorphic conditions due to regional metamorphism metamorphic facies. The fissility of phyllite is quite high (a tendency to split into sheets).

The typical range of phyllite hue is from nearly black to a very dark grey or even a very pale greenish grey. In most cases, the foliation will have a wavy or crinkled appearance. The most common use for phyllites are as decorative aggregates, interior decors, building stones, face stones, garden decorations, and curbing. It has a variety of practical applications in the marketplace, including as gravestones, commemorative tablets, canvas for painting, and slate for note taking and other forms of creative writing.

During microscopic observation at 10x ocular and 5x objective magnification, phylitic foliation and nematoblastic textures were observed, with grain sizes ranging from <1/256 - 1/16 mm and good sorting. The mineral composition consisted of 64% quartz (C1), which displayed colorless absorption in PPL, low relief, no pleochroism, anhedral crystal form, and no cleavage. In XPL, the interference color was order 1 gray-white with wavy dark corners and no twinning. 35% of the minerals were biotite (C5) with brown-greenish absorption in PPL, moderate relief, strong pleochroism, subhedral-euhedral crystal form, and 1-way cleavage. In XPL, the interference color was green-orange order 3 and no twinning parallel dark angles. Additionally, 1% of the minerals were opaque (C2), displaying black absorption color in PPL, low relief, no pleochroism, and euhedral-anhedral crystal form in XPL with interference color being black order 1 and no twinning. In Figure 4.8 shows plane and cross polarized view of phyllite thin section.

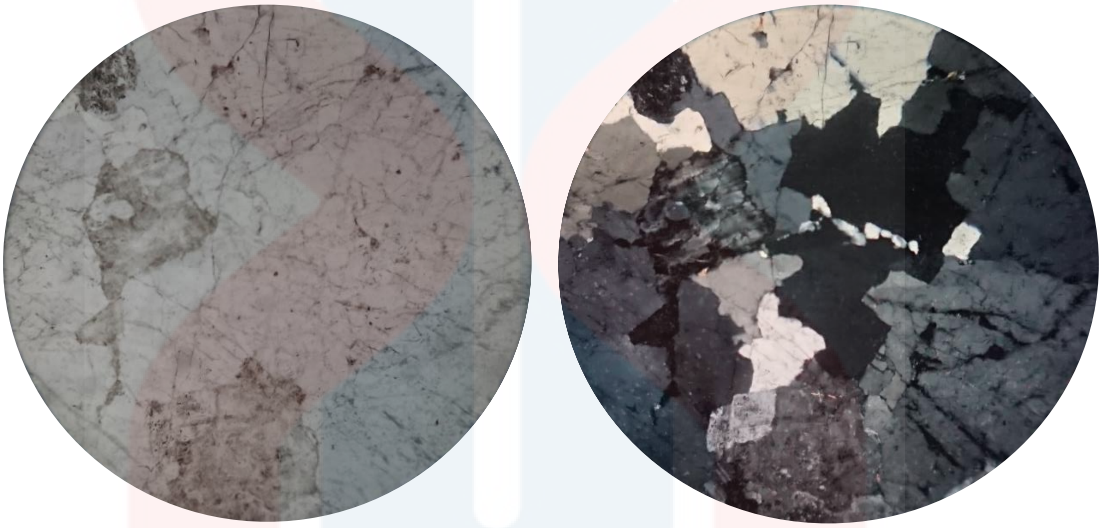
Plane polarized (PPL) **Cross polarized (XPL)**

Figure 4.8: PPL and XPL view of phyllite thin section

d. Quartzite unit

Quartzite is a type of hard, foliated metamorphic rock that was once composed entirely of quartz sand. Quartzite is formed when sandstone undergoes heating and pressure, typically associated with tectonic compression inside orogenic zones. Even while pure quartzite is often grey or white in colour, quartzites can also be found in a wide range of pink and red hues due to the presence of hematite. In contrast, other minerals produce hues like yellow, green, blue, and orange. Sandstones made entirely of quartz grains that have been extensively cemented with more quartz are also occasionally referred to as "quartzite," despite the fact that they have not undergone metamorphism. To differentiate it from metamorphic quartzite, which is sometimes named metaquartzite to underline its metamorphic origins, such sedimentary rock has come to be described as orthoquartzite. Quartzite produces ridges and impervious hilltops due to its extreme resistance to chemical weathering. Due to the lack of organic matter in the virtually pure silica content of the rock, the quartzite ridges are frequently barren or covered by only a very thin layer of soil and little (if any) plant. Some quartzites have just the right number of carbonates and chlorite and other weather-vulnerable nutrient-bearing minerals to create a loamy, moderately rich, albeit shallow and rocky soil.

During microscopic observation at 10x ocular and 5x objective magnification, non-foliated granulose structures and granoblastic textures were observed, with grain sizes larger than 2mm and poor sorting. The mineral composition was primarily composed of 88% quartz (J1), which displayed colorless absorption in PPL, low relief, no pleochroism, anhedral crystal form, and no cleavage. In XPL, the interference color was order 1 gray-white with wavy dark corners and no twinning. 12% of the minerals were feldspar (J6) which began to turn into sericite, it displayed colorless absorption in PPL, low relief, no pleochroism, euhedral-anhedral crystal form, 1 way cleavage and twinning in XPL were albit-kalsbad-kalsbad-albit-polysynthetic with gray-white interference color, dark angles are parallel. In Figure 4.9 shows plane and cross polarized view of quartzite thin section.



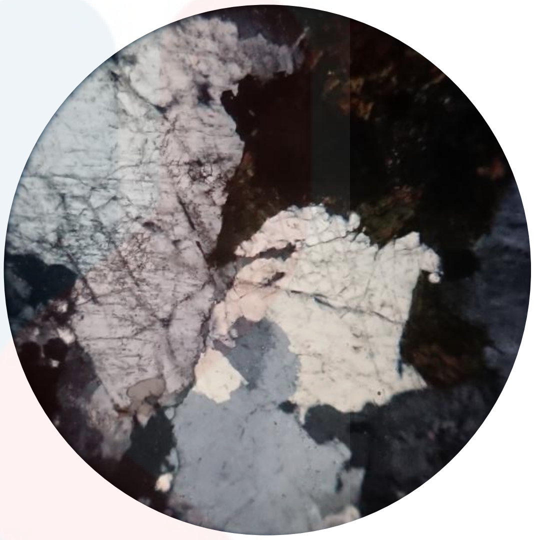
Plane polarized (PPL) **Cross polarized (XPL)**

Figure 4.9: PPL and XPL view of quartzite thin section

e. Acid intrusive

Alkali feldspar, a form of feldspar mineral commonly found in granitic rocks, can dissolve and change when exposed to acidic solutions. Acid attack or acid corrosion describes this phenomenon. Acid intrusions can cause alkali feldspar to disintegrate, allowing other minerals to take its place in granitic rocks. Minerals and elements held in feldspar can be released, altering the rock's texture, structure, and composition. In granitic rocks, the degree to which alkali feldspar is affected by acid intrusions depends on a number of variables, such as the acidity of the liquid, the length of the acid intrusion, and the existence of other minerals that may react with the acid. This can learned more about the geochemical processes that created granitic rocks by examining the connection between acid intrusions and alkali feldspar.

During microscopic observation at 10x ocular and 5x objective magnification, a massive structure and faneric texture were observed, with coarse-medium mineral sizes. The mineral composition consisted of 60% anorthoclase (A10), which displayed colorless absorption in PPL, low relief, no pleochroism, anhedral crystal form, and 1-way cleavage. In XPL, the interference color was gray-white order 1 with parallel-oblique dark angles, and polysynthetic twinning. 18% of the minerals were quartz (J5) with colorless absorption in PPL, low relief, no pleochroism, anhedral crystal form, and no cleavage. In XPL, the interference color was order 1 gray-white with wavy dark corners and no twinning. There was 20% biotite (H1) with brown-greenish absorption in PPL, moderate relief, strong pleochroism, subhedral-euhedral crystal form, and 1-way cleavage. In XPL, the interference color was green-orange order 3 and no twinning parallel dark angles. Additionally, 2% of the minerals were opaque (A6), displaying black absorption color in PPL, low relief, no pleochroism, and euhedral-anhedral crystal form in XPL with interference color being black order 1 and no twinning. In Figure 4.10 shows plane and cross polarized view of alkali feldspar granite thin section.



Plane polarized (PPL) **Cross polarized (XPL)**

Figure 4.10: PPL and XPL view of alkali feldspar granite thin section

4.4 Structural Geology

The field of study known as structural geology examines the three-dimensional organisation of rocks and minerals found within the crust of the earth. It investigates the processes by which rocks are deformed and the ways in which these processes have changed over time. In order to comprehend the forces that have built the earth's crust and to deduce the geologic history of an area, structural geologists employ a number of methods, such as field mapping, laboratory investigation, and computer modelling.

Tectonic pressures, erosion, and weathering are just few of the processes that structural geologists consider in their quest to comprehend the processes that have sculpted the Earth's crust over time. Their contributions are particularly useful in mineral exploration, natural resource management, and environmental preservation.

4.4.1 Lineament Analysis

The field of geology employs a method known as lineament analysis in order to investigate linear structures found either on the surface of the earth or in photographs of the earths subsurface. Lineaments are several forms of linear structures that can be found in rocks. Some examples of lineaments are fractures, faults, fault zones, joint sets, and others. There are several different geologic processes that can result in the formation of lineaments, such as tectonic activity, folding, and erosion. Analysis of lineaments entails locating, charting, and interpreting lineaments in order to comprehend the geologic importance of these features. Several methods, such as field mapping, aerial photography, and satellite imagery, can be utilised to accomplish this goal successfully. The majority of the pressure appears to originate in the north-western part of the study area has been covered. In Figure 4.11 shows lineament map of the study area at Lata Mawo Kampung Lawar Jeli Kelantan. Figure 4.12 shows rose diagram of the study area at Lata Mawo Kampung Lawar Jeli Kelantan.

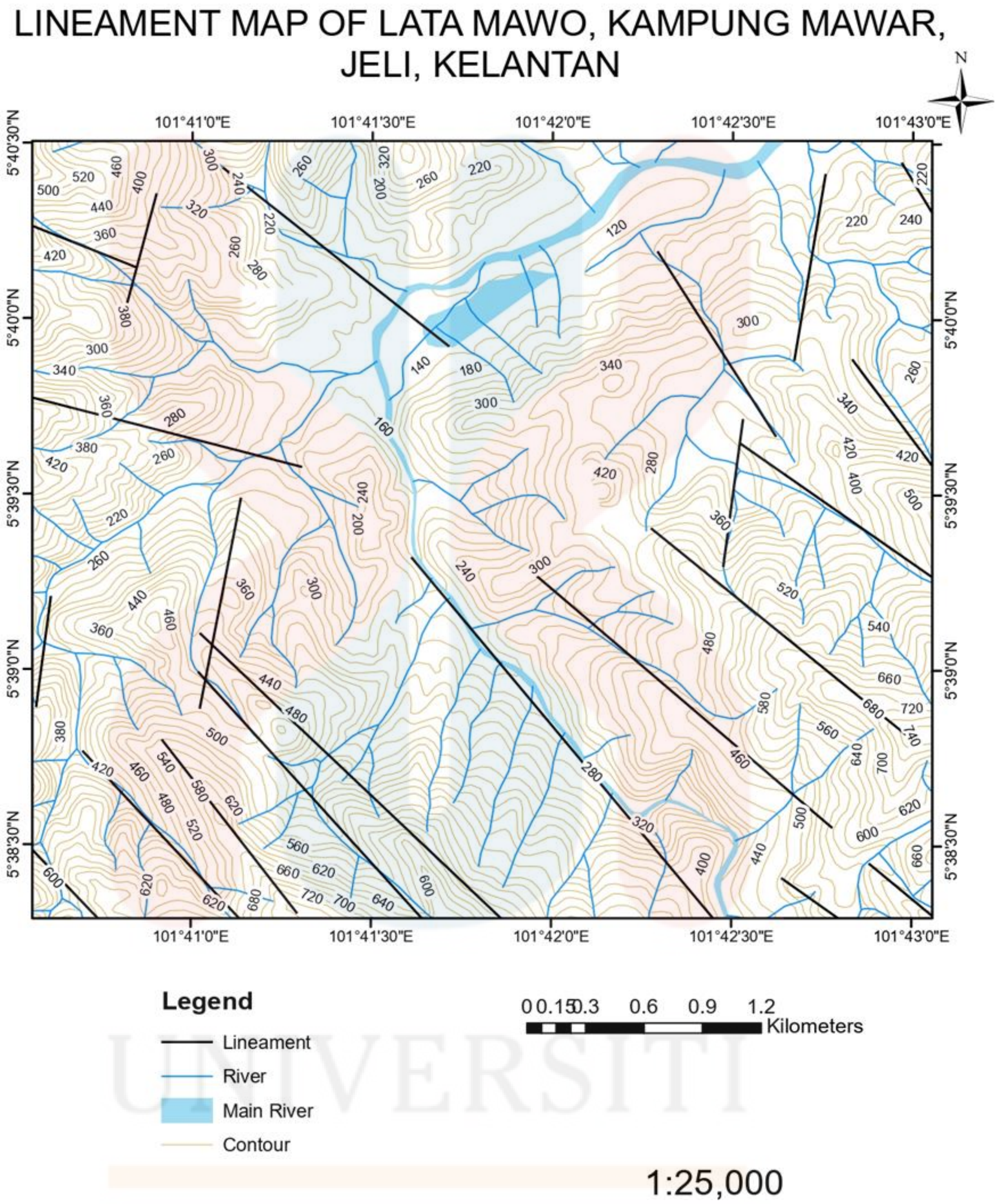


Figure 4.11: shows lineament map of the study area at Lata Mawo Kampung Lawar Jeli Kelantan

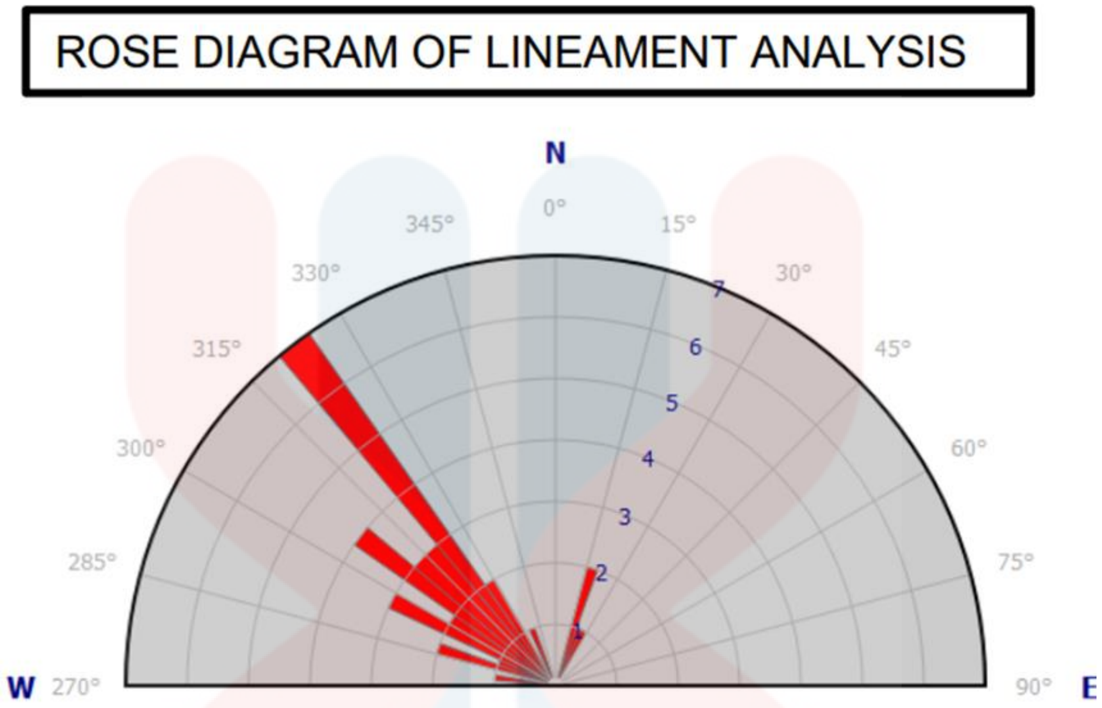


Figure 4.12: shows rose diagram of the study area at Lata Mawo

Kampung Lawar Jeli Kelantan

4.5 Historical Geology

The field of research known as historical geology examines the evolution of Earth and all of its inhabitants over time. Included in this category are investigations into the origin and development of life on Earth, as well as the causes and consequences of extinction. It's a multi-discipline approach to studying the Earth's history that draws from geology, palaeontology, and paleoclimatology. To piece together Earth's past, historical geology employs everything from field observations and others. Using these techniques, can piece together the Earth's geological past and learn about things like hillside, sedimentation basin development, and others. The study area shows the historical geology that we get know and more about the it that can be done the assessment of the area.

Since the Sibumasu Plate and the Indochina Plate collided and finished forming their boundary between the Upper Permian and Upper Triassic, the study region is in close proximity to this boundary, known as the Bentong - Raub Suture Zone. From the Cretacious through the Tertiary, the Gunung Rabong Formation has been the dominant historical geological feature of the investigated area. From the study area it can be found acid intrusives, as well as schist, gniess, phyllite, and quartzite. As for the study area it consists of the Rabong formation and acid intrusive that been dominate it at the site which and be observed and done some assessment.

Phyllites, schists, and gneisses are examples of metamorphic rocks with considerable foliation that are formed as a result of regional metamorphism. Large areas are undergoing this metamorphism because they were subjected to substantial deformation and differential stress as a result of tectonic processes. Tectonic activity may be shown by the orientations of the preponderant local structures in the Jeli district, which run mostly in the northwest-southeast and northeast-southwest directions. The presence of gneiss bodies in the study area gives support to this towards this assessment of the study area at Lata Mawo Kampung Lawar Jeli Kelantan.

CHAPTER 5

GEOHERITAGE ASSESSMENT OF LATA MAWO KAMPUNG LAWAR, JELI, KELANTAN

5.1 Introduction

The assessment of study area which is Lata Mawo in Kampung Lawar Jeli, Kelantan, was the primary topic of discussion in this section. Rocks, landforms, and geomorphological characteristics indication of previous geological events made up the bulk of the studied area's geoheritage resources. Essentially, elements of geodiversity contribute to the value of geoheritage. The historical significance of the research site has been assessed by analysing relevant geosites. To evaluate the study area, this been relied on Lata Mawo's geoheritage assessment of it.

5.2 Assessment of Lata Mawo based on Modified Geosite Assessment Model (M-GAM) method

The assessment of Lata Mawo includes around 50 respondents in the survey through the google form. The assessment of questionnaire related to the M-GAM aspect which they need to be assess based on their own knowledge about study area at Lata Mawo Kampung Lawar Jeli Kelantan. This survey was based on their own knowledge where the data been interpreted and analysed.

Roughly fifty people were surveyed and asked to rate the significance of each of the subindicators on a scale from strongly disagree (0.00) to strongly agree (1.00). The mean values for each sub-indicator were then assessed. In the first section of the questionnaire, basic demographic information is gathered, including respondents' gender, age, education level, and knowledge in geology. Questionnaire section two until six focused on weighting relative significance of M-GAM model indicators and sub-indicators. The graphic displays the summarized percentage responses received from the survey of the google form that been given to the respondents.

The Modified Geosite Assessment Model (M-GAM) consists of two parts: the main values and the additional values, which are all split into a variety of indicators, the values of which range from 0.00 (strongly disagree) to 1.00 (strongly agree). The main values come from its naturally occurring characteristics, while the secondary values are largely the result of human involvement and are flexible to meet the needs of different perspective from the survey that been done based on the respondent's knowledge. This survey related the people whom have background about geology or non-geology.

$$GAM\ M= +\ V\ AV$$

where MV and AV represent symbols for Main and Additional Values. Since Main and Additional Values consist of three or two groups of subindicators, can derive these two equations:

$$MV = +\ VSE\ VSA+VPr$$

$$AV = +\ VFn\ VTr$$

Know that each group of indicators consists of several subindicators, equations (2) and (3) can be written as follows:

MV=VSE+VSA+VPr = ∑SIMV, where 0 ≤SIMV≤ 1

AV=VFn +VTr ∑SIAV, where 0 ≤SIAV ≤1

This is done for each subindicator in the model after which the values are added up

according to M-GAM equation but this time with more objective and accurate final results due to the addition of the importance factor (Im). This parameter is determined by visitors who rate it in the same way as experts rate the subindicators for Main and Additional Values by giving them one of the following numerical values: 0.00, 0.25, 0.50, 0.75 and 1.00, marked as points. The importance factor (Im) is defined, as:

$$Im = \frac{\sum_{k-1}^{K} Iv_k}{K}$$

Where the assessment/score of one visitor for each subindicator and K is the total number of visitors. The Im parameter can have any value in the range from 0.00 to 1.00. Finally, the modified GAM equation is defined and presented in the following form:

$$M - GAM = MV + AV$$

$$MV = \sum_{i=1}^{n} Im_i \cdot MV_i$$

$$AV = \sum_{i=1}^{n} Im_j \cdot AV_j$$

5.2.1 Main value

There are three basic types of values which are educational and scientific (VSE), scenic as well as aesthetic (VSA), and protection (VPr). As for the VSE is it considered based on a few factors like how uncommon they are, how well they're represented, how well one understands about geology, and how much room there is for interpretation. This all includes of the rarity, representatives and other aspects that been assessed. Viewpoints, surface, surrounding landscape and others are components that make up VSA. As for VPr value, it considered related to condition of the study area, the kind of protection provided, the degree of susceptibility, and the relevance of the visitor amount towards the Lata Mawo.

5.2.1.1 Scientific/Educational Values (VSE)

As for Scientific/Educational (VSE) a value between 0 and 1 was assigned to each variable. Table 5.1 shows the values assigned to each category, including those who have a geology background and those who do not. Firstly, rarity been assessed which from the geology background consider to have 0.7 and 0.65 for non-geology background. Next, for representative value that given by the people whom have geology background around 0.76 but non-geology was 0.68. Next, value knowledge on issue from geology background is 0.74 and non-geology around 0.7. Also, as for the level interpretation value considered by geology background is 0.78 and non-geology around 0.7. Having a geology background is generally more valuable in the scientific and educational fields than not having one. 75 percent of those with a geology background filled out the survey, but only 69 percent of those without a geology background did so.

5.2.1.2 Scenic/Aesthetic Values (VSA)

Regarding the viewpoints, people whom have geological background have value around 0.82 but as for non-geology the value a bit lower around 0.65. Next, for the surface consists around 0.74 (geology background) meanwhile 0.65 (non-geology). The surrounding and landscape consist about 0.86 (geology background) and 0.75 (non-geology background). As for the environmental fitting of sites considered about 0.82 (geology background) and 0.71 (non-geology background). This value been assessed by their own knowledge as been divided into two group either geology background and not have. In the scenic/aesthetic value those with a geology background are typically more looked after than those without. Those with a geology background were more likely to complete out the survey (at 81%) than those without (at 69%).

5.2.1.3 Protection value (VPr)

Protection value (VPr) typically consists of sub indicators of the current situation, protection level, vulnerability, and an appropriate number of visits. As for the value current condition it have the same number which around 0.74 given from both whom have geology background and non-geology. Next, as for value from protection level it consists around 0.78 given by geology background and slightly difference which is 0.74 from non-geology background. Meanwhile as the vulnerability it includes value of 0.77 given by people have geology background and 0.70 for non-geology. Also, suitable numbers of visitors been value about 0.76 (geology background) and 0.75 (non -geology background). The experts with a geology background were more likely to complete the survey on the protection value of geological sites, with a completion rate of 77%, compared to those without a geology background, who had a completion rate of 73%.

5.2.2 Additional Values

The additional values evaluated in the survey included the functional value (VFn) and touristic values (VTr). The functional value was assessed based on six elements, including accessibility, additional natural values, additional anthropogenic values, vicinity of emissive centers, vicinity of important road networks, and additional functional values. The touristic value was evaluated based on nine elements, including promotion, annual number of organized visits, vicinity of visitor centers, interpretive panels, number of visitors, tourism infrastructure, tour guide services, hostelry services, and restaurant services.

5.2.2.1 Functional Values (VFn)

As for the functional values are made up of various components, including accessibility, additional natural values, additional anthropogenic values, proximity to emissive centers, proximity to major road networks, and other functional values. As for the accessibility it consists around 0.82 given by people have geology background and 0.73 for non-geology. Next, people with a background in geology gave value for additional natural values at 0.82, while tourists which people whom without a geology background value it at around 0.66. Meanwhile, as the additional anthropogenic it includes value of 0.75 given by people have geology background and 0.69 for non-geology. Also, for vicinity of emissive centers been value about 0.76 (geology background) and 0.64 (non -geology background). Besides that, as for vicinity of important road network been value by people have geology background around 0.75 and 0.71 from non-geology background. Lastly, as for additional functional value people from that have geology background given around 0.74 and 0.73 by non-geology background. The experts with a geology background were more likely to complete the survey on the functional value of geological sites, with a completion rate of 77%, compared to those without a geology background, who had a completion rate of 69%.

5.2.2.2 Touristic Value (VTr)

As for the touristic, functional value (VTR) also been assessed through indicators related to tourism, such as the promotion of the location, the availability of organized tours, the proximity of visitor centers, interpretive panels, the number of visitors, the tourism infrastructure, tour guide services, and accommodations (hostelry) as well. As for the promotion it has the same value which is 0.75 that been given by geology background and not from have geology background. Next, for organized visits it also consists the same value which around 0.73 for both groups. Also, the vicinity of visitor's centre which value given from geology background is a bit lower around 0.73 compared not have geology background around 0.75. The value assigned to interpretive panels by individuals with a geology background is slightly lower than that assigned by tourists, with values of 0.72 and 0.75, respectively. As for the numbers of visitors the value given by geology background is around 0.72 and slightly different which is 0.73 for not from the geology background. The tourism infrastructure given value around 0.73 (geology background) and 0.76 (not from geology background). The value assigned to tour guide services by experts is much lower than that assigned by tourists, with values of 0.73 and 0.66, respectively. Meanwhile, hostelry service been given value by geology background around 0.73 and 0.68 for not in the geology background. Lastly, for restaurant service been given value around 0.73 (geology background) and 0.66 (not have geology background). Table 5.1 shows the scores assigned to different parts of a model called GAM by experts in the field of geology and by people who do not have a background in geology. The scores were given based on the opinions of the experts and visitors. Table 5.2 presents the results of an assessment of geomorphological site using the M-GAM method, which utilizes the expertise of individuals with a background in geology. Table 5.3, on the other hand, presents the results of an assessment of the same site using M-GAM, but based on input and evaluations from tourists who do not have a background in geology.

Table 5.1.: The values assigned to each sub-indicator in the M-GAM model by 50 respondents from geology background and non-geology background.

	Values given by geology background (0–1)	**(Non-geology background) (0-1)**
Main values (MV)		
Scientific/educational value (VSE)		
Rarity	0.70	0.65
Representativeness	0.76	0.68
Knowledge on geoscientific issues	0.74	0.70
Level of interpretation	0.78	0.70
Total	**2.98**	**2.73**
Total Percentage (%)	**75%**	**68%**
Scenic/aesthetic (VSA)		
Viewpoints	0.82	0.65
Surface	0.74	0.65
Surrounding landscape and nature	0.86	0.75
Environmental fitting of sites	0.82	0.71
Total	**3.24**	**2.76**
Total Percentage (%)	**81%**	**69%**
Protection (VPr)		
Current condition	0.74	0.74
Protection level	0.78	0.74
Vulnerability	0.77	0.70
Suitable number of visitors	0.76	0.75
Total	**3.05**	**2.93**
Total Percentage (%)	**76%**	**73%**

	Values given by geology background (0–1)	(Non-geology background) (0-1)
Additional values (AVs)		
Functional values (VFns)		
Accessibility	0.82	0.73
Additional natural values	0.82	0.66
Additional anthropogenic values	0.75	0.69
Vicinity of emissive centers	0.76	0.64
Vicinity of important road network	0.75	0.71
Additional functional values	0.74	0.73
Total	**4.64**	**4.16**
Total Percentage (%)	**77%**	**69%**
Touristic values (VTr)		
Promotion	0.75	0.75
Organized visits	0.73	0.73
Vicinity of visitor's centers	0.73	0.75
Interpretative panels	0.72	0.75
Number of visitors	0.72	0.73
Tourism infrastructure	0.73	0.76
Tour guide service	0.73	0.66
Hostelry services	0.73	0.68
Restaurant service	0.73	0.66
Total	**6.57**	**6.41**
Total Percentage (%)	**75%**	**71%**

Table 5.2: Overall geomorphological site has been assessed by M-GAM, which is a method that relies on expert knowledge which have geology background

Main values (MV)				
Geosites	Scientific/educational value (VSE)	Scenic/aesthetic (VSA)	Protection (VPR)	Total Percentage (%)
Lata Mawo	75 %	81 %	76 %	77
Additional Values (AV)				
Lata Mawo	Functional values (VFns)		Touristic values (VTr)	Total Percentage (%)
	77 %		75 %	76

Table 5.3: Overall geomorphological site has been assessed by M-GAM, using input and evaluations provided by tourists from non-geology background.

Main values (MV)				
Geosites	Scientific/educational value (VSE)	Scenic/aesthetic (VSA)	Protection (VPR)	Total Percentage (%)
Lata Mawo	68 %	69 %	73 %	70
Additional Values (AV)				
Lata Mawo	Functional values (VFns)		Touristic values (VTr)	Total Percentage (%)
	69 %		71 %	70

5.3 Discussion of Geoheritage Value

Table 5.2 and Table 5.3 reveal that individuals with a background in geology possess the highest percentage of main value, at 77%. Those without a geology background have a lower percentage of main value at 70%. Additionally, individuals with knowledge in geology have a higher percentage of additional value at 76%, compared to those without a geology background, who have a percentage of 70%.

The main value percentage of 77% among individuals with a background in geology is considered to be the highest because of their high scores in several categories related to the geology of the study area. These categories include scientific/educational value, scenic/aesthetic value, and protection value. Scientific/educational value pertains to the educational or research potential of the geologic features in the area. Scenic/aesthetic value refers to the visual appeal and beauty of the area's geology. Protection value pertains to the preservation and conservation of the area's geologic features.

Individuals with knowledge in geology scored 75% in these categories, while those without geology background scored 68%. This difference in scores is likely due to a lack of knowledge or awareness of the geology of the study area among tourists without a geology background. Tourists without geology background may not have the same level of appreciation or understanding of the scientific and aesthetic value of the area's geologic features. They may also not be aware of the importance of protecting and preserving the area's geology. In contrast, individuals with a background in geology are more likely to be aware of and appreciate the scientific, aesthetic, and protection value of the area's geologic features, which leads to a higher score on the main value.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In conclusion, the first objective of this project was to update the geological map of Lata Mawo, Kampung Lawar Jeli at a scale of 1:25,000. The second objective was to assess the geodiversity value of the study area for geoheritage assessment. These objectives were successfully achieved through the methods and techniques applied in the project. The updated geological map and assessment of geodiversity value will be valuable resources for further study and understanding of the geology and geohistory of the Lata Mawo, Kampung Lawar Jeli area. A survey was conducted to assess the geological feature known at Lata Mawo using a model called Modified Geosite Assessment Model (M-GAM). The survey participants were divided into two groups: those with a background in geology and those without a background in geology.

The results of the analysis from the assessment suggest that the study area has significant potential for tourism due to its scenic/aesthetic value. The M-GAM model was used to evaluate the geosite at Lata Mawo in Kampung Lawar Jeli Kelantan, revealing the benefits and drawbacks of this location. Overall, it can be concluded that the study area has strong potential for aesthetic value of its beautiful landscape, view and others that can attract more tourist towards that area based on the assessment that been done of the study area. While individuals without a geology background may not possess the same level of knowledge and understanding of the scientific and educational value of the study area's geologic features, they are still able to appreciate the visual beauty and scenic views of the area. This is reflected in the data, with a lower percentage of 68% in the scientific/educational value category for those without a geology background, but a higher percentage in the scenic/aesthetic value category. This illustrates that even without a background in geology, they can still appreciate the natural beauty of the area, and it is not necessary to have a geology background to understand the aesthetic value of the area.

6.2 Recommendation

The results of this study indicate that there are certain aspects that could be improved or revised in order to increase the accuracy and trustworthiness of the findings. It is suggested that these modifications be made in order to enhance the overall thoroughness and excellence of the research. One area that requires particular attention is the functional value, which received among lowest score. To address this issue, it is recommended that steps be taken to improve accessibility to Lata Mawo, such as by creating more convenient access points through the development of roads and walkways. This would make it easier for visitors to reach the site and could potentially increase the functional value of the area.

One of the key areas to be concern in the study area is the lack of modern facilities, which require immediate attention. In order to attract more visitors to Lata Mawo, it is crucial to enhance the provision of modern facilities and improve their cleaning and maintenance. Another pressing issue that needs to be addressed is the poor condition of the road network leading to the study area. These roads are currently in a poor state and pose a significant risk to the safety and well-being of individuals traveling to the area. Therefore, it is imperative that action is taken to improve the roads as soon as possible to ensure the safety of all those visiting the Lata Mawo.

From a functional perspective, Lata Mawo must take steps to increase its capacity for parking and other necessities. By expanding the availability of parking lots and other facilities, it would make it much more convenient for tourists to access the area and park their vehicles with ease. This will not only increase the convenience for visitors but also helps to increase the overall tourism traffic which in the long run would bring more revenue to the Lata Mawo. Additionally, it helps to ensure the safety of the vehicles and allows visitors to fully enjoy their time in the area without having to worry about where to park their vehicle.

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APPENDIX A

GEOLOGY AND GEOHERITAGE ASSESSMENT OF LATA MAWO, KAMPUNG LAWAR, JELI, KELANTAN

Dear respondents, assalamualaikum and greeting to all, this is for a final year student's survey from Faculty of Earth Science (FSB), Universiti Malaysia Kelantan (UMK) pursuing Degree in Bachelor of Applied Science (Geoscience) with Honors. I'm currently conducting a research survey entitled Geology and Geoheritage Assessment of Lata Mawo, Kampung Lawar, Jeli Kelantan.

This questionnaire would take a few minutes to complete answering all the questions. There is no right or wrong answers to this survey based on your own knowledge. All your information is confidential and will not be disseminated or shared with other parties. For any further information about this research, please contact me at 013-9276925. Your cooperation is truly appreciated.

Section 1 of 7

1. Gender

☐ Male

☐ Female

2. Name

3. Age

☐ 17-21

☐ 22-25

☐ 26-29

☐30 and above

4. Education Level

☐School

☐Diploma

☐Degree and above

1. Do you have any background about geology

☐No

☐Yes

Section 2 of 7

Scientific/educational value (VSE)

1. Rarity-Number of closest identical sites.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

2. Representativeness- Site has educative and illustrative qualities.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

3. Knowledge on geoscientific issues- Number of written papers in acknowledged journals, thesis, presentations, and other publications.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

4. Level of interpretation-Level of interpretive possibilities on geological and geomorphologic processes, phenomena and shapes and level of scientific knowledge.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

Section 3 of 7

Scenic/aesthetic (VSA)

5. Viewpoints - Walkable viewpoints for people of the site's area

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

6. Surface- Whole surface of the site. Each site is considered in quantitative relation to other sites.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

7. Surrounding landscape and nature - Panoramic view quality, presence of water and vegetation, absence of human-induced deterioration, vicinity of urban area, etc.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

8. Environmental fitting of sites-Level of contrast to the nature, contrast of colors, appearance of shapes, etc.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

Section 4 of 7

Protection (VPr)

9. Current condition - Current state of the situation that going at site.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

10. Protection level - Protection by local or regional groups, national government, international organizations, etc.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

11. Vulnerability - A measure of a geosite's exposure to invasion

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

12. Suitable number of visitors - Proposed number of visitors on the site at the same time, according to the surface area, vulnerability, and current state of geosite.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

Section 5 of 7

Additional Values (AVs)

13. Accessibility-Possibilities of approaching to the site.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

14. Additional natural values -Number of additional natural values in the radius of 5 km (geosites also included).

Strongly disagree ○○○○○ Strongly agree

15. Additional anthropogenic values - Number of additional anthropogenic values in the radius of 5 km at Lata Mawo (Anthropogenic is human made example greenhouse gasses)

Strongly disagree ○○○○○ Strongly agree

16. Vicinity of emissive centers - features modern facility management of Lata Mawo

Strongly disagree ○○○○○ Strongly agree

17. Vicinity of important road network - Lata Mawo near important road networks in the radius of 20 km

Strongly disagree ○○○○○ Strongly agree

18. Additional functional values - Lata Mawo has parking lots, mechanics, etc.

Strongly disagree ○○○○○ Strongly agree

Section 6 of 7

Touristic values (VTr)

19. Promotion -. Lata Mawo have level and number of promotional resources

Strongly disagree ○○○○○ Strongly agree

20. Organized visits -Annual number of organized visits to the Lata Mawo.

Strongly disagree ○○○○○ Strongly agree

21. Vicinity of visitor's centers - Have sufficient amount information of Lata Mawo like maps that related to tourism

Strongly disagree ○○○○○ Strongly agree

22. Interpretative panels - Interpretative characteristics of text and graphics, material quality, size, fitting to surroundings, etc.

Strongly disagree ○○○○○ Strongly agree

23. Number of visitors – Lata Mawo has a lot number of visitors.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

24. Tourism infrastructure - Lata Mawo consists new facilities (huts, trash bin, restrooms, etc) for visitors

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

25. Tour guide service - If exists, expertise level, knowledge of foreign language(s), interpretative skills, etc.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

26. Hostelry service - Hostelry service close to geosite.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

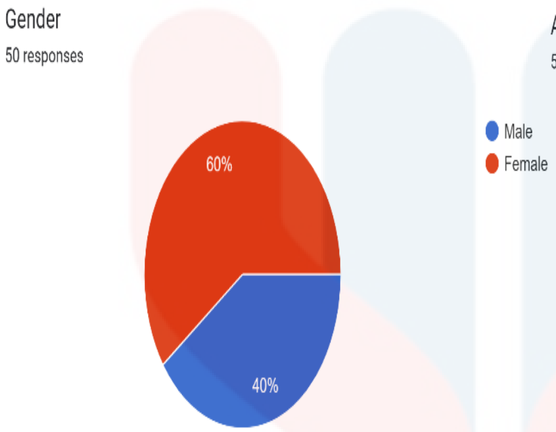
27. Restaurant service - Restaurant service close to geosite.

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

End section 7 of 7

APPENDIX B

i)



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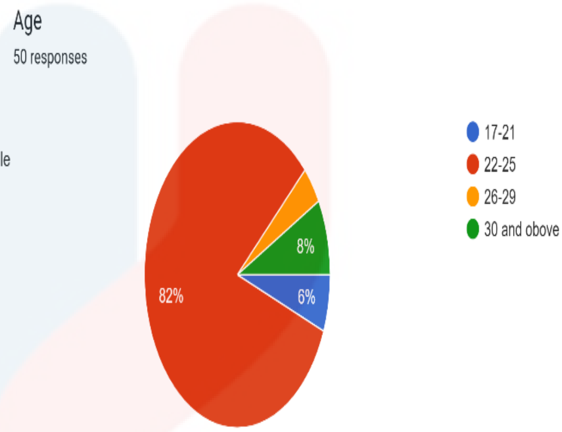

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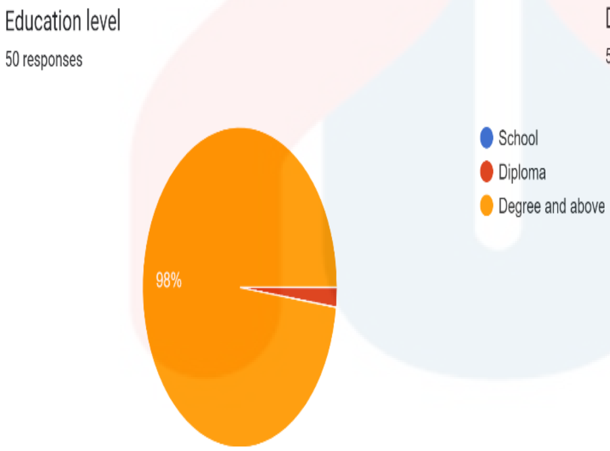

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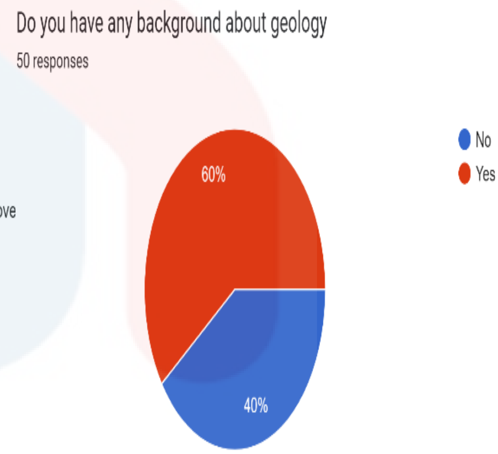
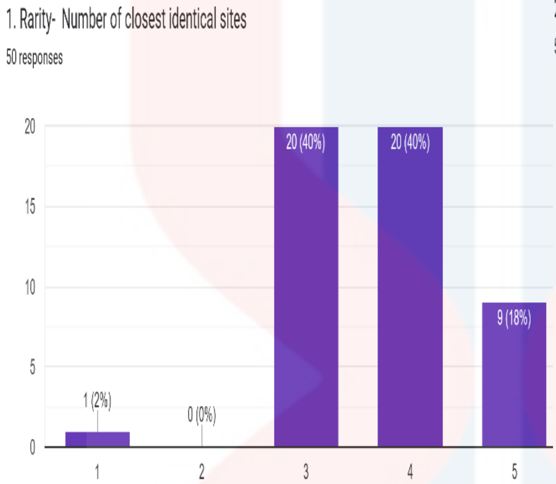


Main value (MV)

Scientific/educational value (VSE)

v)



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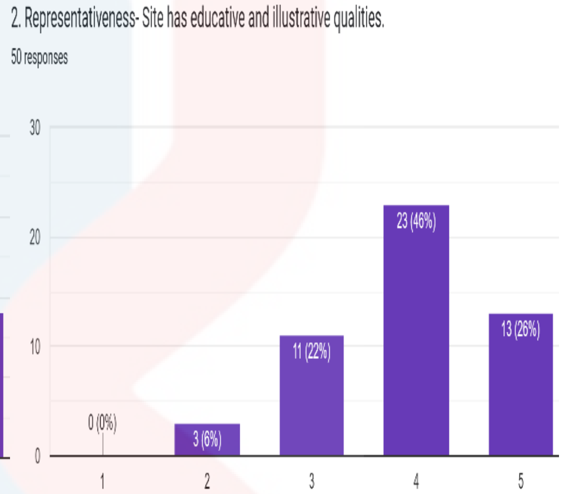

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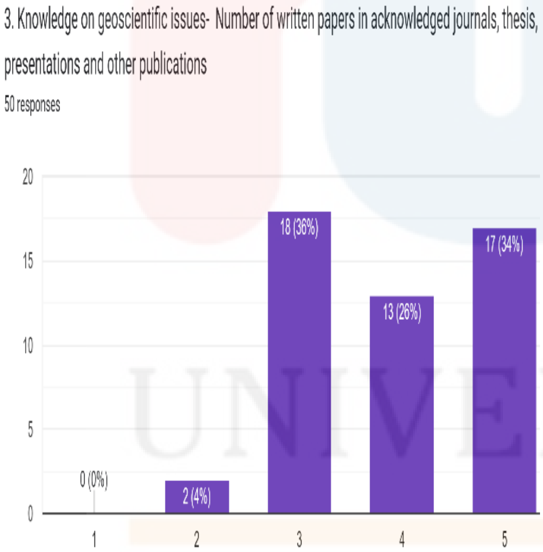

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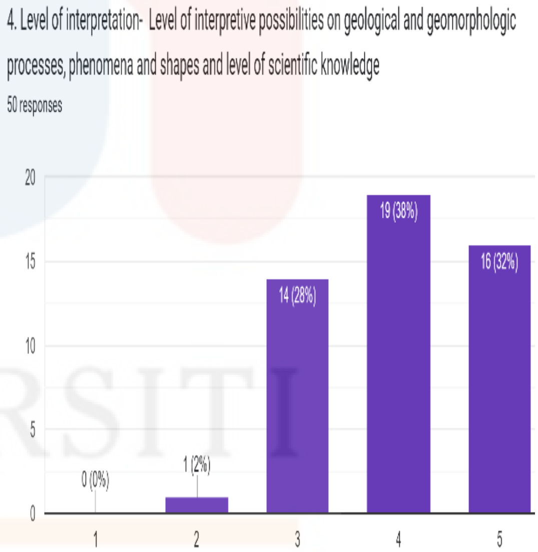
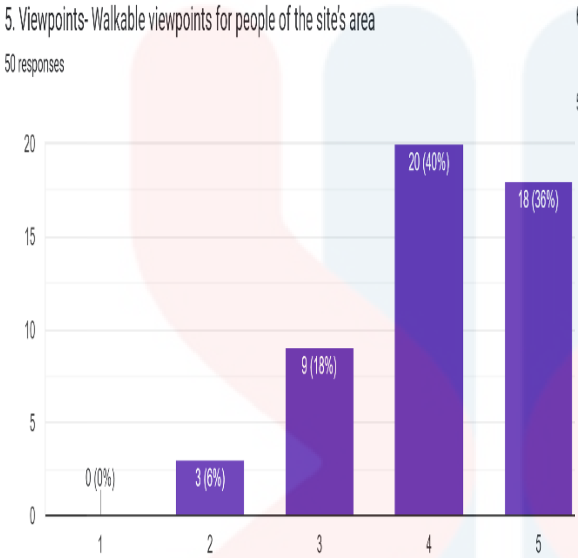
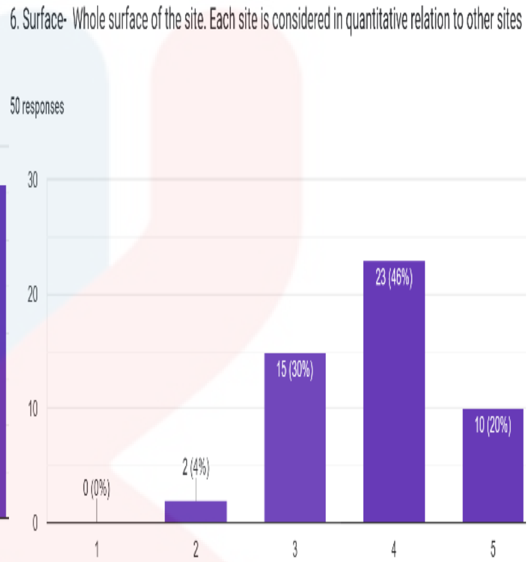


Scenic/aesthetic value (VSA)

ix)



x)



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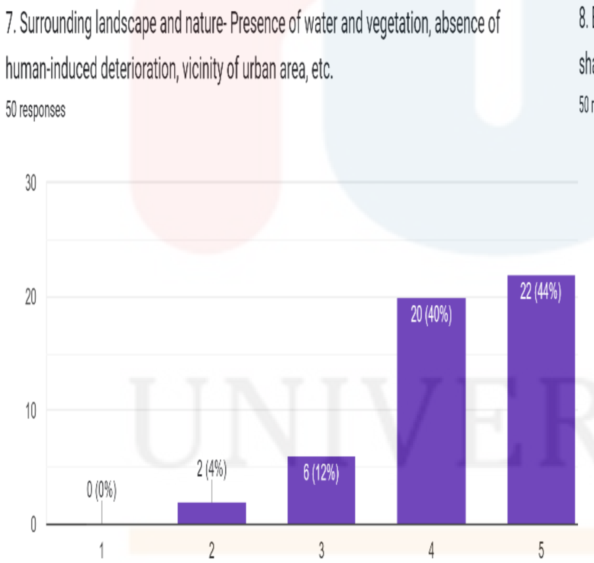

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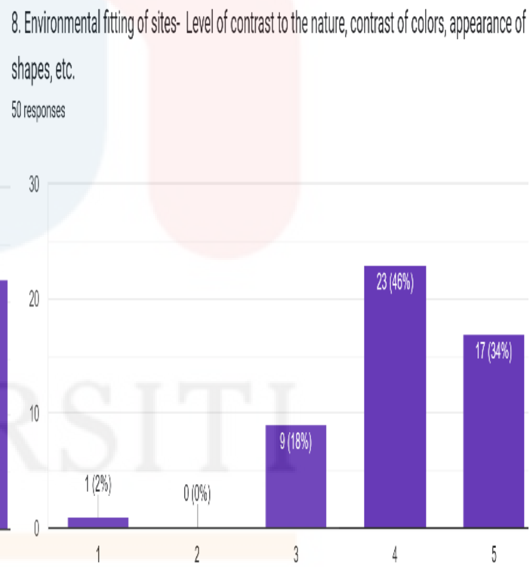
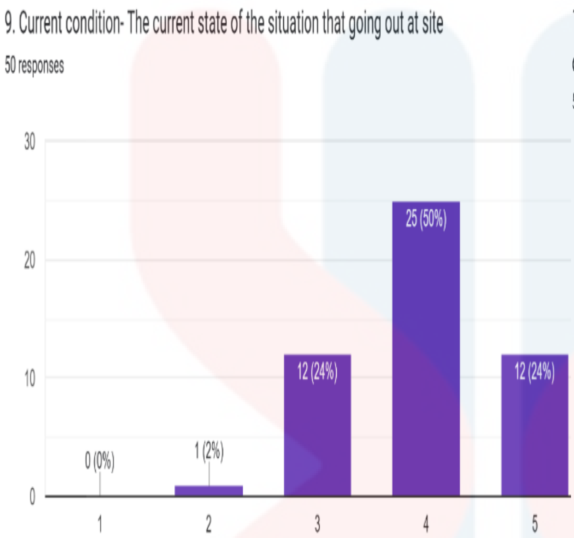


Protection (VPr)

xiii)



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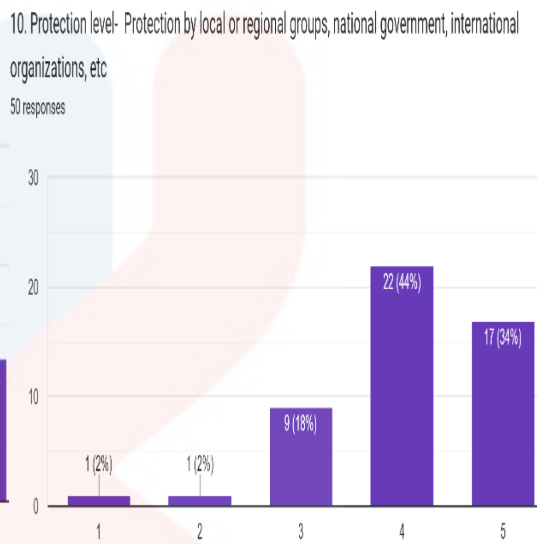

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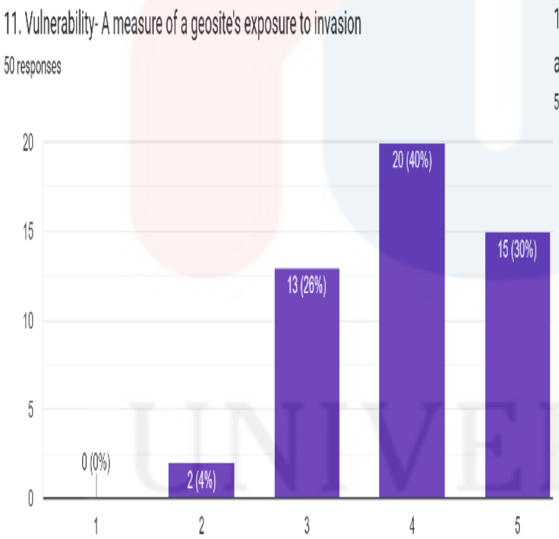

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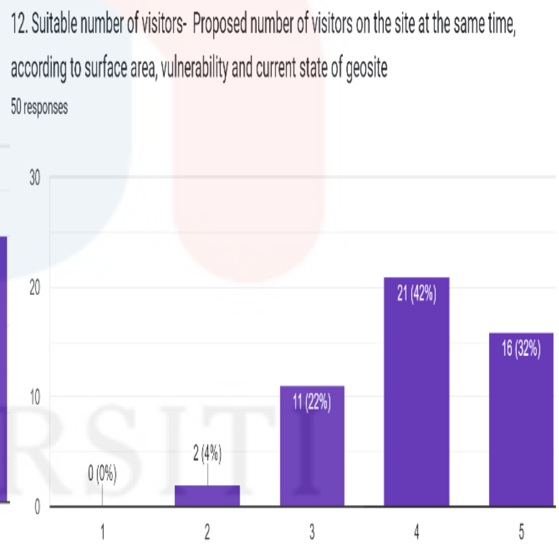
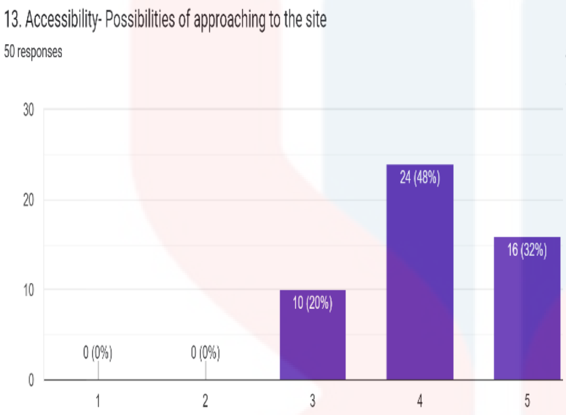


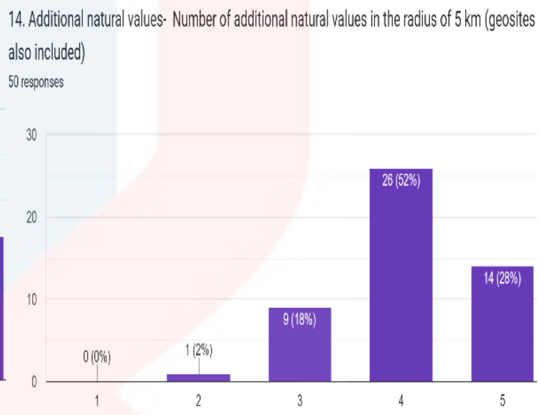
Additional Value (AVs)

Functional Value (VFns)

xvii)



xviii)



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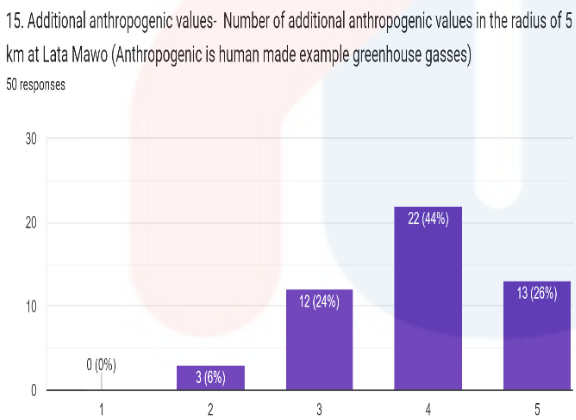

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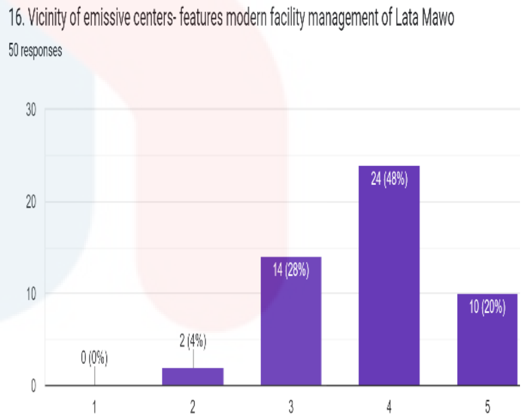

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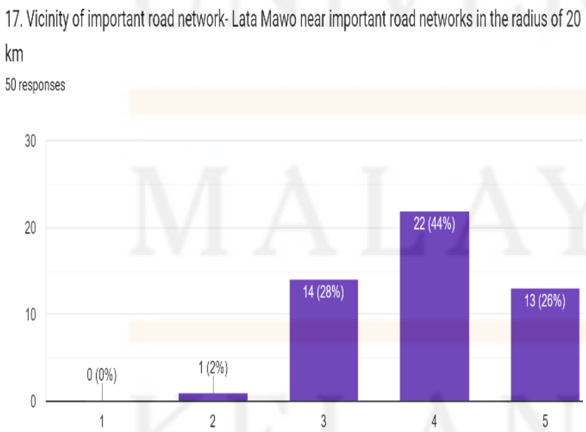

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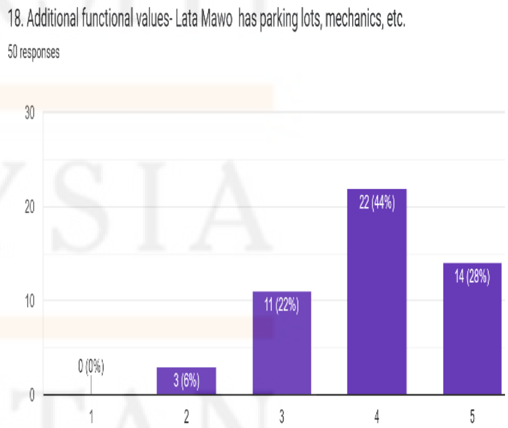
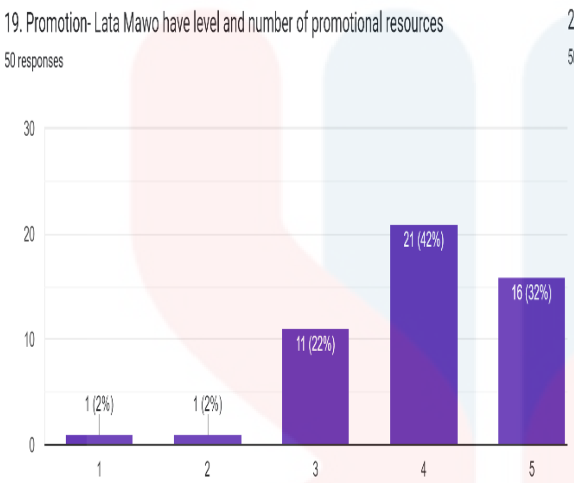


Touristic value (VTr)

xxiii)



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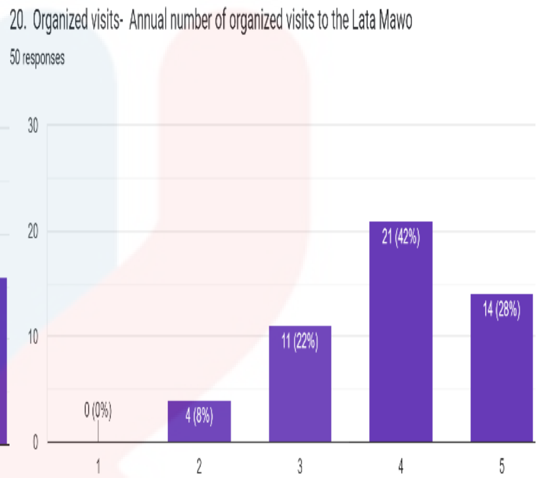

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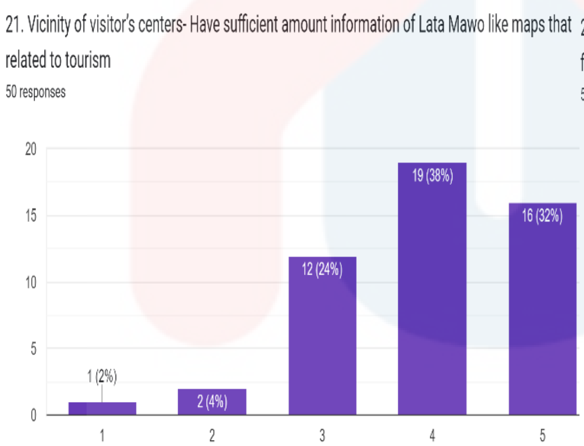

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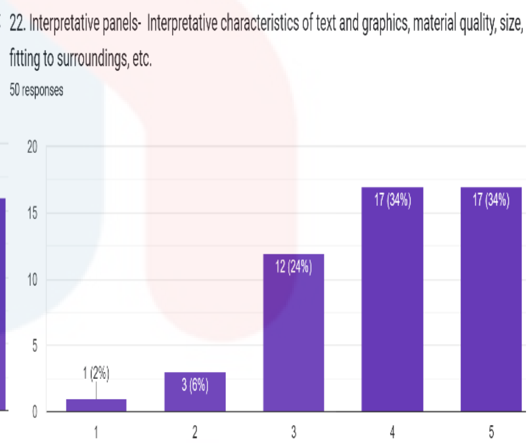

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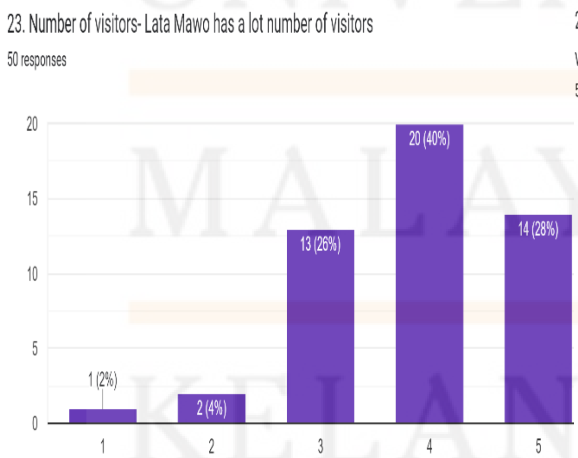

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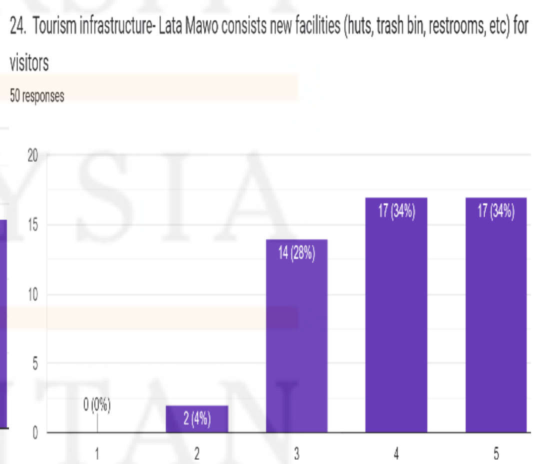
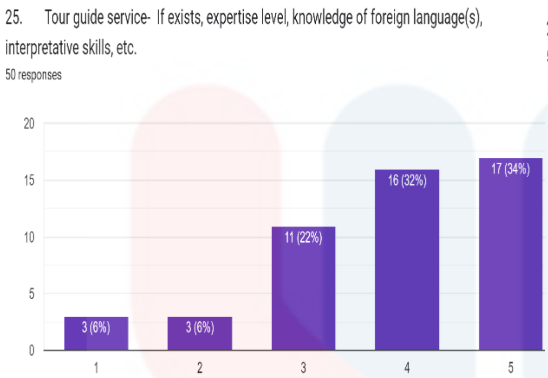
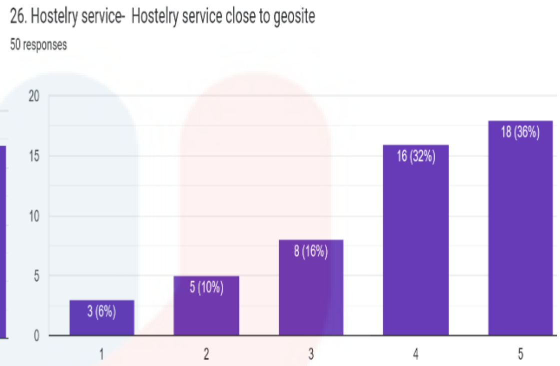


xx)



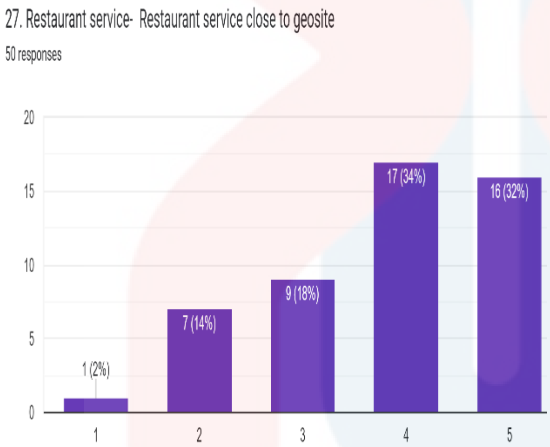
25. Tour guide service- If exists, expertise level, knowledge of foreign language(s), interpretative skills, etc.
50 responses
20
15
10
5
0
3 (6%)
3 (6%)
11 (22%)
16 (32%)
17 (34%)
1
2
3
4
5

xxi)



26. Hostelry service- Hostelry service close to geosite
50 responses
20
15
10
5
0
3 (6%)
5 (10%)
8 (16%)
16 (32%)
18 (36%)
1
2
3
4
5

xxii)



27. Restaurant service- Restaurant service close to geosite
50 responses
20
15
10
5
0
1 (2%)
7 (14%)
9 (18%)
17 (34%)
16 (32%)
1
2
3
4
5