



**GEOLOGY AND GEOTOURISM POTENTIAL OF
LATA HOKKAIDO, LATA JANGGUT, LATA
BOBBY AND MARINA WATERFALL, JELI,
KELANTAN**

by

SITI NUR ADILA BINTI YAZIZUL RAHMAN

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

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2023

DECLARATION

I declare that this thesis entitled “GEOLOGY AND GEOTOURISM POTENTIAL OF LATA HOKKAIDO, LATA JANGGUT, LATA BOBBY AND MARINA WATERFALL, 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.

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APPROVAL

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

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**GEOLOGY AND GEOTOURISM POTENTIAL OF LATA HOKKAIDO,
LATA JANGGUT, LATA BOBBY AND MARINA WATERFALL, JELI,
KELANTAN**

ABSTRACT

Kampung Lata Janggut possesses numerous geological features with geoheritage values within its surrounding area. The study area is situated 5° 39' 49.68" N, 101° 45' 51.48" E, in Jeli District, Kelantan with 5km × 5km amidst the rubber plantation and heavy forest. Geomorphologically, the study area is surrounded by hilly and plain landscapes. The research focusing on the general geology and geotourism potential of Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby. The aim of this study is to produce a detail geological map and to identify the geoheritage elements for geotourism potential development. This study area is a part of the Stong Complex, subunit of Noring Granite. The lithology of the study area is composed of different kind granitic rock (intrusive rocks). Stong Complex Formation consists of granite, pink megacryst biotite granite, alkali feldspar granite and biotite granite with medium to coarse grained in grey to pink colour. These granitic rocks are a part of Terang facies due to the presence of biotite mafic in mineral composition. Whereas Mangga Formation consists of metamorphic rocks, gneiss and schist. Assessment for potential geotourism sites; qualitative and quantitative approach has been assessed at Lata Hokkaido, Lata Janggut, Lata Bobby and Marina Waterfall based on geodiversity/geoheritage value including scientific (educational), aesthetic, recreational, economic and functional, with the local to state level of significance. As for questionnaire survey, majority respondents agreed these sites is suitable for tourism and recreational activities next indicated these sites has diverse geoheritage assets and geoheritage resources that suitable for geotourism destination. Recommendation is suggested that research and scientific projects should always be done in the study area in order to assist in development of geotourism and raise awareness of geoheritage values among local community, students and official authorities participation next inspiring these geosites to be a part of Stong Geopark.

GEOLOGY AND GEOTOURISM POTENTIAL OF LATA HOKKAIDO, LATA JANGGUT, LATA BOBBY AND MARINA WATERFALL, JELI, KELANTAN

ABSTRAK

Kampung Lata Janggut mempunyai pelbagai ciri geologi dengan nilai geowarisan di kawasan sekitarnya. Kawasan kajian terletak 5° 39' 49.68" N, 101° 45' 51.48" E, di Daerah Jeli, Kelantan dengan 5km × 5km di tengah-tengah ladang getah dan hutan. Secara geomorfologi, kawasan kajian dikelilingi oleh landskap berbukit dan dataran. Penyelidikan memfokuskan kepada geologi am dan potensi geopelancongan Lata Hokkaido, Lata Janggut, Air Terjun Marina dan Lata Bobby. Matlamat kajian ini adalah untuk menghasilkan peta geologi dan untuk mengenal pasti unsur-unsur geowarisan untuk pembangunan potensi geopelancongan. Kawasan kajian ini adalah sebahagian daripada Kompleks Stong, subunit Granit Noring. Litologi kawasan kajian terdiri daripada pelbagai jenis batuan granit (batuan intrusif). Pembentukan Kompleks Stong terdiri daripada batuan granit, granit biotit megakris merah jambu, granit feldspar alkali dan granit biotit dengan berbutir sederhana hingga kasar dalam warna kelabu hingga merah jambu. Batuan granit ini merupakan sebahagian daripada fasies Terang kerana kehadiran mafik biotit dalam komposisi mineral. Manakala Formasi Mangga terdiri daripada batuan metamorfik, gneiss dan syiss. Penilaian untuk potensi tapak geopelancongan; pendekatan kualitatif dan kuantitatif telah dinilai di Lata Hokkaido, Lata Janggut, Lata Bobby dan Air Terjun Marina berdasarkan nilai geodiversiti/geowarisan termasuk saintifik (pendidikan), estetik, rekreasi, ekonomi dan fungsian, dengan tahap kepentingan tempatan ke negeri. Bagi tinjauan soal selidik, majoriti responden bersetuju bahawa tapak-tapak ini sesuai untuk aktiviti pelancongan dan rekreasi seterusnya menunjukkan tapak ini mempunyai aset geowarisan yang pelbagai dan sumber geowarisan yang sesuai untuk destinasi geopelancongan. Cadangan disertakan agar penyelidikan dan projek saintifik sentiasa dilakukan di kawasan kajian bagi membantu pembangunan geopelancongan dan meningkatkan kesedaran nilai-nilai geowarisan di kalangan komuniti tempatan, pelajar dan penyertaan pihak berkuasa seterusnya menginspirasi geotapak ini untuk menjadi sebahagian daripada Stong Geopark.

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LIST OF ABBREVIATIONS

SRTM	Shuttle Radar Topography Mission
DEM	Digital Elevation Model
IUGS	Union of Geological Sciences
3D	Three-dimensional
Q	Quartz
A	Alkali
P	Plagioclase



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LIST OF SYMBOLS

%	Percentage
°	Degree
×	Multiply
=	Equal to
∴	Therefore
Σ	Sum of



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CHAPTER 1

INTRODUCTION

1.1 General Background

Malaysia has numerous geological characteristics that have resulted in the formation of uncommon, naturally attractive landscapes, features, diverse types of rocks, minerals, and fossils over the course of geological history. Malaysia is documented to contain naturally abundant hilly landscapes, mountains, seas, rivers, and caves, primarily calcareous karst that varies by area.

The Peninsular of Malaysia can be divided into three longitude belts based on their geological characteristics: the Eastern, Central, and Western Belts. Kelantan State, located in Peninsular Malaysia's Central Belt, contains a number of attractive and unique geological characteristics that make for excellent geological attractions that can be proposed as geoheritage sites, with the potential of conservation and towards potential of geotourism.

Geology is the study of Earth Science that focuses on the physical, structure, and substances of Earth in relation to the processes acting on them and the history of their origin. Geology explores the surface of the Earth, as well as its origin, composition, and structure, and indirectly its people. Petrology, minerology, physical

geology, geomorphology, stratigraphy, geological engineering, and hydrogeology are typical geology sub-fields of study.

Geological map is the carefully created map that illustrates the geological features of the research region. On such maps, geological properties such as structural geology, the limits of lithology, the study area, and others can be observed. Various types of unit rocks are illustrated in the diagram, with each lithology represented by a distinct colour code. Aside from that, the geological map will display varying degrees of contour lines that indicate the subsurface topography patterns of strata.

Geological heritage, also known as 'geoh heritage' is a scientific subject that focuses on unique, remarkable, and outstanding geosites. Geology is supported by this discipline. Geoh heritage is a natural heritage that includes unique locations and Earth's surface materials that play an important role in our knowledge of Earth's past such as its rocks, minerals, fossils, and landscapes. These variability of Earth's surface materials, unique localities and scenic landscapes can be utilized for tourism industry development.

In addition, geoh heritage is a fundamental component of geological heritage, consisting of unique sites and artefacts that contribute significantly to our understanding of the earth's composition, such as rocks, minerals, fossils, and ecosystems. Moreover, geo-heritage is an important aspect of geo-tourism development. Geoh heritage sites are important for comprehending the complex earth

systems, the evolution and diversity of life, climate changes over time, the development of landforms, and the origin of mineral deposits.

Geotourism is a subdiscipline of geoheritage and can be viewed as geographical tourism, a new form of tourism based on geological features and landscapes. It can also be defined as a form of natural environment tourism that focuses especially on geology and landscapes (Newsome & Dowling, 2010). Geotourism as a geology-based form of tourism can promote geotourism, geodiversity conservation, and an awareness of geosites through travel to areas of exceptional natural landscape and distinctive landform via appreciation and learning about them. This is accomplished by self-guided trips to geological features, self-exploration of geological trails and perspectives, geo-activities, sightseeing tours, and activity provided by a patronage (Newsome & Dowling, 2010).

Besides, geotourism may be defined as a tourist trip to spectacular natural areas with the primary goal of promoting geodiversity, natural science education, and geoheritage value based on geological landscapes and occurrences through geological tourism (Newsome and Dowling, 2018). As a result, such tourism development can generate benefits for the conservation, draw tourists' attention to the geotourism region, next can increase the local community's economic income.

1.2 Study Area

This research is held at Kampung Lata Janggut, Kuala Long, Jeli, Kelantan. The research study area was covered approximately 25 kilometers per square, with 5 kilometers \times 5 kilometers.

a. Location

The study area has longitude N 5° 41' 1" to E 101° 44' 39" and latitude N 5° 38' 18" to E 101° 47' 22". The cascades and waterfalls are beautiful and captivating with different uniqueness in the Jeli district. The cascades and waterfalls are situated in the Batu Melintang, which is sub-district of Kampung Lata Janggut, about 17 kilometres from Jeli town. It is a tributary of the Pergau River and flows through the Gunung Basor Forest Reserve. A major fault drives the Long River's formation and growth: the Long Fault that runs northeast to southwest along the river.

Additionally, the study area is surrounded by heavy plantations, and going deeper, there are several scenic cascades and waterfalls that can be seen. Nearby cascades and waterfalls that can be identified in the study area is Lata Janggut, Marina Waterfall and Lata Bobby. The highest elevation of the study area is approximately 700 meters and the lowest elevation is around 100 meters. Geological features such as Long River, streams and contours can be identified in the base map of study area (Figure 1.1).

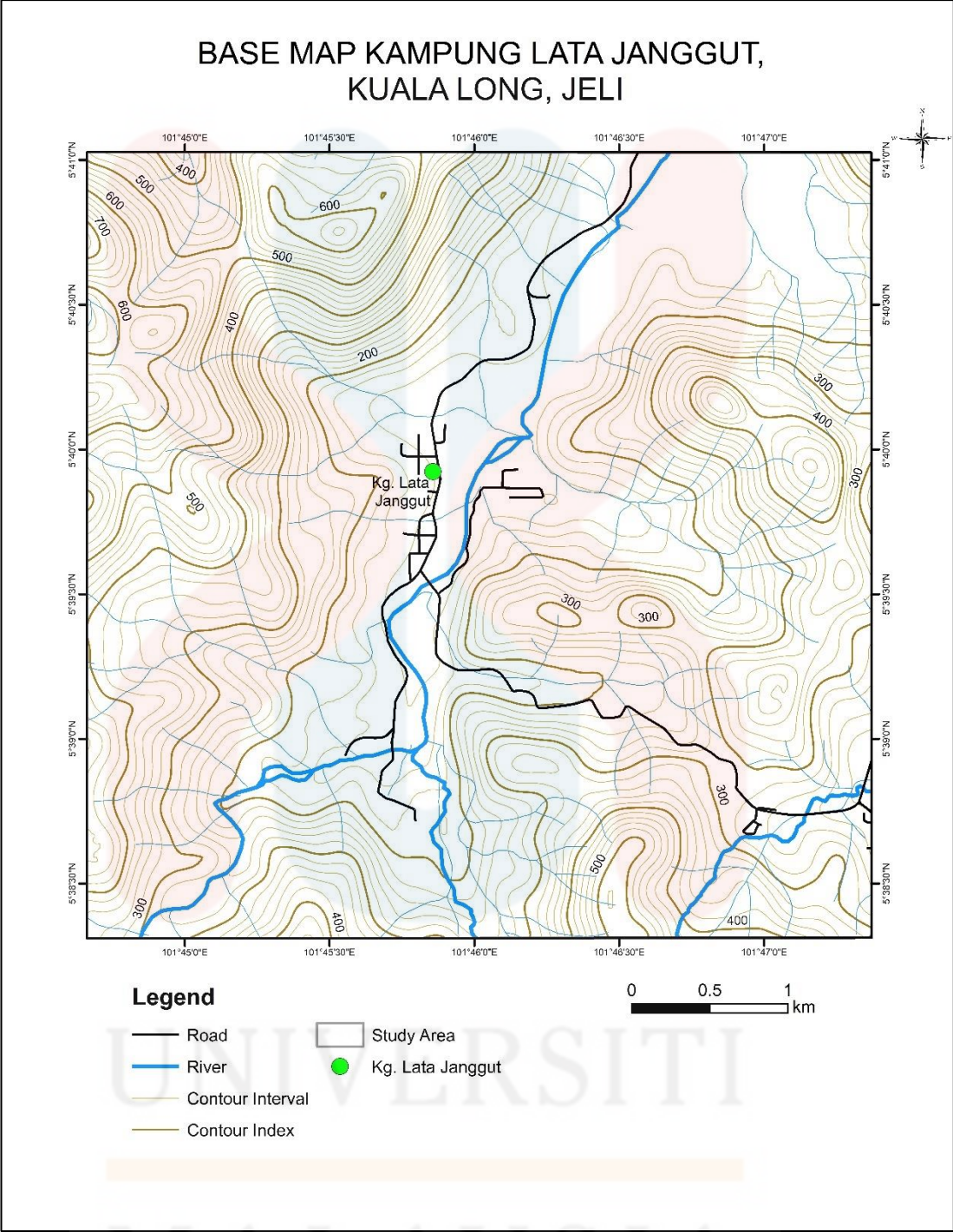


Figure 1.1: Base map of study area, Kampung Lata Janggut, Kuala Long, Jeli, Kelantan.

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b. Road Connection

The study area is located near the East-West Highway in the Jeli district of western Kelantan, close to the Malaysian border. The East-West Highway and village road can be used as the road connection to assess the study area (Figure 1.2). The study area also can be reach by going through Orang Asli village, Kampung Sungai Rual. The closest city that connected to the study area is Jeli town. The study area can be accessed easily but with the four-wheel drive (4WD), it is a better alternatives to access the study area that surrounded by heavy plantations, hilly area and off-road to unpaved road. However, around Kampung Lata Janggut settlement area can be assessed easily by walking, motorcycle and car driving on main road, by-road. Hiking routes or pathway is a better option to reach Marina Waterfall and Lata Bobby sites.

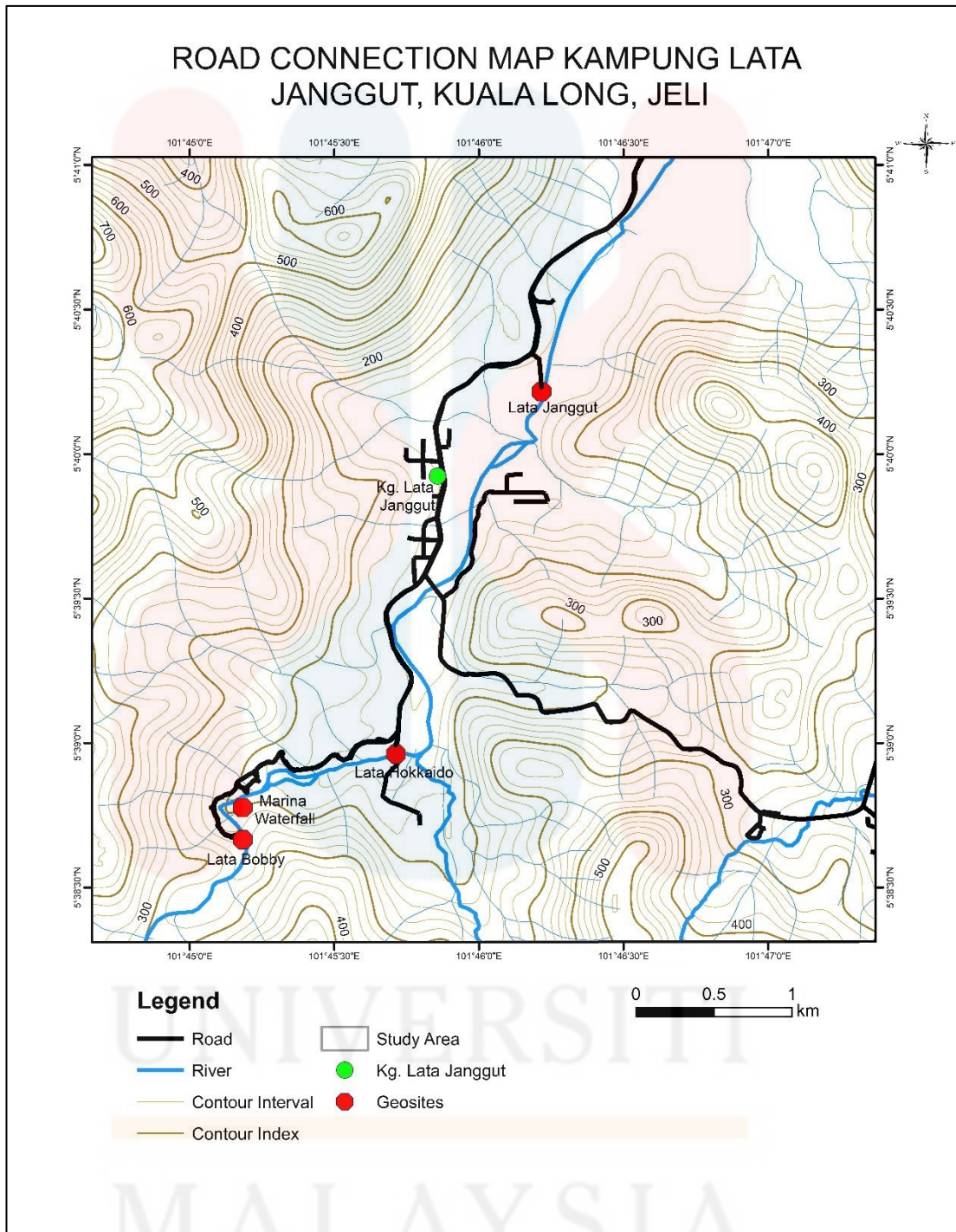


Figure 1.2: Road connection to reach Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby

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c. Demography

Jeli district was originally an autonomous sub-district. Being a totally new residential area, initially Jeli had residents coming from other parts of Kelantan. According to Department of Statistics Malaysia, as of 2020, the district's population is estimated to be 54,656 people. The annual population change since 2010 till 2020 was recorded increased by 3.4% (Table 1.1). Based on pie chart 2010 data in Figure 1.3, it is clearly visible that males are leading Jeli population. Besides, in Jeli district, there are various ethnicities live there, the ethnic group of the population by race in 2010 is shown in the following pie chart (Figure 1.4) and (Table 1.3).

The first generations of Jeli residents mostly involved in rubber tapping and other forms of plantations for a living. The rubber plantations owned by the locals also attract workers from outside the town. Typically, families own a small plantation ranging in size from 6 acres (24,000 m²) to 50 acres (200,000 m²). Jeli's history began when the government encouraged the residents of Kelantan to establish a prosperous agricultural area. This process commenced with a period of land clearing, also known as logging.

Table 1.1: Annual population change from year 2000-2020 .

Name	Status	Population Census (2000-07-05)	Population Census (2010-07-06)	Population Census (2020-07-07)
Jeli	District	35, 988	39, 170	54,656

(Source: Department of Statistics Malaysia, 2020)

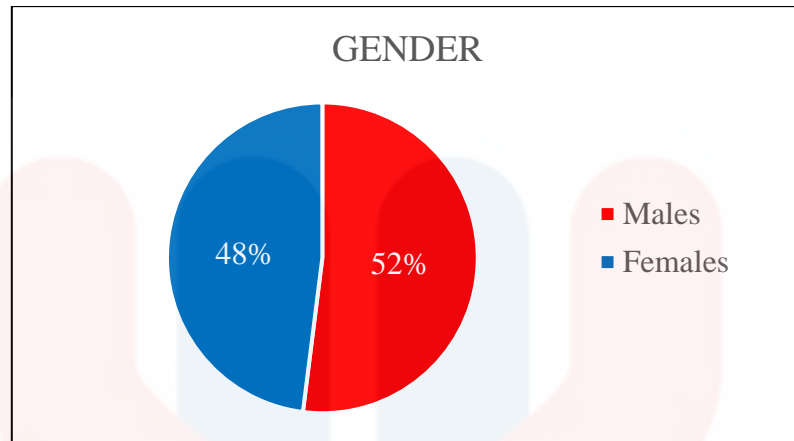


Figure 1.3: Pie chart of Jeli population by gender (Source: Department of Statistics Malaysia, 2010)

Table 1.2: The numbers of total Jeli population by gender.

Gender (Census 2010)	
Males	20, 362
Females	18, 808

(Source: Department of Statistics Malaysia, 2010)

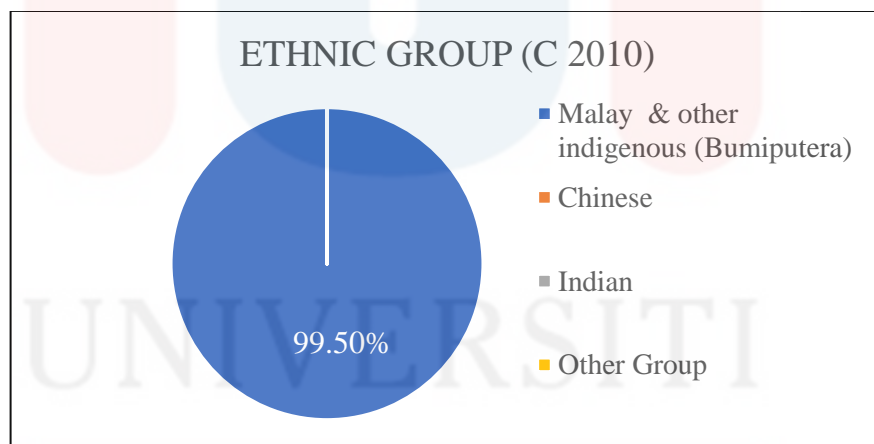


Figure 1.4: Ethnic group population in Jeli district (Source: Department of Statistics Malaysia, 2010)

Table 1.3: The numbers of total ethnic group of Jeli population

Ethnic Group (Census 2010)	
Malay & other indigenous (Bumiputera)	37, 836
Chinese	97
Indian	58
Other group	35

(Source: Department of Statistics Malaysia, 2010)

d. Landuse

Land uses describe the function of land that is used, and land uses vary from place to place. Based on Internet Geography (2020), housing and industry are urban land uses, whereas agriculture and forestry might be categorised as countryside land uses in rural areas. According to Muhammad Firdaus Abdul Karim et al., (2020), Jeli's primary forest has decreased drastically over the years, while other land uses, especially agriculture, have increased. The steady growth of highly profitable industries like oil palm and rubber through the years is shown in Figure 1.5. The transition in land use shows that agriculture is the main income for the locals in Jeli (Muhammad Firdaus Abdul Karim et al., 2020).

As time passes and the economy of the Jeli district grows when a new political took over the administrations, the land use of the areas also began to grow. From 1984 to 2012, (Figure 1.5) shows the image classification for land use changes. Figure 1.6 presents an overview of land change and land uses in Jeli. Above all, rubber plantations, palm plantations, and forest land make up the majority of the land use in the study area.

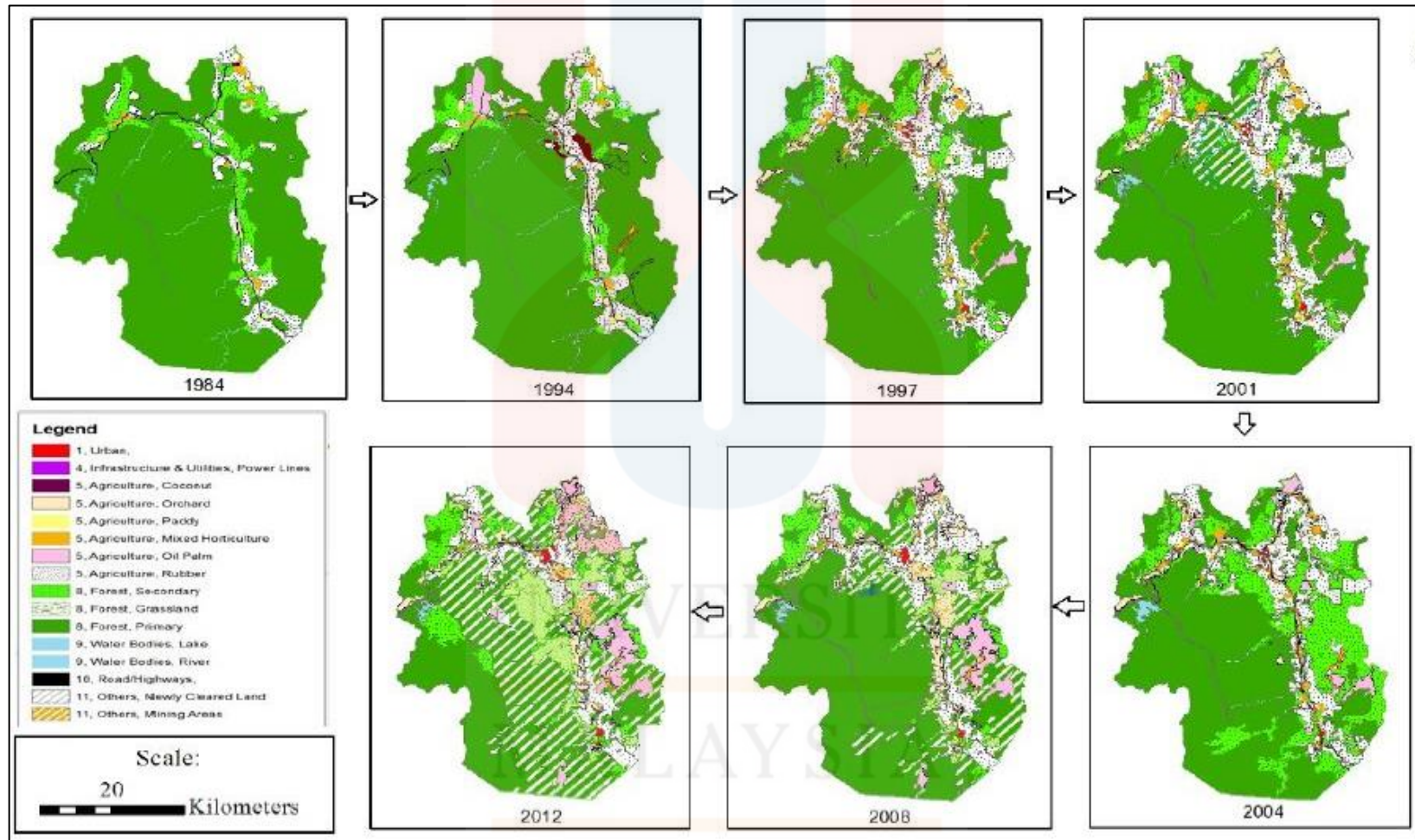


Figure 1.5: Image classification for land use changes of Jeli (1984 - 2012) (Sources: Muhammad Firdaus Abdul Karim et al., 2020).

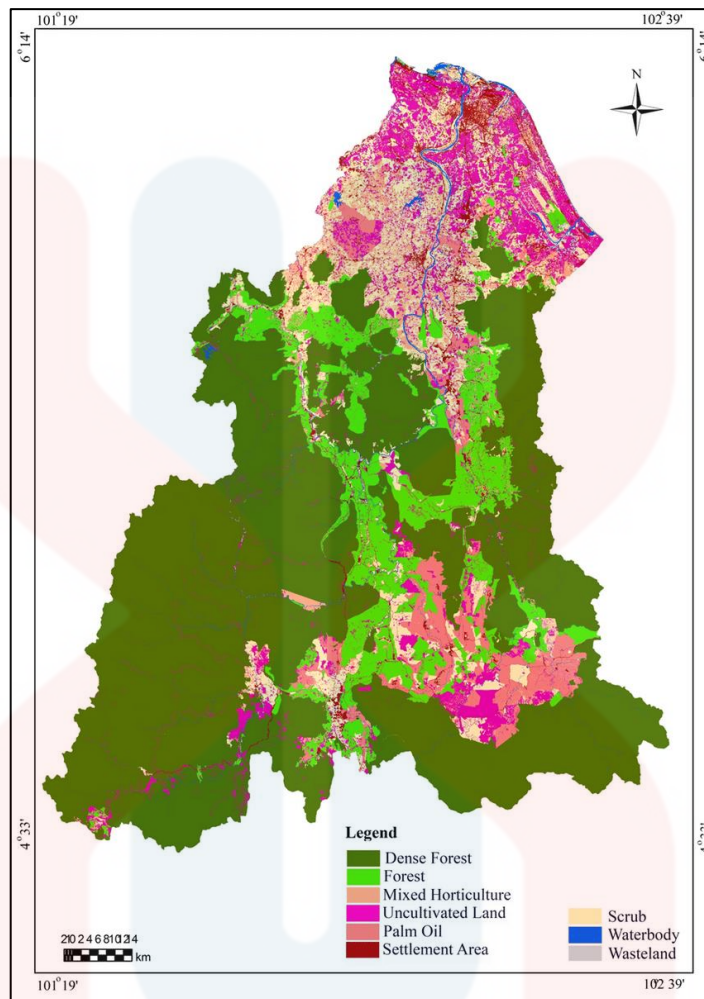


Figure 1.6: Map of land use and land change in Jeli, Kelantan (Source: Mohd Talha Anees et al., 2017).

e. Social economic

As Jeli undergoes rapid growth through out the years, it has a positive effect on both locals and non-locals, as more work opportunities become available to them. In the study area, the main economic are consisted rubber plantation. In Jeli area, most of the land are used for agriculture purposes which can offer jobs vacancies to residensts to work hence can generates their economic as well as contribute to the Jeli district developments.

1.3 Problem Statement

In Kelantan's state, numerous natural and geological attractions are highly wonders. Jeli district is one of the ten districts in Kelantan states, and gifted with beauty of nature, wonders and scenic geological landforms/landscapes, distinctive geological occurrences, and unique geological portrays such as caves, hills, cascades, hot springs, rivers, waterfalls and gold deposits (Dony Adriansyah Nazaruddin et al., 2015). These are all possible geological heritage sites in the area. These gifts enhance nature's beauty, and most of them existed long before man walked on the Earth. Unfortunately, the geological significance of certain tourist attraction's locations is frequently overlooked, with tourists passing by without even knowing their presence. This is due to the lack of geological awareness and knowledge among the public, and also a lack of information provided by the authorities. Therefore, these untapped geosites must put greater effort into creating awareness to ensure preservation and protection measures are undertaken as an approach to list the sites as a geotourism potential.

1.4 Objective

- i. To produce a detail geological map of Kampung Lata Janggut, Kuala Long, Jeli in scale 1:25 000.
- ii. To identify the geoheritage elements for geotourism potential development of Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby, Kampung Lata Janggut, Kuala Long, Jeli.

1.5 Scope of Study

The study area of geological mapping and assessment methods was conducted at Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby, Kampung Lata Janggut, Jeli district. The geological mapping was primarily based on fieldwork activities, such as collecting samples from fresh outcrops, records structural geological trends in the rocks, and other field observations studies such as geomorphological features and rock boundaries within 5×5 kilometres square of study area. All of the field data were processed in GIS software to create geological and thematic maps, as well as petrographic analyses were conducted to study more about the rock minerals. Additionally, several assessment method was used for assessing the potential geotourism site through two approaches which are qualitative and quantitative methods.

1.6 Significance of Study

The main focus of this study is to update and produce a detail geological map of Kampung Lata Janggut, Jeli. Next, to determine the localities of the geological features and assessing the geotourism potential for tourism development. The fieldwork is based on observations of the site's unique and significant geological and geomorphological features. Since this study area is barely unknown to the local and non-local, and it is still untapped geosites, thus geological mapping as well as assessing the geotourism potential is necessary as a good starting point for geotourism. Geological mapping was conducted in the study area as to identify the geological features, the unique occurrence, and their rarity. At the same time, this study can provide many benefits for society especially for geoscience student, geologists, ecotourist and public in terms of educational.

On the other hand, several assessment were conducted as an approach to identify the geoheritage (geological value for human society) and geoconservation needs that implying the necessity for preservation. An assessment was conducted using qualitative and quantitative approaches by valuing or scoring the geosites to assess the potential of a site and balance its conservation for geotourism. Moreover, this study can also promote the study area for tourism and recreation, educate the public to appreciate natural beauty, learn about geological features and earth processes, and generate benefits in terms of conservation, community, and the economy in Jeli districts.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is an essential aspect of any research since it identifies previously undiscovered theoretical and scientific knowledge and helps the reader understand the research paper better. An extensive literature review can be found in several sources, such as journals and books as well as online materials that are related to a specific topic of study as a theory.

Geology is the study of Earth's evolution from the past to the future, which includes the geological history processes and formations that shape into present-day features. In general, geological studies involve the collection of geology-related information from prior studies, books, and scientific journals and publications in order to provide a deeper knowledge for the research paper.

2.2 Regional Geology and Tectonic Setting

Geologically, Peninsular Malaysia consists of three belts, as shown in Figure 2.1, the Western, Central, and Eastern Belts. According to Hutchinson, C. (1989), the geology and tectonic history of each of these belts are different.

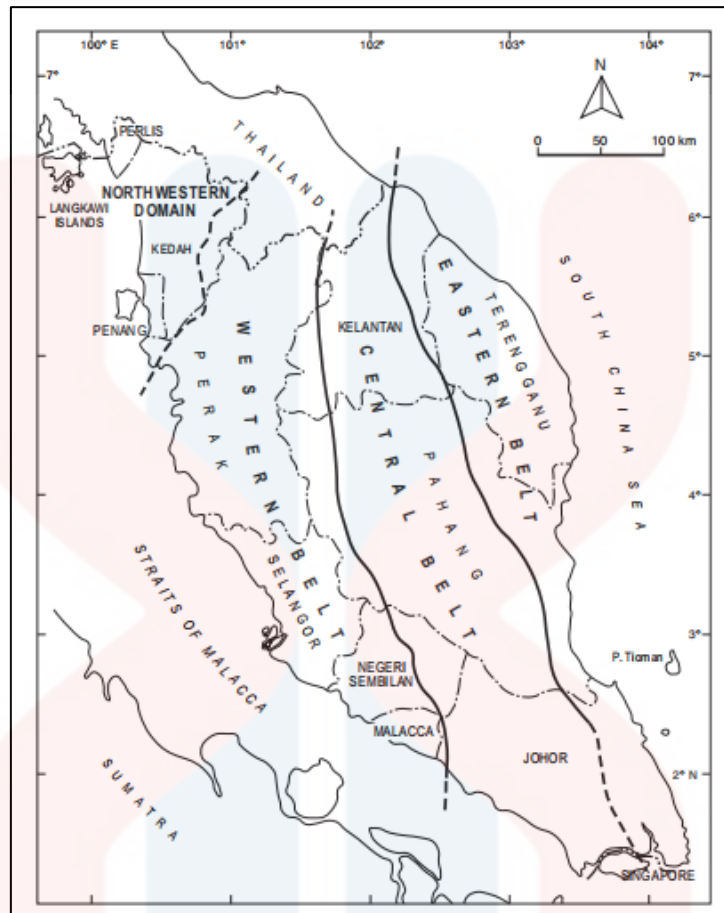


Figure 2.1: Map of Peninsular Malaysia showing Western, Central and Eastern Belts (Source: Hutchison & Tan, 2000).

During the Permian and Triassic eras in Peninsular Malaysia, deep marine formations were common. The Triassic Semantan and Semanggol formations are recognised as deep-sea sediments based on sedimentology and palaeontology studies. Malaysia generally comprises eastern Malaysia and the tectonostratigraphic terrain of Sibumasu (Metcalf, I., and Azhar, H. (1994).

According to Quarry Resources planning for the state of Kelantan (2003), there are four different distributions of rock types in the state of Kelantan, and the weathering process has an impact on each of these rock types. Based on the geological map in Figure 2.2, the geology of the state of Kelantan can be categorised as shown in Table 2.1.

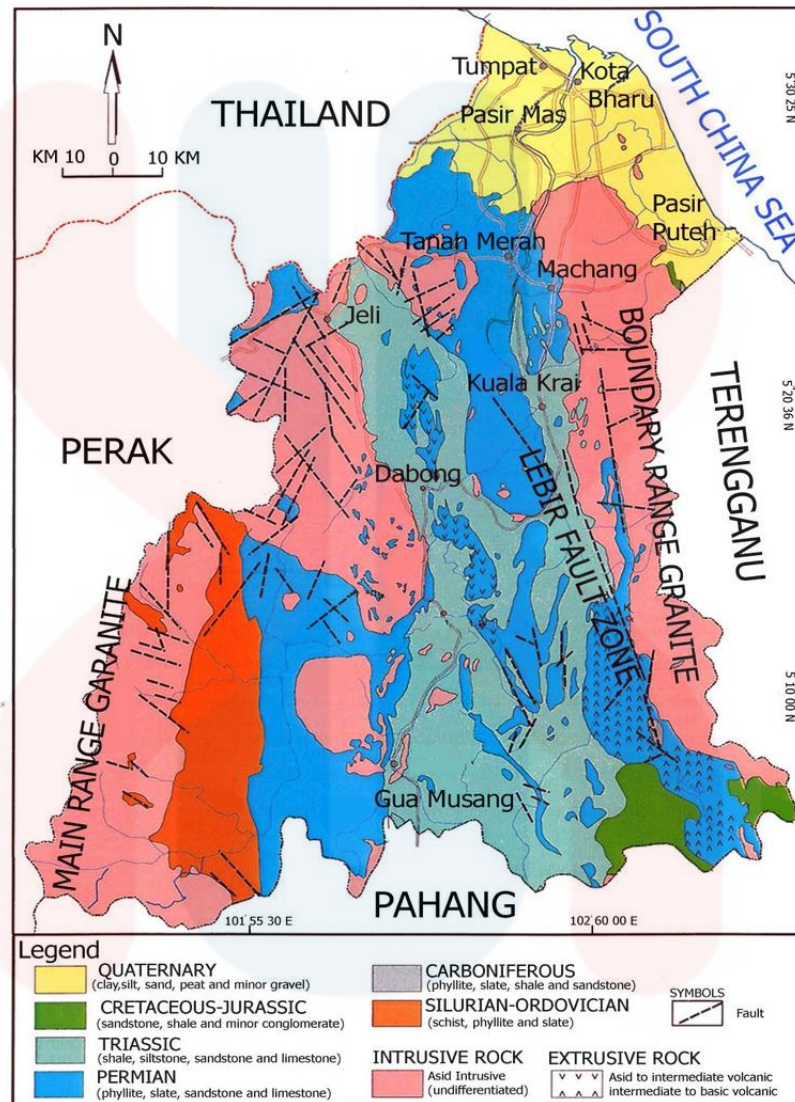


Figure 2.2: General geological map of the Kelantan state (Source: Department of Minerals and Geoscience Malaysia, 2003).

Table 2.1: Rock type in the Kelantan state.

Rock type	Area	
Granitic rocks	33%	Total km: 15, 022km ²
Sedimentary/metasedimentary rock	51%	
Extrusive rocks (volcanic rocks)	10%	
Unconsolidated sediment	6%	

(Source: Quarry Resources planning for the state of Kelantan, 2003)

Approximately 15,022 km² of the state of Kelantan are covered by various types of rocks. The north-south central region of Kelantan is dominated by sedimentary/metasedimentary rock, which constitutes the majority of the area. The state was surrounded on the west and east by the granites of the Main Range and Boundary Range, respectively. In the north-south direction, the unconsolidated sediments of the Kelantan Alluvial Plain tend to cut off these belts of granite and other county rocks (Quarry Resources planning for the state of Kelantan, 2003).

According to Hutchison (1989), Peninsular Malaysia is the most essential part of the Eurasian plate, while Sundaland is the Southeastern part of Asia. Peninsular Malaysia consists of three longitudinal belts: the eastern belt, the western belt, and the central belt. Each belt has its own geological evolution and distinguishing characteristics. The distribution is determined by geology and rock distribution.

Additionally, during the Permian to Triassic in peninsular Malaysia, the deep marine formation is typical. According to sedimentology and palaeontology, the Semantan and Semanggol Triassic Deposits are known as deep-sea deposits. Generally, Malaysia is in eastern Asia (Metcalf and Azhar, 1994).

Peninsular Malaysia's tectonic activity during the Paleozoic and Mesozoic eras is primarily responsible for the formation of faulting and folding. Sedimentary rocks exhibit folding, jointing, and faulting, whereas granitic rocks exhibit jointing and faulting (Department of Minerals and Geoscience Malaysia, 2003). In Kelantan, the most common structural pattern is north-south to northwest-southeast. As per

local structures, Jeli district is dominated by northwest-southeast and northeast-southwest directions (Dony Adriansyah Nazaruddin et al., 2015).

Geologically, the Jeli district is dominated by granitic rocks, with enclaves of sedimentary and metasedimentary rocks. Based on the geology of Kelantan as described by the (Department of Minerals and Geoscience of Malaysia, 2003), the district consists of three types of rocks: (1) Permian sedimentary rocks (Gua Musang Formation) made up of phyllite, slate, sandstone, and limestone; (2) Triassic sedimentary rocks (Gunong Rabong Formation) made up of shale, siltstone, sandstone, and limestone; and (3) The Main Range. Granitic rocks (acid intrusive) that are generally of Middle Triassic age and are located roughly in the west side of the district up to the Perak-Pahang state border.

Geomorphologically, Kelantan can be divided into four types of landscape, they are: (1) Mountainous areas; (2) Hilly areas; (3) Plain areas; and (4) Coastal areas (Tanot Unjah et al., 2001). The western and northern part of the district feature a mountainous landscape. This landscape is composed of the Strong Migmatite Complex, the Main Range granite, and schist. This landscape consists of mountain ridges and mountain valleys. Jeli district hilly areas are distributed at the base of mountain ranges. There are two types of hills in this landscape: isolated hills and elongated hills. The isolated limestone hills typically exposed in low-lying areas, such as Gunung Reng. Elongated hills are ridges, typically lower than mountain ridges. Meanwhile, plain landscape forms in the central and east of the district (Department of Minerals and Geoscience Malaysia, 2003).

2.3 Stratigraphy

According to Harbury et al., (1990), upper Palaeozoic and Mesozoic strata that show axial-plane cleavage, degree and orientation of folding, structural style, and faulting during Triassic, Jurassic, and Cretaceous rocks are a part of the central basin and have a lot in common with the central basin of the Philippines make up Peninsular Malaysia's historical geology. Rocks from the Triassic period exhibited a variety of bedding and cleavage, with axial planar cleavage standing out in particular. Additionally, a part of Mesozoic strata that have been dated to the Upper Jurassic and Lower Cretaceous periods is the Tembeling and Gagau Group. Figure 2.3 depicts the geologic sequence of Peninsular Malaysia as well as the crucial periods of its historical deformation.

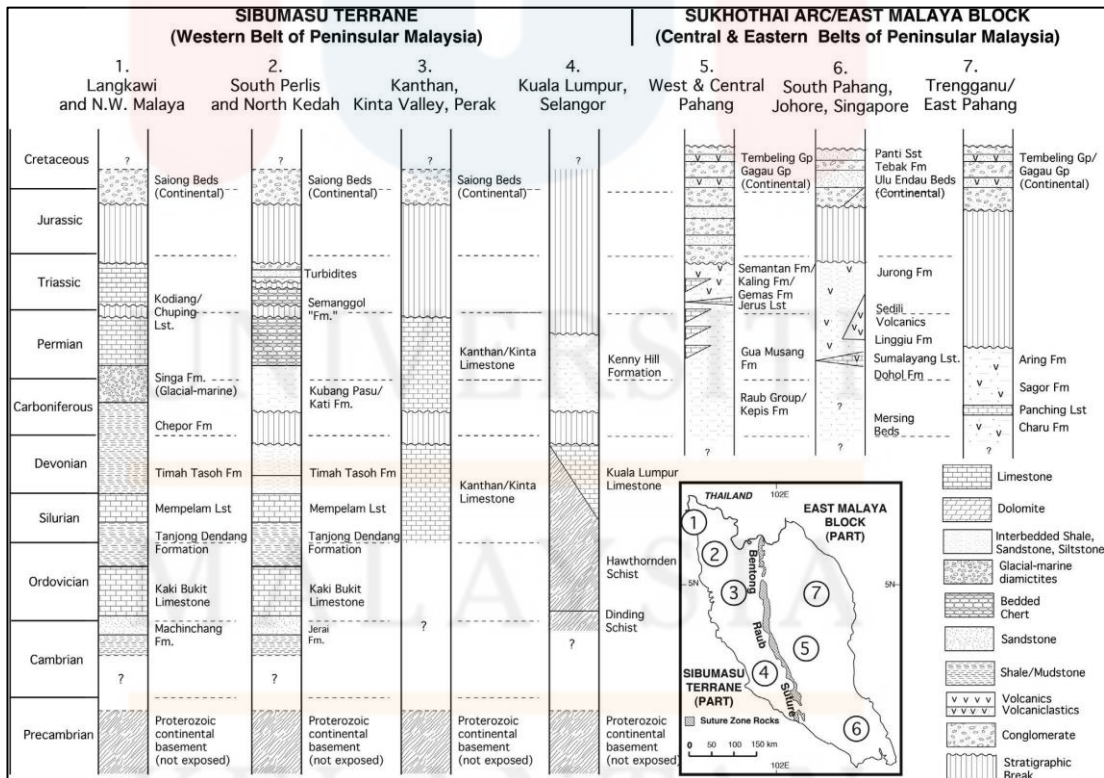


Figure 2.3: Representative stratigraphic columns for the Sibumasu Terrane and East Malaya Block (Sukhotai Arc). Modified after Metcalfe (2000). Langkawi and NW Malaya Paleozoic stratigraphy after Lee (2009).

MacDonald et al., (1967) stated that most of the material is made up of metapelites, with some arenaceous and calcareous pieces mixed in. Only recently have the minerals amphibolite and serpentinite been found, and they are very rare. In the south-western part of Kelantan, Permian volcanic-sedimentary rocks make up most of the eastern half of the island and are irregularly overlain by a Lower Paleozoic sequence rocks on the western side. The Taku Schist is the oldest type of rock on the region. It covers most of central and northern part of Kelantan.

Bignell and Snelling (1977) obtain late Triassic, 212 ± 8 Ma metamorphism ages for the Taku Schist from biotite K-Ar geochronology in the dome's western edge. K-Ar studies of biotite minerals from schist enclaves within Kemahang granite, on the other hand, indicate a Late Cretaceous age of metamorphism, around 107 ± 3 Ma. Ng et al. (2015) revealed recent U-Pb ages of the Kemahang granite intrusions, revealing Late Triassic ages (226.7 ± 2.2 Ma) equal to the Stong complex's Berangkat tonalite sub-unit, which gives an age of 220.4 ± 3.9 Ma. The age differs from those of neighbouring subunits in the north, which show late Cretaceous intrusion ages for the Kenerong leucogranite (83.9 ± 0.8 Ma) and Noring granite (75.7 ± 0.6 Ma).

In the Jeli District, sedimentary rocks from the Triassic (Gunung Rabong Formation), sedimentary rocks from the Permian (Gua Musang Formation), and granitic rocks made by acid intrusions can be found (Dony Adrianshah Nazaruddin, 2015). The Main Range is mostly made up of granitic rocks, with a few enclaves of sedimentary and metasedimentary rocks thrown in for good measure. Most of Kelantan's Triassic rocks are in the middle and southern parts of the country. This

group of sediments is mostly made up of argillo-arenaceous sediments with intercalations of volcanic and limestone in them. Many Permian rocks can be seen protruding through the Triassic layer of sedimentary rock (MacDonald, 1967).

2.4 Structural Geology

Kelantan is located in Peninsular Malaysia's north-eastern region. The compressional force that occurred in the region resulted in a succession of geological events, including folding and faulting. According to Khoo (1983), the dominating structure in the N-S to NW-SE direction was generated by orogenesis. Orogenic process is the primary mechanism which is continent mountains were formed. The process occurs when the continent plate fractures and is forced upwards, resulting in the formation of one or more mountain ranges and an orogenic belt. Orogenesis refers to a succession of geological processes that occur collectively.

A large structural zone, known as the Bentong-Raub Suture Zone, has emerged in the state of Kelantan, which is situated in the central belt of Peninsular Malaysia. Bentong-Raub Suture Zone that is found in the Central Belt is a part of the primary Devonian to Middle Triassic Paleo-Tethys ocean that forms the boundary between Gondwana, developed from Sibumasu and Indochina terranes (Metcalf, 2000). Paleo-Tethys ocean that produce ribbon-bedded cherts preserved in the suture zone range in age from Middle Devonian to Middle Permian, while chert and limestone clast-containing mélangé range in age from Lower Carboniferous to Lower Permian. This ribbon-bedded chert and mélangé reveals that the Paleo-Tethys opened during the Devonian period, when Indochina and other

Chinese blocks separated from Gondwana, then closed during the Late Triassic period. The suture zone is the result of the late Paleozoic northward subduction of the Paleo-Tethys ocean beneath Indochina and the late Triassic collision of the Sibumasu terrane with the under thrusting of Indochina.

Moreover, Jeli's structural geology area is influenced by both regional and local structures. Local structures include faulting, folding, and jointing in sedimentary rocks, and faulting and jointing in granitic rocks. Regional structures include faulting and folding (Department of Minerals and Geoscience Malaysia 2003).

2.5 Historical Geology

The 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 form Kelantan can be categorised as unconsolidated sediments, extrusive rocks like granite and volcanic rocks, sedimentary or metasedimentary rocks, and sedimentary rocks. The granite that can be found in Kelantan is separated into two distinct bodies, which are known as the Main Range and the Boundary Range.

Unconsolidated sediments are deposits created by secondary sedimentation and repositioning of previously eroded rocks, as well as by solution chemical and biological precipitation which are not compacted or lithified. The unconsolidated sediments constitute the coastline from Thailand to Terengganu, intrude on the

northern part of the state of Kelantan. The silt composing the alluvial plain is Quaternary in age and lies on the bedrock of granite.

Moreover, based on Kelantan's Geology and Mineral Distribution Map (2000), in the central zone and along the eastern border of the state, where the Boundary Range granite is the extrusive rocks formed an elongated body that running from north to south which formed during the Permian period. The sedimentary and metasedimentary rocks from the Ordovician to the Cretaceous eras cover 51% of the state's land surface. These rocks covered the area in the middle of Kelantan State that runs north to south (Kelantan's Geology and Mineral Distribution Map, 2000).

The state of Kelantan has numerous wonders natural and geological attractions. Jeli district has magnificent geological landforms, landscapes, distinctive geological phenomena, and rich with Earth resources, including hills, cascades, rivers, caves, waterfalls, hot springs, and gold deposits. Jeli district is one of Kelantan's ten districts and is situated in the western part of the state. Jeli district is strategically placed near the state borders of Kelantan and Perak and the international borders of Malaysia and Thailand (Dony Adriansyah Nazaruddin, 2015). According to the (MDJ, 2011), this district has a total area of approximately 129,680.26 acres and is divided into three subdistricts: Jeli, Batu Melintang, and Kuala Balah. This district is home to many different and noteworthy geological features suitable for geotourism development.

2.6 Geological Heritage

Malaysia is one region that actively preserves and develops its geoheritage resources. According to Ibrahim Komoo (2004), the preservation of geological monuments and landscapes was authorised by the Third Malaysian Plan (1976–1980) as the first step in the protection of geoheritage resources in Malaysia. The Malaysian Geological Heritage Group was formed in 1996 to lead systematic efforts to promote geoheritage conservation. Following that, several research projects were carried out to analyse and characterise numerous geoheritage sites for conservation and development.

According to Dowling, (2013), geoheritage refers to the valuable geological elements and features, whereas geotourism is geological tourism based on the geological heritage of the Earth. Geotourism is one of the subcomponents of tourism's primary components that is based on the geological environment.

Brocx, (2007) stated that geoheritage also possessing conditions such as unique occurrence, rarity, and representativeness of particular geological features was a necessity for recognising a possible site of geological significance. Moreover, he categorised geological heritage according to its scope, which included mineralogical sites, geomorphological sites, hydrogeological sites, structural sites, petrological sites, and others associated with geological distinctive features.

Noteworthy geologic features that are considered to be important for the preservation of geological history and may have a variety of values, including scientific value, historic value, educational value, aesthetic value, or economic

worth (Sharina Abdul Halim & Nor Azizah Ishak, 2017). From a geological viewpoint, the landscape is typically associated with some form of heritage value, which can be broken down into numerous categories (Dony Adriansyah Nazaruddin et al., 2016).

According to Joanes (2008), states that educational and scientific values are what offer the general people with knowledge about the evolution of the Earth's physical characteristics. Geologic features and landscape, distinctive rock or mineral kinds, or other geologic characteristics that are valuable to research and crucial for geologic records and the history of Earth all have scientific significance. Educational value is related to education, such as in educating individuals regarding the geological places and features that are present. This is almost identical to the scientific value. When compared to educational value, the worth of scientific research is more organised and all-encompassing. The geological resources have significant educational significance since they can be used as resources to gain an understanding of the geological processes that shape the area under study as well as the region as a whole.

Cultural value is associated with geological characteristics or the landscape that plays a role on cultural or historical event in social or local community for societies of the past, present, or future (Dony Adriansyah Nazaruddin et al., 2016). According to Kamal Roslan Mohamed (2016), other forms of added value include economic values, which includes the economic worth of resources that vary according to their geological characteristics, geography, or natural setting. In terms

of its practical value, it is connected to the way the resources of the research area are exploited.

2.6.1 Geotourism

Geotourism is now being practised all around the world. The National Geographic Society was the first to identify tourism as a geographical activity (Stueve et al., 2002). They proposed that geotourism is tourism that sustains or promotes the distinctive geographical characteristics of a place, such as its environment, heritage, aesthetic, culture, and locals' well-being. In 2011, at the conclusion of an International Congress on Geotourism, it was declared that geotourism should be defined as tourism that sustains and enriches the character of a place, considering its geology, environment, culture, aesthetics, heritage, and locals' well-being. In addition, geological tourism can be understood as one of geotourism's various components when the term is taken in its broadest terms.

Other than that, there is numerous existence of distinct and captivating geological landforms and geomorphological features such as cascades, waterfalls and rivers in Jeli area. All of these earth natural product features all have significance and will greatly enhance the geotourism potential sites in the study area. Afterwards, these geologically significant formations should be proposed as geosites to promote geotourism as well as recreation, public education and aesthetic appreciation.

On this matter, all of these geosites should be regarded as geoheritage resources that require research, harmonious exploitation, preservation and protection both for the community and future generations learn about the earth's geological

history, educate to appreciate natural beauty, as well as generate local economic growth. Within this framework, such geosites in the study area were determined, evaluated and classified in relation to the geoheritage and potential of tourism activities.

2.6.2 Geoheritage Assessments

Assessment such as qualitative and quantitative approaches is essential to assessing the study area for potential geoheritage and geotourism development at selected areas. The qualitative method was focusing on geoheritage value of the site, mostly the use of their scientific (important for geological records and Earth's history), educational (to train and educate schools, university students, professional geoscientists, and the general public), aesthetic (features which are beautiful or unusual), recreational (suitable for a variety of nature recreational activities), cultural value (associated with beliefs and historical and archaeological values), and some additional values such as economic (the financial value of the resources depending on their nature) and functional values (related to the uses of the resources) as they support geotourism potential principle (Gray, 2004, 2005). Next, the significance level of each site will then be determined based on the geoheritage resources, such as international, national, statewide, regional, and local (Brocx and Semeniuk 2007).

2.6.3 Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby as Geoheritage Site and Potential of Geotourism

In particular, the study was identified and determined geological and geomorphological features that can be proposed as geosites and assess the potential

of geotourism in the study area using two approaches: qualitative and quantitative methods. Since all these sites is still untapped resources site from geological research, this study area may increase awareness among researchers, geoscientists and geoscience students about the unique of geological heritage feature that existed in their surroundings, enhanced understanding and knowledge of geology and geomorphology, increase the nature appreciation, conservation, and protection of natural beauty with considerable potential for recreation and tourism.

Additionally, with establishing the geotourism and recreation activities, it also can enhance recognition by public as well as generates benefits for local economy. Thus, these untapped resources need now be carefully and seriously researched and harmoniously exploited in order to guarantee preservation and protection measures are undertaken. Lastly, a concerted effort is necessary to convince state authorities of the importance of such sites to promote education, health, aesthetic value and recreation of the people by assessing the potential of geotourism. Effective strategy and cooperation by state government, Jeli District Council, and private tourism agency in district area is important for creating awareness, promoting geotourism and natural beauty appreciation in the way of commercial video, print media, brochures, and books.

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 Introduction

Several materials and methods were used to complete the geological mapping, data collection, geological analysis and interpretation process, generate a complete geological map of the study area, as well as determined the geoheritage values for geotourism potential in Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby, Kampung Lata Janggut, Jeli district.

3.2 Materials

Several mapping materials were needed for the geological mapping (Table 3.1). All data, information and analysis from the geological mapping were recorded in the note book and pictures of the outcrops of geological and geomorphological features were taken for a references.

Table 3.1: List of materials and their function.

No.	Materials	Functions
1.	Base Map	The data and information about the study area are obtained from the base map
2.	Global Positioning System (GPS)	Used for finding one position, mark the coordinate, elevation and record traversing track while mapping in the study area

3.	Tip-point Hammer	Used for collecting fresh samples and measuring features scale
4.	Brunton compass	Used to measure strike and dip of geological structure and azimuth reading
5.	HCL acid	Used to identify and distinguish carbonate rocks
6.	Measuring tape	Used for taking actual measurements of lithologies thickness and structures
7.	Plastics sample	Used to collect samples
8.	ArcGIS Software	Used to generate the geological map, map analysis and geographic data of the study area.

3.3 Methodology

Several method was used to reach the objectives of this study. Geological mapping and characterisation were carried out to analyse and describes the study area in detail. Geological mapping and geological assessment were conducted in two approaches: qualitative and quantitative assessments for geoheritage and potential of geotourism in the study area.

3.3.1 Preliminary Studies

In the early stages of conducting this study, the preliminary study was conducted as a means of preparation and data collection concerning the study area and research. Numerous sources, including journals, articles, books, internet sites, and a previous research studies was being referred. In general, preliminary study can support this research by highlighting the overall geological settings, geological heritage, and geological diversity of the study area. Preliminary study must be completed by collecting previously published papers. Thus, by reviewing journals,

articles, books, internet sources, and past research can provide information that clarified the topic area and served as a guide for future research.

3.3.2 Field Studies

During field studies, primary data was collected during geological mapping and geological assessment with two approaches, qualitative and quantitative, for geoheritage and potential of geotourism. To achieve first objective, the geological mapping was conducted to produce a detail geological map of the study area. For the geological mapping, as the integration of primary data, it will be focusing on the description of general geological characteristics such as lithology, succession characteristics, texture, geomorphological, and identification of structural elements, field observations and surveys, strike-dip readings, field photographs, and outcrop sketching, it will later be used to interpret geomorphological characteristics, substantiate the role of lithology and structure in the development of today's landscape.

The steps of geological mapping which are observation, characterisation and measurement were essential in the field studies. Petrology, structural geology, geomorphology, palaeontology, stratigraphy, and sedimentology scopes were included in the geological mapping of the study area. Moreover, several samples of fresh outcrops were collected during the mapping for the rock and mineral identification.

Additionally, to achieve the second objective, geological assessment: qualitative and quantitative approaches were conducted by assessing the study area

for potential of geotourism. The qualitative method was focusing on geoheritage value of the site, mostly the use of their scientific, educational, aesthetic, recreational, economic and functional values (Komoo, 2003; Gray, 2004, 2005). Next, the significance level of each site will then be determined based on the geoheritage resources, such as international, national, statewide, regional, and local (Brocx and Semeniuk 2007).

Meanwhile, the quantitative method is the numerical assessment related to the need to numerically assess the geological sites (valuing) or score the sites (Kubalikova, 2013). This method was conducted by assessing the potential geoheritage features based on their geodiversity and geoheritage values for potential of geotourism development. This method was carried out by establish six classes of values: 0 – 5, represents none, very poor, poor, fair, good, very good respectively (Kubalikova, 2013). The observation and scoring were taken carefully by considering the characteristics, the variety of geological and geomorphological feature of geoheritage value and geotourism potential based on scientific (educational), aesthetic, recreational, and cultural value, and several additional values such as economic and functional values for geotourism potential in the study area.

Additionally, a questionnaire survey was focused on analyzed and interpreted public opinions on geoheritage and geotourism to support the results from assessment approaches (Kubalikova et al., 2021). The questionnaire was collected using a semi-structured questions type. The students, lecturers, geoscience professionals, ecotourist, local, tourists, and public are the survey's target group. The

sample of respondents is systematic, which were considering the demographic aspects such as age (13 – 60), gender (female, male), education level (high school, pre-university, degree and doctorate) and origin (local, non-local). The questionnaire was covered with 38 questions; definition (term), awareness, importance, benefits of geoheritage and geotourism, recognition geological and geomorphological features, and geoheritage values. In total, 50 respondents filled out questionnaires survey distributed via Google forms.

3.3.3 Laboratory Work

During this stage, samples from fresh outcrop were gathered for further identification during laboratory work. The petrographic analysis and thin section were conducted for the rock samples by observing and determining the rocks and minerals for their texture, composition and others microscopic information. Thus, petrographic and thin section analysis is essential in this study.

3.3.4 Data Processing, Analysis and Interpretation

For the data analysis stage, all the data that were collected from the study area were processed, analyzed and interpreted using ArcGIS software. All the data obtained from geological mapping and secondary data was considered for geological analysis and interpretation of data in the study area to produce different types of geological map.

Samples from fresh outcrops were identified through lab analysis by thin section procedure to determine the rock type, mineral composition, texture of the

rock, and other microscopic information included in the interpretation of study area and lithology map.

Next, from the observation of the site (qualitative method) the level of significance were analyzed and interpreted based on the values scientific (educational), aesthetic, recreational, and cultural value, and some additional values such as economy and functional values of the study area. Besides, valuing or scoring the site (quantitative method) also were classified and analyzed based on the same geoheritage parameter values by six classes of values: 0 – 5, represents none, very poor, poor, fair, good, very good respectively. As for the questionnaire, the respondents answer was analyzed and discussed. Their opinions were considered to support results from qualitative and quantitative approaches of the potential geotourism development in the study area.

3.3.5 Research Flow Chart

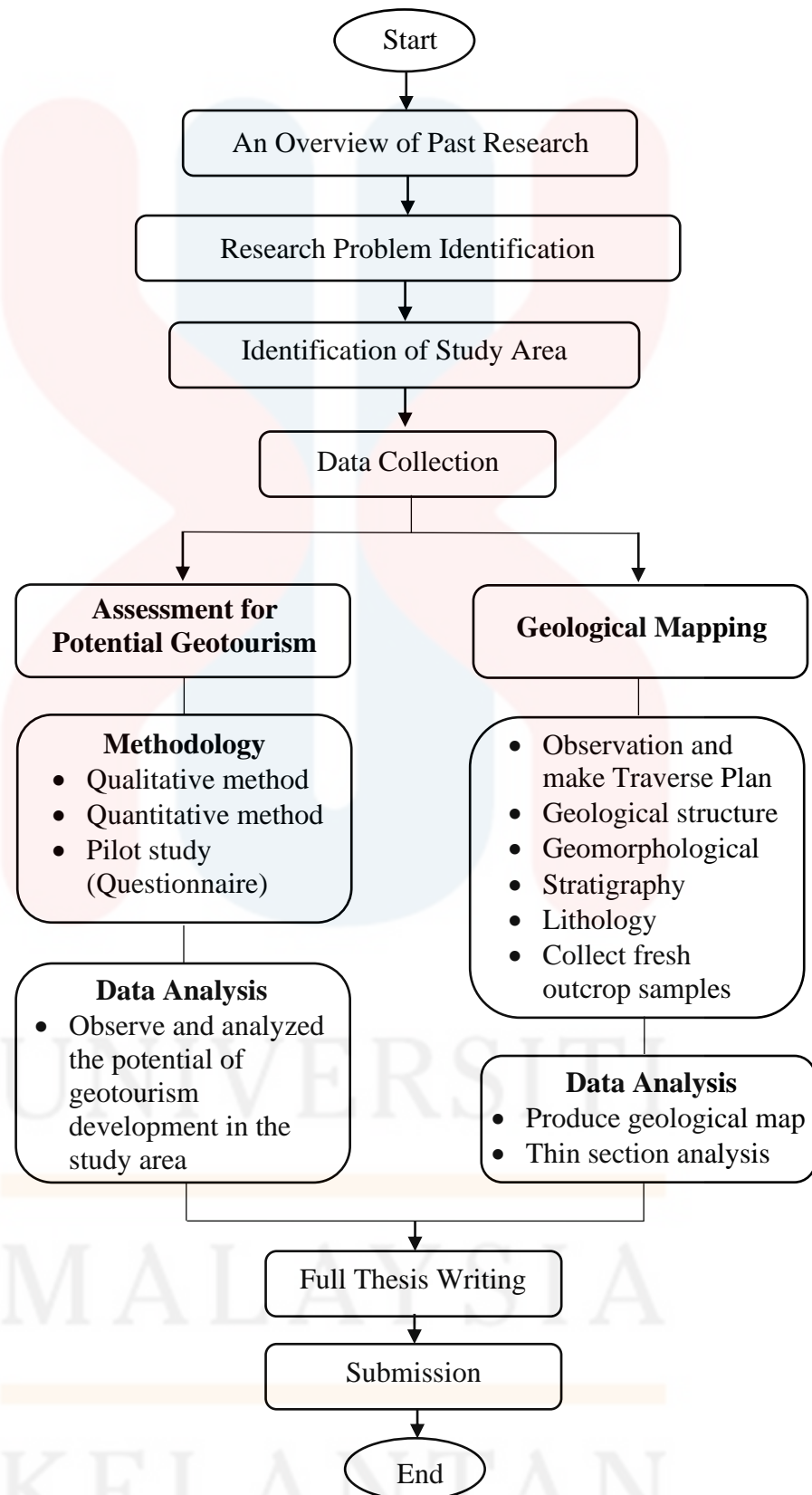


Figure 3.1: Illustration of Research flow process

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

In this chapter, general geology of the study area is fundamentally analyzed and discussed based on the primary data that was collected during geological mapping and from the previous research. It is mainly covering the geomorphology, structural geology, stratigraphy, lithology and historical geology of the study area. All of these data then were generated by analyzing, processing and interpreting from obtained geological mapping data. The primary outcome of this chapter is the geological map that were produced from the field studies where it shows the distribution of lithology rock units, stratigraphy and geological structures of the study area.

4.1.1 Accessibility

The accessibility of Kampung Lata Janggut is quite good due to the situated near the East-West Highway. In order to access the study area, the main road, by-road or villagers pathway, and certain vehicles or transport is required such as motorcycle, four-wheel drive car and other vehicles that suitable with road size and conditions. Telecommunication system such as telephone network, computer network and internet also excellent at the settlement area, due to the internet centre that have been provided to the communities by government. However, only certain

area such as heavy forest and rural area have a low coverage. In addition, socioeconomic also can be related to the accessibility of the people at Kampung Lata Janggut for example with the existence of school, mosque, internet centre, homestay and plantation as well as the main roads, by-road, off-road to unpaved road that mostly contributed to the economy and social of Kampung Lata Janggut communities. As a result, mapping activities are extremely effective.

4.1.2 Settlement

As for the settlement, Kampung Lata Janggut is surrounded by rubber plantation and orchards at hilly area which mostly contributes to local. There are also fish farming activity near Lata Hokkaido that gave positive impact to local's economy and toward outsider to settle down at Kampung Lata Janggut (Figure 4.2).



Figure 4.1: Settlement area of Kampung Lata Janggut.



Figure 4.2: Fish farming activities near Lata Hokkaido, Kampung Lata Janggut.

4.1.3 Vegetation

The study area is surrounded by rubber plantation and heavy forestry. The rubber plantation is about 20% of the study area and heavy forestry is about 70%. Fish farming, orchard, and scrubland covered another 10% of study area. Mostly the heavy forestry is on high hills area and surrounding Lata Hokkaido, Lata Janggut, Marina waterfall and Lata Bobby. Meanwhile, as for the rubber plantation, it is mostly found on hilly, around settlement area and roadside area which the main economy contributors for people in Kampung Lata Janggut. Figure 4.5 shows the land use map of Kampung Lata Janggut.



Figure 4.3: Rubber plantation at beside road and settlement area in Kampung Lata Janggut



Figure 4.4: Heavy forestry on high hills surrounding study area

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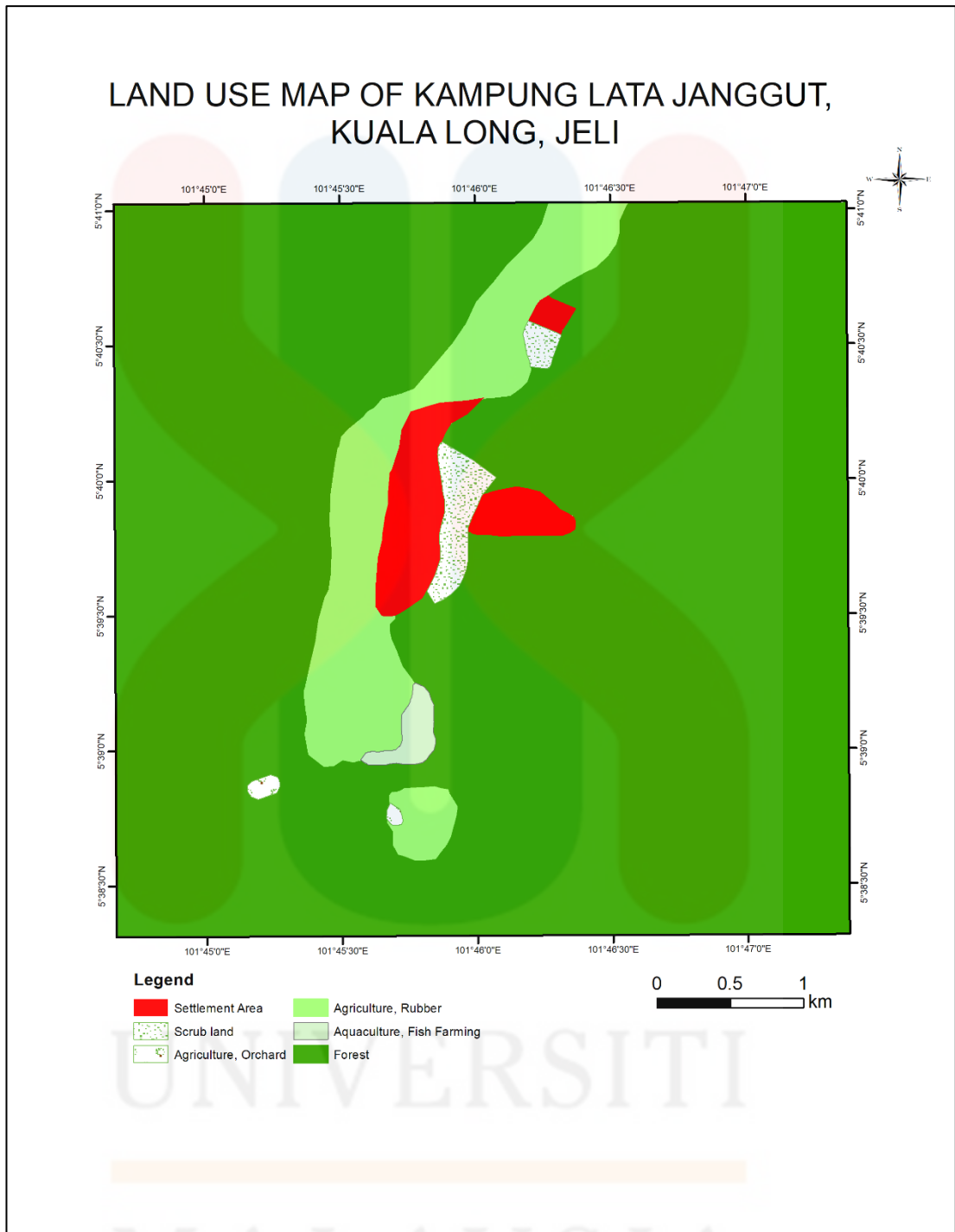


Figure 4.5: Land use map of study area

4.1.4 Traverse and Observation

Mapping activities were accomplished by traversing and observation methods in order to collect data and rock samples along the roads or river in the study area. The fresh, weathered and well exposed outcrop were discovered and observed at the settlement, hilly, plain, and along the river areas. The traverse routes have been planned before the mapping activities so it can be finished within the expected time. The traverse routes and observation points were recorded in GPS as plotted in the map shown in Figure 4.6.

Each observation points that have been marked by GPS also were recorded in notebook for detailed description includes elevation, coordinate, strike and dip, lithology, rock sample's colour, vegetation, landform, structural geology, vegetation and weathering grades. Based on the Figure 4.6, about 45% of the study area have been traversed and observed during geological mapping. The certain part of the study area has not been traversing due to several challenging situation such as high slopes, and no accessibility.

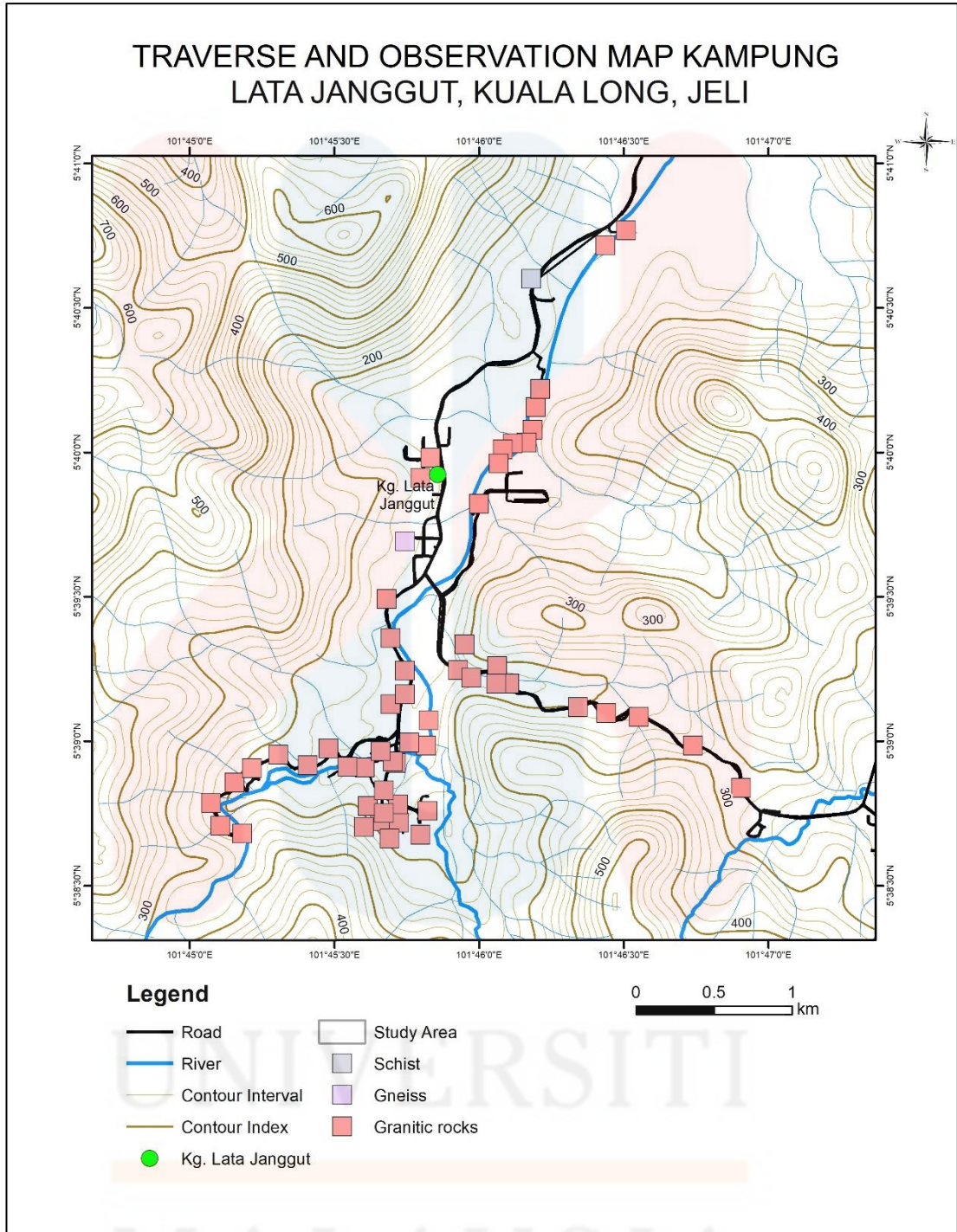


Figure 4.6: Traverse and observation point map of study area.

4.2 Geomorphology

Geomorphology section is discussed includes the topography classification, drainage pattern and weathering process that occurred in the study area. By observing the classify the geomorphology for a certain location, it can help to identify the different types of landscape and landform features and determine how the earth's landforms have changed physically over time. The geomorphology of a certain location in the study area has been identified and shown in Figure 4.7.



Figure 4.7: Plain and high hills landform in the study area.

4.2.1 Geomorphological Classification (Geomorphic Unit Map)

Geomorphology of the study area can be portrayed through topography, drainage pattern, differences in landform and valley shape that present in the study area. It is also included water morphology and vegetation in the study area. Geomorphology in the study area were analyzed during field studies, satellite imagery and topography map analysis.

4.2.2 Topography

Topography is essential in geomorphology study as it described and classified the different landforms and features in the study area. From the topography observation, topographic map can be generated which can be useful to shows the elevation of a landform and its contour pattern (Figure 4.8). The topography of the study area can be classified into two which are hilly and mountainous and gently rolling to very steeply undulating (Figure 4.9). Gently rolling slope is mostly at plain area covered low hills at centre part of study area. Meanwhile steeply undulating slope is covered high hills at north-west part of the study area.

The specific rock type at the surface is indicated by the topographical relief where certain rocks have difference resistance to weathering and erosion and are reflected by slope changes on topography. Very steep slopes indicate the rocks were resistant to weathering and erosion, while gentle slopes indicate rock that are less resistant to weathering and erosion. The granitic rocks and gneiss that are discovered in the study area are the group type of rocks that are very resistant to weathering and erosion where its occurs at steep slope and higher elevation.

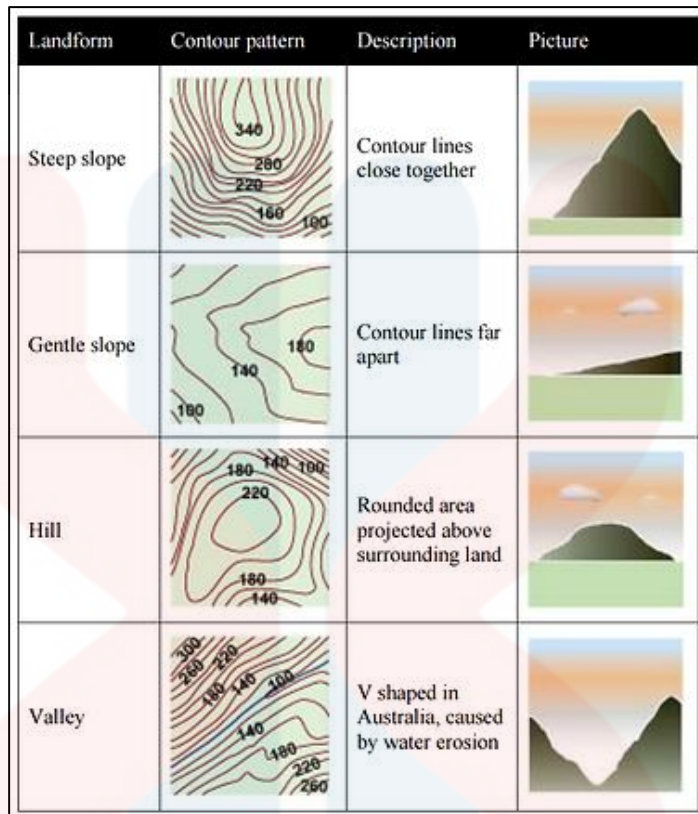


Figure 4.8: Landform and its contour pattern (Source: State of New Wales, Department of Education and Training, 2009)

Table 4.1: Classification of absolute height with morphology elements.

Absolute Height (meter)	Morphology Elements
<50	Lowlands
50-100	Inland Lowlands
100-200	Low Hills
200-500	Hills
500-1500	High Hills
1500-3000	Mountains
>3000	High Mountains

(Source: Van Zuidam, 1985)

All the study area’s morphological elements were identified and classified based on the particular contour elevation in Table 4.1. Based on the 3D landform

map in Figure 4.10, the most part of the study area is surrounded by hilly mountainous where the highest elevation is observed has reached over 700 meter which signify high hills. The high hills can be seen in the north-west and south-east part of the study area with elevation stretch from 500-700 meter.



TOPOGRAPHY MAP OF KAMPUNG LATA JANGGUT, KUALA LONG, JELI

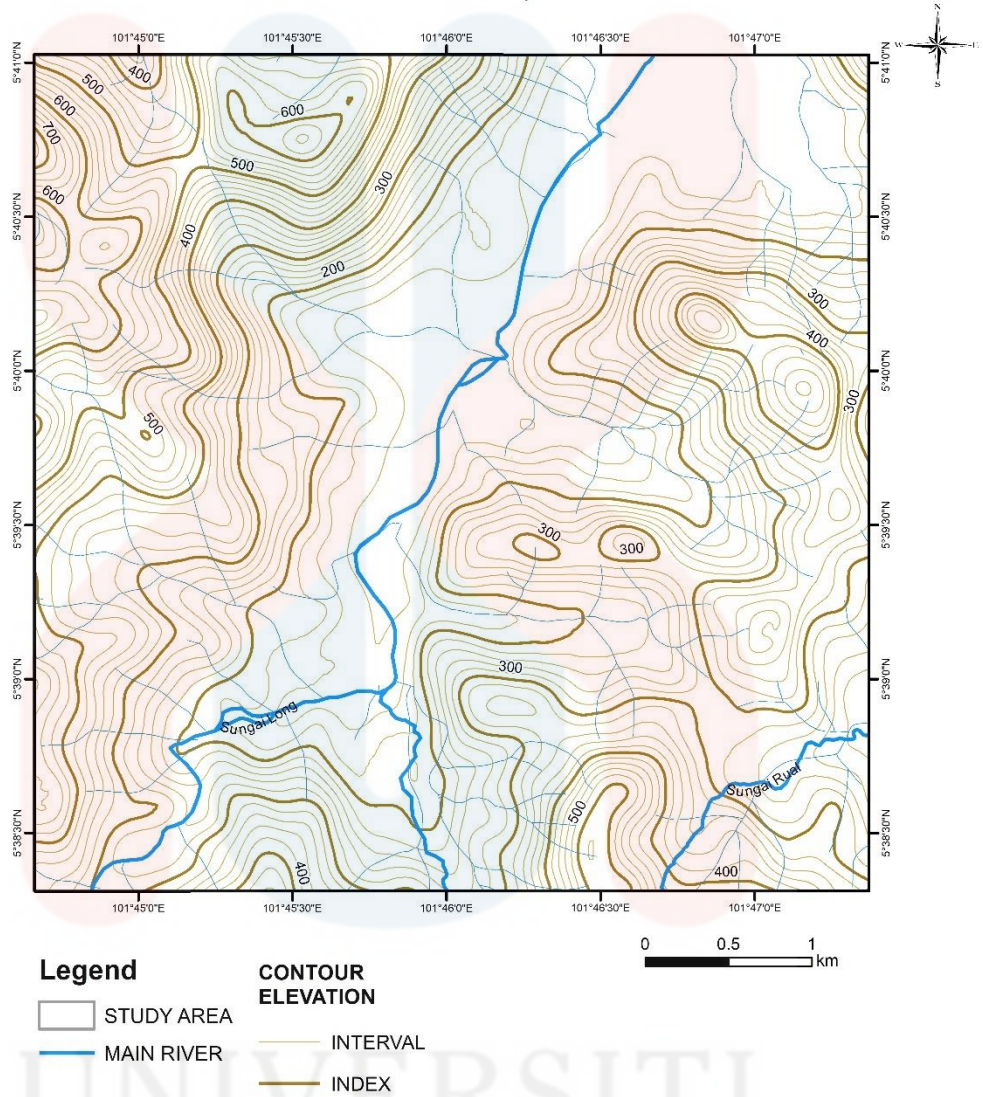


Figure 4.9: Topographic map of the study area.

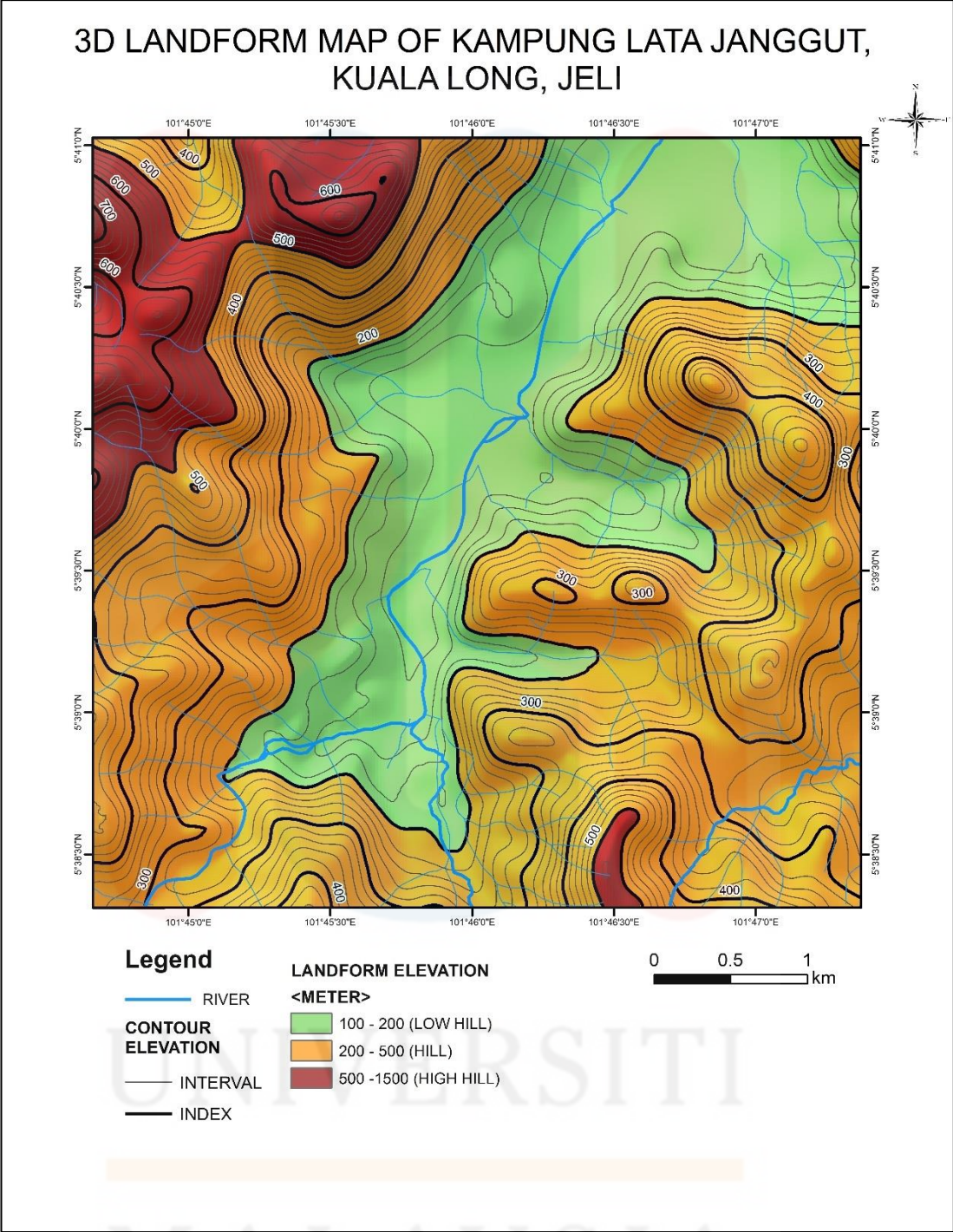


Figure 4.10: 3D landform map of the study area.

4.2.2 Weathering

Weathering describes the alteration of rocks at or near the earth's surface as a result of exposure to water, or organisms. Depending on the environment and other conditions, weathering can occur by physical or chemical processes. There are mainly three forms of weathering: physical, chemical, and biological. The main weathering process that can be found in the study area were physical and biological weathering.

Physical weathering is the processes that causes rocks to degrade without chemical alteration but it can change the rock shape. Physical weathering that develops in the study area is due to the temperature, pressure, abrasion by water and frost wedging.



Figure 4.11: Physical weathering of rock in the study area. (a) & (b) Abrasion/wear away by water along the river. (c) Caused by climate and pressure (d) Pot hole that caused by the frost wedging process.

Other than that, granitic outcrop surrounding Lata Hokkaido that were discovered along the river was exposed to the weathering process. Majority granitic outcrop and boulders in the river, cascade and hilly area were identified as slightly to moderately weathered due to the physical weathering agent, erosion and biological. Erosion mostly occurs when the flood river or rain wear down the rocks.

Apart from that, the outcrops and boulders also weathered by biological weathering where the rocks are disintegrated by plants, animals and microorganisms. Plants root, lichen or moss and algae are the biological agents that are mostly causes the weathering in the study area (Figure 4.12).



Figure 4.12: Biological weathering in the study area causes by tree, root plants, and black algae.

4.2.3 Drainage Pattern

In particular, the drainage pattern is generated by the rivers, streams and lakes in a specific drainage basin. The pattern formed by stream erosion over time exposes features of the types of rocks and geologic formations found in a stream-drained landscape region. The drainage pattern is determined by the land's topography, gradient, and whether a particular location is dominated by hard or soft rocks. Additionally, the geological history, rock type, rock structure, topography and slope will all affect an area's drainage pattern and reveal the geology of that area.

Study area drainage patterns can be distinguished into three type of drainage patterns. As shown in Figure 4.13, the Long River and the Rual River are the two major river that are included in the study area. Both river is flowing northward. Due to the hilly topography of Kampung Lata Janggut, the drainage system flows from the higher elevation areas to the lower elevation areas. The study area is mostly dominated by dendritic pattern and parallel patterns as well as minor sub-parallel patterns.

The study area is dominated by dendritic or tree-branch pattern where the water flowing westward. In general, parallel pattern shows a sloping area moderate to slightly steep and can be found in an elongated hilly landform. The formation of dendritic system develops in V-shaped valleys, thus it may be inferred that dendritic pattern occur in the study areas are underlain by homogenous material or non-porous rock types. Based on the observation, granite intrusive has good weathering resistance and the types of rock that form beneath this drainage pattern.

Additionally, parallel to sub parallel drainage pattern consists of a number of streams that run parallel to one another and follow the regional slope. The streams are swift and straight with few tributaries that all flowing in the same direction. This system develops in areas on very long, parallel or elongated landforms with a steep slope in the study area. From the drainage map analysis, parallel to subparallel pattern forms V-shaped valleys and the patterns is mainly occurs on centre of the study area with the water flowing towards Long River from steep high hills landform. These patterns are made of up metamorphic rock and some areas with presence of intrusive rocks.

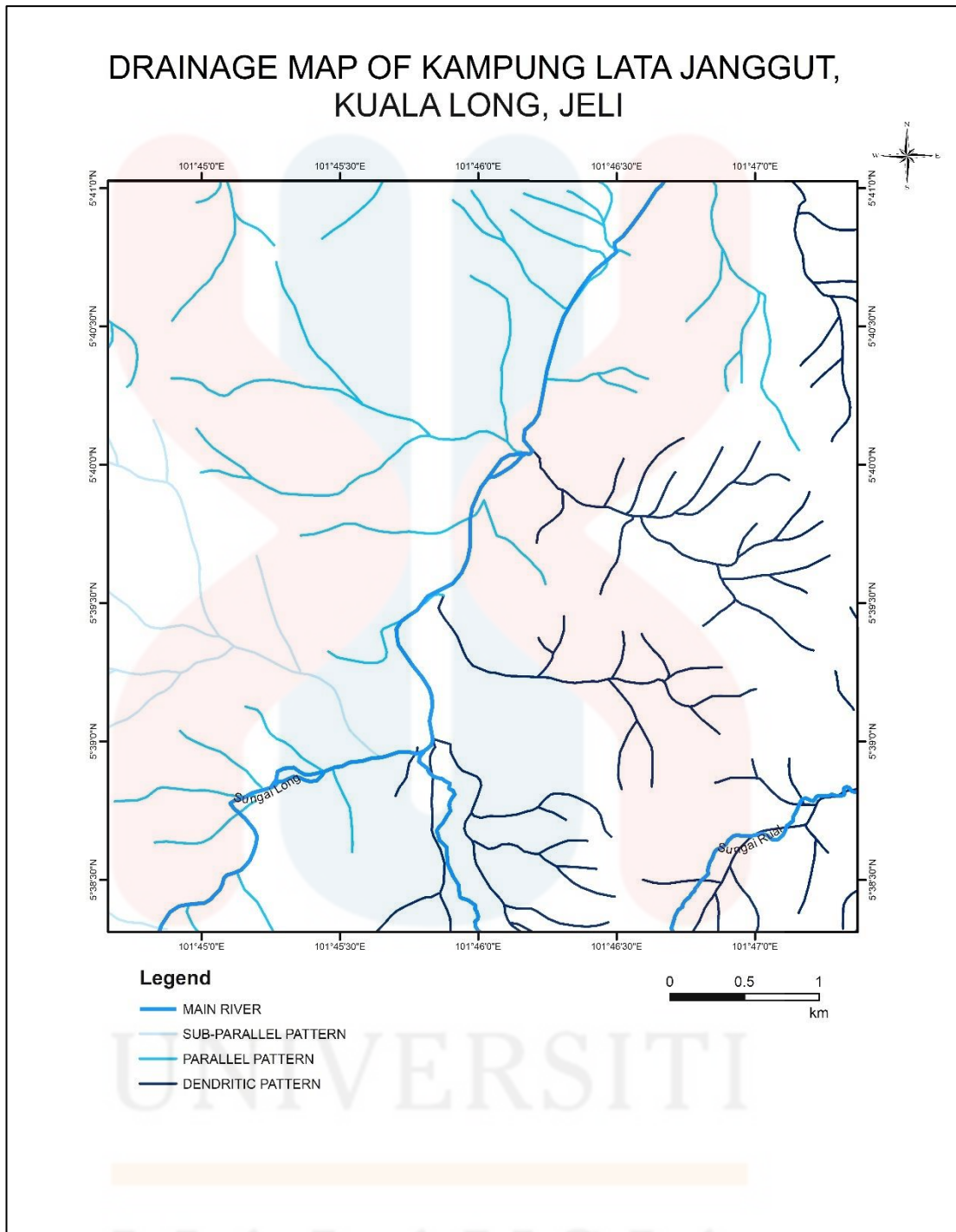


Figure 4.13: Drainage map of study the area.

4.3 Lithostratigraphy

In lithostratigraphy, the different types of rock units are characterised and arranged into categories according to the stratigraphic features they possess. The most fundamental component of geological features is called lithostratigraphic units. Other components of geological features include geological structure and bedding orientation. The analysis and interpretation of the contour topography, slope gradient, and water system are used to establish the rock unit's lithology.

4.3.1 Stratigraphic Position

Stratigraphy is the study of rock succession and their interpretation in relation to determining geologic time that are involved. It is also significant as a part of historical geology, as stratigraphy column deals and concerned with compositions, formation, correlation unit of the sequences or the entire sequence of stratified rock and sediments. The law of superposition, which states that in every undisturbed deposit, the oldest layers are often found at the lowest level, is a main principle in the application of stratigraphy.

According to Singh et al. (1984) the Stong Complex is the igneous complex composed of three sub-units in order of decreasing age; the Berangkat Tonalite, the Kenerong Leucogranite and the Noring Granite, where the earliest two being highly deformed. The Berangkat Tonalite, the earliest intrusion, is a mafic, megacrystic tonalite with a biotite and hornblende matrix and massive K-feldspar crystals. The Kenerong Leucogranite, which was formed in a subsequent intrusive episode and consists of a sequence of crosscutting veins made of leucogranite and biotite granite, cuts the Berangkat Tonalite.

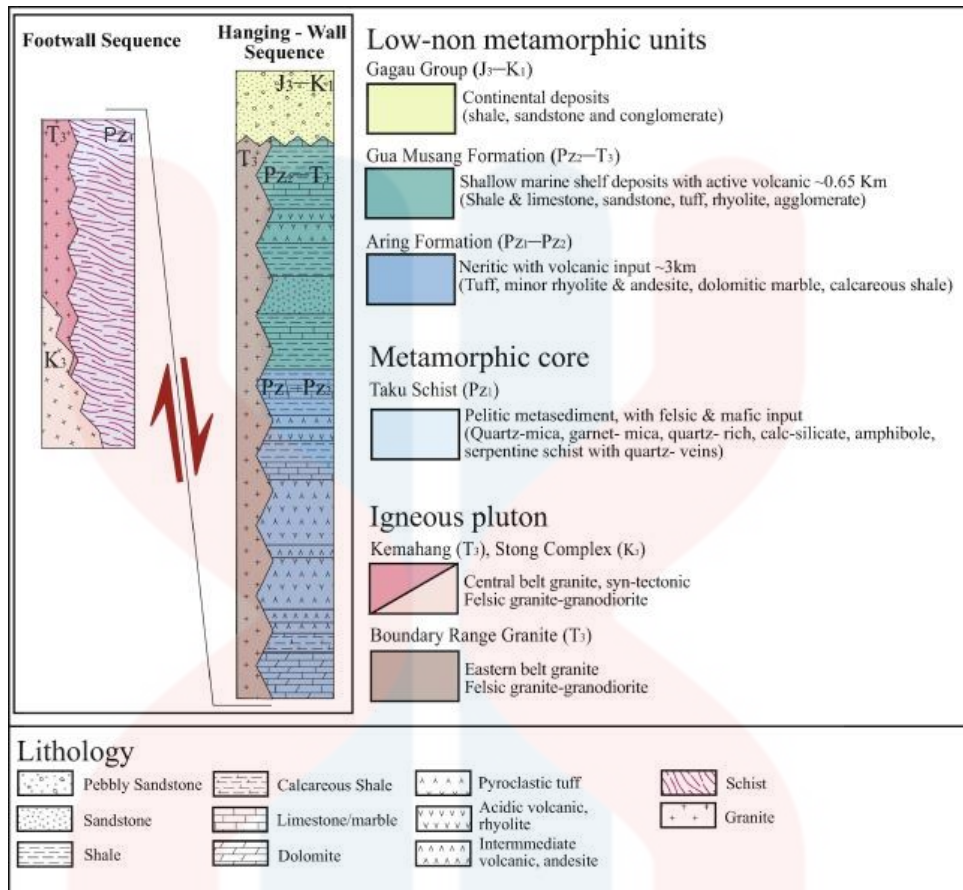


Figure 4.14: Stratigraphic plot of the Stong complex and the surrounding units (Source: Muhammad Afiq Md. Ali et al., 2018)

Unlike the most recently emplaced block, the Noring Granite, both the Berangkat Tonalite and the Kenerong Leucogranite display metamorphic foliation. The latter make up the bulk of the sub-plutonic structure, and they are characterised by pink megacrystic biotite granite abundant in massive K-feldspar crystals. Zones of thick biotite schlieren are discovered at the contact between the Noring Granite and the older Kenerong Leucogranite. Similarities in mineralogy and texture between the Berangkat tonalite and the Noring Granite indicate that they are both I-type signature granitoids of the Eastern Belt (Ghani, 2000, 2009).

According to Ng et al. (2015), ages within three sub-units of the Stong Complex define Late Triassic ages for Berangkat Tonalite (231.8 ± 1.8 Ma),

whereas Late Cretaceous ages for the Kenerong Leucogranite (83.9 ± 0.8 Ma) and the Noring Granite (75.7 ± 0.6 Ma). The study area which located at Kampung Lata Janggut is a part of Noring Granite formation, therefore indicate the age of igneous (acid intrusive) from study area is from Late Cretaceous. The oldest formation is formed by Mangga formation with age from period Carboniferous, whereas the distribution of rocks that have been identified in the study area is metamorphic rocks.

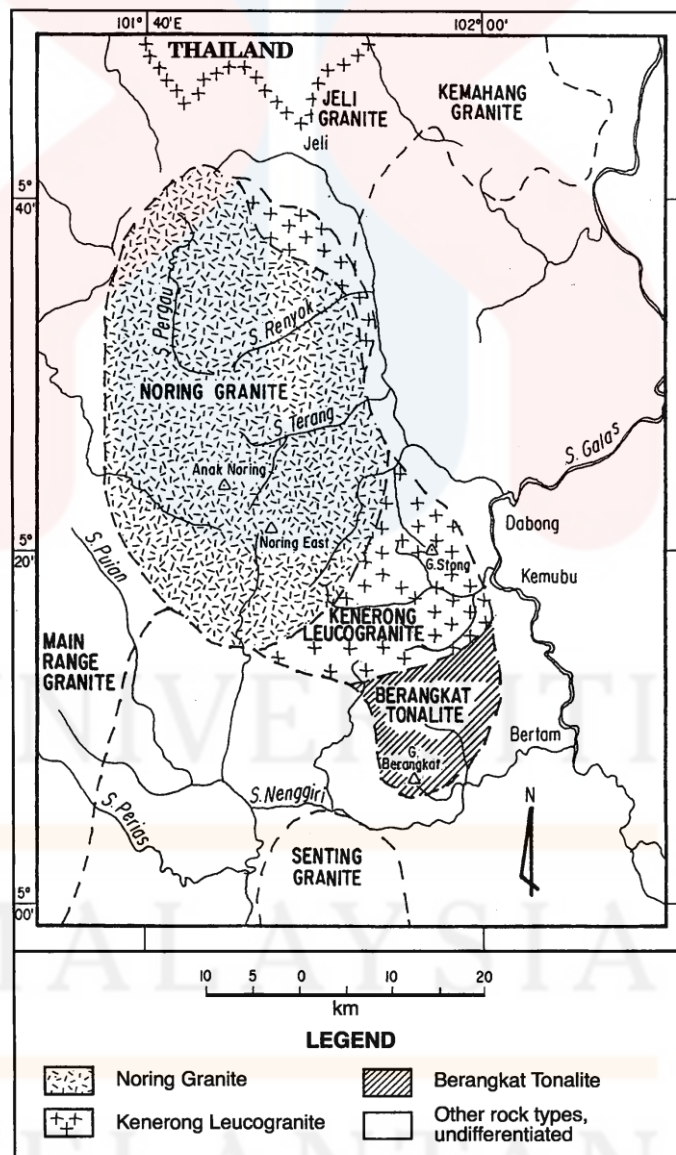


Figure 4.15: Map of Stong Complex and its sub-units. (Source: Singh et al., 1984)

Based on the primary data of geological mapping and previous literature, the formation, ages and distribution of the rock type of the study area was identified. The study area is consisting of schist unit, gneiss unit, and acid intrusive unit. Further explanation is shown in the geological map in Figure 4.16 and stratigraphic column found in Table 4.2.



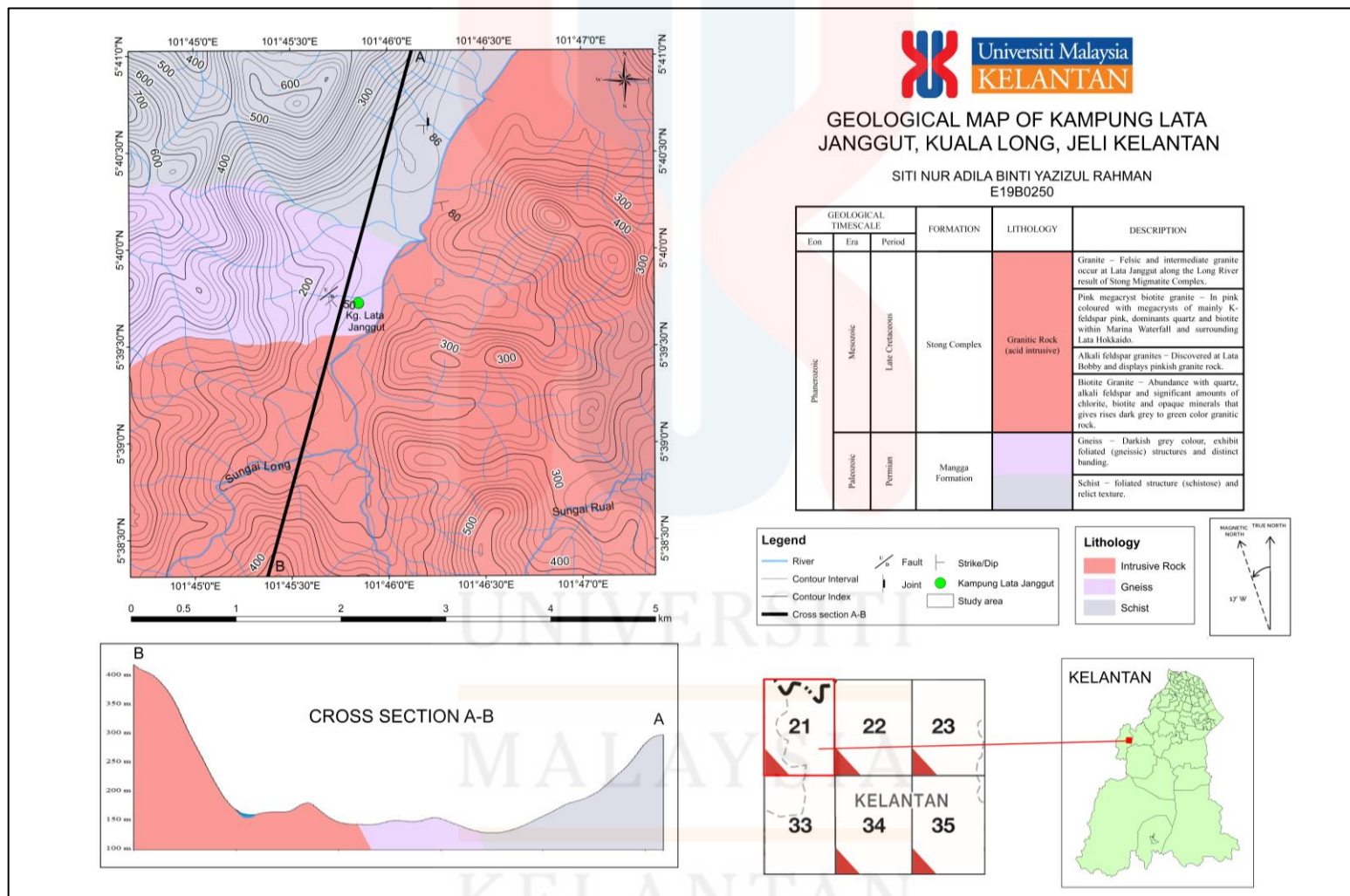


Figure 4.16: Geological map of study area.

Table 4.2: Lithostratigraphy column of study area.

GEOLOGICAL TIMESCALE			FORMATION	LITHOLOGY	DESCRIPTION
Eon	Era	Period			
Phanerozoic	Mesozoic	Late Cretaceous	Stong Complex	Granitic Rock (acid intrusive)	Granite – Felsic and intermediate granite occur at Lata Janggut along the Long River result of Stong Migmatite Complex.
					Pink megacryst biotite granite – In pink coloured with megacrysts of mainly K-feldspar pink, dominants quartz and biotite within Marina Waterfall and surrounding Lata Hokkaido.
					Alkali feldspar granites – Discovered at Lata Bobby and displays pinkish granite rock.
	Paleozoic	Permian	Mangga Formation		Biotite Granite – Abundance with quartz, alkali feldspar and significant amounts of chlorite, biotite and opaque minerals that gives rises dark grey to green color granitic rock.
Gneiss – Darkish grey colour, exhibit foliated (gneissic) structures and distinct banding.					
					Schist – foliated structure (schistose) and relict texture.

4.3.2 Unit explanation

a) Schist Unit

A metamorphic rock with medium-sized grains that exhibits considerable schistosity. 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 orientated in such a way that the rock may be easily broken into thin flakes or plates. Schist also a rock that has been subjected and exposed to moderate levels of heat and pressure during metamorphism.

The outcrop is situated beside East-West Highway road, at low hilly area. The outcrop formed small waterfall within its bodies in Figure 4.17 (a). The schist is discovered in the study area were in foliated structure (schistose) which can be seen in Figure 4.17 (b). The rock is light in colour and develop joints structure.

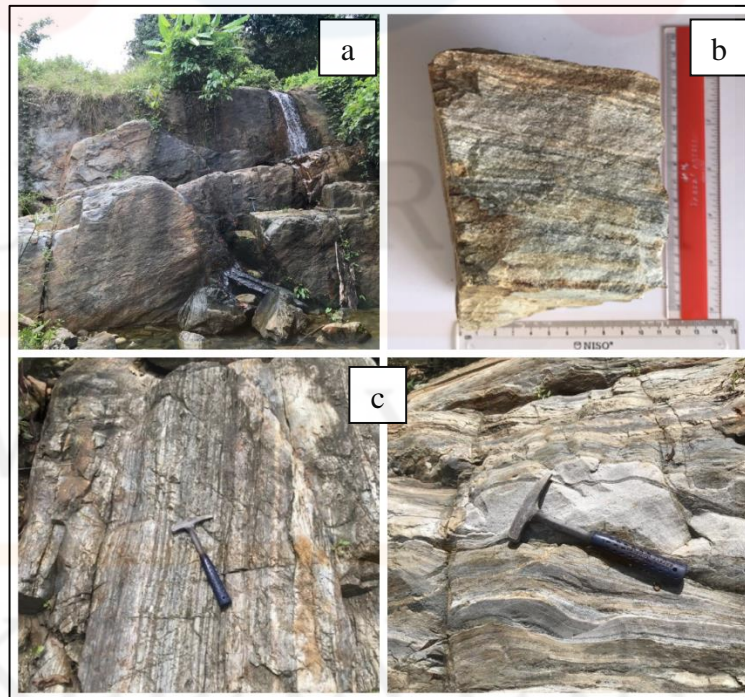
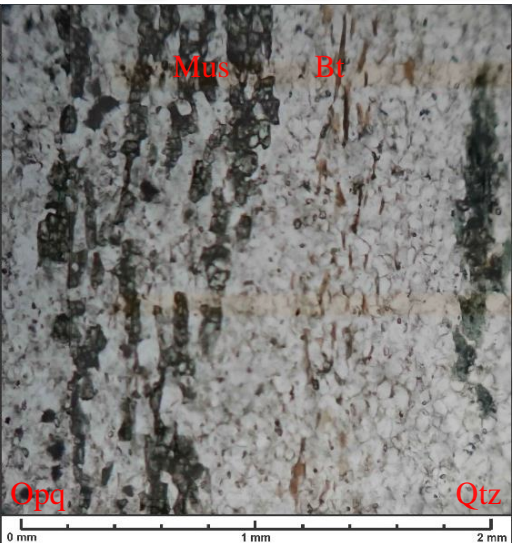
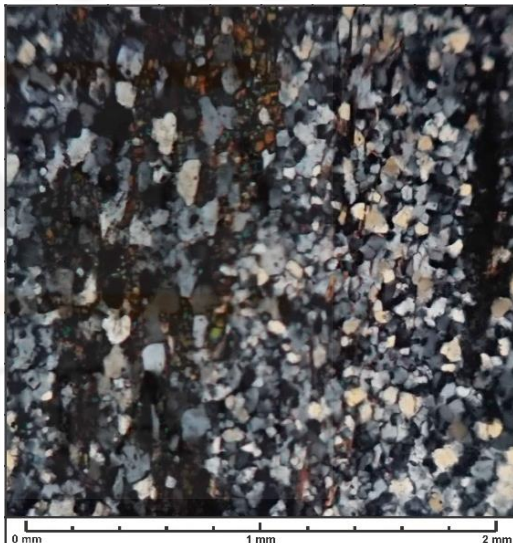


Figure 4.17: (a) Schist outcrop formed small waterfall. (b) In hand specimen of foliated schist.
(c) Schist exhibits strong foliation

The mineral composition of schist under thin section can be defined and explain further, whereas plane (PPL) and cross polarization (XPL) is observed under thin section in Table 4.3.

Table 4.3: Description of schist rock.

Sample code	: A-D2-S3	Location: E-W Highway
Coordinate	: 5° 39' 15" N, 101° 45' 57" E	
Rock name	: Schist	
Colour	: Light colour, greyish	
Structure	: Foliated (schistose)	
Texture	: Relict texture	
Groundmass	: Medium, fine-medium grain sized with moderate sorting	
Thin Section Analysis		
Minerals	%	Description
Quartz (Qtz)	77	PPL: Low relief, no pleochroism, anhedral, no cleavage, colourless. XPL: grey to white, wavy extinction.
Muscovite (Mus)	20	PPL: brownish colour, moderate relief, strong pleochroism, subhedral – euhedral, exhibit perfect cleavage. XPL: yellow to orange colour.
Biotite (Bio)	2	PPL: brown to greenish colour, moderate relief, strong pleochroism, subhedral – euhedral, perfect cleavage. XPL: green to orange colour.
Opaque (Opq)	1	PPL: euhedral – anhedral, low relief, no pleochroism, black colour under PPL and XPL.
Description		
Schist rock shows relict texture, this textures are inherited from the original rock type that survived from metamorphism and exhibit foliated structure.		
PPL (Plane Polarized Light)		XPL (Cross Polarized Light)
		

(a) Gneiss Unit

Gneiss is foliated metamorphic rock with bands and lenses of variables minerals composition. Gneiss can be distinguished by its banded appearance and texture rather than mineral composition. Gneiss in the study area is discovered at settlement area, along unpaved road. From the field observation, the outcrop was moderately weathered by physical and biological agents.

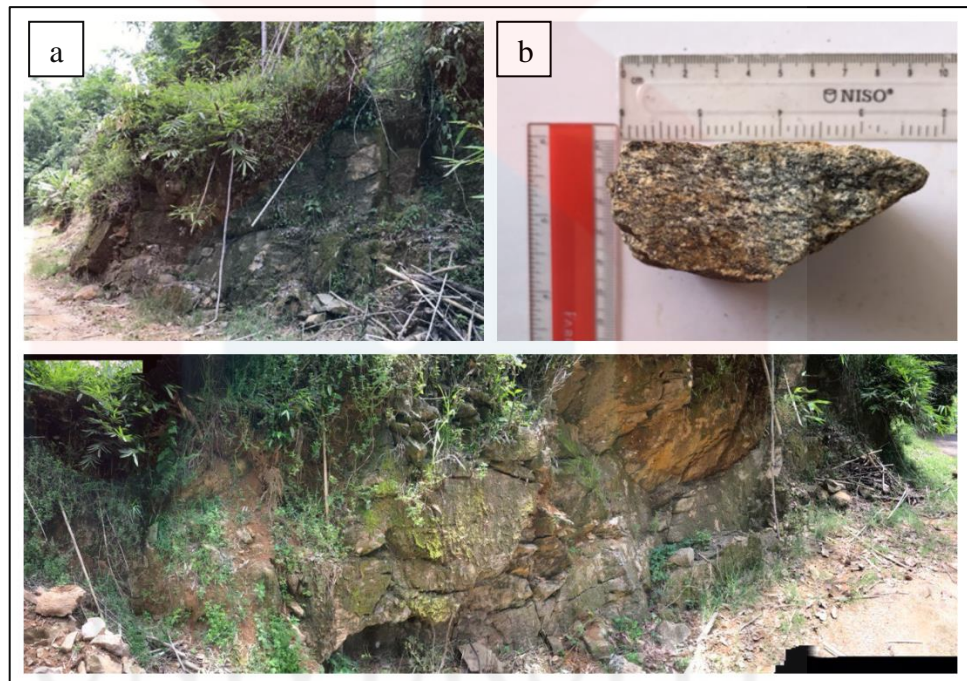
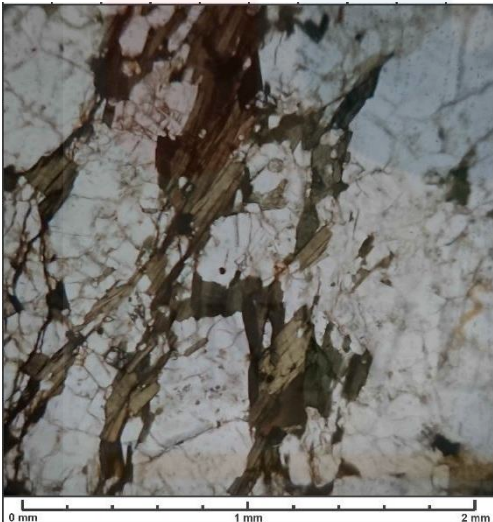
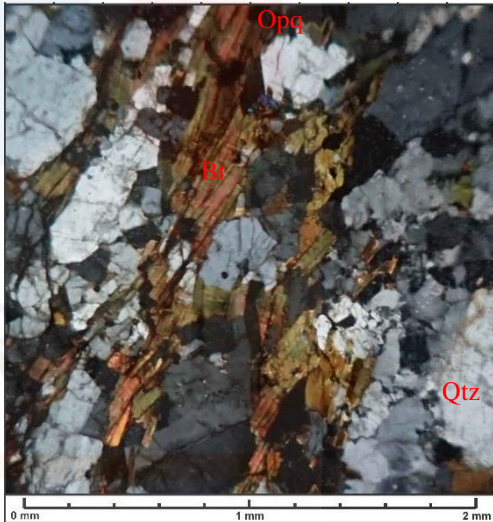


Figure 4.18: (a) Gneiss outcrop in the study area. (b) In hand specimen of gneiss.

(c) Outcrop gneiss extend about 15m long.

The mineral composition of gneiss under thin section can be defined and explain further, whereas plane (PPL) and cross polarization (XPL) is observed under thin section in Table 4.4.

Table 4.4: Description of gneiss rock.

Sample code	: A-D1-S2	Location: Settlement area
Coordinate	: 5° 39' 42" N, 101° 45' 45" E	
Rock name	: Gneiss	
Colour	: Dark colour	
Structure	: Foliated (gneissic)	
Texture	: Crystalloblastic (porphyroblastic) texture	
Groundmass	: Fine-medium grained with moderate sorting.	
Thin Section Analysis		
Minerals	%	Description
Quartz (Qtz)	70	PPL: colourless, low relief, anhedral, no pleochroism and cleavage. XPL: grey to white, wavy extinction.
Biotite (Bio)	25	PPL: brown to greenish colour with moderate relief, strong pleochroism, subhedral – euhedral, perfect cleavage. XPL: green to orange colour.
Opaque (Opq)	5	PPL: euhedral – anhedral shape, low relief, no pleochroism, black colour under PPL and XPL.
Description		
Schist rock is fine grained with distinct banding appearance and exhibit foliated structure.		
PPL (Plane Polarized Light)		XPL (Cross Polarized Light)
		

(c) Granitic Rock (Acid Intrusive)

Granitic rock in the study area is a part of Stong Complex with Granite Noring lithology unit. From the geological mapping and petrographic analysis, four types of granite acid intrusive had been identified; (i) granite (ii) pink megacryst biotite granite (iii) alkali feldspar granite (iv) alkali feldspar biotite granite. To differentiate between alkali feldspar granite and alkali feldspar biotite granite is with based on the composition of the feldspar group mineral, plagioclase and orthoclase where biotite granite has moderately high of plagioclase mineral composition on it. All granitic rocks in the study area were exhibits in the same lithology with same dominant mineral composition. The calculation for IUGS classification is shown in Appendix A.

All granitic outcrops were found in different places such as Lata Janggut, Lata Hokkaido, Marina waterfall and Lata Bobby areas. According to Singh et al, (1984), all the coarse grained granite is a part of Noring Granite (Stong Complex), where had been divided into two facies which is Terang facies and Belimbing facies. This facies division is based on the presence of biotite mafic and biotite hornblende minerals. The granitic rocks discovered in the study area is composed of quartz, K-feldspar and biotite, thus indicated all the granitic rocks in the study area is part of Terang facies.

i. Granite

This batholith granite body is a part Lata Janggut which was formed as a result of Noring Granite magma penetration which is 69-75 million years in

the Stong Migmatite Complex, the surface of this granitic bodies is smooth. Grey colour of granite is intermediate igneous rock while the felsic is dominant at there. There were also quartz veins as a secondary mineral that deposited into it. The occurrence of pot holes can be found at the cascade surface due to the erosion and weathering process that took million years to form.

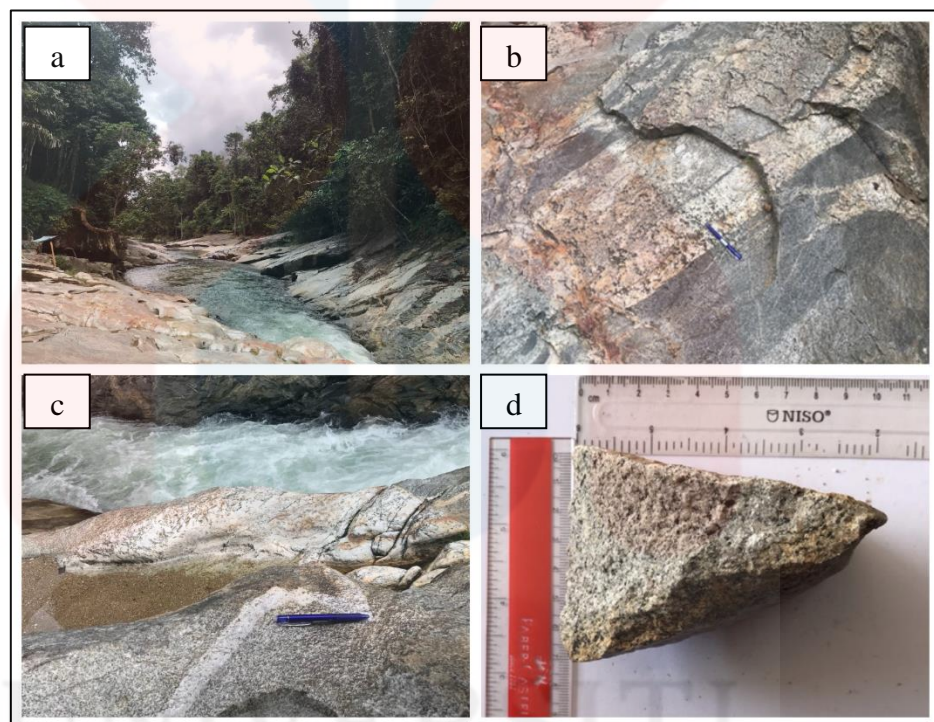

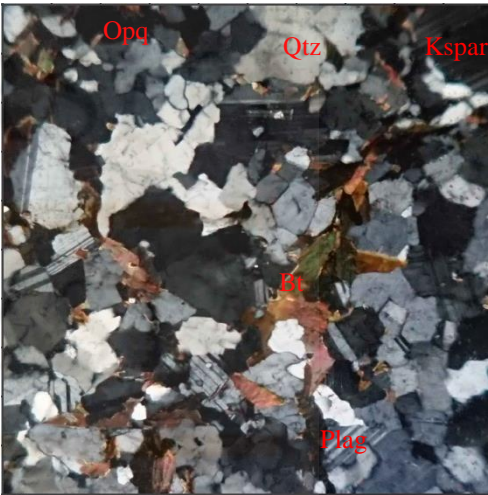


Figure 4.19: (a) Granite bodies at Lata Janggut. (b) Close up view. (c) Quartz vein.
(d) In hand specimen.

Table 4.5 shows plane and cross polarized view of granite under thin section and its minerals composition description.

Table 4.5: Description of granite rock.

Sample code	: A-D1-S4	Location: Lata Janggut
Coordinate	: 5° 40' 9" N, 101° 46' 12.5" E	
Rock name	: Granite	
Colour	: Light colour, white, grey	
Structure	: Massive	
Texture	: Phaneritic	
Groundmass	: Coarse to medium	
Thin Section Analysis		
Minerals	%	Description
Quartz (Qtz)	50	PPL: colourless, low relief, anhedral, no pleochroism. XPL: grey to white, wavy extinction, no twinning.
Feldspar (Kspar)	32	PPL: colourless, low relief, no pleochroism, subhedral – anhedral, perfect cleavage. XPL: grey – white, polysynthetic twinning.
Plagioclase (Plag)	8	PPL: Colourless, no pleochroism, euhedral – anhedral, perfect cleavage. XPL: grey-white colour, polysynthetic twinning.
Biotite (Bio)	8	PPL: brown to greenish colour, moderate relief, strong pleochroism, subhedral – euhedral, perfect cleavage. XPL: green to orange colour.
Opaque (Opq)	2	PPL: euhedral – anhedral shape, low relief, no pleochroism, black colour under PPL and XPL.
<p>Description</p> <p>The hand specimen is moderately fresh and phaneritic, with all the minerals can be observed with naked eyes. Based on the IUGS Classification in Appendix A (i), the rock is named as Granite.</p>		
<p>PPL (Plane Polarized Light)</p> 		<p>XPL (Cross Polarized Light)</p> 

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ii. Pink Megacryst Biotite Granite

This kind of granitic rock is called pink megacryst biotite granite due to the resembled of its mineral within. From field observations, the occurrences of this granitic bodies are discovered in Lata Bobby and dispersed randomly surrounding Lata Hokkaido and hilly area. Hand specimen of this granitic rocks is characteristically in pink coloured and porphyritic with megacrysts of mainly K-feldspar pink, dominants quartz and lesser biotite set in a medium to coarse grained groundmass (Figure 4.20).



Figure 4.20: (a) Marina waterfall with granitic bodies. (b) Granitic outcrop and several quartz veins. (c) Outcrop at Lata Hokkaido (d) In hand specimen.

From the microscopic observation, plane (PPL) and cross polarization (XPL) of pink megacryst biotite granite thin section is shown in Table 4.6.

Table 4.6: Description of pink megacryst biotite granite.

Sample code	: A-D1-S1 A-D3-S1	Location: Lata Hokkaido Marina Waterfall
Coordinate	: 5° 38' 44" N, 101° 45' 39.7" E 5° 38' 47" N, 101° 45' 10.9" E	
Rock name	: Pink megacrysts biotite granite	
Colour	: Light pink, dark (mica group)	
Structure	: Massive	
Texture	: Phaneritic	
Groundmass	: Coarse to medium mineral size.	
Thin Section Analysis		
Minerals	%	Description
Quartz (Qtz)	35	PPL: colourless, low relief, anhedral, no pleochroism. XPL: grey to white, wavy extinction, no twinning.
Feldspar (Kspar)	14	PPL: colourless, low relief, no pleochroism, subhedral – anhedral, perfect cleavage. XPL: grey – white, polysynthetic twinning.
Plagioclase (Plag)	16	PPL: Colourless, no pleochroism, euhedral – anhedral, perfect cleavage. XPL: grey-white colour, polysynthetic twinning.
Biotite (Bio)	20	PPL: brown to greenish colour, moderate relief, strong pleochroism, subhedral – euhedral, perfect cleavage. XPL: green to orange colour.
Chlorite (Chl)	14	PPL: green, low-moderate relief, weak-moderate pleochroism, anhedral-subhedral. XPL: grey to dark green colour
Opaque (Opq)	1	PPL: euhedral – anhedral shape, low relief, no pleochroism, black colour under PPL and XPL.
Description		
<p>This granitoid bodies is a fresh rock, distinctive coarse-grained granite with large pink orthoclase feldspar and black mica group. Since pink megacryst K-spar minerals is abundance with significant amounts of biotite mineral and based on the IUGS Classification in Appendix A (ii), the rock is named as Pink Megacrysts Biotite Granite.</p>		
PPL (Plane Polarized Light)		XPL (Cross Polarized Light)

iii. Alkali Feldspar Granite

Alkali feldspar granites are K-feldspar rich end member of granites. It is a dense rock with a phaneritic texture. This type of granitic rocks can be discovered at Lata Bobby. Quartz is abundance in this granitic rock composition. Due to the high K-feldspar minerals content, this rock displays a pinkish granitic rock with mafic black minerals (Figure 4.21).

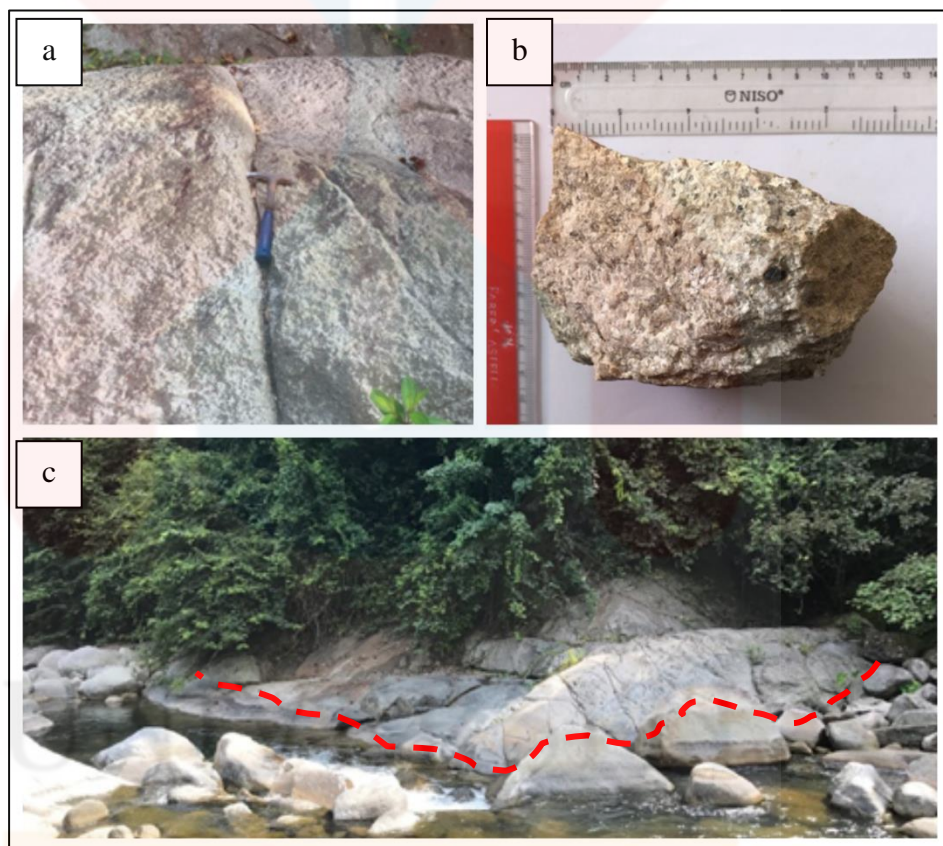
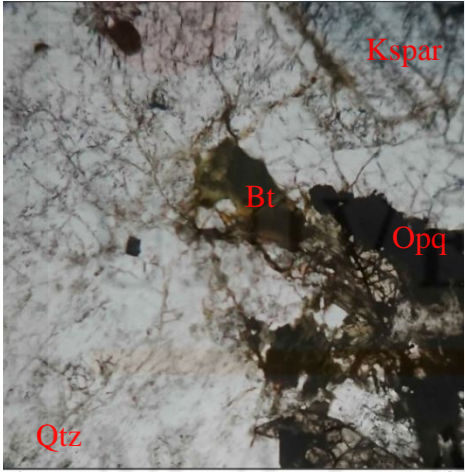
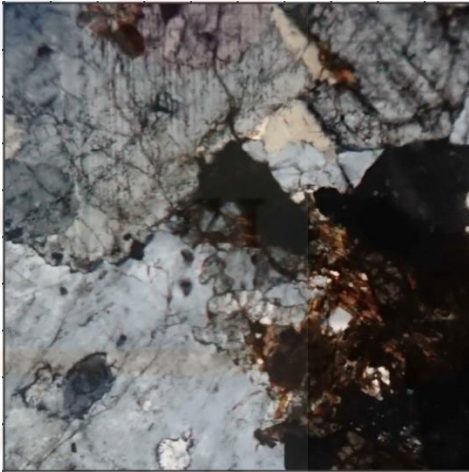


Figure 4.21 (a) Close up view of granitoid bodies. (b) In hand specimen. (c) Alkali feldspar granite bodies at Lata Bobby.

From the microscopic observation, plane (PPL) and cross polarization (XPL) of granitic rock thin section is shown in Table 4.7.

Table 4.7: Description of alkali feldspar granite.

Sample code	: A-D3-S2	Location: Lata Bobby
Coordinate	: 5° 38' 40" N, 101° 40' 10.9" E	
Rock name	: Alkali feldspar granite	
Colour	: Light colour, pinkish	
Structure	: Massive	
Texture	: Phaneritic	
Groundmass	: Coarse to medium mineral size.	
Thin Section Analysis		
Minerals	%	Description
Quartz (Qtz)	48	PPL: colourless, low relief, anhedral, no pleochroism. XPL: grey to white, wavy extinction, no twinning.
Feldspar (Kspar)	41	PPL: colourless, low relief, no pleochroism, subhedral – anhedral, perfect cleavage. XPL: grey – white and exhibit polysynthetic twinning.
Biotite (Bio)	8	PPL: brown to greenish colour, moderate relief, strong pleochroism, subhedral – euhedral, perfect cleavage. XPL: green to orange colour.
Opaque (Opq)	3	PPL: euhedral – anhedral shape, low relief, no pleochroism, black colour under PPL and XPL.
<p>Description Since K-spar minerals is abundance and based on the IUGS Classification in Appendix A (iii), the rock is named as Alkali Feldspar Granite. Alkali feldspar granite is felsic plutonic igneous rocks which are consisting of quartz and K-feldspar with more than 20%.</p>		
<p>PPL (Plane Polarized Light)</p> 		<p>XPL (Cross Polarized Light)</p> 

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iv. Biotite Granite

This granitic rock bodies were discovered at settlement and hilly rubber plantation area. From field observation and in hand specimen, the outcrop is dark in colour with phaneritic texture. Beside, abundance with quartz and alkali feldspar, this rock also contains significant amounts of chlorite, biotite, opaque minerals that gives rises the rock appearance grey to green colour as shown in (Figure 4.18).

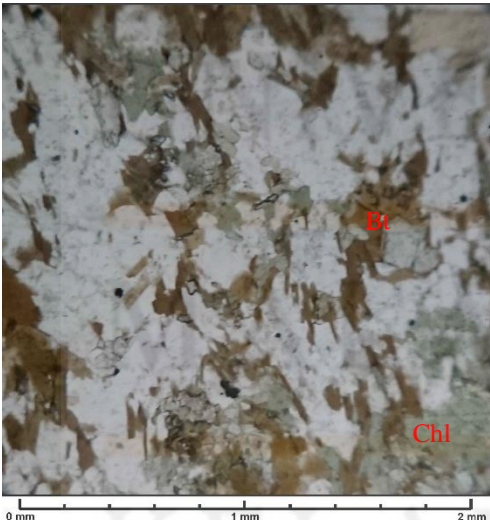
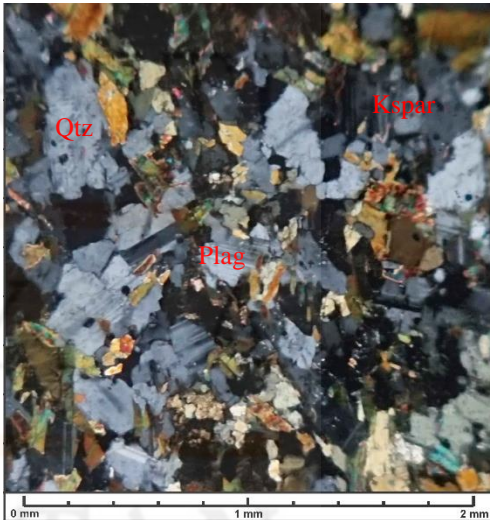


Figure 4.22: (a) Biotite granite bodies at hilly rubber plantation area. (b) In hand specimen.

Table 4.8 shows plane and cross polarized view of granitic rock under thin section and its minerals composition description.

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Table 4.8: Description of biotite granite.

Sample code	: A-D4-S3	Location: Rubber plantation area
Coordinate	: 5° 39' 29" N, 101° 45' 40" E	
Rock name	: Biotite granite	
Colour	: Dark colour, grey, green	
Structure	: Massive	
Texture	: Phaneritic	
Groundmass	: Coarse to medium	
Thin Section Analysis		
Minerals	%	Description
Quartz (Qtz)	35	PPL: colourless, low relief, anhedral, no pleochroism. XPL: grey to white, wavy extinction, no twinning.
Feldspar (Kspar)	16	PPL: colourless, low relief, no pleochroism, subhedral – anhedral, perfect cleavage. XPL: grey – white, polysynthetic twinning.
Plagioclase (Plag)	22	PPL: Colourless, no pleochroism, euhedral – anhedral, perfect cleavage. XPL: grey-white colour, polysynthetic twinning.
Biotite (Bio)	17	PPL: brown to greenish colour, moderate relief, strong pleochroism, subhedral – euhedral, perfect cleavage. XPL: green to orange colour.
Chlorite (Chl)	10	PPL: euhedral – anhedral shape, low relief, no pleochroism, black colour under PPL and XPL.
Description		
This granitoid is in fresh with dark grey to green. Since biotite minerals is abundance and based on the IUGS Classification in Appendix A (iv), the rock is named as Biotite Granite.		
PPL (Plane Polarized Light)		XPL (Cross Polarized Light)
		

4.4 Structural Geology

Structural geology is a subdiscipline of geology that studies how large bodies of rock are arranged in three dimensions, how rocks deform in response to the stresses that act within the Earth, as well as their surface and the composition of that units. Especially to learn about the history of tectonic movements, past geological events, and environments that could have changed the rocks. These can be used to figure out when certain parts of the structure were made.

In particular, there are two categories of geological structure: primary structure and secondary structure. During the development of rocks, the primary geological structure was established. Otherwise, the secondary structure is developed after an external force has been applied to a rock formation.

The presence of bedding and lamination indicates that rocks contain primary structure. In the meanwhile, rocks are thought to have secondary structure if they exhibit folding and cracks. In geology terminology, a fracture is any separation. Joints and faults, for instance, split the rock into two or more distinct pieces. Fractures are often caused by stresses that exceed the rock's strength limit, causing the rock to lose cohesiveness along its weakest plane.

4.4.1 Lineament Analysis

Based on the lineament analysis, structure in the study area can be predicted and locate the underlying geological structure. The lineament analysis can be done by preliminary study and compared it with geological mapping observation.

Based on the extraction of structural lineaments from images derived from SRTM – DEM, manual digitized of lineaments were identified. From the rose diagram analysis, the dominant direction of the positive and negative lineament in the study area is in the Northwest direction.

Generally, lineaments maps of study area show positive lineament which indicate any linear feature such as linear hill (Figure 4.23) and negative lineament (Figure 4.24) related to brittle structures, expressed by river and valley systems which indicate there is structures that resulting the expression such as joints and minor faults that has been found in the study area.

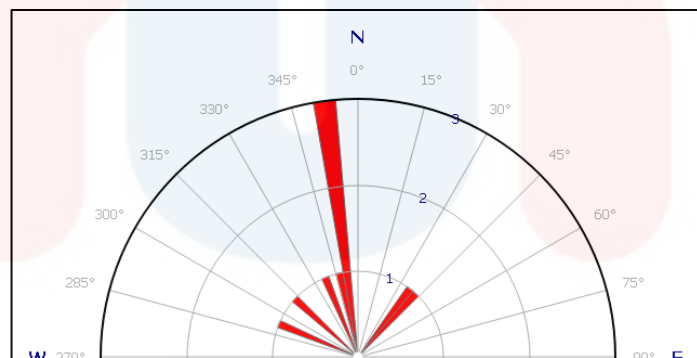


Figure 4.23: Positive lineament in the study area.

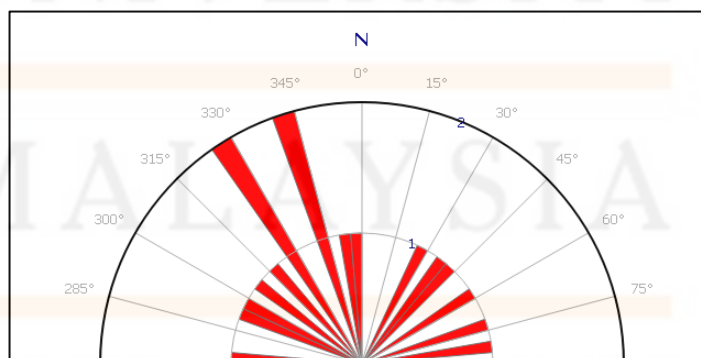


Figure 4.24: Negative lineament in the study area

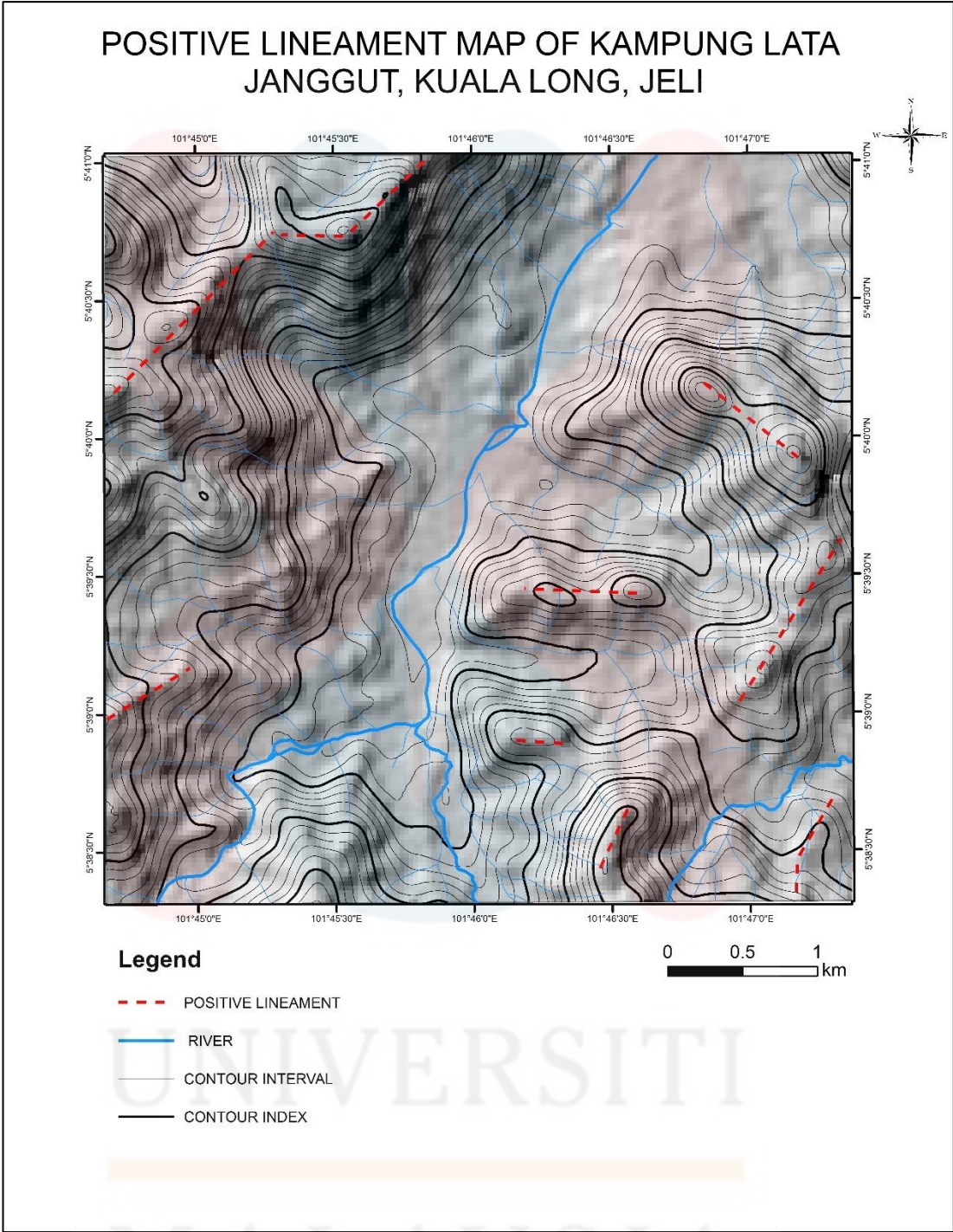


Figure 4.25: Positive lineament map of study area

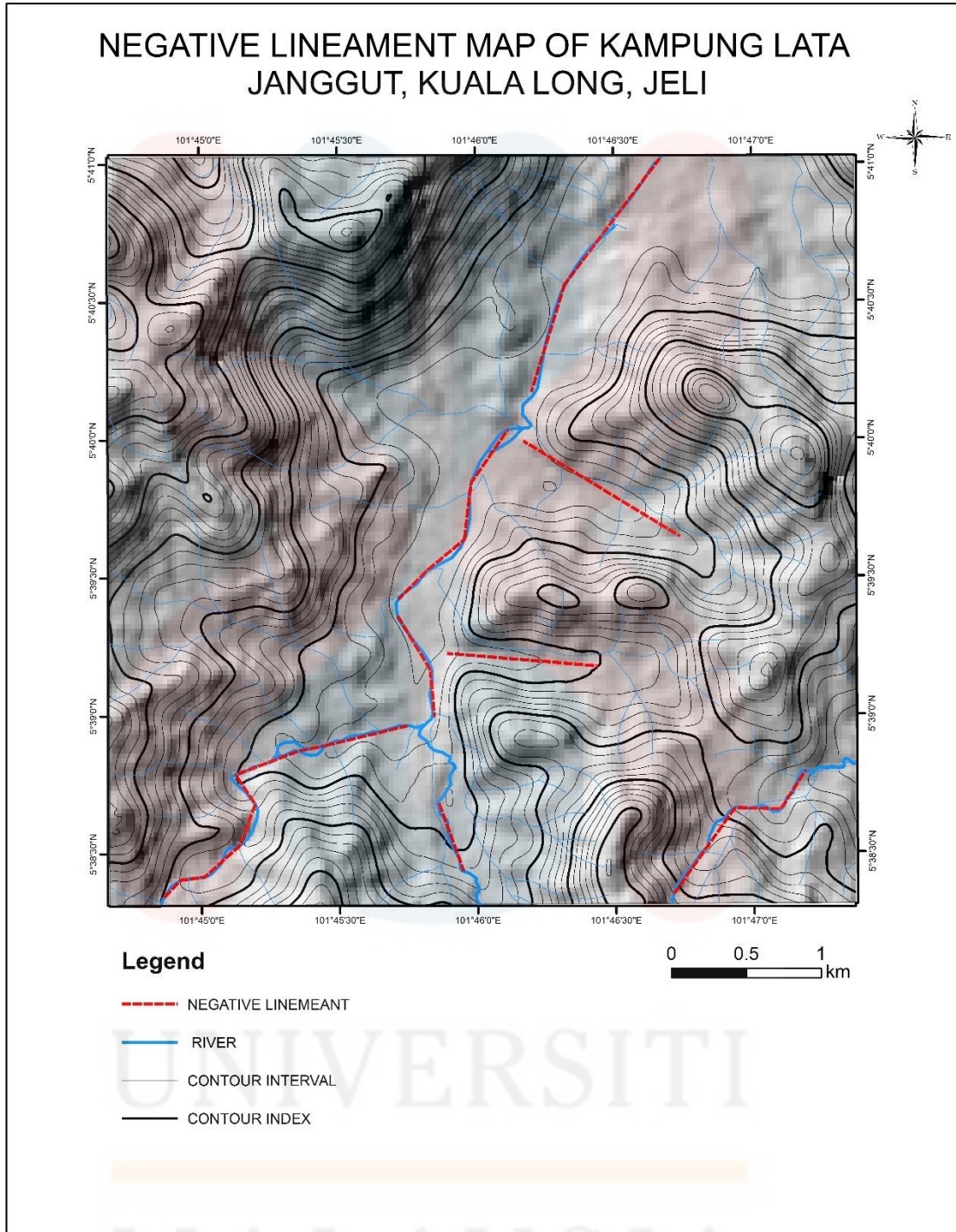


Figure 4.26: Negative lineament map of study area

4.4.2 Joint Analysis

Joints are fissures or fractures in rocks that have not been displaced. Joints are produced when rocks compress as a result of heating or compaction. From field study, joints formed on schist bodies can be classified as tension joints. Joints that have been developed as a result of tension forces are referred to as tension joints. These joints are rather open and have surfaces that are rough and uneven in appearance. The joints that have been found in the study area was located beside main road East-West Highway, on shist bodies that formed small waterfall. From the joint analysis in Figure 4.28, the greatest stress direction, σ_1 is from North-West (NW) direction.



Figure 4.27: Joints on schist outcrop

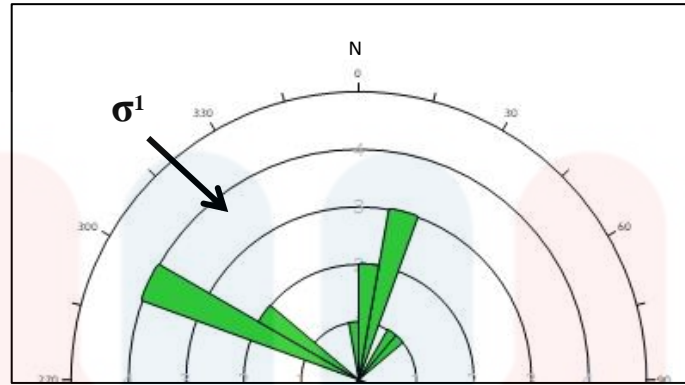


Figure 4.28: A joint analysis at schist rock

4.4.3 Fault Analysis

Geological structures that can be found in the study area is fault. Fault is a planar fracture that demonstrates significant movement or displacement as a result of the movement of rock mass. Minor fault can be observed within this gneiss outcrop. It may be associated with formation of major fault along Sungai Long that situated in the study area called as Long Fault. From the fault analysis in Figure 4.30, the greatest stress direction, σ_1 is from North-West (NW) direction.



Figure 4.29: Fault structure within gneiss outcrop.

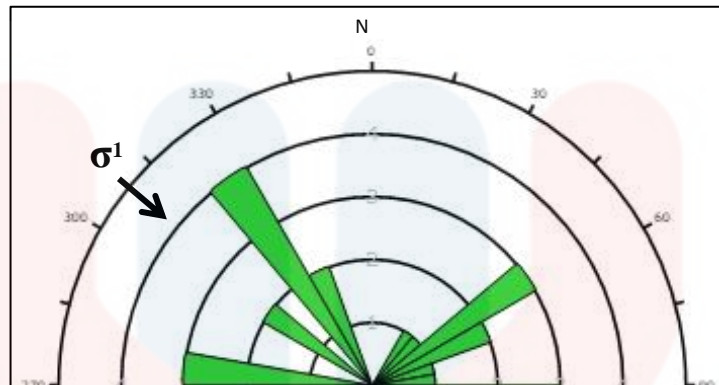


Figure 4.30: A faults analysis on gneiss rock

4.5 Historical Geology

In the field of historical geology, topics such as geological processes and the evolution of the study area, as well as how the tectonic setting influences the geology of the study area are discussed. Historical geology assists in the explanation of geologic processes that affect the surface and subsurface of the Earth. The information regarding stratigraphy and structural geology is required to define the sequence of events based on the geological evidence time scale.

Peninsular Malaysia has long been recognised as being divided into three broad N-S bands, namely the Western, Central, and Eastern belts, which are distinguished by differences in magmatism, stratigraphy, structures, and metamorphism (Hutchison, 1973; Metcalfe, 2000 & 2013). These three distinct belts were formed as the Indosinian Orogeny progressed during the Permo-Triassic period. The late Triassic collision of two continental plates (Sibumasu and Indochina) resulted in the formation of Peninsular Malaysia's Bentong-Raub Suture Zone.

The historical geology of the study area started from Permian age under Mangga Formation until Late Cretaceous under Granite Noring (Stong Complex). Mangga formation is represented by a high-grade metamorphic sequence of schist and gneiss. The existence of metamorphic rock units in the study area is influenced by the tectonic activities in Peninsular Malaysia during the Paleozoic and Mesozoic era affect the land mass principally on the formation of faulting and folding. The faulting that has been generated in the study area caused the rock unit in the study area were experienced a higher temperatures and pressures.

In addition, Stong Mount is located within the rock unit known as Stong Complex. The Stong Complex consists of three suite rock units whiz the Berangkat Suite, Kenerong Suite and Noring Suite. The Berangkat Suite can be divide into three litodemics unit called as Sungai Lah Granite, Bertam Granodiorite and Dabong Tonalite, whereas the Kenerong Suite consists of Stong Leucogranite and Sg Kenerong Migmatite. For Noring Suite, it was divided into Sungai Long Granite, Sungai Suda Granite and Sungai Terang Microgranite (Mohd Rozi Umor et al., 2002).

CHAPTER 5

GEOTOURISM POTENTIAL OF LATA HOKKAIDO, LATA JANGGUT, MARINA WATERFALL AND LATA BOBBY, JELI, KELANTAN

5.1 Introduction

In this chapter, the geotourism potential of Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby, Jeli, Kelantan is discussed, analyzed and interpreted. Geological mapping and geoheritage mapping including identification, description of those geosites as well as their relations to the tourism development of the study area is used to identify the geodiversity.

The identification is based on the presence of significant geological and geomorphological elements in the study area. Some possible geoheritage locations have been identified by previous researchers, while others are newly proposed prospective geoheritage sites. The mapping is based on fieldwork to determine the sites as well as their recent geological occurrences. In particular, the evaluation of geoheritage value of these geosites is used based on the assessment method, qualitative and quantitative to assess the potential of geotourism in the study area.

5.2 Assessment Analysis

The qualitative approaches were conducted by assessing the study area involved geoheritage and potential of geotourism. The qualitative method was focusing on geoheritage value of the site, mostly the use of their scientific

(educational), aesthetic, recreational, economic and functional values as they support geotourism potential principle (Gray, 2004, 2005). Next, the significance level of each site will then be determined based on the geoheritage resources, such as international, national, statewide, regional, and local (Brocx and Semeniuk 2007). The qualitative assessment of potential geotourism sites in the study area on the basis of geoheritage values and levels of significance (ranking) is summarized in (Table 5.1).

Additionally, the quantitative approach is the numerical assessment related to the need to numerically assess the geological sites (valuing) or score the sites. This method was conducted by assessing the potential geoheritage features based on their geodiversity and geoheritage values for potential of geotourism development. This method will be carried out by establish six classes of values: 0 – 5, represents none, very poor, poor, fair, good, very good respectively. Table 5.2 presents the quantitative assessment scores obtained for all sites.

5.2.1 Lata Hokkaido

Lata Hokkaido (coordinates: 5° 38' 57' N, 101° 45' 42" E) is one of several scenic cascade situated in Kampung Lata Janggut, Jeli, Kelantan, approximately 17 kilometres from Jeli town. Lata Hokkaido is part of the Long River, a tributary of the Pergau River and flows through the Gunung Basor Forest Reserve. A major fault drives the Long River's formation and growth: the Long Fault that runs northeast to southwest along the river. Lata Hokkaido area is dominantly composed of pink megacrysts biotite granite scattered around the cascade and river to hilly area.

Lata Hokkaido is named after its look-alike to the Hokkaido, Japan scenic landscape and atmosphere thanks to its abundant boulders along the cascade and river as well as view of fog in the morning or after the rain in high hills making it similar as oversea surrounding. Additionally, the water is cool, clean and shallow, making it ideal for bathing and swimming for adults, however parents must watch their children's safety due to the swift currents and slippery rocks.

The picnic area is also clean and spacious, which suitable for camping and barbecues activities. The spectacular view from the hilly areas around the river makes the area more interesting and fun to explore. A bridge was built over the cascade for the convenience of tourists for photography session and observation. Other activities that also suitable is sightseeing, jungle trekking, fishing and photography session. The available facilities here are only parking lot, other facilities are still not available. However, Lata Hokkaido is still enjoyable to explore and as a tourism destination.



Figure 5.1: Lata Hokkaido scenic landscape with boulders along the river.



Figure 5.2: (a) & (b) Camping and barbecues site beside the river.
 (c) Horizontal bridge over the cascade both for local and tourist observing the site.



Figure 5.3: Downstream of Lata Hokkaido with swift current



Figure 5.4: Megacrysts K-feldspar with quartz vein intrusion

5.3.2 Lata Janggut

Lata Janggut is one of several spectacular cascade located in Kampung Lata Janggut, Jeli, Kelantan approximately 13 kilometers from Jeli town (coordinates: 5° 40' 13" N, 101° 46' 13" E). The name of Lata Janggut existed before the 1960s, it is still unknown who gave the name Lata Janggut yet. Lata Janggut is also part of the Long River, a tributary of Pergau River. This cascade formed on a bodies of exposed batholith granitic rock.

The water here is very clean and cool, going through the upper of this cascade, a powerful three levels waterfall can be discovered. The waterfall is about 5 metres height with a fan-type fall and the water current there is relatively rapid. There are several pools formed from the rocks in the rapids as well as a few potholes structure exposed on the igneous bodies near the waterfall.

Lata Janggut is a hotspot place on weekends both for visitors from local and non-local as it has many interesting and suitable activities such as picnic, camping, barbeques, swimming, diving and jungle trekking. Among the facilities that can be found at Lata Janggut are rest waqf/hut, prayer hall, camping ground, cemented walkway and parking lot. There are also stalls from locals that opened on weekend sold food and drinks along the walkway.

Other than that, it also provides safety equipment such as floats, life jackets for both adult and kids size where visitor can rent these on low price. Precautions safety measures such as warning sign, rope, long bamboo stick and patrolling guard were also available for emergency situations.



Figure 5.5: The flow of Long River in Lata Janggut



Figure 5.6: (a) Beautiful waterfall in Lata Janggut. (b) Pothole structure on granitic bodies.
(c) Quartz veins intrusion.

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Figure 5.7: (a) & (b) Floats and life jacket (safety equipment). (c) Parking area. (d) Rest and observation area. (e) Cemented trail to reach the waterfall.

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5.2.3 Marina Waterfall

Marina Waterfall is a small, beautiful waterfall located in Kampung Lata Janggut, surrounded by the heavy forest in the hilly area (coordinates: 5° 38' 46" N, 101° 45' 04" E). This waterfall is located about 1 kilometre away from Lata Hokkaido and takes around half an hour to reach by hiking path. Marina Waterfall is composed of pink megacrysts biotite granite with quartz veins intrusion.

Marina waterfall is undoubtedly giving it uniqueness by its aesthetic small fall, rock features as well as relaxing view that will attract visitors' attention. The waterfall gives the fan-type shape fall and is around 6 metres high. Visitors will find this location to be an ideal spot for photography session.



Figure 5.8: Marina Waterfall with its aesthetic small fall.

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5.3.4 Lata Bobby

Lata Bobby is a magnificent cascade and waterfall landform in Kampung Lata Janggut, situated in the middle heavy forest (coordinates: 5° 38' 40" N, 101° 45' 11" E). It is also called as Lata Perah by Jeli's local. Lata Bobby is located in the Long River, a tributary of Pergau River. To reach this cascade it takes around 40 minutes and approximately 1.4 kilometres from Lata Hokkaido by hiking path. Tourists have to use the same hiking path as Marina Waterfall and passed it to reach Lata Bobby.

The hilly area and heavy forest surrounding the cascade and powerful waterfall give a panoramic view. The spectacular waterfall landform formed on exposed huge granitic bodies (Figure 5.8). The waterfalls are observed produce a fan-type fall. The granitic bodies that are exposed at the cascade was identified as alkali feldspar granite.

The water here is very clean and abundant of boulders along the river makes the downstream quiet swift. However, at the upstream of the cascade, the water current is calm and quiet deep. The visitors should be careful and bring safety equipment along when visiting here. Swimming, diving, fishing, barbecues, camping, hiking, photography session and picnics are some of the suitable activities in the area.



Figure 5.9: Lata Bobby in the middle of heavy forest.



Figure 5.10: Close-up view of spectacular waterfall landform on granitic bodies

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Table 5.1: The qualitative assessment of potential geotourism sites in Kampung Lata Janggut

No.	Geological site	Scientific (and educational) value	Aesthetic value	Recreational value	Economic value	Functional value	Level of significance
1.	Lata Hokkaido	Pink megacrysts K-feldspar of Noring Granite	Panoramic landscape of cascade area with fresh and clean water	Sightseeing, picnic, camping, barbeques, fishing, jungle trekking, swimming, and photography session	Potential to generate income from tourism and recreational activities	As a recreational site and breeding freshwater fish activities	State
2.	Lata Janggut	The formation and development of the river influenced by a fault	Breathtaking waterfall, river and rock structure	Sightseeing, picnic, camping, barbeques, jungle trekking, swimming, diving, and floats activities	Potential to generate income from tourism and recreational activities	As a tourism and recreational site	State
3.	Marina Waterfall	Pink megacrysts K-feldspar of Noring Granite with quartz veins	Beautiful and graceful small waterfall	Sightseeing, jungle trekking, and photography session	Potential to generate income from tourism activities	-	Local
4.	Lata Bobby	Pink alkali feldspar granite	Spectacular cascade with gigantic water spout	Sightseeing, picnic, barbeques, jungle trekking, swimming, photography session	Potential to generate income from tourism activities	-	Local

Table 5.2: The quantitative assessment of potential geotourism sites in Kampung Lata Janggut.

No.	Geological site	Scientific (and educational) value	Aesthetic value	Recreational value	Economic value	Functional value	Total
1.	Lata Hokkaido	5	5	4	1	1	16
2.	Lata Janggut	5	5	5	2	2	19
3.	Marina Waterfall	5	5	1	0	0	11
4.	Lata Bobby	5	5	4	0	0	14

Note: 0 = none; 1 = very poor; 2 = poor; 3 = fair; 4 = good; 5 = very good

Table 5.2 presents the scores achieved for each geosites. Lata Janggut gets the highest quantitative score (19) due to its geoheritage values are more complete and higher: scientific (and educational), aesthetic, recreational, economic, and functional values. The sites of Lata Hokkaido and Lata Bobby are geologically significant due to their unique rock types; yet, they have a lower score (16) and (14) than Lata Janggut due to the uncompleted geoheritage values as well as their low scores for economic and functional values.

5.3 Geosites Analysis for Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby Based on Questionnaire.

The survey data was analyzed in order for these geosites to be considered a prospective Geoheritage and potential Geotourism sites. Section 1 (Figure 5.11) is considering measured the demographic aspects (gender, age, education level, origin, and group of survey). Section 2 (Figure 5.12 and Figure 5.13) is related to the general knowledge of geoheritage and geotourism (meaning, awareness, importance, benefits and recognition). As for the section 3, a Likert scale was used to evaluate the

geodiversity functional and services, with each criterion being assigned a value between 0-5.

This survey is essential for identifying the potential for geological tourism, including suitable activities for the location and supporting the previous assessment (qualitative and quantitative). It may also reflect the level of public knowledge concerning the conservation of the site among the community. The following pie-charts presents the simplified percentage results obtained from the respondents survey.

Section 1: Demographic aspects

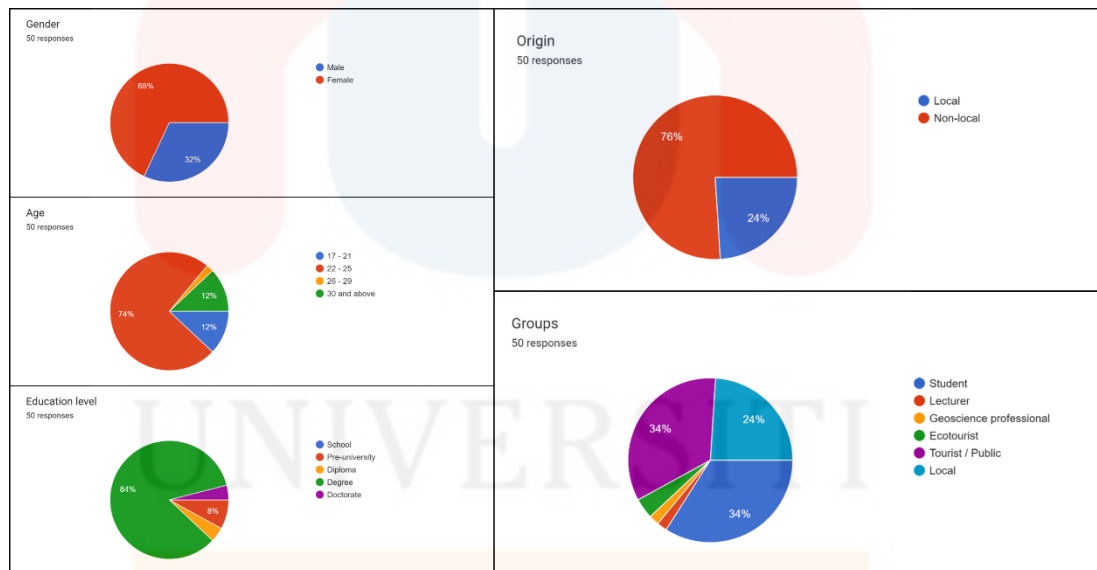


Figure 5.11: Demographic aspects of 50 respondents.

In total, 50 respondents responded to the questionnaire via google forms, 68% were women and 32% men. The age distribution was as follows; up to 17-21 years: 12%, 22-25 years: 74%, 26-29% years: 2%, 30 and above: 12%. Regarding education, the structure was the following: 4% respondents with diploma and doctorate level, 8% respondents with pre-university level and 84% respondents with

degree level. The origin; 76% were non-local and 24% were local respondents. As for the groups respondents; 34% were both students and tourist/public, 24% local, 4% ecotourist, and 2% were both lecturer and professional geoscientist.

Section 2: General Knowledge of Geoheritage and Geotourism

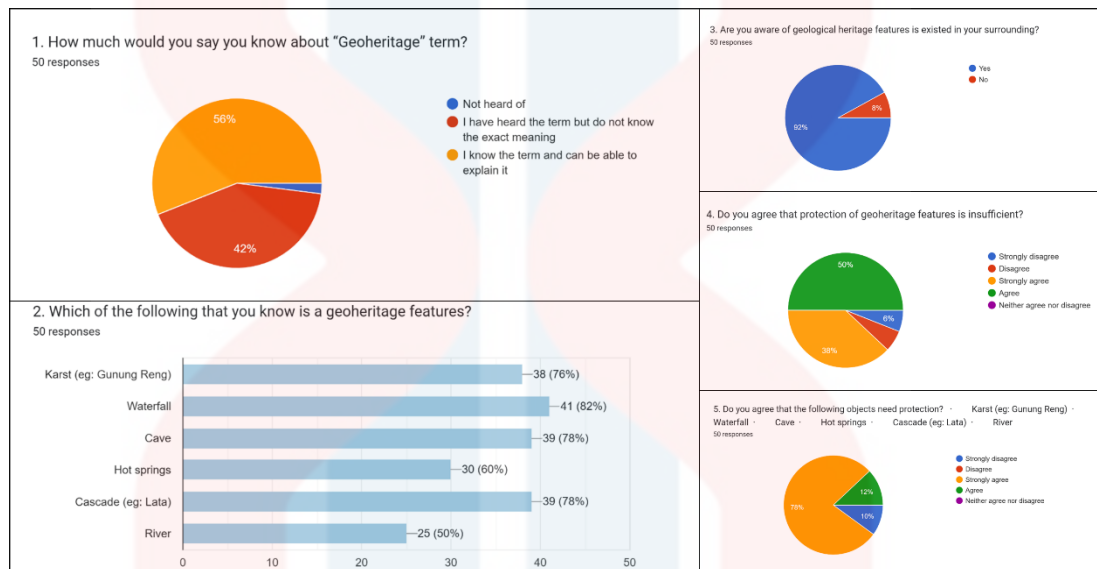


Figure 5.12: Questionnaire results general knowledge of geoheritage.

Section 2 questions were focused on the general knowledge of geoheritage and geotourism (meaning, awareness, importance, benefits and recognition). The first part of section 1 is discussed about geoheritage knowledge. Approximately 56% of respondents known and be able to explain the “geoheritage” term; 42% of respondents have heard the term, but do not know its exact meaning meanwhile the remaining respondents (2%) have never heard of the term. 92% of respondents aware that geoheritage features were existed in their surroundings. However, majority respondents known the waterfall as the geoheritage feature with 82% because of it aesthetically attractive while other features were varied from 50%-78%. The majority of respondents (50%) agree that the protection of geoheritage features is insufficient

and 78% strongly agree that the following objects should be protected (karst, waterfall, cave, hot spring, cascade and river).

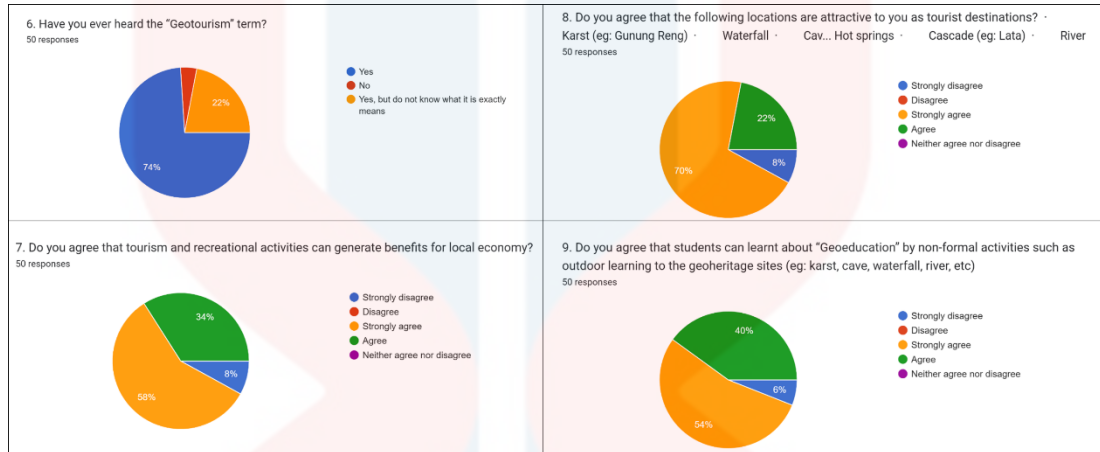


Figure 5.13: Questionnaire results general knowledge of geotourism.

The second part of section 2 is focused on geotourism knowledge. 75% of respondents have heard "geotourism" term and 22% of respondents claimed to have heard the word, but unsure of its meaning. Only 4% have never heard of it or absolutely do not know what it is. Approximately 58% of respondents strongly agreed the tourism and recreational activities can generate benefits to local economy growth. 70% of the respondents agreed the karst, waterfall, cave, hot springs, cascade and river features were attractive to them as a tourists. Respondents strongly agreed that student can learnt about "Geoeducation" by non-formal activities such as outdoor learning to the geoheritage sites (e.g., karst, cave, waterfall, river, etc) with 54%.

Section 3: Geoheritage Values

Section 3 were analysed based on geosites geoheritage value by a Likert scale to evaluate the geodiversity functional and services, with each criterion being assigned a value between 0 = none; 1 = very poor; 2 = poor; 3 = fair; 4 = good; and 5

= very good. Some questions were included pictures of the geosites in the case of lack personal experience at the geosites. The questions were covered about geosites scientific/educational value, aesthetic, recreational, economy, and functional values as well as suggestions to improve the geosites.

a) Lata Hokkaido

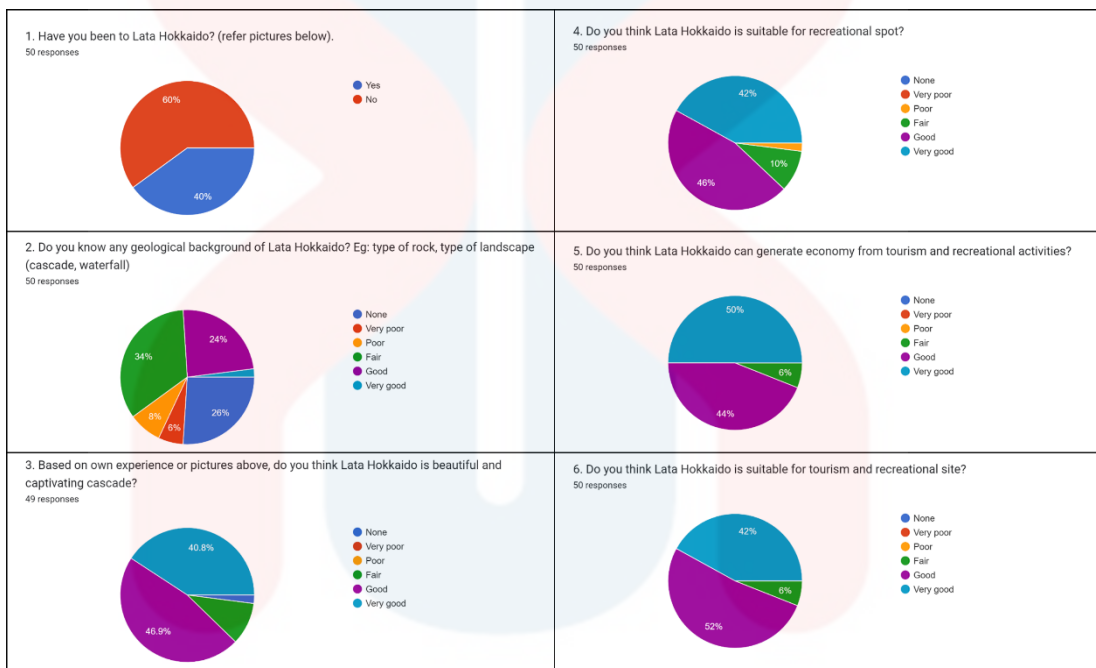


Figure 5.14: Questionnaire result in percentage of Lata Hokkaido based on geoheritage values.

According to the survey, majority of the respondents has a fair scientific/educational of geological knowledge of Lata Hokkaido with 34% depicts its newly discovery. 46.9% of respondents (good) finds the site is beautiful and captivating cascade. Hence, indicated the site has aesthetics value that can be the attraction to the tourist witness the natural beauty itself. Regarding recreational value, 46% of respondents (good) think the site is suitable for recreational spot. Based on the suggestion of the respondents, the suitable activities at the geosite are ATV tour, juggle trekking, and water sport such as river cruising along the river, build camping and picnic area as well as added facilities such as toilet and waqf/rest area. Half of

the respondent votes economy value (very good) as the geosite can generate economy from it tourism and recreational activities. To conclude, respondents think Lata Hokkaido is suitable for tourism and recreational site with good to very good votes (52%) and (42%) respectively.

b) Lata Janggut

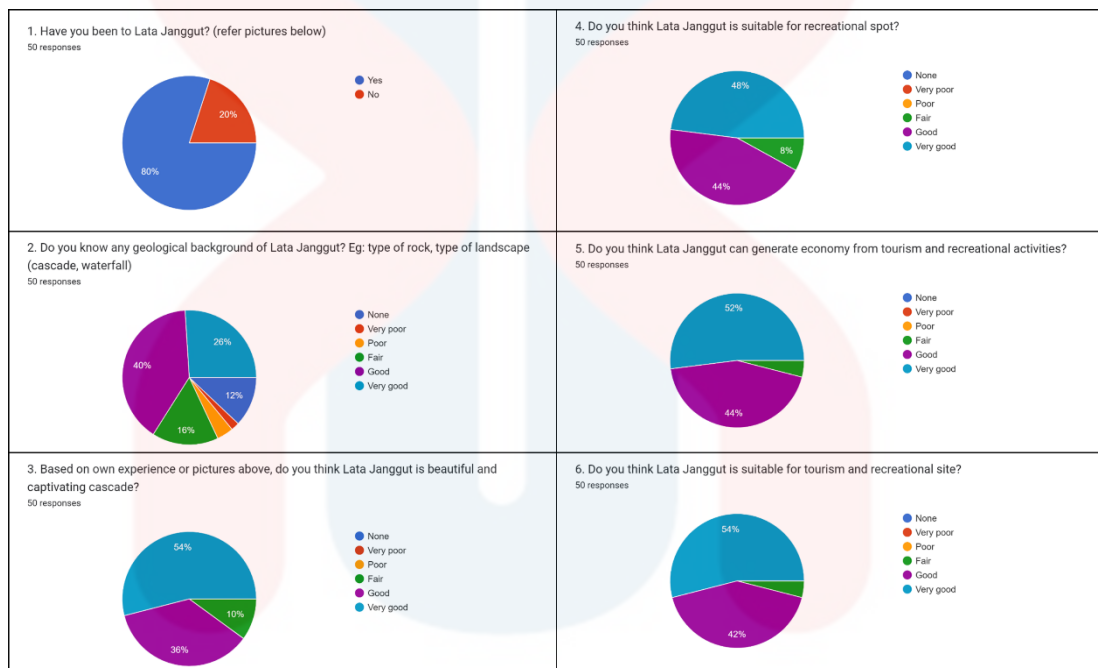


Figure 5.15: Questionnaire result in percentage of Lata Janggut based on geoheritage values

Based on the survey, 40% of respondents vote good for scientific/educational value of Lata Janggut. Due to the site popularity both among geoscience student and researcher for its geological structures and Stong Migmatite Complex Formation. 54% of respondents vote very good for aesthetic value of Lata Janggut as the site has an attractive cascade and waterfall with natural formation within its surrounding. Over 48% (very good) of respondent vote the site is suitable for recreational spot. On the other hand, 52% (very good) of respondents state that Lata Janggut can generate economy from tourism and recreational activities and suggested water sport such as

river cruising, kayaking, and water rafting as well as flying fox, as the new proposed activities at the site. Respondents also suggested to increased hospitality such as restaurant, toilet, camp site and chalet. In conclusion, 54% (very good) of respondents think Lata Janggut is suitable for tourism and recreational site.

c) Marina Waterfall

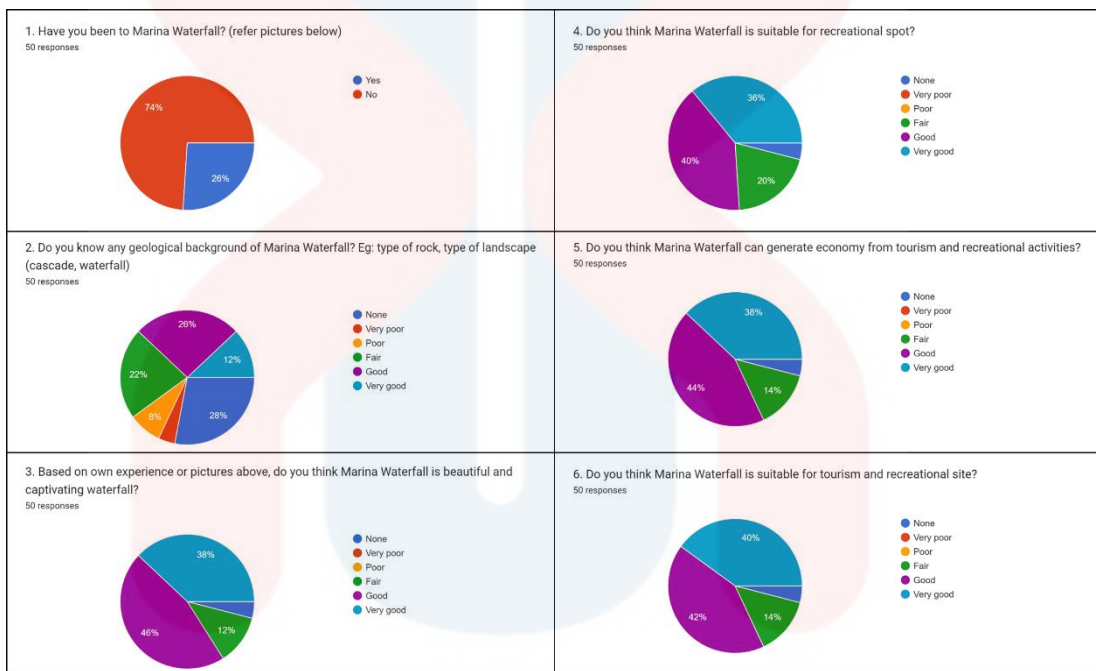


Figure 5.16: Questionnaire result in percentage of Marina Waterfall based on geoheritage values.

The survey shows only 26% of respondents has a good knowledge of geological background of Marina Waterfall. This is because this geosite is a new discovery and proposed geosite, thus not many tourist, researcher and geoscience student aware of its existence yet. Approximately 46% (good) of respondents finds the site is aesthetically displayed beautiful and captivating waterfall. Regarding recreational value, 40% of respondents vote the geosite is suitable for recreational spot. Apart from that, over 44% (good) of respondents vote the geosite can generate economy from tourism and recreational activities with suggesting the sightseeing while enjoying the landscape and ATV tour as the main activities. Above all, 40-42%

of respondents vote very good to good respectively indicated the Marina Waterfall is suitable for tourism and recreational site.

d) Lata Bobby

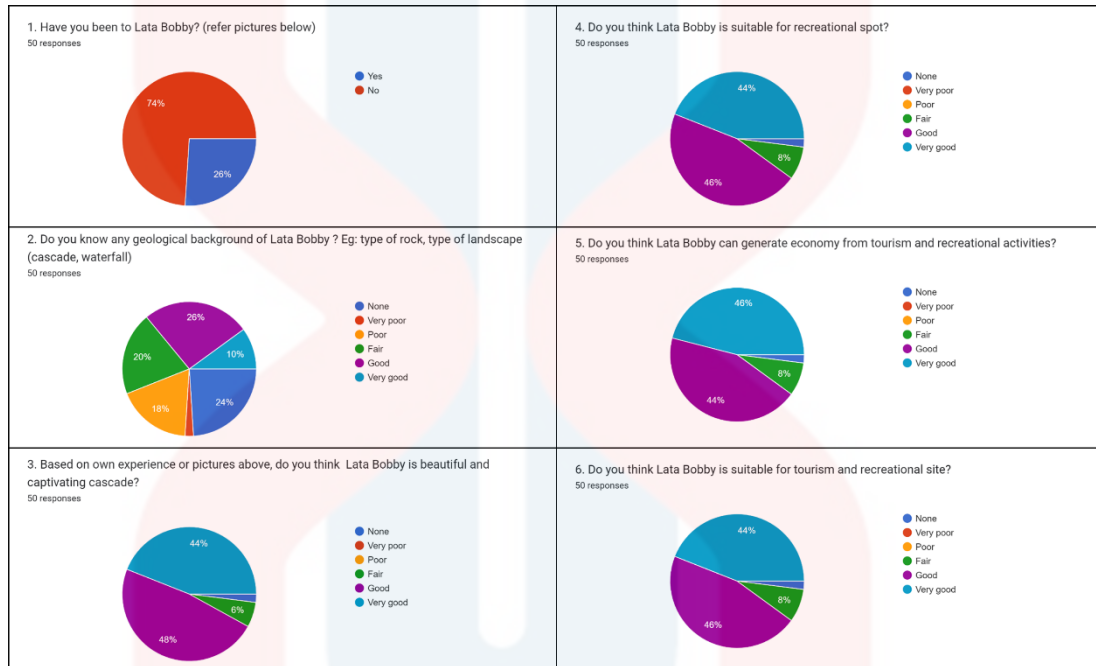


Figure 5.17: Questionnaire result in percentage of Lata Bobby based on geoheritage values.

According to the survey, 26% of respondent has a good knowledge of geological background of Lata Bobby. Approximately, 48% of respondents votes good for Lata Bobby’s aesthetic value as they find is aesthetically and spectacular landscape within its surrounding. Most of the respondents votes good to very good (46%-44%) as its suitable for recreational spot. 46% of respondents agreed that the geosite can generate economy from tourism and recreational activities with suggesting suitable space for camping site, jungle adventure activities, and geo-trail. Above all, 46% of respondents votes Lata Bobby is suitable for tourism and recreational activities.

Despite the fact that the respondent had excellent responses, they decided to suggest improving the area by adding more places and suitable activities for tourists enjoy and relax with their family in the midst of natural remedy. This was done in the hopes of attracting a larger number of visitors to the sites. The other responders all proposed new activities that can be enjoy at the sites as well as upgrading and provide good hospitality and facilities at the area for tourist convenience. This responses could be beneficial for a future authorities or the official government in enhancing these localities, Lata Hokkaido, Lata Janggut, Marina Waterfall, and Lata Bobby so that they might become Malaysia's top geotourism sites.

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In conclusion, a geological map of study area with scale 1:25,000 has been produced and updated in Kampung Lata Janggut, Jeli, Kelantan. Geologists require an up-to-date geological map as a reference for doing research and geological field work or surveys. Instead, an up-to-date geological map will let future researchers collect data and geological facts about a location more efficiently.

The lithology rock unit identified in the study area was divided into three unit of lithologies; schist unit, gneiss unit and granitic rock (acid intrusive) unit with older to younger age respectively. The oldest unit rock is Mangga Formation followed by Stong Complex (Noring Granite). The study area age for lithostratigraphy ranging from Permian to Late Cretaceous period.

Geomorphologically, landscape that occurred in the study area are plain and hilly areas (low hills, hills and high hills) with elevation ranging from 100-700 meter above sea level. There was some structural geology that has been identified such as jointing and minor faulting in metamorphic rocks in the study area. The positive and negative lineament in the study area were expressed by ridge, and river as well as valley. It may be associated with formation of major fault along Sungai Long that

situated in the study area called as Long Fault. Thus, from these data, geological map with scale 1:25,000 were able to produce.

A geoheritage study has been conducted in Kampung Lata Janggut, Jeli, Kelantan. The potential geoheritage resources of the study area have been assessed, and several geological sites have been identified as being part of those resources. Lata Hokkaido, Lata Janggut, Marina Waterfall, and Lata Bobby are the four sites or localities that have been recognised as potential geoheritage sites and potential of geotourism development in the study area.

Potential geotourism sites in the study area has been identified and analyzed from the assessments approaches; qualitative and quantitative as well as questionnaire survey data. Based on the findings of the assessment, these localities have certain geoheritage value, which include scientific (and educational), aesthetic, recreational, economic, and functional value, with local to state level of significance. Meanwhile, for the quantitative (valuing) the sites, Lata Janggut has the highest values among the other sites.

The geological elements that possess by the cascades and waterfalls are an additional significant and important factor in the visitor's preferences. The abundance of scientific-geological information regarding cascades, waterfalls and their surrounds could be utilised as an educational element for geoscience students and researchers.

Apart from that, these geosites present diverse aesthetically cascade and waterfall scenery where visitors can appreciate the stunning landscape and beautiful landform as well as enjoy clean air, green environment and various suitable recreational activities such as hiking, swimming, fishing, camping, picnic, water sport, and photograph session with their families at the sites.

Based on the survey data, respondents agreed Lata Hokkaido, Lata Janggut, Marina Waterfall and Lata Bobby were suitable for tourism and recreational activities with majority votes 40%-54% represent good to very good (Figure 5.13 - Figure 5.15). Therefore, indicated these sites has diverse geoheritage assets and geoheritage resources as well as suitable for geotourism destination.

6.2 Recommendation

Geotourism and conservation are crucial for ensuring the preservation and maintenance of this natural heritage. Geological heritage must be preserved since it is a component of the natural heritage that has its own importance for geological research. Small harms and threats can have large effects on the geology of the study area, hence geoconservation is essential to protect the geology of the area. Such area with high geological heritage potential must be monitored and its development must be planned seriously.

Human activities in the surrounding area, such as forestry, construction, excavation and land use, pose a potential risk to the geological heritage value of the site. To sustain and protect the area against rapid growth, it requires effective management planning to prevent any development that could endanger its geological

history. Geologist, official authorities, Jeli District Council, private tourism agency in district area and educational institutions play a significant role in educating the public about the significance of these historical values, thereby exposing them to the necessity of preserving geological resources.

Therefore, it is recommended that research and scientific initiatives should always be done in the study area in order to establish all of these significant geoheritage sites, while also supporting the protection and development of the area. All geoheritage resources of the study area can be harmoniously exploited in the development of geotourism, with the geo-education and geo-trail serving as one of the supporting approaches. On the other hand, it is also in hopes for local community and official authorities participation in protection of geoheritage assets and geotourism development as a steppingstone through inspiring Lata Hokkaido, Marina Waterfall and Lata Bobby to be a part of Stong Geopark as Lata Janggut.

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APPENDIX A

i. A-D1-S4

Quartz (Qtz)	50%	(Q)
Feldspar (Kspar)	32%	(A)
Plagioclase (Plag)	8%	(P)
Biotite (Bio)	8%	-
Opaque (Opq)	2%	-

$$\Sigma QAP = 50 + 32 + 8 = 90$$

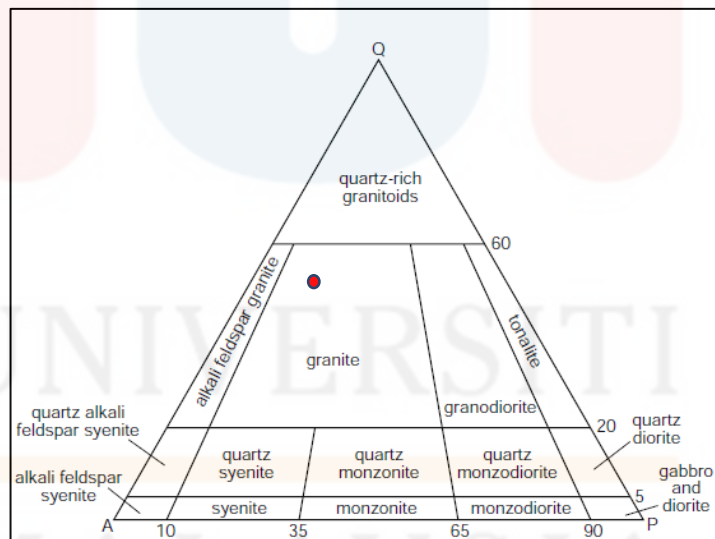
Recalculate QAP %:

$$Q, \frac{50}{93} \times 100 = 55.5\%$$

$$A, \frac{32}{93} \times 100 = 35.5\%$$

$$P, \frac{8}{93} \times 100 = 9\%$$

∴ From the calculation QAP, the rock lies on Granite.



ii. A-D1-S1, A-D3-S1

Quartz (Qtz)	35%	(Q)
Feldspar (Kspar)	14%	(A)
Plagioclase (Plag)	16%	(P)
Biotite (Bio)	20%	-
Opaque (Opq)	1%	-
Chlorite (Chl)	14%	-

$$\Sigma QAP = 40 + 34 + 12 = 86$$

Recalculate QAP %:

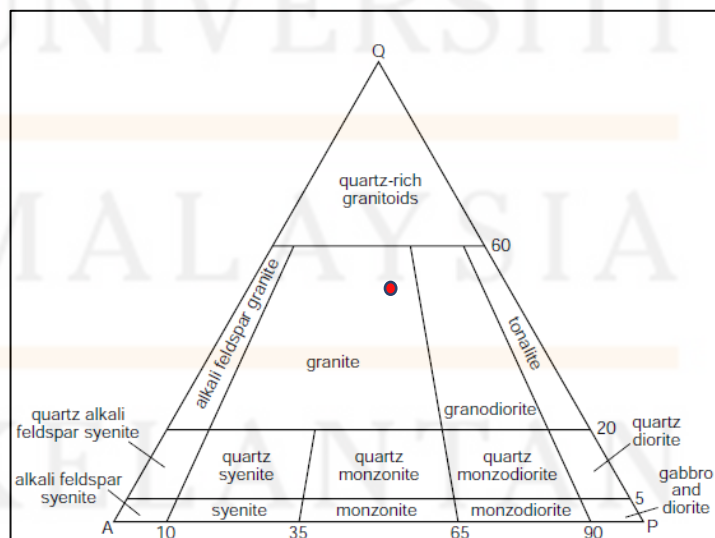
$$Q, \frac{35}{64} \times 100 = 54\% \qquad A, \frac{14}{64} \times 100 = 21\% \qquad P, \frac{16}{64} \times 100 = 25\%$$

∴ From Q percentage, the rock is lies on below 60% of the quartz concentration.

Recalculate A or P %:

$$P = \frac{25}{21+25} \times 100 = 54.3\%$$

∴ Since P concentration is 54.35%. Thus, the granitoid is the Biotite Granite.



iii. A-D3-S2

Quartz (Qtz)	48%	(Q)
Feldspar (Kspar)	41%	(A)
Plagioclase (Plag)	0%	(P)
Biotite (Bio)	8%	-
Opaque (Opq)	3%	-

$$\Sigma QAP = 48 + 41 + 0 = 89$$

Recalculate QAP %:

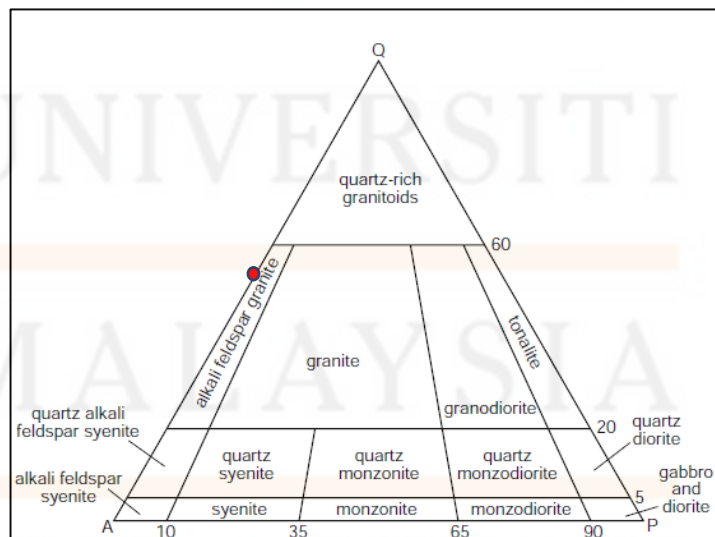
$$Q, \frac{48}{89} \times 100 = 54\% \qquad A, \frac{41}{89} \times 100 = 46\% \qquad P, 0\%$$

∴ From Q percentage, the rock lies on below 60% of the quartz concentration.

Recalculate A or P %:

$$A = \frac{46}{46+0} \times 100 = 100\%$$

∴ Since A concentration is 100%. Thus, the granitoid is the Alkali Feldspar Granite.



iv. A-D4-S3

Quartz (Qtz)	35%	(Q)
Feldspar (Kspar)	16%	(A)
Plagioclase (Plag)	22%	(P)
Biotite (Bio)	17%	-
Opaque (Opq)	10%	-

$$\Sigma QAP = 35 + 16 + 22 = 73$$

Recalculate QAP %:

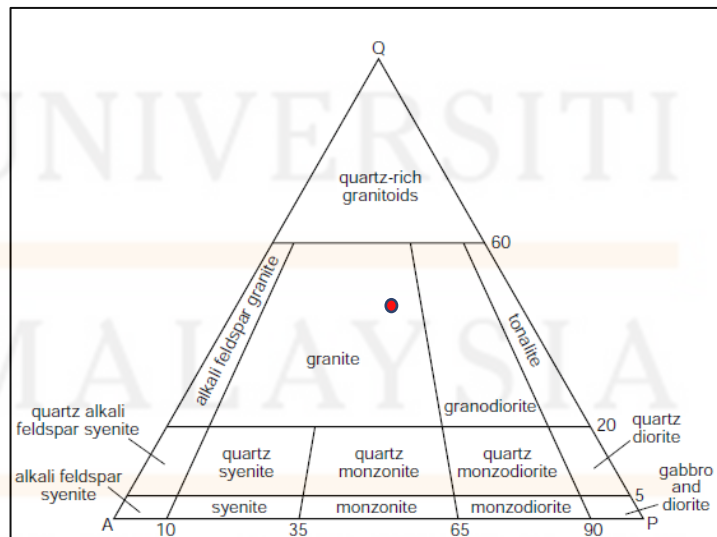
$$Q, \frac{35}{73} \times 100 = 47.9\% \quad A, \frac{16}{73} \times 100 = 21.9\% \quad P, \frac{22}{73} \times 100 = 30.1\%$$

∴ From Q percentage, the rock is lies on below 60% of the quartz concentration.

Recalculate A or P %:

$$P = \frac{30.1}{21.9+30.1} \times 100 = 57.9\%$$

∴ Since P concentration is 57.9%. Thus, the granitoid is the Biotite Granite.



APPENDIX B

1/15/23, 4:29 AM

GEOLOGY AND GEOTOURISM POTENTIAL OF LATA HOKKAIDO, LATA JANGGUT, LATA BOBBY AND MARINA WATERF...

GEOLOGY AND GEOTOURISM POTENTIAL OF LATA HOKKAIDO, LATA JANGGUT, LATA BOBBY AND MARINA WATERFALL, JELI, KELANTAN

Assalamualaikum and Greetings to all dear respondents,

I am final year students 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 regarding "Geology and Geotourism Potential of Lata Hokkaido, Lata Janggut, Lata Bobby and Marina Waterfall, Jeli Kelantan".

I would appreciate if you could spare approximately 10 minutes of your time to complete this questionnaire. Your participation in this study is completely voluntary. The completion and return of the attached questionnaire is taken to constitute your consent to participate in the study.

Your participation with this study would be highly appreciated. I guarantee that your response will be kept fully private and used exclusively for academic purposes. Your private information won't be shared or used for anything but academic research.

Thank you for your valuable time, attention and cooperation.

Regards,
Siti Nur Adila Yazizul Rahman

* Required

1. Gender *

Mark only one oval.

Male

Female

<https://docs.google.com/forms/d/1enC8R1f0U3q11719Hz5MplwqvffQdCdBTE82Lk.Jj/edit>

1/20

2. Age *

Mark only one oval.

- 17 - 21
- 22 - 25
- 26 - 29
- 30 and above

3. Education level *

Mark only one oval.

- School
- Pre-university
- Diploma
- Degree
- Doctorate

4. Origin *

Local (Jeli's resident)
Non-local (Non Jeli's resident)

Mark only one oval.

- Local
- Non-local

General Knowledge of Geoheritage and Geotourism

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5. 1. How much would you say you know about “Geoheritage” term? *

The term “Geological heritage/Geoheritage” can be applied to sites or areas of geologic features with significant scientific, educational, cultural, and/or aesthetic value.

Mark only one oval.

- Not heard of
- I have heard the term but do not know the exact meaning
- I know the term and can be able to explain it

6. 2. Which of the following that you know is a geoheritage features? *

Check all that apply.

- Karst (eg: Gunung Reng)
- Waterfall
- Cave
- Hot springs
- Cascade (eg: Lata)
- River

7. 3. Are you aware of geological heritage features is existed in your surrounding? *

Mark only one oval.

- Yes
- No

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KELANTAN

8. 4. Do you agree that protection of geoheritage features is insufficient? *

Mark only one oval.

- Strongly disagree
- Disagree
- Strongly agree
- Agree
- Neither agree nor disagree

9. 5. Do you agree that the following objects need protection? *

- Karst (eg: Gunung Reng)
- Waterfall
- Cave
- Hot springs
- Cascade (eg: Lata)
- River

Mark only one oval.

- Strongly disagree
- Disagree
- Strongly agree
- Agree
- Neither agree nor disagree

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10. 6. Have you ever heard the “Geotourism” term? *

Mark only one oval.

- Yes
- No
- Yes, but do not know what it is exactly means

11. 7. Do you agree that tourism and recreational activities can generate benefits for *
local economy?

Mark only one oval.

- Strongly disagree
- Disagree
- Strongly agree
- Agree
- Neither agree nor disagree

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12. 8. Do you agree that the following locations are attractive to you as tourist destinations? *

- Karst (eg: Gunung Reng)
- Waterfall
- Cave
- Hot springs
- Cascade (eg: Lata)
- River

Mark only one oval.

- Strongly disagree
- Disagree
- Strongly agree
- Agree
- Neither agree nor disagree

13. 9. Do you agree that students can learnt about “Geoeducation” by non-formal activities such as outdoor learning to the geoheritage sites (eg: karst, cave, waterfall, river, etc) *

Mark only one oval.

- Strongly disagree
- Disagree
- Strongly agree
- Agree
- Neither agree nor disagree

Geoheritage Values:

a) Lata Hokkaido

14. 1. Have you been to Lata Hokkaido? (refer pictures below). *



Mark only one oval.

Yes

No

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15. 2. Do you know any geological background of Lata Hokkaido? Eg: type of rock, *
type of landscape (cascade, waterfall)

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

16. 3. Based on own experience or pictures above, do you think Lata Hokkaido
is beautiful and captivating cascade?

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

17. 4. Do you think Lata Hokkaido is suitable for recreational spot? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

18. 5. Do you think Lata Hokkaido can generate economy from tourism and recreational activities? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

19. 6. Do you think Lata Hokkaido is suitable for tourism and recreational site? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

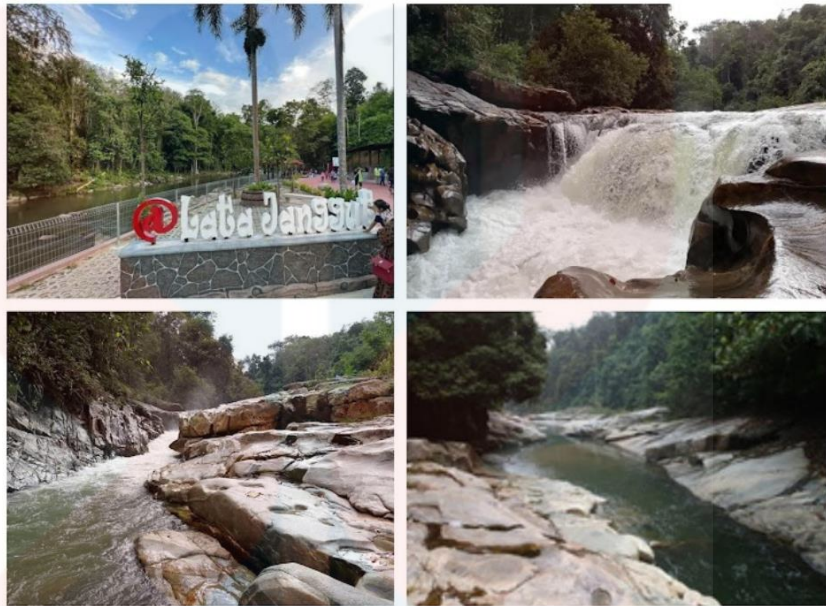
b. Lata Janggut

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20. 1. Have you been to Lata Janggut? (refer pictures below) *



Mark only one oval.

- Yes
 No

21. 2. Do you know any geological background of Lata Janggut? Eg: type of rock, type of landscape (cascade, waterfall) *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

22. 3. Based on own experience or pictures above, do you think Lata Janggut is beautiful and captivating cascade? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

23. 4. Do you think Lata Janggut is suitable for recreational spot? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

24. 5. Do you think Lata Janggut can generate economy from tourism and recreational activities? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

25. 6. Do you think Lata Janggut is suitable for tourism and recreational site? *

Mark only one oval.

- None
- Very poor
- Poor
- Fair
- Good
- Very good

c. Marina Waterfall

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KELANTAN

26. 1. Have you been to Marina Waterfall? (refer pictures below) *



Mark only one oval.

Yes

No

27. 2. Do you know any geological background of Marina Waterfall? Eg: type of rock, type of landscape (cascade, waterfall) *

Mark only one oval.

None

Very poor

Poor

Fair

Good

Very good

28. 3. Based on own experience or pictures above, do you think Marina Waterfall is beautiful and captivating waterfall? *

Mark only one oval.

None

Very poor

Poor

Fair

Good

Very good

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29. 4. Do you think Marina Waterfall is suitable for recreational spot? *

Mark only one oval.

- None
- Very poor
- Poor
- Fair
- Good
- Very good

30. 5. Do you think Marina Waterfall can generate economy from tourism and recreational activities? *

Mark only one oval.

- None
- Very poor
- Poor
- Fair
- Good
- Very good

31. 6. Do you think Marina Waterfall is suitable for tourism and recreational site? *

Mark only one oval.

- None
- Very poor
- Poor
- Fair
- Good
- Very good



33. 2. Do you know any geological background of Lata Bobby ? Eg: type of rock, *
type of landscape (cascade, waterfall)

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

34. 3. Based on own experience or pictures above, do you think Lata Bobby is beautiful and captivating cascade? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

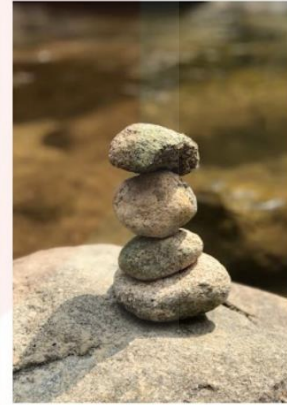
35. 4. Do you think Lata Bobby is suitable for recreational spot? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

d. Lata Bobby

32. 1. Have you been to Lata Bobby? (refer pictures below) *



Mark only one oval.

Yes

No

36. 5. Do you think Lata Bobby can generate economy from tourism and recreational activities? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

37. 6. Do you think Lata Bobby is suitable for tourism and recreational site? *

Mark only one oval.

- None
 Very poor
 Poor
 Fair
 Good
 Very good

38. Any suggestion activities and what can be suggested to attract more tourists to these areas? (if possible, 1 suggestion on each area) / Sebarang cadangan aktiviti dan apakah yang boleh dicadangkan untuk menarik lebih ramai pelancong ke kawasan ini? (jika boleh, 1 cadangan pada setiap kawasan) *

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MALAYSIA

KELANTAN