GEOLOGY AND PETROGRAPHY OF IGNEOUS ROCK AT PANGGUNG LALAT, GUA MUSANG

by

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

FACULTY OF EARTH SCIENCE

UNIVERSITI MALAYSIA KELANTAN

2017

DECLARATION

I declare that this thesis entitled Geology and Petrography of Igneous Rock at Panggung Lalat, Gua Musang is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : _______________________________

Name : _______________________________

Date : _______________________________

ACKNOWLEDGEMENT

First and foremost, I would like to praise my grateful to Allah because of His power and mercy that I am able to complete my Final Year Project thesis. Furthermore, I would like to express my gratitude to my parents for their dedication and commitment in praying for my success and believing in me. Without them, I am nothing. Besides that, I highly appreciate the help from my supervisor Dr Muqtada Ali Khan for his guidance and continuous support in completing the thesis.

In addition, personally I would like to express my sincere thanks to Nur Shafiqah Shahman for her dedication, commitment and sincerity in helping me completing the thesis and throughout my years of studying in this institution. Next, I would like to wish thanks to Ridhwan for assisting me in mapping and accompanying me during the research period.

I also would like to express my thanks to Nur Aina, Jannah, Sabariah, Zaki, Syafiq, Al Azim, Ariffudin, Shawalrina, Adda, Azira, Shaz, Nizam, Irfan, Ilyas, Zuhdi, Shamine, Nina Azman, Suresh, Syawal, and many of my friend who are always supporting me. I will always remember and cherish them.

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LIST OF ABBREVIATION

Al_2O_3 - Aluminium oxide

BaO - Barium oxide

$CaAl_2Si_2O_8$ - Calcium aluminosilicate

$CaCO_3$ - Calcium Carbonate

CaO - Calcium oxide

Cl - Chlorine

Fe_2O_3 - Iron(III) oxide

GIS – Geographic Information System

K_2O- Potassium oxide

$KAlSiO_3O_8$ - Potassium feldspar orthoclase

La_2O_3 - Lanthanum oxide

MgO - Magnesium oxide

MnO - Manganese(II) oxide

Na_2O - Sodium oxide

$NaAlSi_3O_8$ - Sodium feldspar albite

P_2O_5 - Phosphorus pentoxide

Rb_2O - Rubidium oxide

SiO_2 - Silicon dioxide

SO_3 - Sulfur trioxide

SrO - Strontium oxide

TiO_2 - Titanium dioxide

ZrO_2 - Zirconium dioxide

LIST OF SYMBOL

N - North

S – South

E – East

W – West

General Geology and Petrography of Igneous Rock at Panggung Lalat, Gua Musang

ABSTRACT

This study was about the geology and petrography of igneous rock at Panggung Lalat, Gua Musang in south Kelantan with coordinate of latitude ranges from 4 52 30 N to 4 54 30 N and longitude from 101 50 00 E to 101 53 30 E. The purpose of the research is to produce an updated version of geological map with ratio 1: 25 000 and to identify characteristic of igneous rock based on the petrography. The method that was used in general geology was traversing and rock sampling while for igneous rock petrography were thin section and x- ray fluorescence (XRF). The rock samples that been collected are limestone, gyranite, sandstone and shale. The granite that presence in study area is identified as Monzogranite and Quartz- Rich Granite. Both of the granite samples contain the highest SiO_2 concentration. Results from this study can contribute to the fundamental geology knowledge of the study area and become reference for future researchers.

Geologi Am dan Petrografi Batu Igneous Di Panggung Lalat, Gua Musang

ABSTRAK

Kajian ini adalah mengenai geologi dan petrografi batu igneus di Panggung Lalat, Gua Musang di selatan Kelantan dengan koordinat julat latitud dari 4 52 30 N 4 54 30 N dan longitud 101 50 00 E 101 53 30 E. Tujuan penyelidikan ini adalah untuk menghasilkan versi terkini peta geologi dengan nisbah 1: 25 000 dan untuk mengenal pasti ciri-ciri batuan igneus berdasarkan petrografi itu.Kaedah yang digunakan bagi disiplin geologi adalah mengembara dan perekodan batu sementara pula bagi petrografi batuan igneous kaedah yang digunakan adalah keratan nipis dan x-ray fluorescence (XRF). Sampel batu yang telah dikumpulkan adalah batu kapur, granit, batu pasir dan syal. Granit yang wujud di kawasan kajian dikenal pasti sebagai Monzogranite dan Quartz- Rich Granite. Kedua-dua sampel granit mengandungi kepekatan SiO2 yang tinggi. Hasil daripada kajian ini boleh menyumbang kepada pengetahuan asas geologi kawasan kajian dan menjadi rujukan kepada penyelidik pada masa akan datang

CHAPTER 1

INTRODUCTION

1.1 General Background

This valuable study will be conducted to identify the general geology and igneous petrography at Panggung Lalat, Gua Musang. Geological studies are to examine the source rocks or outcrops on the Earth's surface. This research focused on igneous rock at Panggung Lalat, Gua Musang.

Basically the outcrops are the significant indicator for geological studies. Rock samples from the research area can identify the type of rock, stratigraphy and possibly finding fossils in it. Igneous rock is classified into two categories which are volcanic and plutonic rock.

Plutonic rocks also known as intrusive rocks. They are formed from magma that cools and solidifies within the crust of Earth's. The magma cools slowly hence make it in the form of coarse grained. The mineral grains can be seen by naked eyes.

Volcanic rock known as extrusive rock. They are formed at the Earth's surface. Volcanic rock cools and solidified quicker than plutonic rock thus make the rocks is in fine grained texture.

In conducting the research, geological mapping is significant to gained, comprehend and understand the information regarding the study area. It is also vital to update the geological map.

Petrography is the discipline where one identifies minerals that embedded in the rocks. Throughout thin section of the samples and by using specialised microscopes, minerals can easily be identified.

1.2 Problem Statement

Based on the preliminary studies that had been conducted, there have less details and limited data information about geology of Panggung Lalat, Gua Musang. Igneous rock that existed at study area were unique due to its characteristic, textures and colours based on observation by previous fieldtrips. The provided information regarding the area was not enough and not proper.

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1.3 Research Objective

i. To update the geological map of research area with scale 1: 25 000

ii. To identify the characteristics of igneous rock based on petrography in research area.

1.4 Study Area

The research focus in Panggung Lalat where it located at Gua Musang. The study area that is covered is 5 km width x 5 km height with the total area of 25 km^2 as shown in Figure 1.1 and Figure 1.2. This research area was predicted to have the plutonic rock based on previous research. The study was covered by vegetation. The research area is bordered near with the state of Perak. The highest elevation in the base map are 540 metres while the lowest elevation is 120 metres.

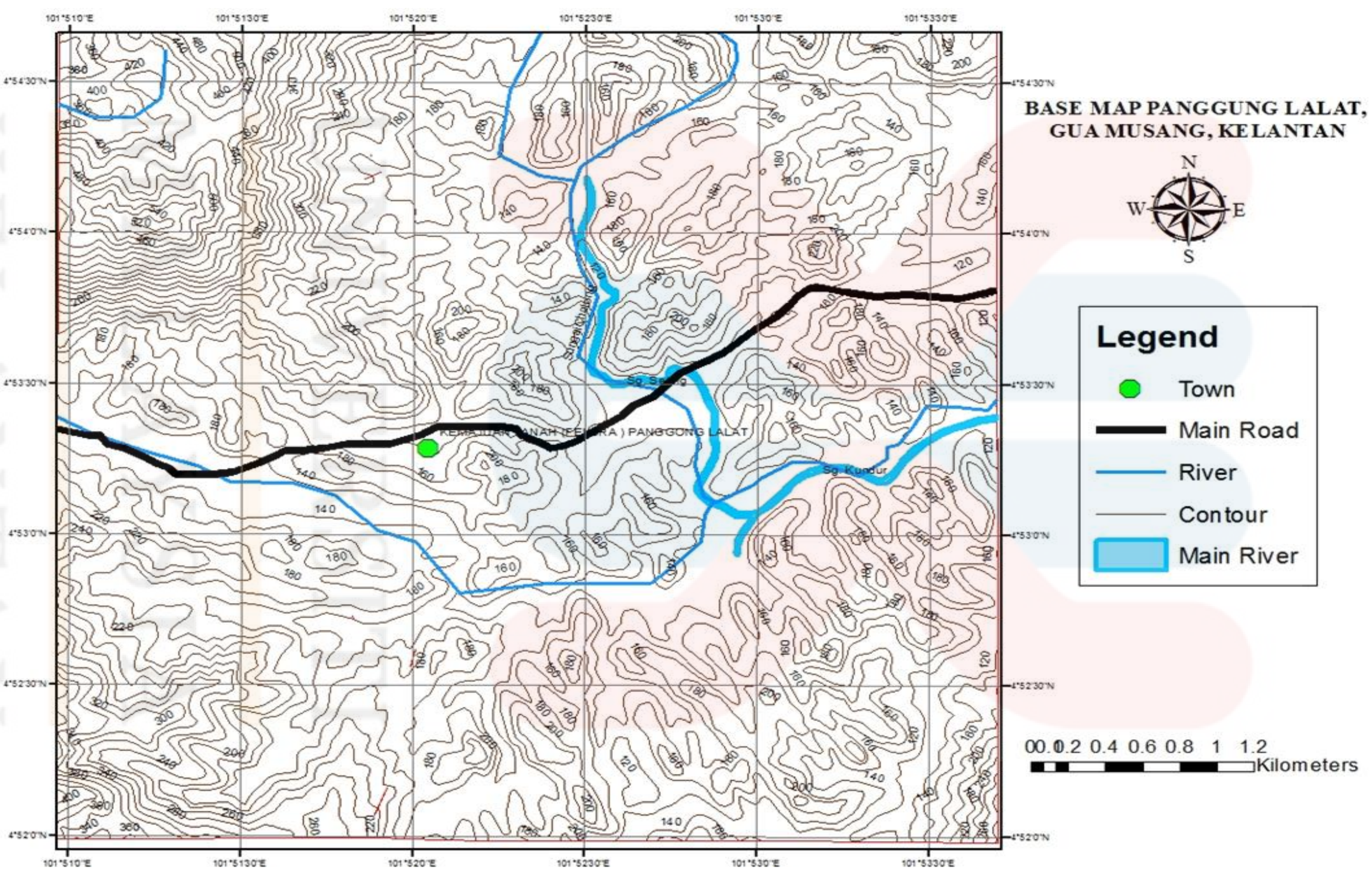


Figure 1.1: Base Map of Panggung Lalat, Gua Musang

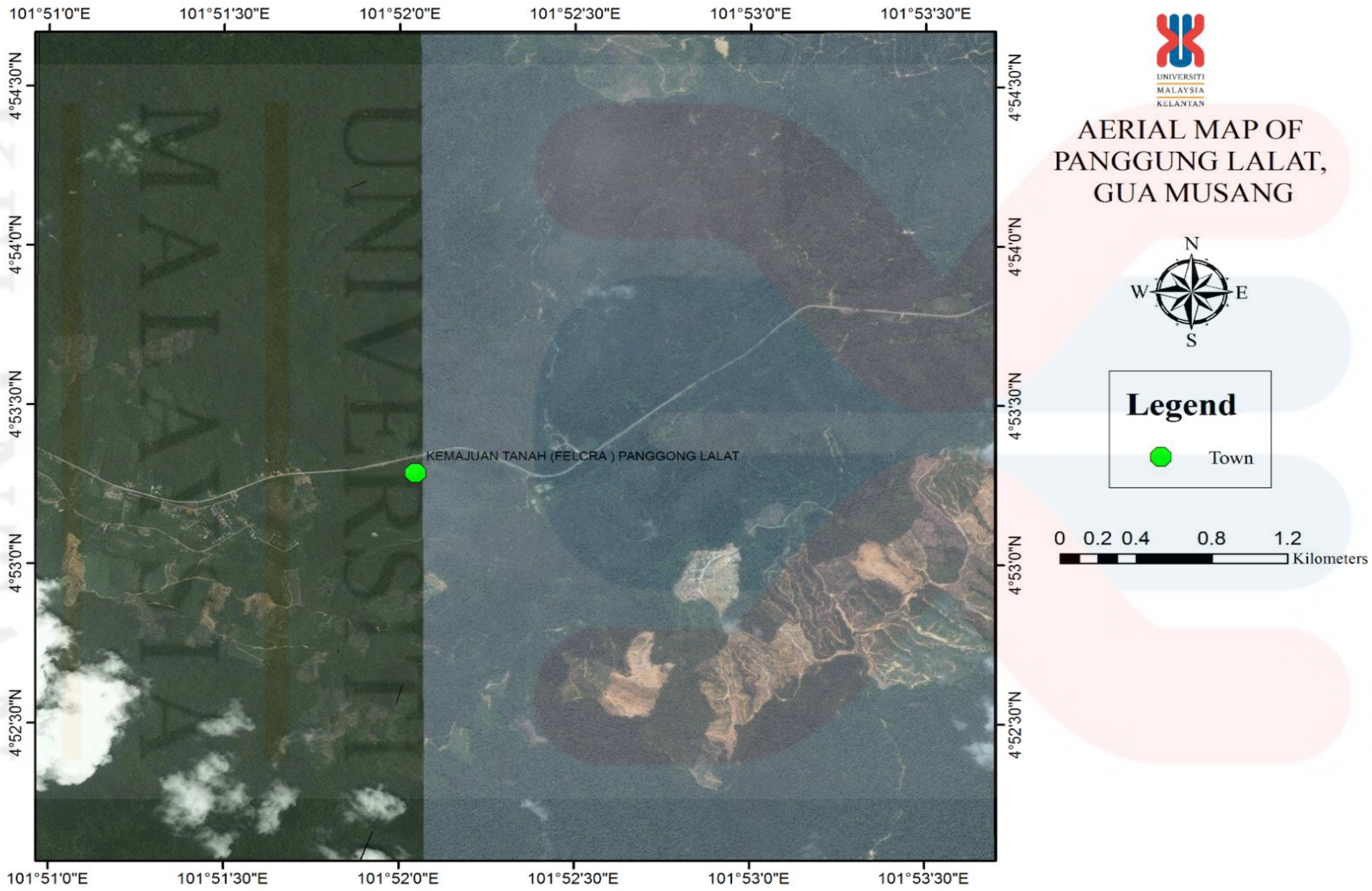


Figure 1.2: Base map of aerial imagery of the study area.

1..4.1 Demography

Table 1.1 show total population in Gua Musang. The highest race population are Malays with total of 44,581 peoples. The lowest population by race is Indian with the total of 47 peoples. The total amount of peoples in Gua Musang are 86,189 peoples according to Statistic Departments of Malaysia, 2010.

Table 1.1 Total Populations in Gua Musang by Ethnic in 2010 (Statistic Department of Malaysia,2010).

Total Population in Gua Musang by Ethnics						
Area\Ethnic	Malay	Chinese	Indian	Other ethnic	Non-Malaysian	Total
Batu Papan	1,512	883	132	16	51	2594
Bertam	1,131	1	1	0	9	1142
Chegar Bongor	398	24	0	4	68	494
Gua Musang	15,285	2,217	155	118	645	18420
Kerinting	128	1	15	0	13	157
Limau Kasturi	893	5	0	7	70	975
Paya Tupai	325	0	0	0	12	337
Other area in Gua Musang	44,581	739	47	12586	4117	62070
Total Population						86189

In table 1.2 it represents the genders distribution in Gua Musang. The highest sex distribution is male with total of 46,359 peoples while females with total of 39, 830 peoples. This statistic show that males population is higher than females.

Table 1.2 Total Populations in Gua Musang by Sex in 2010 (Statistic Department of Malaysia, 2010).

Area	Sex		Total Population by Sex
	Male	Female	
Batu Papan	1,355	1,239	2,594
Bertam	570	572	1,142
Chegar Bongor	269	225	494
Gua Musang	9,743	8,677	18,420
Kerinting	84	73	157
Limau Kasturi	503	472	975
Paya Tupai	182	155	337
Other area in Gua Musang	33,653	28,417	62,070
Total	46,359	39830	86,189

1.4.2 Rain Distribution

Table 1.3 represent the daily rainfall of Kuala Betis region. The highest distribution of rainfall occurs at October with the value of 467.5 mm while the lowest distribution of rainfall occurs at February with the value of 52.5 mm.

Rainfall Distributions at Kuala Betis district, Kelantan District Year 2015 (mm)										
Day	January	February	March	April	May	June	July	August	September	October
1	0	0	0	13	1.5	0.4	0	28.8	16.5	14.4
2	2.6	0.5	0	15	22.5	0	0	3.2	0	39.6
3	0.4	2.5	0	0	28	0	16.1	9	21.9	22.5
4	0	15.3	0	0	1.9	1	15.4	0.5	88.6	4
5	4.5	10.1	0	0.4	11.1	1.5	0	2.5	1	0
6	26.5	1.6	0	11	48	3	3.5	5	6	22.5
7	16.1	0.5	0	0	0.4	0.5	12.5	2	18	0
8	25.1	2.5	5.5	0	27.1	22.9	5	6.5	0	11.5
9	6.9	1.5	59.2	0	45	0.6	34	0.5	0.5	42.6
10	16.4	1.1	1.3	5	15.5	2.9	0.5	4.5	0	3.9
11	8.4	0.9	0	9.9	0	27.6	0	19.5	9.8	3.2
12	10.5	0.6	0	12	23	2.5	0	5.6	15.4	3.3
13	0.5	0	0	4.8	0.5	2.3	0.4	13.7	4.3	39.1
14	0.6	0	0	1.3	18.5	2.2	12.4	1	0	22.9
15	0	2	0	2.7	19.5	13.5	0.1	2.1	0	1
16	0	0	0	8	1.5	0	0	0	0	31.6
17	0	0	0	0	0	0	6	16.8	0	13.7
18	0	0.6	0	12	14.8	0	24.3	32.9	0	23.2
19	1	8.9	0	16	16.7	0	6.7	0.8	1.5	0
20	0	0	0	8.3	26.8	0	3.5	0	0.4	0
21	0.6	0	2.5	1.5	2.7	0	3.5	0	9.1	0
22	0.4	3.5	0	0	18.6	0	0	0	24.9	0
23	0	0.5	0	0.5	0.4	0	21	8.5	1.6	0
24	1	0	0	0	2	0	0.5	7.5	0	14.6
25	0	0	1	0	0.4	0	25	0	0	33.7
26	0	0	3.5	1.5	0.6	0	5.5	7	0	4.4
27	0	0	1.8	5.5	3.5	0.5	28.5	0.5	0.5	16.8
28	0	0	2.7	4.1	21.5	6	40	1.8	1	36.9
29	2.7	-	2.1	5.9	18.5	0	0	0.2	32	33.5
30	0.7	-	5.4	15	0	0	5.5	10.5	44	28.5

31	0.1	-	19	-	27.5	-	19.5	2.5	-	0
Total	125	52.5	122	151	418	87.4	289.5	193.5	297	467.5

Table 1.3 Daily Rainfall Distribution at Kuala Betis region from January to October in 2015

(Department of Irrigation and Drainage Malaysia, 2015)

1.4.3 Land Used

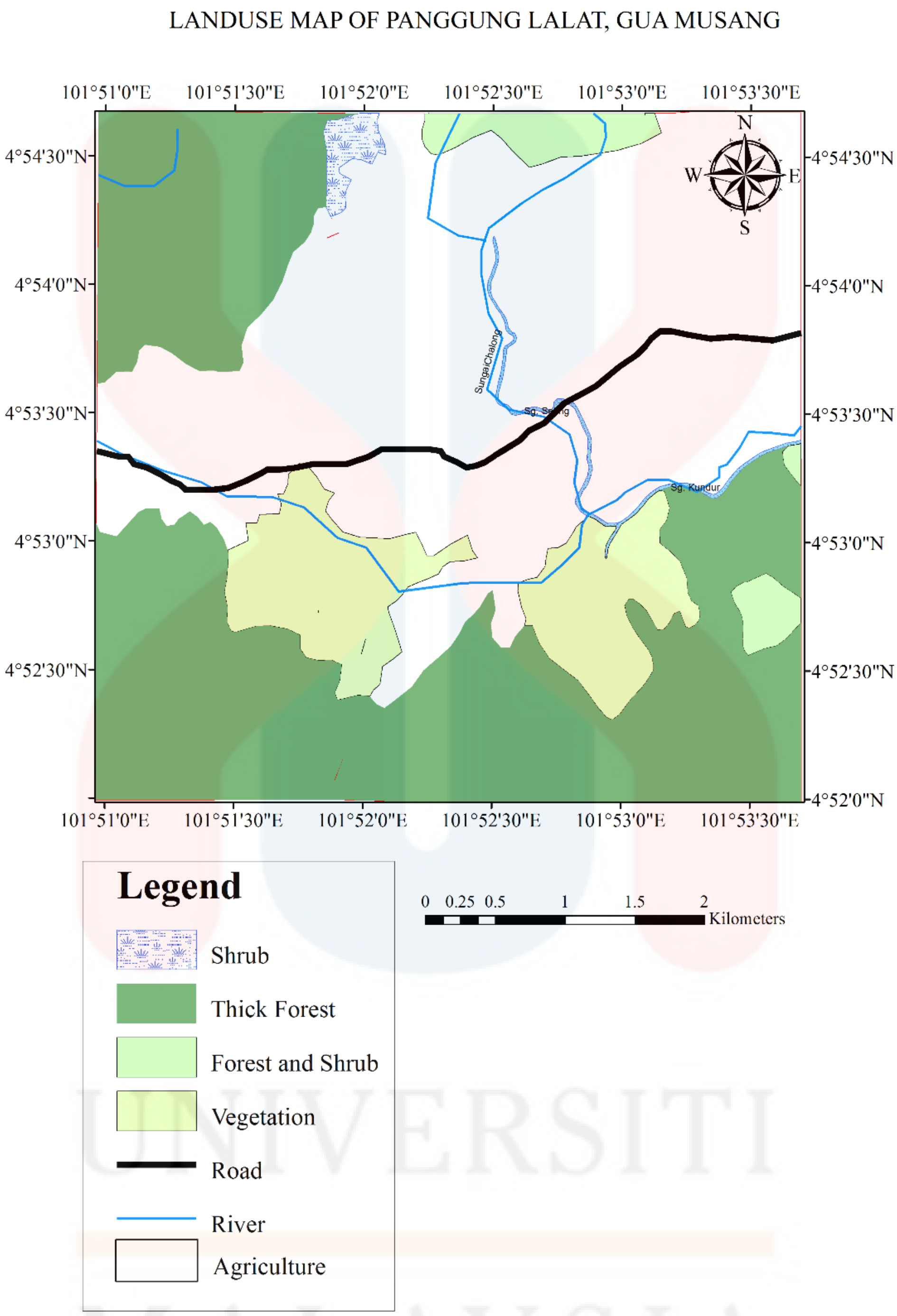


Figure 1.3: Figure show the land use of the research area.

At the study area, the land used is mainly covered by the vegetation. The main vegetation is rubber tree plantation and palm oil. This vegetation is widely spread around district of Gua Musang due to its richness in natural resources. The villagers are very dependent on plantations and agricultures as their source of incomes. Another type of land used is the residential area in which the villagers live.

1.4.4 Social Economic

Social economics of the people at the study area are mainly the plantation and agriculture. This is because the people own huge land which is beneficial for plantations such as palm oil and rubber plantation. Therefore, people depending on the plantation as their main source of income and due to the demanding market for the palm oil and rubbers, people tend to open more plantations to increase the production. Furthermore, another social economic is the food business. It means the people open their restaurants and stalls as their source of income.

1.4.5 Road Connection

The road connection at the study area is accessible with the main road across the study area. The main road is paved road where it known as Gua Musang – Lojing road. There are also unpaved roads or off-roads that is use by the villagers to their plantation. The unpaved road connection is widely spread across the study area.

Figure 1.4: Paved road of Gua Musang – Lojing road.

Figure 1.5: Unpaved road towards villagers' plantations.

1.5 Scope of the Study

The scope of the study focused at Panggung Lalat area at Gua Musang. This research will update the geological information regarding the study area. This study also covers the petrography discipline which will be done by analysing thin section of the samples. The analysis will result in the determination of what type of minerals, colours, cleavage and shapes of the respective rock samples.

1.6 Research Importance

This research is helpful in providing geological information about the research area such as lithology, stratigraphy, mineralogy and structural data. Throughout the study, one can identify what type of rocks located in the study area. This study also vital to understand what kind of minerals that located in the study area.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Peninsular Malaysia, with a total land area of 130, 268 km, forms part of Sundalands, which includes Borneo, Java and Sumatera, as well as the intervening shallow seas from which emerge a number of smaller islands (Van Benmelen ,1949)

Sundaland is the partly submerged southeastern extension of the Asia continent to which the Peninsula is connected by the Isthmus of Kra, which at its narrowest is only 64 km wide. The Peninsula is elongated in a general NNW-SSE direction with a maximum length of 750 km and breath of 330 km.

To the south, it is separated from Singapore Island by the narrow Johor Strait whilst, to the west, it is separated from Sumatra Island by the Straits of Malacca. To the southeast and east the South China Sea separates the Peninsula from Borneo Island.

2.2 Geological Review

2.2.1 Regional Geology and Tectonic Setting

Peninsular Malaysia can be divided into 3 longitudinal belts, Western, Central and Eastern, each of which has its own unique characteristics and geological development. The Western Belt can be subdivided into a northwest sector and a Kinta-Malacca sector.

The northwest sector consists of clastics, limestones and minor volcanics. The time of the Langkawi folding phase of Koopmans (1965) is revised from Devonian to mid-Permian and this phase is not only confined to southeast Langkawi but covers the whole of Langkawi and Terutao area and extends southeast into mainland Kedah forming a northwest trending belt called the Patani Metamorphics.

There is some evidence for a Devonian phase of folding and uplift as well but evidence for it is not strong. The post mid-Permian saw deposition of carbonates and clastics in this sector and the whole region was uplifted by the culminating late Triassic orogenic event which affected the whole of the peninsula.

In the Kinta-Malacca sector, there was deposition of argillaceous and calcareous sediments in the early Palaeozoic followed by more limestone deposition in the Kinta region but by clastics in the Kuala Lumpur area.

There is evidence for a post-Silurian event of folding and metamorphism in the Kuala Lumpur area, possibly Devonian. In the Kinta region there is scant evidence to date this tectonic event. There is no known Mesozoic sediment in this sector (Khoo,1983)

2.2.2 Regional Stratigraphy

The Central Belt stretches from Kelantan to Johor between the eastern foothills of the Main Range, forming its western boundary, to its eastern boundary marked by the Lebir Fault in the north down to the western boundary of the Dohol Formation in the south.

The Palaeozoic rock consists largely of Permian clastics with sporadic outcrops of Carboniferous limestone that occur as linear belt flanking Mesozoic sediments on both edges of the belt.

In the western part of the Central Belt are Upper Palaeozoic rocks of the Gua Musang and Aring Formations in south Kelantan and Taku Schist in east Kelantan, and further south are the Raub Group in west Pahang and Kepis Beds in Negeri Sembilan.

These Upper Palaeozoic rocks are predominantly of argillaceous strata and volcanics rocks, with subordinate arenaceous and calcareous sediments deposited in a shallow-marine environment, with intermittent submarine volcanism, starting from the Upper Carbonifereous and peaking in the Permian to Triassic.

Lower Triassic lava unconformably overlies Permian phyllite in south Pahang and Johor, marking a change from submarine to subaerial volcanism in the south (Foo,1983)

2.2.3 Structural Geology

In the Gua Musang area, a sequence of well-bedded tuffaceous siltstone, sandstone, carbonaceous shale and minor limestones lenses, belonging to the Permian to Middle Triassic Gua Musang Formation, is exposed at the Gua Musang-Pulai junction (Khoo, 1983).

A refolded fold is exposed associated with two well-develop cleavages. Another example of multiple deformation in Permo-Triassic strata in Kelantan is exposed along a road leading to Dabong from Kuala Krai.

The slate characteristically contains a bedding- parallel or sub-parallel slaty cleavage that has been folded together with bedding into tight to isoclinal folds with bedding into tights to isoclinal folds with gentle southerly plunges, associated with a well-developed crenulation cleavage.

These early structures were further deformed by a series of steep easterly-dipping N-S reverse dextral faults. Steeply plunging drags along these faults further complicate the overall structures. These were transected by later conjugate strike-slip faults.

2.3 Petrography of Igneous rock

Petrography is a subdivision of petrology that focuses on thorough descriptions of rocks. The mineral content and the textural relationships within the rock are described in details. The classification of rocks is based on the information acquired during the petrographic analysis.

Petrographic descriptions start with the field notes of the outcrop and include macroscopic description of hand specimens. Nevertheless, the most significant tool for the petrography discipline is the microscope.

The detailed analysis of minerals by optical mineralogy in thin section and the micro-texture and structure are critical to understand the basis of the rock. Electron microprobe analysis of individual grains as well as whole rock chemical analysis by atomic absorption, X-ray fluorescence(XRF), and laser-induced breakdown spectroscopy are used in a modern petrographic lab.

Granite is classified according to QAPF diagram and is named according to the percentage of quartz, alkali feldspar and plagioclase feldspar. The mineralogical composition and physical classification granite was analysed using thin sections. Results were plotted on ternary diagrams of Quartz-Alkali Feldspar-Plagioclase (Streckeisen,1974)

Igneous rock generally ranging in colour from pink to light or dark grey and mostly consisting mostly of quartz and feldspar, accompanied by one or more dark minerals. Some dark coloured igneous rocks which are actually basalt, gabbro, dionite, diabase and anorthosite are quarried and sold as “black granite”. These stones contain little or no quartz or alkali feldspars, but, for all practical purposes, they are used interchangeably with true granites.

In addition to the quartz and feldspars, granite may also contain other minerals such as mica, hornblende and occasionally pyroxene. Compared to calcareous sandstones, marble and limestone, granite is not an acid soluble stone and is much more resistant to the effects of acidic solutions, rainwater or cleansing agents. In general, granite have more inert composition; show much lower rates of deterioration; have lower water absorption, and are harder than marbles, limestones and sandstones.

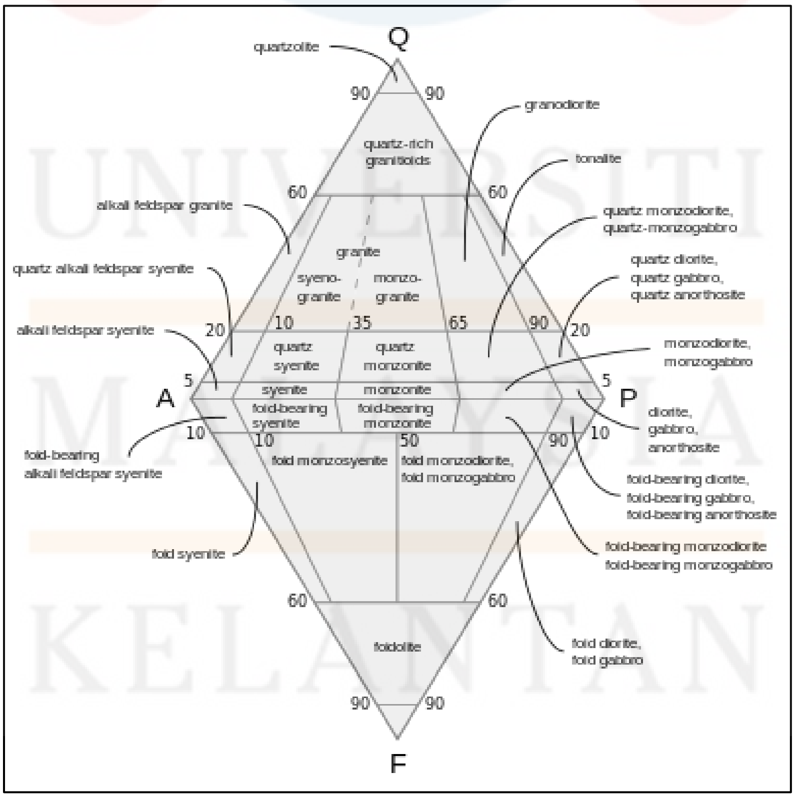


Figure 2.1: QAPF ternary diagram

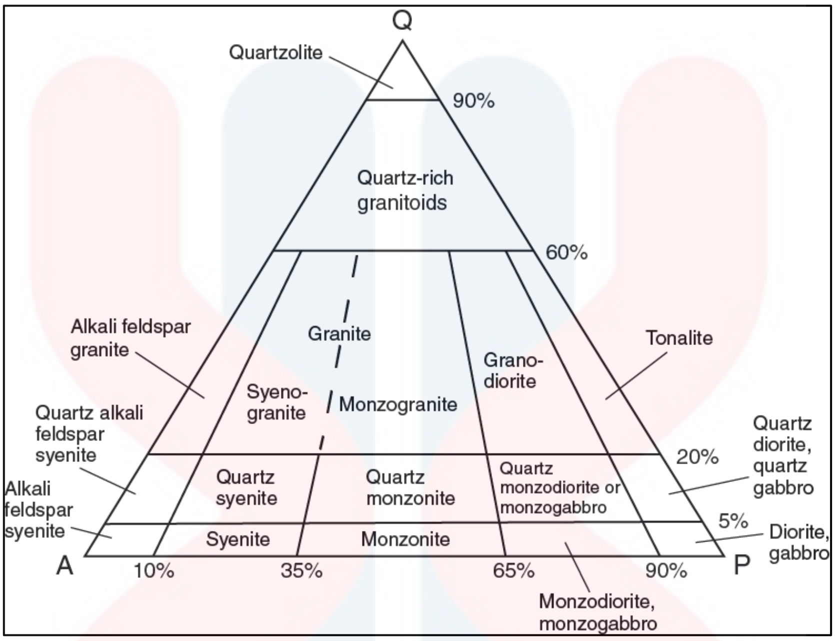


Figure 2.2: QAP diagram

CHAPTER 3

MATERIALS AND METHODOLOGIES

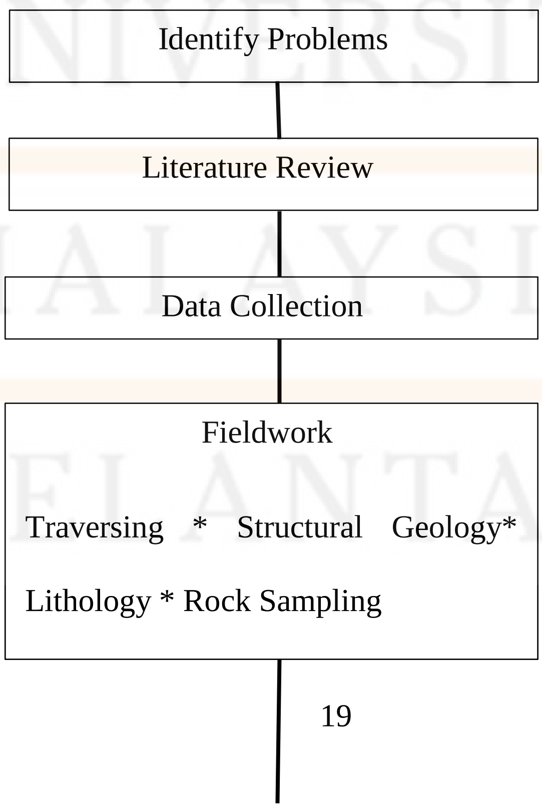
3.1 Introduction

This chapter introduce the material and method were used to study geological and analysis of igneous petrography of Panggung Lalat, Gua Musang. The methodology used included data collection, data processing, data analysis and interpretation.

3.2 Preliminary Researches

This research starts on February 2016. In preliminary research, the study area can be investigated by previous thesis, books, journals and internet research. With the aiding of the materials such as books and journals, the rudimentary knowledge of the area can be gain.

Before heading to the site, a map is a significant tool. It can interpret the study area by analysing the contour, drainage pattern and the structural features. Basically map can be divided to several such as topographic map, base map and structural map.



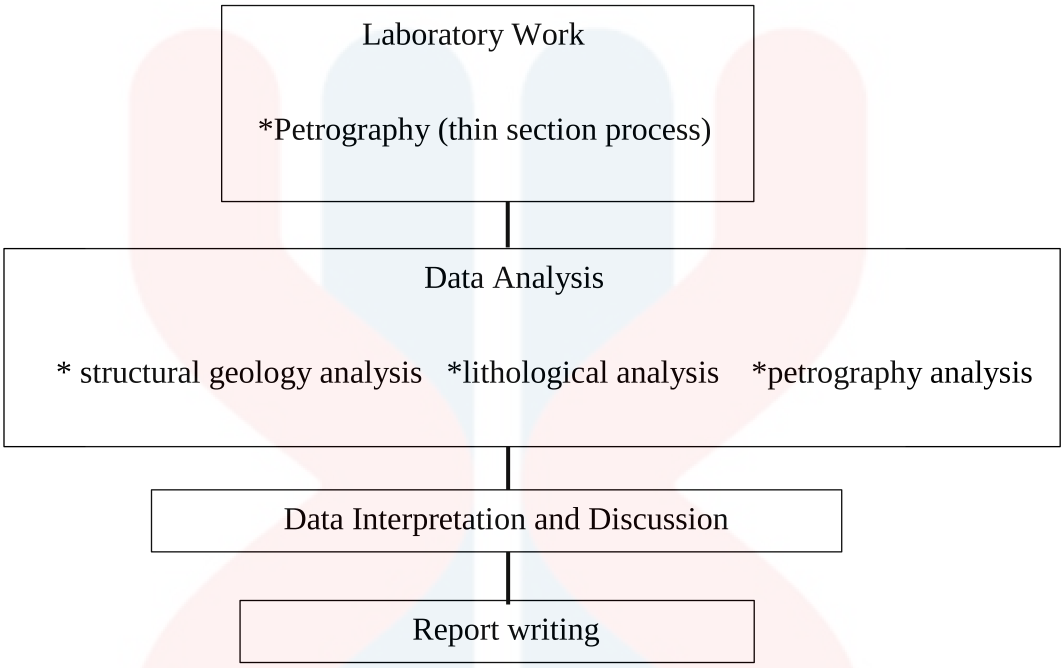


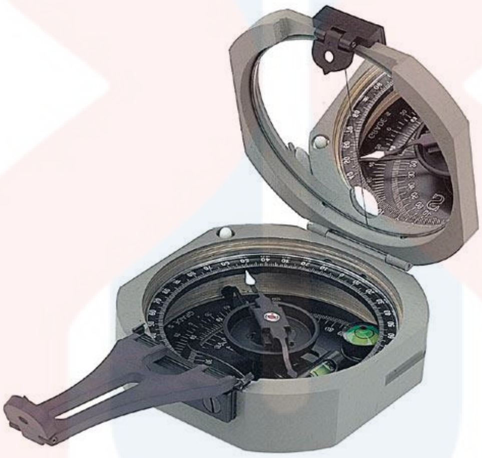
Table 3.1: Flowchart of the research

3.3 Materials and Method

Table 3.2 refers to several materials and equipment that were used in this study.

Table 3.2: Materials for geological mapping

Name	Picture	Details

Geological Hammer		This instrument is used for breaking and splitting rocks sample. It can attain the rock sample to determine its mineralogy, composition and history factor. Occasionally, geological hammer can be used as the scale in a photograph
Brunton Compass		This compass is much accurate than Suunto compass. Brunton compass is used on the field by geologist, students and lecturers. Brunton compass provide hand level capability and can be used by waist and eyes level. Examples of the usage of Brunton compass are taking reading azimuth, pinpoint location on map, folding and used in geological mapping

Garmin GPS		Garmin GPS (Global Positioning System) is a satellite based navigation system involving three parts, the satellite in space, monitoring stations and the GPS receivers. GPS provide latitude and longitude data. It also provides the altitude reading. In field, it can store up our track movements and also act as a compass.
Hand lens		It used to identify the mineral on the volcanic rock by naked eyes on the field. Basically, it used to identify the physical properties such as colour, texture and identifiable mineralogy

Hydrochloric Acid		It is used to observe the reaction of the rock in order to differentiate between calcite and chlorite. It also used to distinguish most common carbonate rock, dolomite and limestone
Measuring Tape		It is used to take measurement of lithology and structure. As an example, in layering, it is necessary to measure the thickness of each layer precisely.
Microscope		To identify minerals of the rocks by examine the thin sections of the tock samples.

3.4 Field Studies

Fields studies or known as field work are an effective method in gathering data. By going to the site, there are numerous information can be gathered for research purpose.

Mapping is the most effective ways in field studies. Basically, outcrop sketching and traversing the mapping area will contribute to the geological data. By mapping, one can identify the type of rock, the geomorphology of the surrounding and the stratigraphy.

3.5 Laboratory Investigation

Laboratory investigation can be divided into two methods that known as thin sectioning and X-ray Fluorescence (XRF) method. Each method have their own significant and purposed.

3.5.1 Thin Sectioning

Thin section is a process where rock is cut into thin size. It is used to identify minerals, textures, colours and other characteristic. It has 5 necessary step to convert rocks into thin section. There are sectioning, precision sectioning, bonding, re-sectioning and the last step is grinding and polishing

Sectioning is a process where it manages the size of the sample to be cut. Precision sectioning is low deformation cutting where the machine that is used is known as IsoMet. It is the machine for precision sectioning of petrographic specimens. Heat are required as the bonding agent.

In addition to that, re sectioning process is a process where it is to remove excess material quickly and efficiently with PetroThin Thin Sectioning System. This machine consists of diamond cutting, diamond grinding wheels and vacuum chuck. The finale process is grinding and polishing where grinding is to remove deformation induces in sectioning and remove excess material. Polishing is to remove final deformation induces by grinding process.

3.5.2 X- ray Fluorescence (XRF)

X ray Fluorescence (XRF) is the method used to analysis major and minor element existed on rock samples. Samples must clean and dry so that no contamination could occur during being crushed and powdered using rock crusher. The powder sample weight 1- 2 grams with pressure equal or under 20 kpa by a press pellet compressor.

After all the necessary step, the samples will be analysed by XRF machine. This method usually takes 20- 30 minutes and the result is recorded and detected with ppm values.

3.6 Data Analyses and Interpretation

ArcGIS software is used for geological map formation and mapping. By using ArcGIS software, geomorphology, lithology and drainage pattern can be identified.

3.7 Report Writing

At the end of the research study, every result and data collection and analysis will be recorded in the complete report. The report must include several main contents such as introduction, research objective, literature review, methodology, data analysis and result, conclusion.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

In General Geology chapter, this chapter comprise the geomorphology of the study area, petrography, stratigraphy of Panggung Lalat, structural geology and historical geology. It has been stated that from the previous study of researchers, Panggung Lalat area divided into two types of rock group, igneous and sedimentary rocks.

Igneous rock is formed through the cooling and solidification of magma or lava. In the research area, it has been identified as mostly granites that occupied in the study region. Sedimentary rocks are types of rock that are formed by the depositions and subsequent cementations at the Earth's surface and within bodies of water through period of times. It has been identified that for sedimentary rock discipline, limestones and shales have been found.

Petrography studies is briefly explained in this chapter. Further elaborations and analysis will be continued in chapter 5 as research specifications. This chapter will make readers comprehend the general geology of study area.

4.2 Geomorphology

Geomorphology can be defined as scientific study of landforms and the processes that shape the landscapes as they do nowadays. Comprehension of geomorphology discipline is vital to the understanding of physical geography.

In a recent essay Rhoads (1999) claimed that "the extent to which geomorphology as a distinct field of science can be justified on ontological or epistemological grounds seems to depend on the extent to which landforms can be viewed as natural kinds."

Geomorphology of the area had been analyse by observation, traversing and mapping the particular area. Geomorphological can be described by topography, drainage system and weathering process in the study area.

4.2.1 Topography

Mountains are among the most prominent of geographic features (Smith and Mark,2001). Topography is a field of earth science that comprise the study of surface shape and features of the earth. It is a thorough description of surface shapes, contours and features. In general, topography involves the recording of terrains, the three- dimensional quality of the surface and the identification of specific landforms.

The topography of Kelantan ranges from highlands to the west and south flat coastline to the north. The state in bounded to the west by Main Range with prominent granite peaks at above 1700 metres elevation. To the south, are the highlands of Central Belt where the highest mountains in the Peninsular Malaysia, Gunong Tahan, at 2186 metres height is located.

Surface shape of study area consists of hill type where it is the best palm plantation and rubber plantation adaptation. The lower elevation in this study is 120 m while the highest is 540 m.

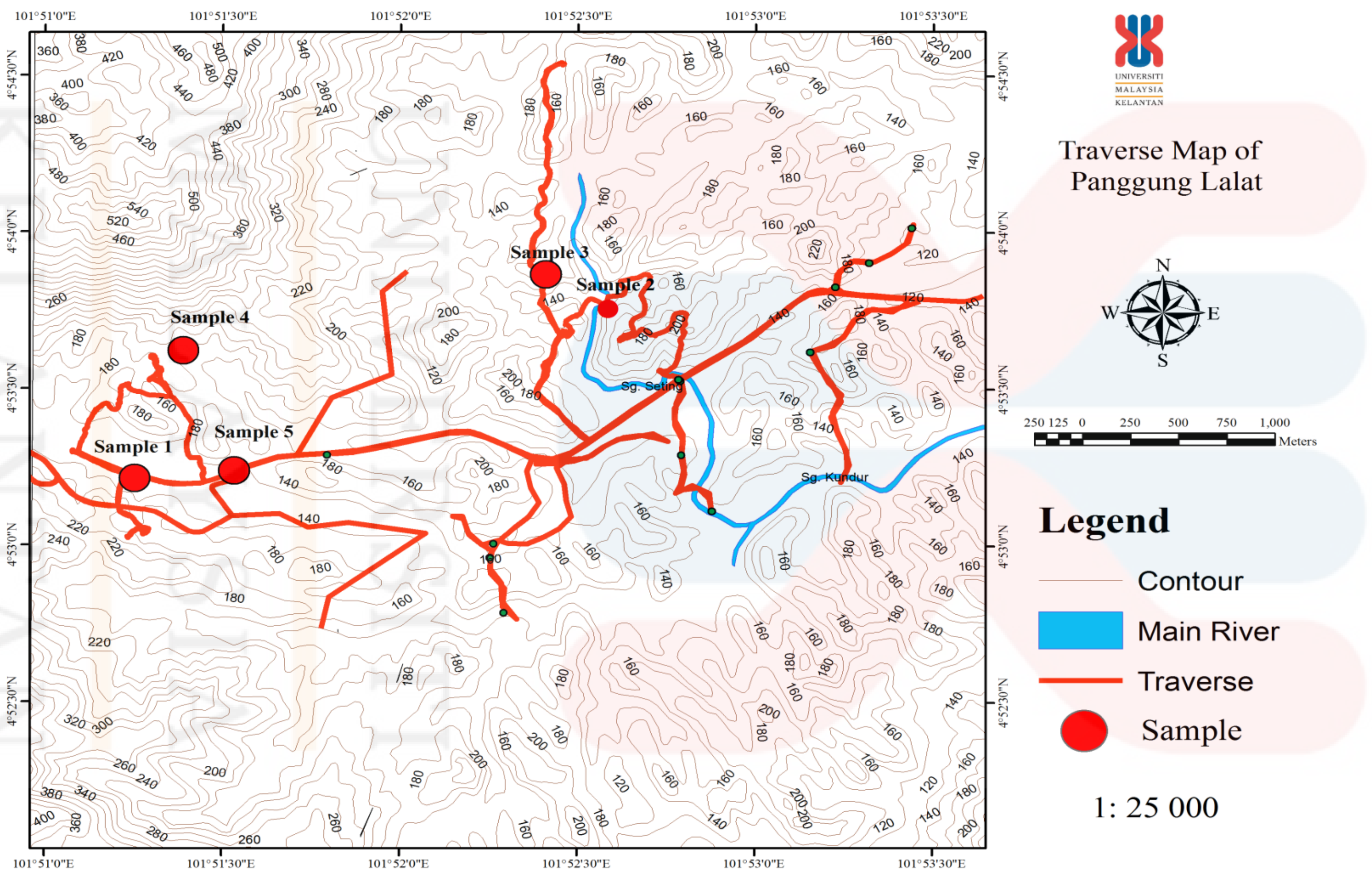


Figure 4.1: Traverse map of the Panggung Lalat

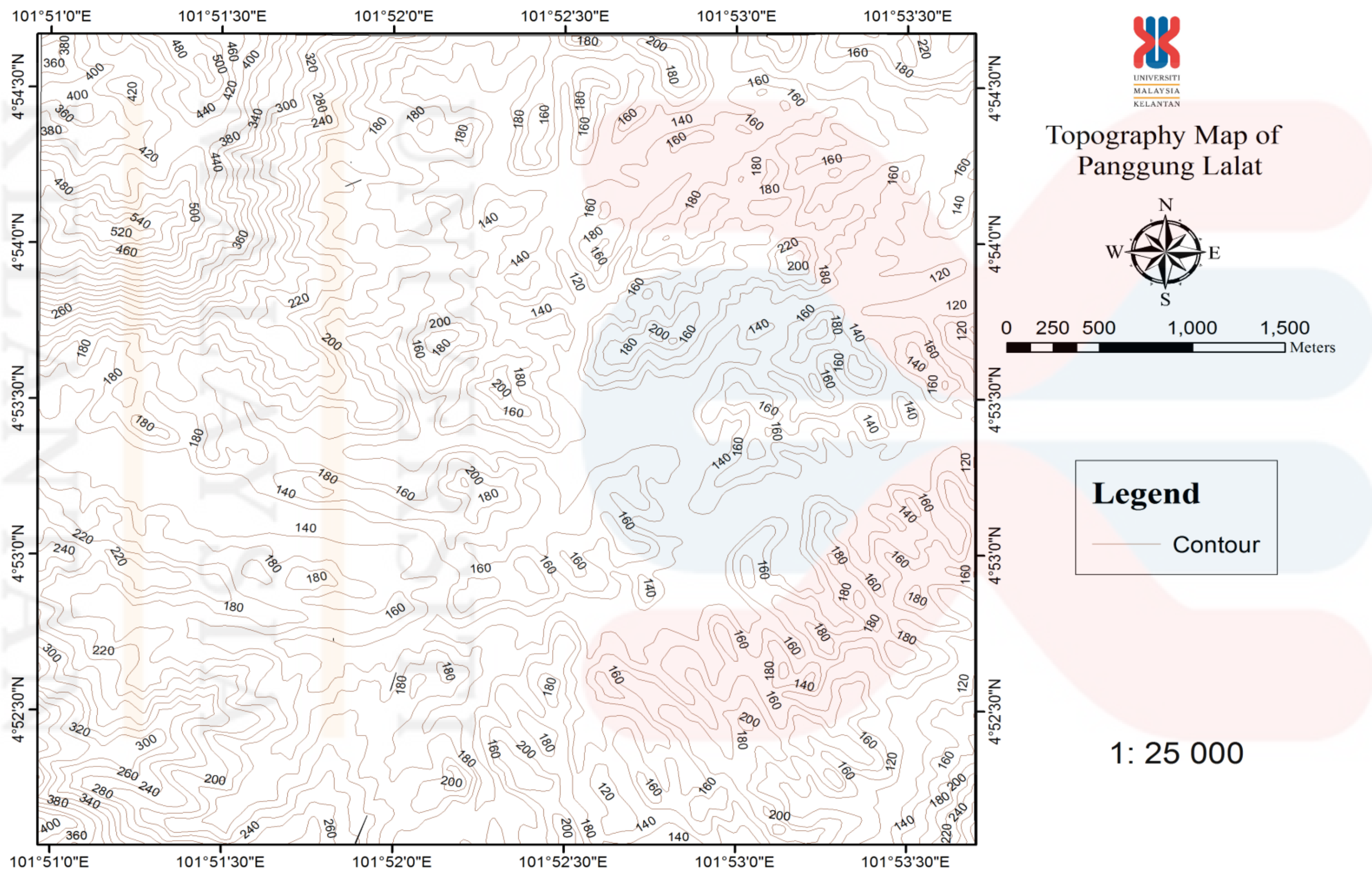


Figure 4.2: Topography map of Panggung Lalat.

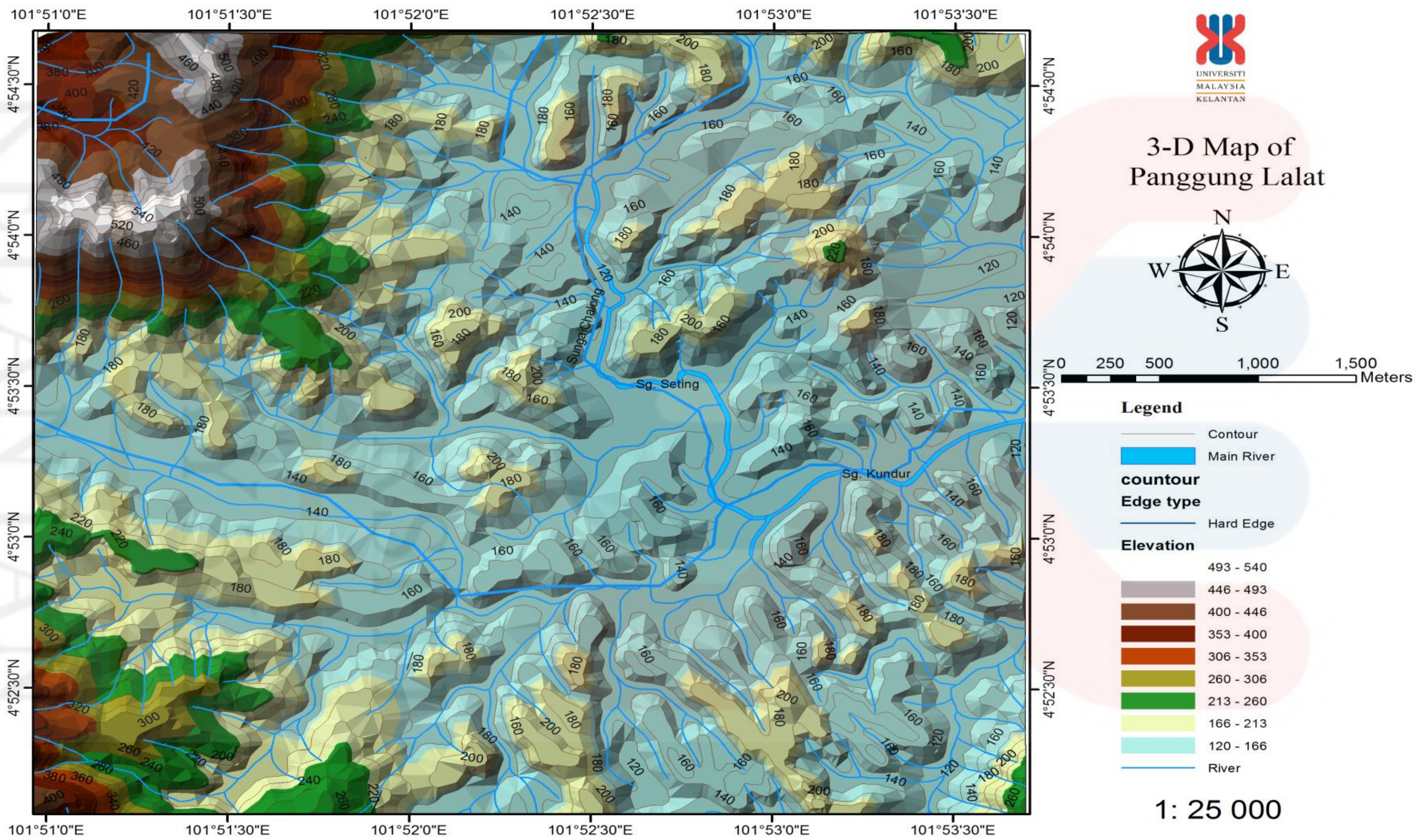


Figure 4.3: 3-D Map of Panggung lalat

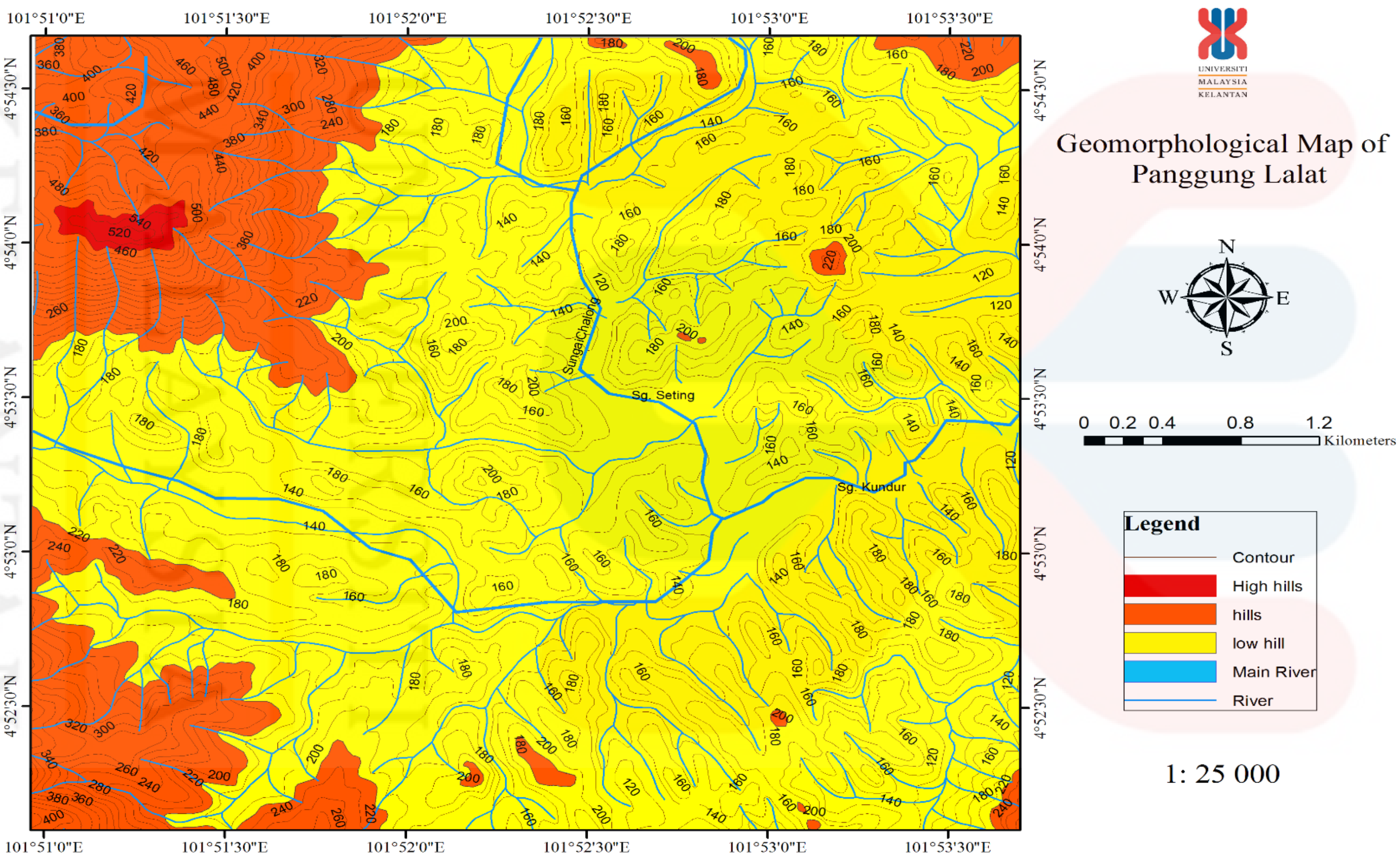


Figure 4.4: Geomorphological map of Panggung Lalat.

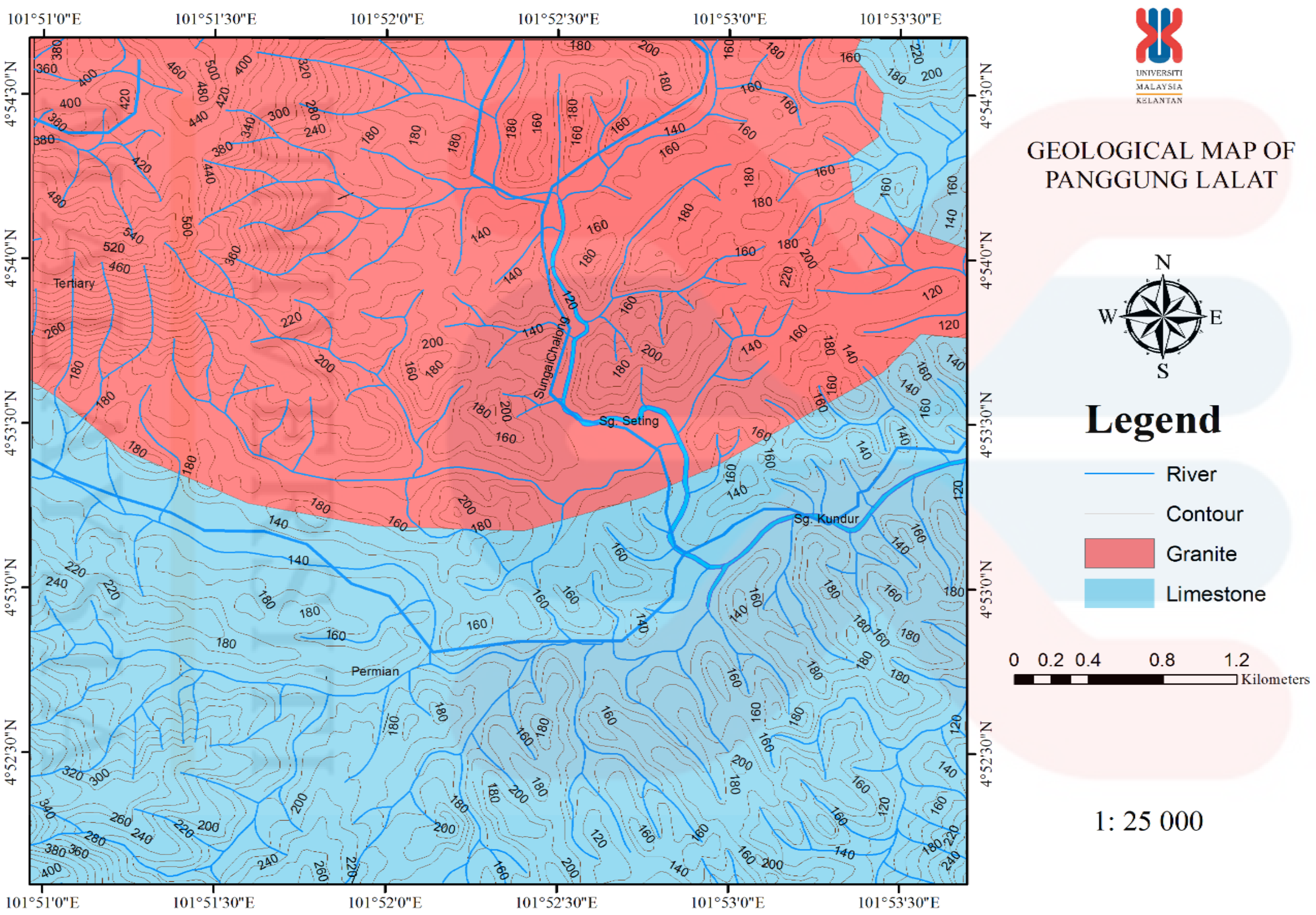


Figure 4.5: Geological map of Panggung Lalat

.4.2.2 DRAINAGE PATTERN

Drainage system is the pattern formed by the streams, rivers and lakes in a particular drainage basin. Drainage patterns are primarily controlled by the overall topography and underlying geologic structure of the watershed (U.S Environment Protection Agency, 1998). A drainage basin is the topographic region from which a streams receives runoff, through flow and groundwater flow.

There are different types of drainage system according to their pattern. There are dendritic, parallel, trellis, rectangular, radial, centripetal, deranged, annular and discordant. Different pattern will indicate different geomorphology.

The drainage pattern in this study area is dendritic, rectangular and parallel drainage pattern. Dendritic drainage system is the most common form of drainage system. In this area, it is the most abundant. In a dendritic system, there are many contributing streams (analogues to the twigs of a tree), which are then joined together into the tributaries of the main river (the branches and the trunk of the tree, respectively).

They develop where the river channel follows the slope of the terrain. Dendritic systems form in V-shaped valleys as a result, the rock types must be impervious and non-porous. In parallel drainage system, pattern of rivers caused by steep slopes with some relief (flat parts). Due to the steep slopes, the streams are swift and straight, with very few tributaries (branches), and all flow in the same direction

Rectangular drainage system develops on rocks that are of approximately uniform resistance to erosion. This means that the all the rock types are the same in that area. However, the rocks join at right angles. This causes the streams to form along the joints where the rocks are attached. The streams are then mostly straight lines along the system.

Based on the figure 4.7, dendritic drainage pattern is represented by A, parallel drainage pattern is represented by B and rectangular drainage pattern is represented by C.

Most of the streams that presence in the study area known as brook streams. Brook stream is smaller than a creek and characterised by its shallowness and its bed being composed primarily of rocks and soil. Refer figure 4.6

Figure 4.6: Brook stream presence in the study area.

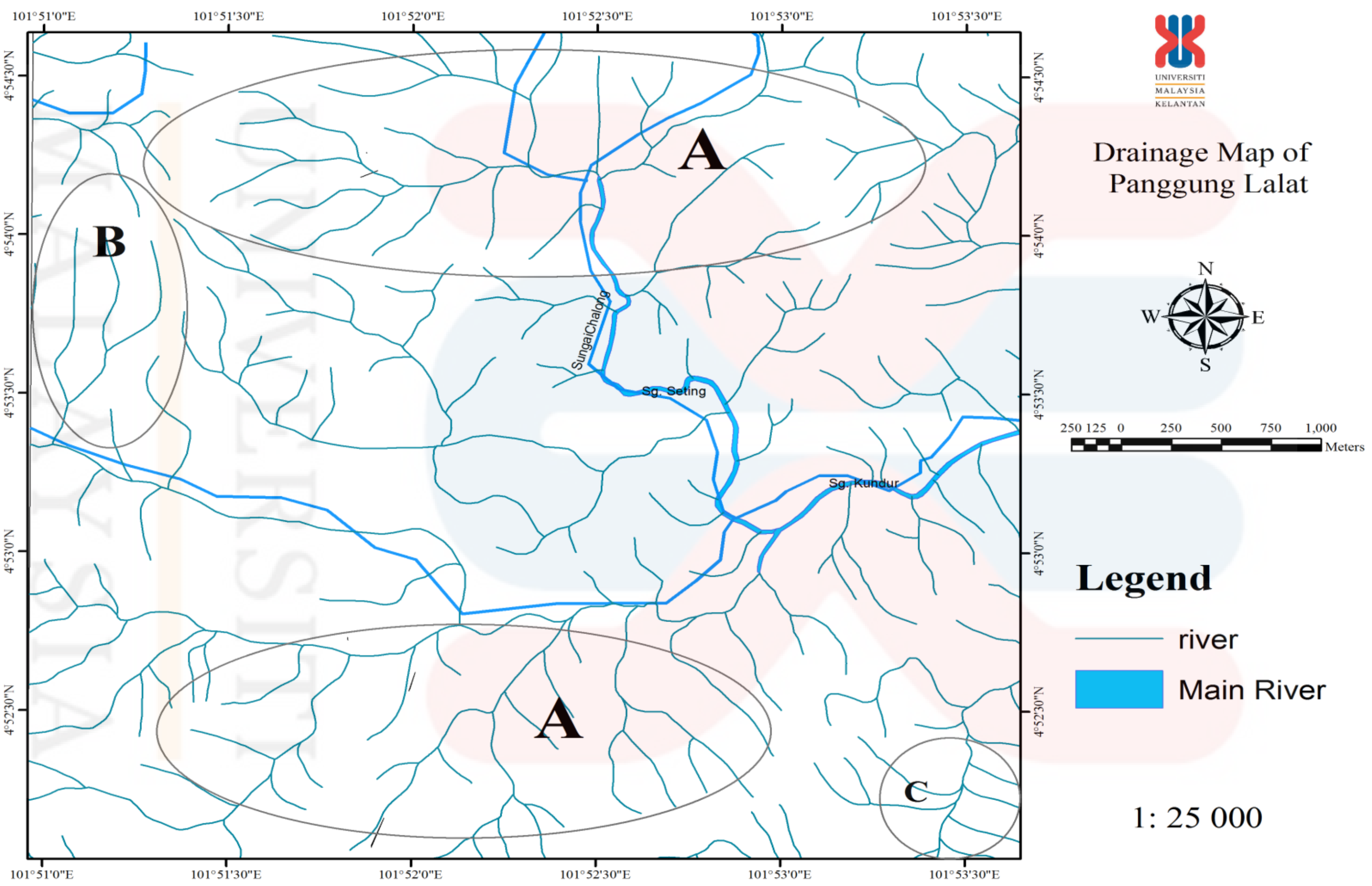


Figure 4.7: Drainage map of Panggung Lalat (A=Dendritic,B=Parallel,C=Rectangular)

4.2.3 WEATHERING

Weathering is a process where rock minerals and rock masses are altered and breakdown when they are exposed to the atmosphere. The process usually occurs on in situ where most of the time, it will change the hardness of the rock from a hard state to a weaker state, that causes the rock to be eroded and deposited into another area.

Gerber & Scheidegger (1969) postulated that fractured rock cropping out in steep slopes is submitted to more intense weathering caused by pre-existing stresses, which favours the degradation of rock strength.

Due, to the climate of Panggung Lalat which also the same as the Peninsular Malaysia's climate, the activity of weathering is much more dynamic than other countries due to the amount of rainfall, humidity and temperature and many contributing factor.

There are three types of weathering that occur in the study area, which are physical weathering, chemical weathering and biological weathering. Physical weathering is a type of weathering that result in mechanical disruption of rocks. It is caused by rains, winds, temperature, pressure and others.

Chemical weathering is the decay of rock forming minerals caused by water, temperature, oxygen mild acids and more. Biological weathering is caused by the presence of vegetation or the activity of animals such as root wedging and the production of organic acids.

Based on figure 4.8, physical weathering occurred in the study area was known as exfoliation. Exfoliation occur when the rock mass at depth is under high pressure from underlying rocks.

As the erosion and tension are developed through time, the rock were detached from the surface. Figure 4.9 show biological weathering occurred in the study area. In the figure, the trees were embedded with the outcrop thus make it known as biological weathering.

Figure 4.8: Physical weathering occurred in the study area.

Figure 4.9: Biological weathering of the study area.

4.3 Stratigraphy

Stratigraphy can be defined as sub discipline of geology that studies the rock layering it is commonly used in the sedimentology studies. Sequence stratigraphy has turned out to be one of such extraordinary helpful techniques in generating exploration prospects and predicting reservoir and seal quality in both stratigraphic and structural prospects.

This concept involves the integration of seismic data, well logs and high resolution bio stratigraphic data for provision of chronostratigraphic framework for the analysis, correlation and mapping of sedimentary packages. It encompasses the identification of the key bounding surfaces, systems tracts, depositional sequences and sedimentary cycle deposition; assigning ages to the identified key bounding surfaces as well as correlating genetically related chronostratigraphic surfaces. (Adegoke, Adebanji Kayode,2012)

Sample 1

Figure 4.10: Sample 1 outcrop

Figure 4.11: Sample 1 hand specimen

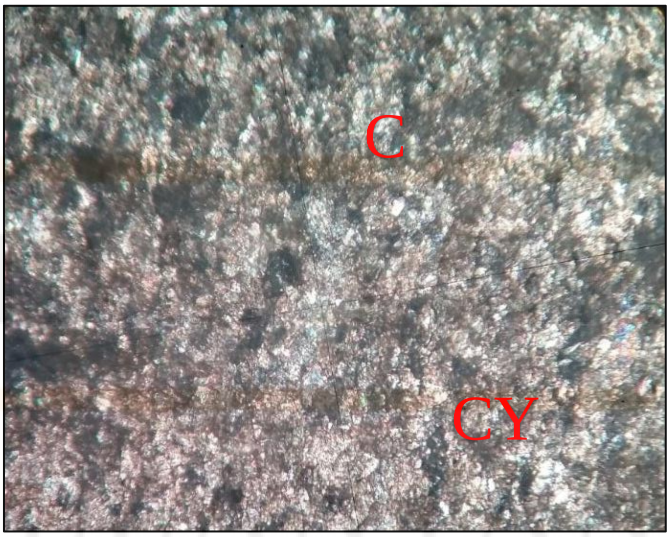


Figure 4.12: Cross polarized image of sample 1 thin section (C=Calcite, CY=Clay)

This sample was taken at coordinate N 04 53 12.8 E 101 51 15.2. The hand specimen size is larger than hammer. The outcrop of the sample was located clearly on the Earth surface. Sample 1 is known as limestone. Limestone is a sedimentary rock. Limestone composed mostly of calcium carbonate ($CaCO_3$).

Sample 2

Figure 4.13: outcrop of sample 2

Figure 4.14: Sample 2 hand specimen

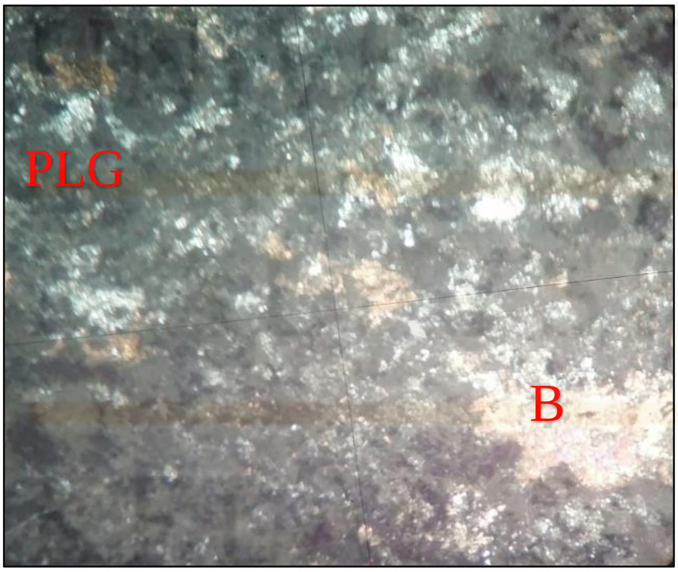


Figure 4.15: Cross polarized image of sample 2 thin section (B=Biotite, PLG= Plagioclase)

The sample was taken at the coordinate N 04 53 45.4 E 101 52 35.1. The hand specimen size is bigger than 15 cm. Based on physical characteristic, sample 2 known as granite. It is located at the river stream. There were abundance of outcrop lying around at the significant area. Granite are igneous rock and comprises mainly of feldspar and quartz with minor amounts of mica, amphiboles, and other minerals. The texture was aphanitic and fine grained. Biotite in shiny form. Crystallised Biotite in range size of 0.1-0.2 cm. Contain Muscovite Mica where the size is ranged from 0.1- 0.3 cm.

Sample 3

Figure 4.16: Sample 3 outcrop.

Figure 4.17: Sample 3 hand specimen

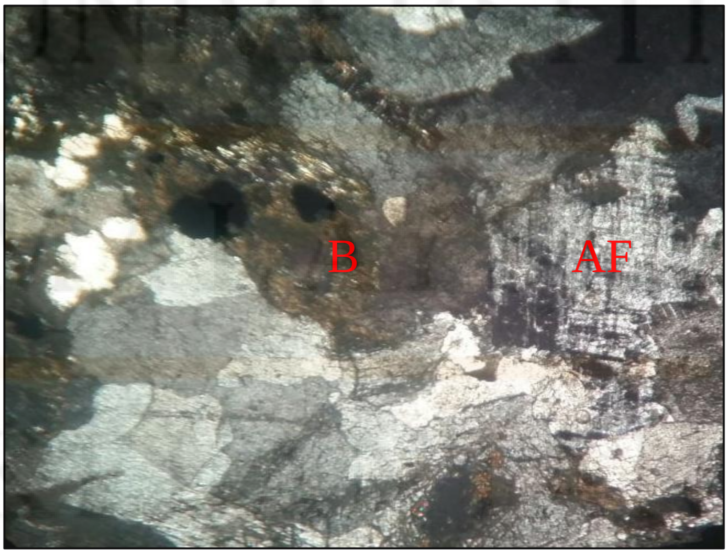


Figure 4.18: Cross polarized of sample 3 thin section (B=Biotite, AF= Alkali Feldspar)

The sample was taken at coordinate N 04 53 40.7 E 101 52 24.6. It is located at a mini waterfall. The hand specimen of sample 3 is much larger than sample 2. Sample 3 was identified as granite. Granite is composed mainly of quartz and feldspar with slight amounts of mica, amphiboles, and other minerals. This mineral composition usually gives granite a pink, red, white, or grey colour with dark mineral grains visible throughout the rock. The range size of biotites were 0.1 cm- 0.3 cm. The Alkali Feldspar is in white colour with the range of 0.1-0.5 cm. the smallest quartz was 0.1 cm.

Sample 4

Figure 4.19: Sample 4 hand specimen

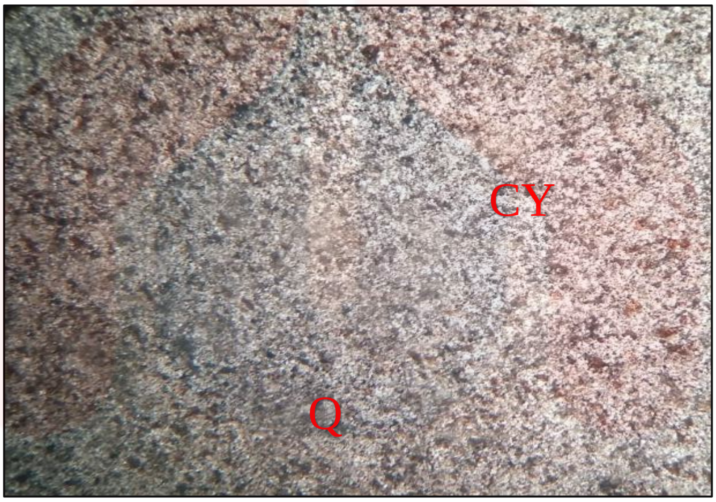


Figure 4.20: Plane polarized of sample 4 thin section (CY=Clay, Q=Quartz)

The sample was taken at the coordinate N 04 53 37.3 E 101 51 23.4. The size of hand specimen was bigger than size of the fist. Sample 4 known as sandstone where it is a type of sedimentary rock. Sandstone composed of sand-size grains of rock, mineral, or organic material. It also contains a cementing material that holds the sand grains together and may contain a matrix of silt- or clay-size particles that inhabit the spaces between the sand grains.

Sample 5

Figure 4.21: Sample 5 outcrop

Figure 4.22: Sample 5 hand specimen

The sample was taken at coordinate N 04 53 14.3 E 101 51 32.0. The outcrop of the sample is clearly visible while the hand specimen is larger than fist of the hand. Based on field observation, the fresh colour of hand specimen was brownish grey and the weathered colour was brownish. Sample 5 was identified as shale where it is known as part of sedimentary rock group. Shale composed mainly of clay.

Table 4.1: Stratigraphic Column of Panggung Lalat

Era	System	Lithostratigraphy	Lithology
Mesozoic	Triassic	Granite	Light grayish colour with medium grain. Made up of mostly quartz, feldspar and plagioclase.
Palaeozoic	Permian	Limestone	Light grayish colour with fine grains. Contains mostly calcite.
		Sandstone	Grey colour with fine grain. composed of sand-size grains of rock, mineral, or organic material
		Shale	Grey colour with fine grain. Compaction of silt and clay minerals.

4.4 Structural Geology

Structural Geology aims to characterise deformation structures (geometry), to characterize flow paths followed by particles during deformation (kinematics), and to infer the direction and magnitude of the forces involved in driving deformation (dynamics). A field-based discipline, structural geology operates at scales ranging from 100 microns to 100 meters such as from grain to outcrop.

Structural geology is at the core of hydrocarbon and mineral exploration, as structures control the migration, trapping and escape of hydrocarbon fluids. Structural geology is the first stage to any regional geophysical and geochemical surveys aiming at identifying new mineralized provinces. It is also critical for the interpretation of geophysical, geochemical, and geochronological data. (Patrice, 2016).

4.4.1 Joint Analysis

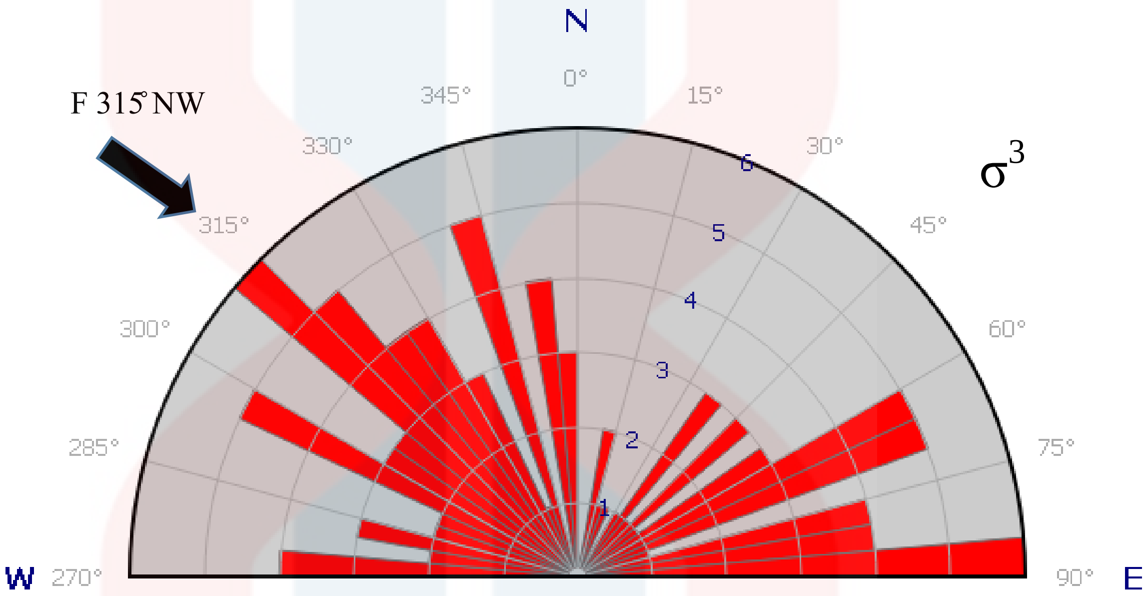


Figure 4.23: Rose diagram of joint analysis in the study area

Joints may result from regional tectonics (i.e. the compressive stresses in front of a mountain belt), folding (due to curvature of bedding), faulting, or internal stress release during uplift or cooling. They often form under high fluid pressure (i.e. low effective stress), perpendicular to the smallest principal stress.

Joint analysis is the method that determine the direction of force acted on a rock mass. In geological point of view, among the importance properties of rock need to be observed for a joint analysis is fracturing and discontinuities on a rock. Most of the rock have been exposed by fractures and discontinuities.

The principal force come from 315° NW where it was taken from coordinate N 04° 53 40.7 E 101° 52 27.9 where the σ^3 was NE 45 degree.

4.4.2 Lineament analysis

A lineament is a linear feature in a landscape which is an expression of an underlying geological structure such as a fault. Typically, a lineament will comprise a fault-aligned valley, a series of fault or fold-aligned hills, a straight coastline or indeed a combination of these features. Fracture zones, shear zones and igneous intrusions such as dykes can also give rise to lineaments. Following Gabrielsen et al. (1984) and Nystuen (1989), fractures or lineaments may constitute sets, systems, complexes and zones.

Not only the lineaments can be tectonic features such as faults, folds, joints and fractures, but they can also be other natural features, such as steep to vertical strata, rivers, vegetation and some cultural features such as roads and boundaries between areas of different agricultural use. M. Kirami ÖLGEN (2004)

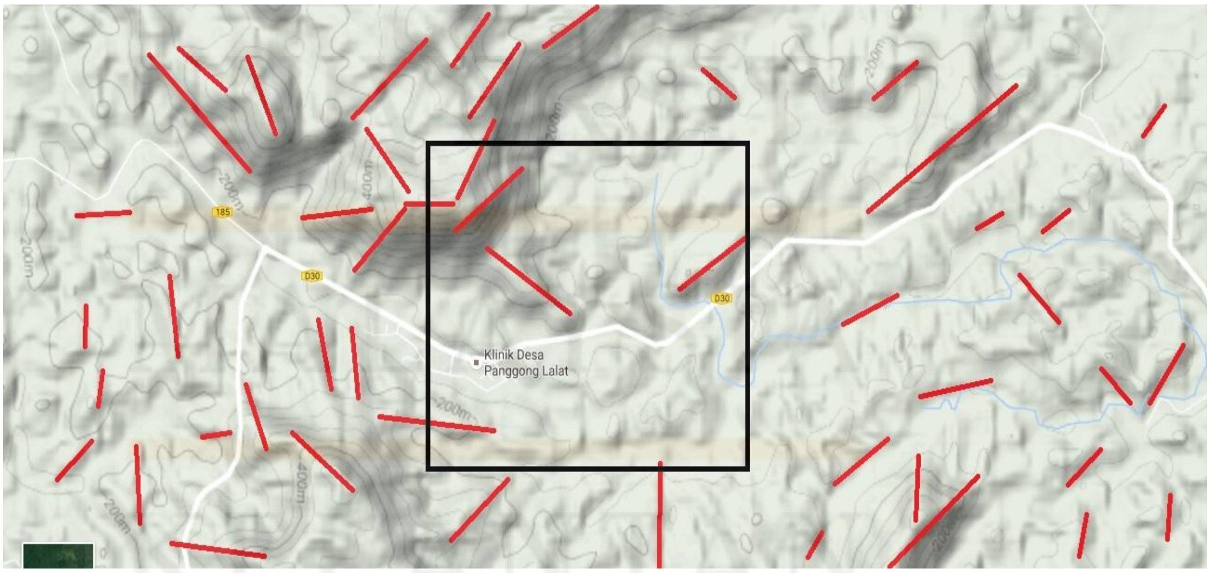


Figure 4.24: Lineament map of the study area.

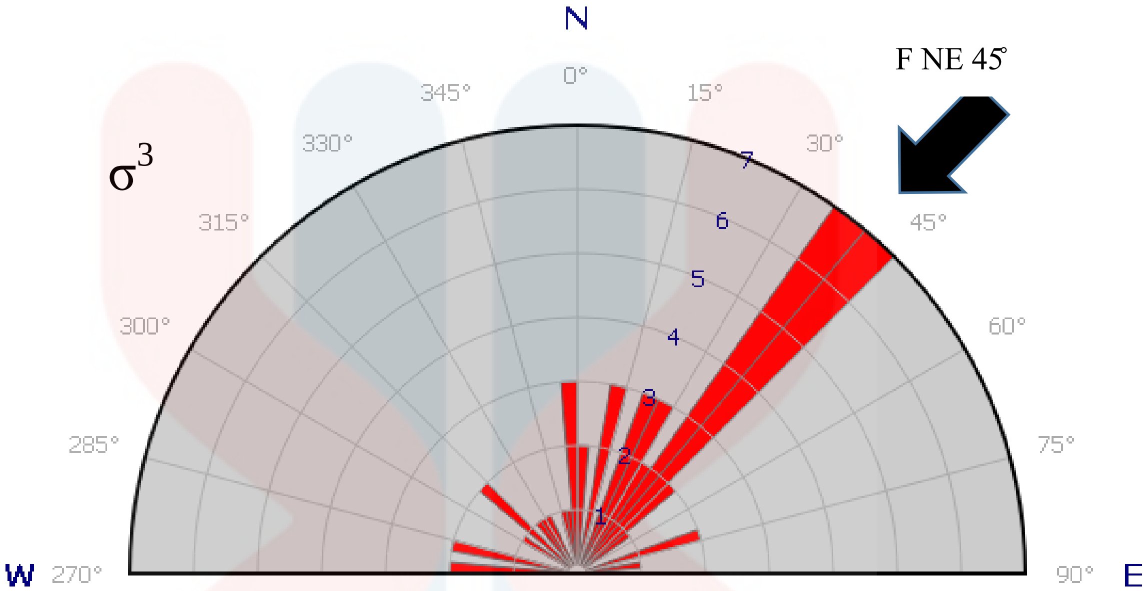


Figure 4.25: Rose diagram of lineament analysis of study area.

Based on the figure 4.25, the force direction is NE 45˚ where the σ^3 that is known as the lowest force is NW 315˚.

4.5 Historical Geology

Historical geology is a discipline that uses the ideologies and methods of geology to reconstruct and understand the geological history of Earth. It emphases on geologic processes that change the Earth's surface and subsurface; and the use of stratigraphy, structural geology and palaeontology to tell the sequence of these events.

The Middle Permian to Upper Triassic Gua Musang Formation (Mohd Shafeea Leman,1993 and 2004) was mapped by Yin (1965) in south Kelantan. The formation, estimated to be 650 m thick, is made up of crystalline limestone, interbedded with thin beds of shale,tuff, chert nodules and subordinate sandstone and volcanics.

Poorly- preserved fusulines, including Verbeekina from Gua Musang, give a Permian age to parts of the limestone and Lower Triassic (Scythian) ammonoids (Hada,1966) have also been described from the limestone nearby.

The thin-bedded, laminated and fissile shale is usually grey in colour but is black when carbonaceous. The argillaceous sandstone is fine to medium grained with angular quartz in a matrix of limonitic or carbonaceous clay (Foo,1983)

The formation is the lateral equivalent of the pyroclastic Aring Formation and is synonymous with the Telong Formation of Aw (1990) in south Kelantan (Foo,1983).

CHAPTER 5

PETROGRAPHY OF IGNEOUS ROCK

5.1 Introduction

Traditionally, petrography was limited to the identification of rocks, minerals and ores and to the characterization of properties such as cleavage, twining, reflectance, and so forth. Today, however, petrographic techniques were employed to analyse many materials other than minerals, for example, ceramics, glass, concrete, cement, soils, biomaterials, polymers, to name just a few. (Wase Ahmed & George Vander Voort,2015)

Petrography is a subdivision of petrology that focuses on thorough descriptions of rocks. The mineral content and the textural relationships within the rock are described in details. The classification of rocks is based on the information acquired during the petrographic analysis.

X- ray Fluorescence (XRF) is an analytical method to determine the chemical composition of all kinds of materials. The materials can be in solid, liquid, powder, filtered or other form. XRF can also sometimes be used to determine the thickness and composition of layers and coatings. (Peter Brouwer, 2003)

The methods were fast, accurate and non-destructive, and usually require only a minimum of sample preparation. Applications were very broad and include the metal, cement, oil, polymer, plastic and food industries, along with mining, mineralogy and geology, and environmental analysis of water and waste materials.

XRF is also a very useful analysis technique for research and pharmacy. (Peter Brouwer, 200

5.2 Result and Discussion

Sample 1

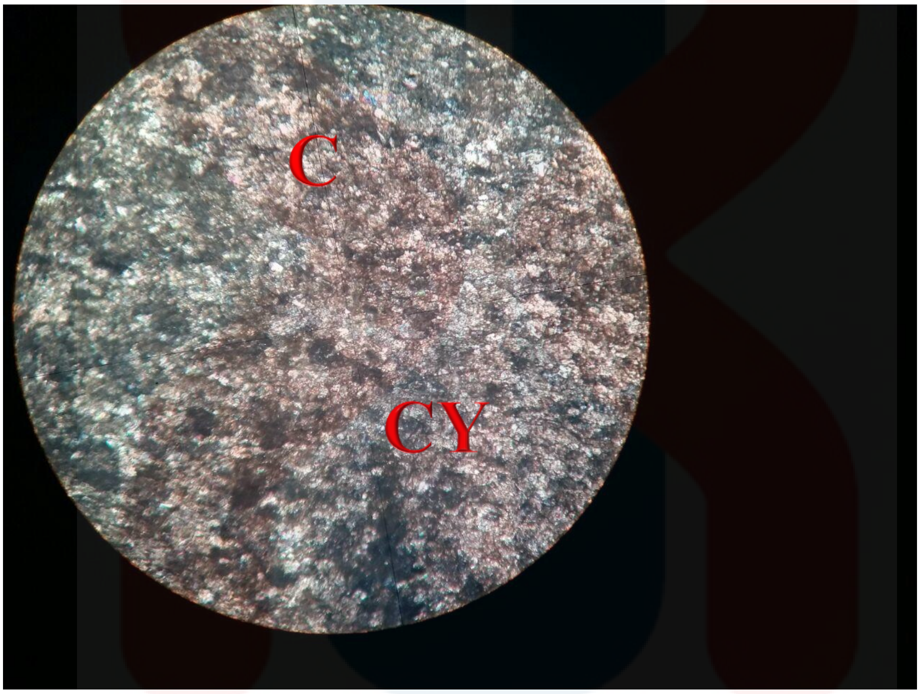


Figure 5.1: Sample 1 cross polarized image (C=Calcite, C=Clay)

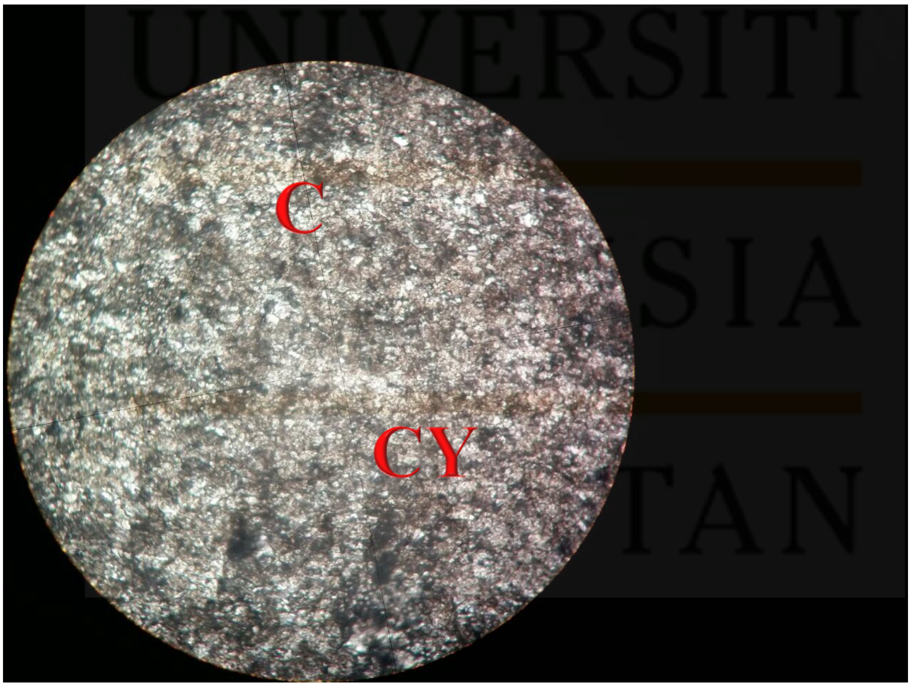


Figure 5.2: Sample 1 plane polarized image (C=Calcite, C=Clay)

Limestone is a common sedimentary rock composed primarily of the mineral calcite (CaCO3). Limestone constitutes approximately 10 percent of the sedimentary rocks exposed on the earth's surface. It forms either by direct crystallization from water (usually seawater) or by accumulation of shell and shell fragments.

The minor minerals that usually contain in limestone are aragonite, dolomite, siderite, quartz, pyrite. The most common colour for the limestone are white, grey and pink. For this sample, the colour of the limestone is in grey colour and it is in fine grained textures.

Calcite is known for the great variety and beautiful development for its crystals. It is the most common form of calcium carbonate. Its crystal occurs most often as scalenohedra and are commonly twinned, sometimes forming the heart-shaped butterfly twins.

The crystals showing rhombohedral terminations are also common, and calcite readily cleaves into rhombohedra. Those with steep rhombohedral or scalenohedral terminations are also known as dogtooth spar: those with shallow rhombohedral terminations are called nailhead spear; and highly transparent crystal are sometimes called optical spar, a reference for their use in polarizing filters.

Calcite perfectly demonstrate the optical property of double refraction: light passing through is split into two components, giving a double image of any object viewed through it.

In its pure form, it is colourless, pale-coloured, or white, but usually it is found in virtually all colours, including blue and black. Although, it forms spectacular crystals, most calcite is massive, occurring either as limestone or marble. It is also found as fibres, nodules, stalactites and as an earthly aggregate.

In hydrothermal deposits, the habits of its crystal were good indicators of depositional temperature and other conditions.

Clay minerals were a group of sheet silicate minerals that crystallize primarily in the monoclinic system. They were generally white, buff or yellowish when pure and only rarely form visible crystals. The various clay minerals were hard to tell apart in hand specimens.

Under a microscope, most crystals of clay minerals were pseudohexagonal plates. Clay minerals generally consists of two structural units: a layer of silicon-oxygen tetrahedral arranged in a hexagonal network in two dimensions; and two layers of closed packed oxygen or hydroxyl ions.

This second component creates sites in which metals, usually sodium, calcium, aluminium, magnesium, or iron are located. Most clay are the result of the weathering of feldspar or other aluminium rich minerals.

Different clay minerals can result from the same parent rock depending on the climate and the amount, chemistry and flow of the water involved in the weathering process. Clay minerals are widespread in sedimentary rock and at the same time, the sample that been taken for this petrography analysis is mud supported.

Sample 1

Table 5.1: Chemical composition of sample 1

Elements	Concentration (%)
Na2O	9.00
MgO	2.22
Al2O3	0.725
SiO2	1.98
P2O5	0.387
SO3	0.425
Cl	0.273
K2O	0.744
CaO	83.0
Fe2O3	0.367
SrO	0.225
BaO	0.184
La2O3	0.168

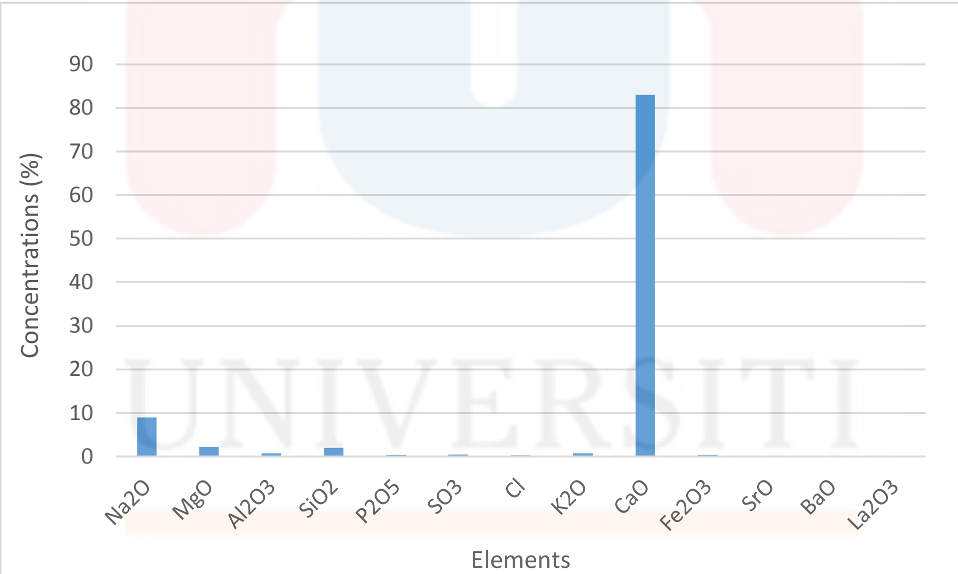


Figure 5.3: Sample 1 element concentration bar graph

The highest concentration with 83.0% was CaO followed by Na2O with 9.00%. the 3rd and 4th place are MgO and SiO2 with 2.22% and 1.98% respectively. Al2O3, P2O5, SO3, Cl, K2O, Fe2O3, SrO, BaO and La2O3 all were elements that below 0% respectively with the lowest concentration was La2O3 with 0.168%.

Sample 2

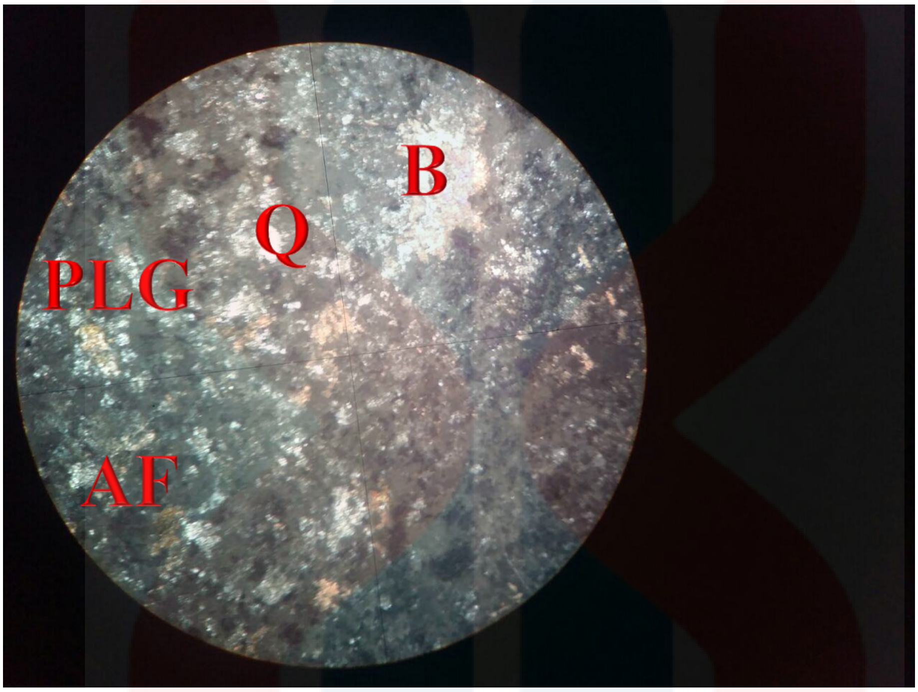


Figure 5.4: Sample 2 cross polarized image (B=Biotite, Q=Quartz, PLG= Plagioclase, AF= Alkali Feldspar)

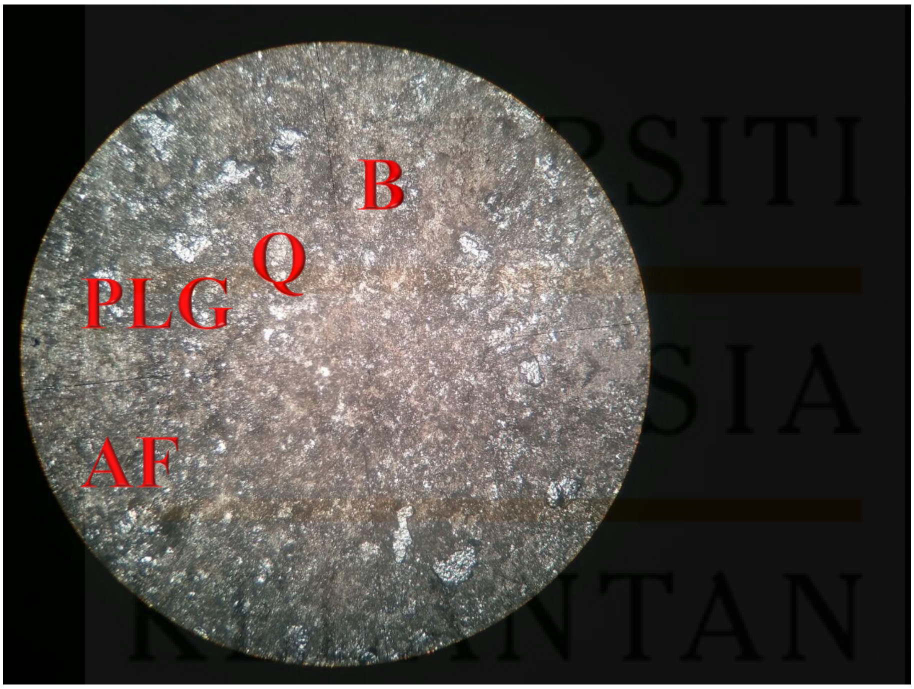


Figure 5.5: Sample 2 plane polarized image (B=Biotite, Q=Quartz, PLG= Plagioclase, AF= Alkali Feldspar)

Sample 3

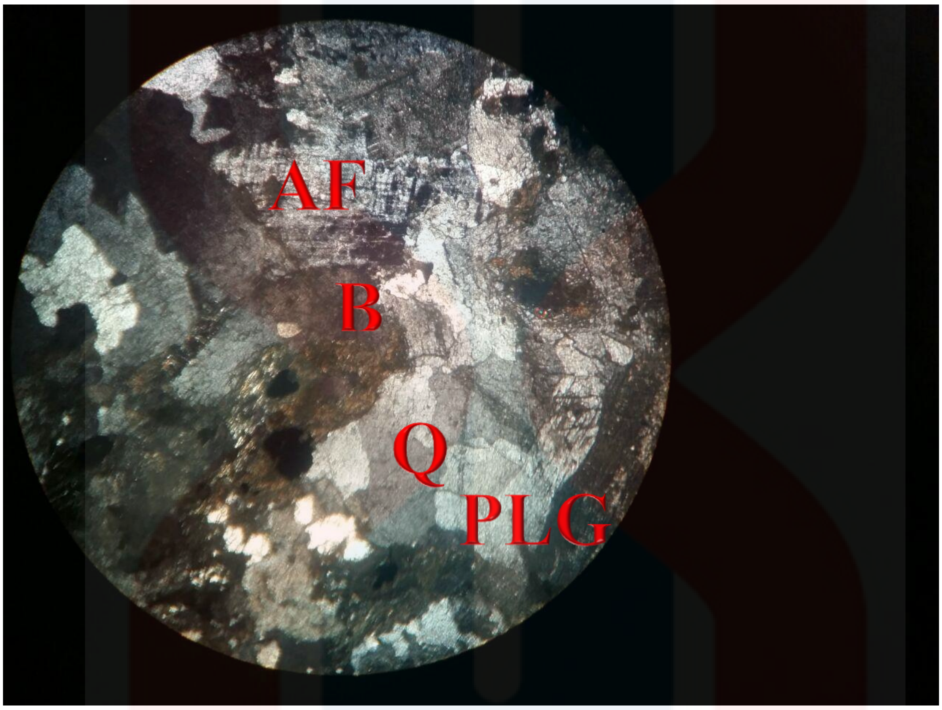


Figure 5.6: Sample 3 cross polarized image (B=Biotite, Q=Quartz, PLG= Plagioclase, AF= Alkali Feldspar)

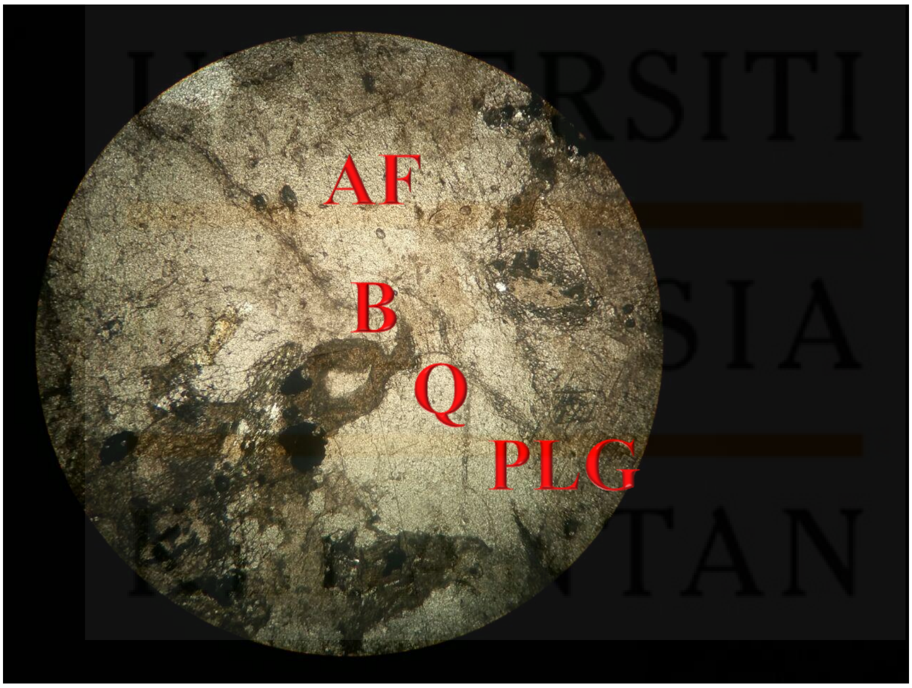


Figure 5.7: Sample 3 plane polarized image (B=Biotite, Q=Quartz, PLG= Plagioclase, AF= Alkali Feldspar)

Granite was light coloured, acid igneous rock composed principally of alkali-feldspar, quartz and biotite, with some plagioclase. It forms from the slow crystallization of magma below Earth's surface. In this sample there were minerals of biotite, quartz, plagioclase, alkali feldspar and heavy metal.

Biotite also called as black mica. It is very widespread and is common in both igneous and metamorphic rock. The crystal system is monoclinic and the colour usually in form of black, brown, pale yellow, tan or bronze.

It forms large crystal in granites and granite pegmatites, and forms tabular to short prismatic crystals often pseudohexagonal in cross section. It readily cleaves into thin, flexible sheets. The cleavage is perfectly basal.

Quartz is a chemical compound consisting of one-part silicon and two parts oxygen. It is silicon dioxide (SiO_2). It is the most common mineral found in Earth's crust after ice and feldspar.

Quartz comes essentially in two forms: crystalline or fully crystalline; and cryptocrystalline, formed of microscopic crystalline particles. Crystalline quartz is usually colourless and transparent (rock crystal) or white and translucent (milky quartz) but it can also occur in varieties of colours.

Crystallized impurities occur in some crystalline quartz varieties, such as hair-like inclusions of rutile, needles (rutilated quartz) or green, moss-like clumps of chlorite. Quartz occurs in nearly all silica-rich metamorphic, sedimentary, and igneous rock.

Feldspars were the major component of most igneous rocks. There are two groups of feldspars: the alkali feldspars and plagioclase feldspars. The plagioclase can be differentiated from the alkali feldspar by the presence of polysynthetic twinning.

Alkali feldspars were formed at high temperatures, a solid- solution series exist within the alkali feldspars between the potassium feldspar orthoclase (KAlSiO3O8) and the sodium feldspar albite (NaAlSi3O8). Unlike plagioclase, which all crystallize in the triclinic crystal system, the alkali feldspars crystallize both in the triclinic and monoclinic systems.

There were also monoclinic varieties in which barium replaces some or all of the potassium. These known as barium feldspars. Albite appears as the end member of both the alkali feldspar and the plagioclases, and is considered to be both an alkali and a plagioclase feldspar.

Plagioclases were a major group of rock- forming feldspars that are a continuous series of solid solutions between the end members' albite (NaAlSi3O8, or sodium aluminosilicate, abbreviated Ab) and anorthite (CaAl2Si2O8, or calcium aluminosilicate, abbreviated An). Various members of intermediate composition are given names dependent on the percentages of albite or anorthite they contain.

Heavy metals were generally defined as metals with relatively high densities, or atomic numbers. In both of the samples, heavy metals can be distinguished by other minerals by looking at the plane polarized and seeing the black spot.

QAP diagram are being used to classified igneous rock based on mineral composition. In sample 2, based on the QAP diagram where Q stands for quartz, A stands for alkali feldspar and P stand for plagioclase. Quartz is 55%, Alkali Feldspar is 25% and Plagioclase is 30% hence make it classified into Monzogranite group.

In sample 3, based on the QAP diagram, the Quartz have 86%, Alkali Feldspar have 11% and Plagioclase have 3% make it sample 3 being identified as Quartz-Rich Granitoids.

Sample 2

Table 5.2: Chemical Composition of sample 2

Elements	Concentrations (%)
SiO2	73.1
Al2O3	11.4
K2O	8.68
Fe2O3	1.44
CaO	1.26
SO3	1.18
P2O5	1.05
Cl	0.765
ZrO2	0.347
TiO2	0.246
Rb2O	0.148
BaO	0.115

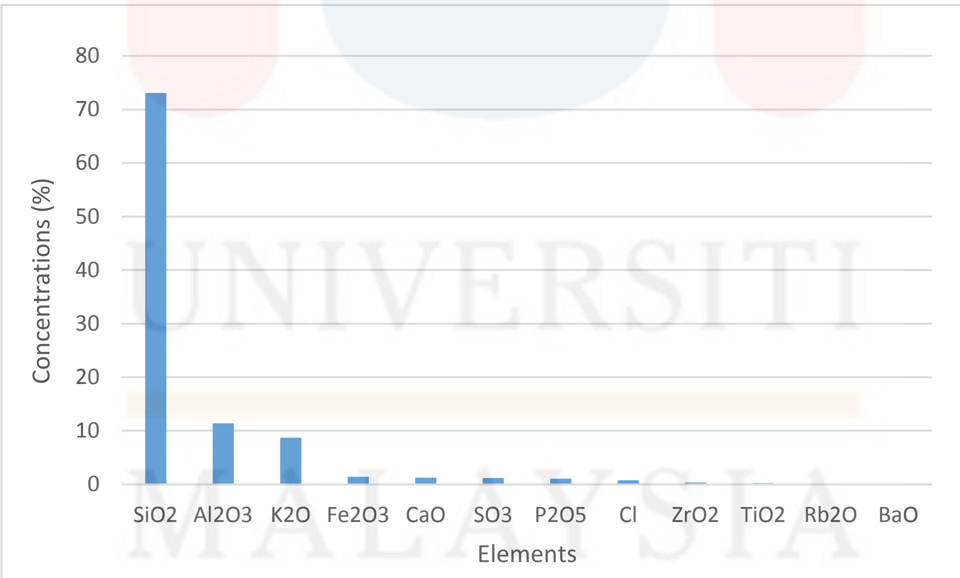


Figure 5.8: Sample 2 element concentration bar graph

The highest concentration was 73.1% of SiO2 followed by Al2O3 with 11.4%. the 3rd and 4th place goes to K2O and Fe2O3 with percentage of 8.68% and 1.44% respectively. Cao, SO3 and P2O5 have the percentage of 1.26%, 1.18% and 1.05%

correspondingly. Elements Cl, ZrO2, TiO2, Rb2O, BaO all were below 0% with the lowest was BaO with 0.115%.

Sample 3

Table 5.3: chemical composition of sample 3

Elements	Concentrations (%)
Na2O	6.11
MgO	1.54
Al2O3	10.7
SiO2	52.8
P2O5	0.955
SO3	0.718
Cl	0.474
K2O	9.53
CaO	4.27
TiO2	1.31
MnO	0.203
Fe2O3	9.77
ZrO2	0.397
BaO	0.829

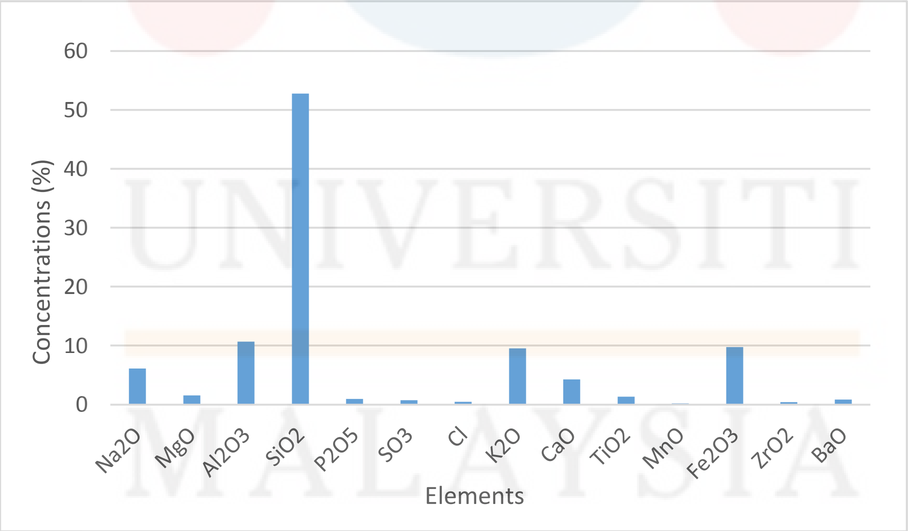


Figure 5.9: Sample 3 element concentration bar graph

The highest element concentration was SiO2 with 52.8 % followed by Al2O3 with 10.7%. the 3rd and 4th spot are taken by Fe2O3 and K2O with the percentage of 9.77% and 9.53% respectively. Na2O and CaO have the concentration percentage of

6.11% and 4.27% respectively. MgO and TiO2 have the percentage of 1.54% and 1.31% separately. P2O5, SO3, Cl, MnO, ZrO2, BaO all are below 0% with the lowest concentration is element was MnO with 0.203%.

Sample 4

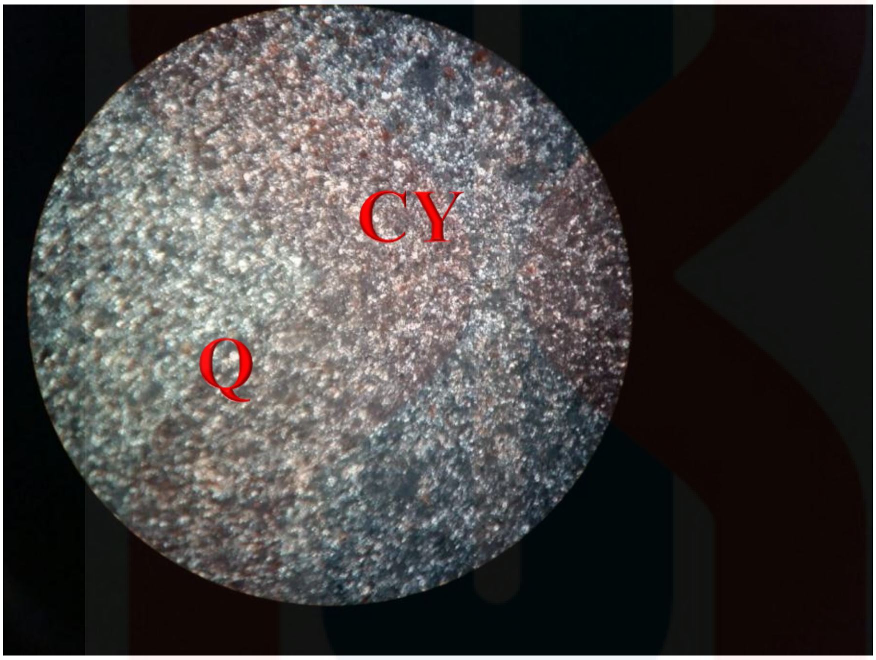


Figure 5.10: Sample 4 cross polarized image (CY=Clay, Q=Quartz)

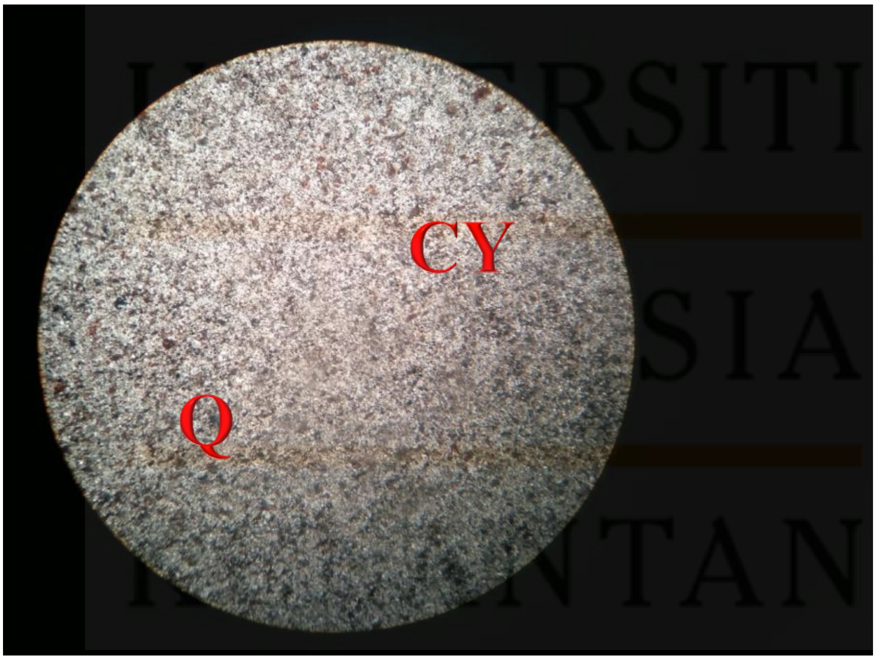


Figure 5.11: Sample 4 plane polarized image (CY=Clay, Q=Quartz)

Sandstone makes up about 10% - 20% of the sedimentary rock in the Earth's crust. It is the lithified accumulation of sand- sized grains, 0.063-2mm in diameter and it has a wide range of textures and mineralogy where it is an important indicator of erosional and depositional processes.

Sand grains can be composed of any mineral but monocrystalline quartz grains are by far the most abundant type of sandstone grain. Quartz is a chemical compound consisting of one-part silicon and two parts oxygen. It is silicon dioxide (SiO_2). It is the most common mineral found in Earth's crust after ice and feldspar.

Quartz comes essentially in two forms: crystalline or fully crystalline; and cryptocrystalline, formed of microscopic crystalline particles. Crystalline quartz is usually colourless and transparent (rock crystal) or white and translucent (milky quartz) but it can also occur in varieties of colours.

Crystallized impurities occur in some crystalline quartz varieties, such as hair-like inclusions of rutile, needles (rutilated quartz) or green, moss-like clumps of chlorite. Quartz occurs in nearly all silica-rich metamorphic, sedimentary, and igneous rock.

Clay minerals were a group of sheet silicate minerals that crystallize primarily in the monoclinic system. They are generally white, buff or yellowish when pure and only rarely form visible crystals. The various clay minerals are hard to tell apart in hand specimens.

Under a microscope, most crystals of clay minerals were pseudohexagonal plates. Clay minerals generally consists of two structural units: a layer of silicon-oxygen tetrahedral arranged in a hexagonal network in two dimensions; and two layers of closed packed oxygen or hydroxyl ions.

This second component creates sites in which metals, usually sodium, calcium, aluminium, magnesium, or iron are located. Most clay were the result of the weathering of feldspar or other aluminium rich minerals.

Different clay minerals can result from the same parent rock depending on the climate and the amount, chemistry and flow of the water involved in the weathering process.

Sample 4

Table 5.4: Chemical composition of sample 4

Elements	Concentration (%)
Na2O	6.14
MgO	1.57
Al2O3	13.0
SiO2	51.1
P2O5	1.14
SO3	1.45
Cl	0.578
K2O	6.16
CaO	2.23
TiO2	1.35
MnO	0.120
Fe2O3	14.1
CuO	0.110
ZrO2	0.191
BaO	0.261

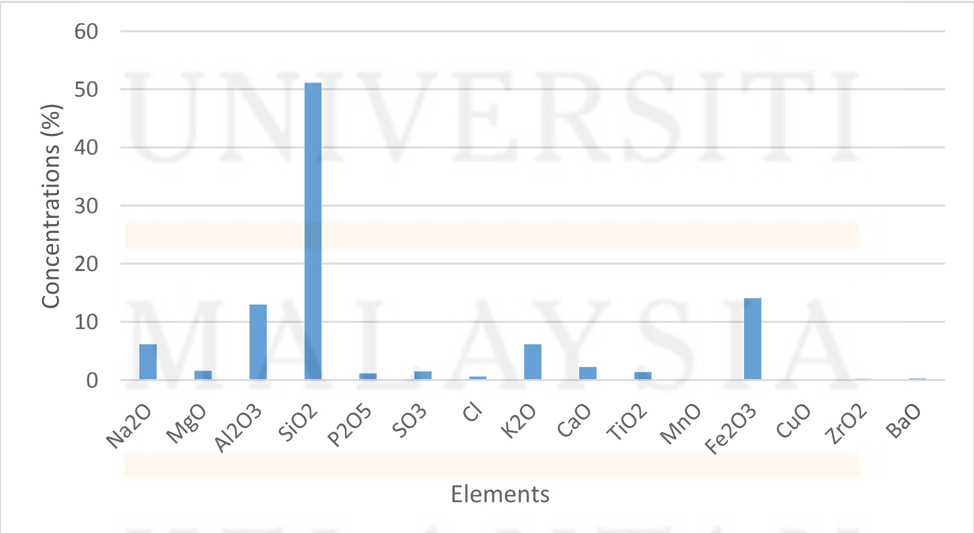


Figure 5.12: Sample 4 element concentration bar graph

The highest element concentration for sample 4 was SiO2 with 51.1 % followed by Fe2O3 with 14.1%. The 3rd and 4th place goes to Al2O3 and K2O with the percentage of 13.0% and 6.16%. Na2O in the 5th place with the percentage of 6.14%. Element CaO and TiO2 have the percentage of 2.23% and 1.35% respectively. Elements Cl, MnO, ZrO2, CuO and BaO all are below 0% with the lowest concentration is CuO with 0.110 %.

Sample 5

Table 5.5: Chemical composition of sample 5

Elements	Concentration (%)
SiO2	51.3
Al2O3	16.5
Na2O	10.2
K2O	9.64
Fe2O3	7.22
TiO2	2.12
P2O5	1.17
SO3	0.512
Cl	0.408
CaO	0.383
ZrO2	0.156
BaO	0.151

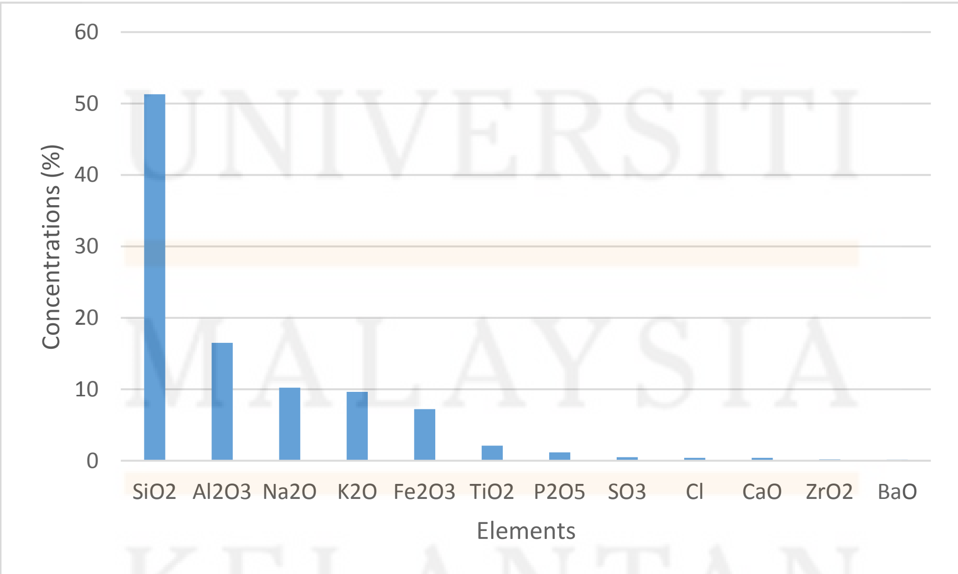


Figure 5.13: Sample 5 element concentration bar graph.

The highest concentration element was SiO2 with 51.3% followed by Al2O3 with 16.5%. Na2O and K20 both hold 3rd and 4th position respectively with the value of 10.2% and 9.64% correspondingly. Fe2o3, Tio2 and P2O5 have the value of 7.22%, 2.12% and 1.17% respectively. SO3, Cl, CaO, ZrO2 and Bao all are below 0% with the lowest was BaO with 0.151 %.

CHAPTER 6

CONCLUSION AND SUGGESTION

6.1 Conclusion

As conclusion, in order to update geological map with the ratio of 1:25 000, extensive research was done by carried out mapping and field observation. By carried out this activities, new information was gained such as new roads and villages been discovered. Recent data of geological information such as shale was being found in igneous section.

Based on the studies, the igneous rock that being found at the study area is granite. There are 2 types of granite that was found at the study area where sample 2 known as Monzogranite and sample 3 known as Quartz- Rich Granitoids. The classifications were based on QAP diagram analysis. Both of the samples contain quartz, alkali feldspar, plagioclase, biotite and heavy minerals. For both of the samples, the XRF analysis indicate that the highest concentration is SiO2.

6.2 Suggestion

To produce more accurate and precise data, samples that being collected should be add more so that more data can be obtain. For petrography discipline, the institution should have an advance microscope instrument so that it will easier to take thin samples pictures and minimize the light refraction error. In XRF analysis, there should be an experienced staff that can handle the analysis so that error can be minimize and can prevent contamination of the samples.

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