General Geology and Study of Iron Oxide in Temangan

by

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DECLARATION

I declare that this thesis entitled 'General Geology and Study of Iron Oxide in Temangan' 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 : ______________________________

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LIST OF ABBREVIATION

Al_2O_3 - Aluminium oxide

BaO - Barium oxide

CaO - Calcium oxide

CeO_2 – Cerium (IV) oxide

Cl – Chlorine

Fe_2O_3 - Iron(III) oxide

GIS – Geographic Information System

K_2O - Potassium oxide

La_2O_3 – Lanthanum oxide

MnO - Manganese(II) oxide

Na_2O - Sodium oxide

P_2O_5 - Phosphorus pentoxide

Rb_2O - Rubidium oxide

SiO_2 - Silicon dioxide

SO_3 - Sulfur trioxide

TiO_2 - Titanium dioxide

ZrO_2 - Zirconium dioxide

General Geology and Study of Iron Oxide in Temangan, Kelantan

ABSTRACT

This study is about the general geology and study of iron oxide in Temangan district in Kelantan with coordinate of latitude ranges from 05° 39' 30" N to 05° 42' 00" N and longitude from 102° 09' 30" E to 102° 11' 30" E. The purpose of this study is to produce a geological map of the study area and studying the physical and chemical properties of iron oxide within the study area. Field observation and mapping at the study area have been done accordingly. Five rock samples were collected within the study area for petrography studies. The study area was made up of Permian to Jurassic of Gua Musang Formation with the intermediate igneous rocks and ignimbrite. Three samples that contained iron oxide minerals were analysed using X-Ray Diffraction and X-Ray Fluoresence techniques for physical and chemical properties. From the XRD analysis, the three samples have shown the similar graph patterns compatible with value of the highest peak. Based on the result of X-Ray Fluoresence, it was cleared that the concentration of the elements in each sample is controlled by the structural and geomorphological setting of the locality specifically for the composition of iron oxide (Fe_2O_3).

Geologi dan Kajian Oksida Besi di Temangan, Kelantan

ABSTRAK

Kajian ini berkaitan dengan geologi dan kajian oksida besi di jajahan Temangan, Kelantan dengan koordinat latitude dari 05° 39' 30" N hingga 05° 42' 00" N and longitud dari 102° 09' 30" E hingga 102° 11' 30" E. Tujuan kajian tersebut adalah untuk menghasilkan peta geologi bagi kawasan kajian dan mengkaji cirri-ciri fizikal dan kimia oksida besi dalam kawasan kajian. Kerja lapangan telah dilakukan dan lima sampel batuan diambil untuk analisis mikroskop. Kawasan kajian merupakan Formasi Gua Musang yang berusia Permian hingga Jura Kapur dengan batuan andesit dan ignimbrit. Tiga sampel oksida besi diambil untuk menghuraikan dan menganalisa ciri-ciri fizikal dan kimia oksida besi dengan menggunakan analisis X-Ray Difraction (XRD) dan X-Ray Fluoresence (XRF). Hasil dapatan daripada analisis XRD, ketiga-tiga sampel menunjukkan persamaan dari segi corak graf beserta nilai bagi puncak yang tertinggi. Berdasarkan analisis dari X-Ray Fluoresence, ini jelas mennjukkan bahawa kepekatan unsure dalam setiap sampel oksida besi dipengaruhi oleh penepatan struktur dan geomorfologi bagi sesuatu kawasan terutamanya bagi kepekatan oksida besi (Fe_2O_3).

CHAPTER 1

INTRODUCTION

1.1 General Background

This research entitled 'General Geology and Study of Iron Oxide In Temangan'. Iron oxide is any one of a range of chemical compounds made up of iron and oxygen. Iron is a metallic element with the chemical symbol Fe and one of the most prolific and commonly occurring mineral substances on Earth. Iron ore deposits are commonly found in sedimentary rocks. They formed from chemical reactions that combined iron and oxygen in marine and fresh waters. The two most important minerals in these deposits are hematite and magnetite.

Most deposits of iron ore in the world are found in rocks known as a banded iron formation (BIFs). These are sedimentary rocks that have alternating layers of iron rich minerals and a fine grained silica rock that is chert. The silica was precipitated out from the seawater as layers of silica jelly which slowly get harder and formed as chert. Soluble iron oxide was also produced due to the weathering process of rocks and was washed into the sea by rivers. During 2500 million years ago, oxygen producing life forms began to evolve and oxygen became part of the Earth's air. In time, more or less of the oxygen also dissolved in the seawater where it responded with the soluble iron oxide to form an insoluble iron oxide. This fell out of solution and on to the sea floor as the minerals magnetite and hematite.

The main usage of iron ore is in the production of iron. Iron is utilized in the manufacturing of steel. The sword is the most used metal in the world by tonnage and purpose. It is applied in the automobiles, airplanes, beams used in the structure of edifices.

1.2 Problem Statement

For this previous years, there is no related research that study about the physical and chemical properties of the iron oxide in the study area. Thus, further research is needed to described the properties of the iron oxide in Temangan. Apart from that, there are several factors that may cause the geology and geomorphologic changed in the research area such as weathering and erosion process. Hence, this research can help to complete and update the geological feature in the study area.

1.3 Research Objectives

The main purpose of the study:

I. To produce the geological map of the study area with scale 1:25000.

II. To characterise the physical and chemical properties of iron oxide.

1.4 Study Area

The selected study area is located in Temangan, Kelantan as shown in Figure 1.1. Temangan is a town which is located in the district of Machang, Kelantan. Based on the base map in Figure 1.1, the study area is bounded by longitude 102° 9’ 30” E to 102° 11’ 30” E and latitude 5° 39’ 30” N and 5° 42’ 0” N. The main villages in the study area are Kampung Pauh, Kampung Pangkal Keras, Kampung Banggol, Kampung Pisang, Kampung Tok Bilal and Kampung Kemunchup. There is also palm oil fields which is Ladang Onn Chwee Lee. At the centre part of the study area is Hutan Rizab Temangan. There is also the Tumpat-Gemas railway line along the study area. The total area covered is 5×5 kilometers square.

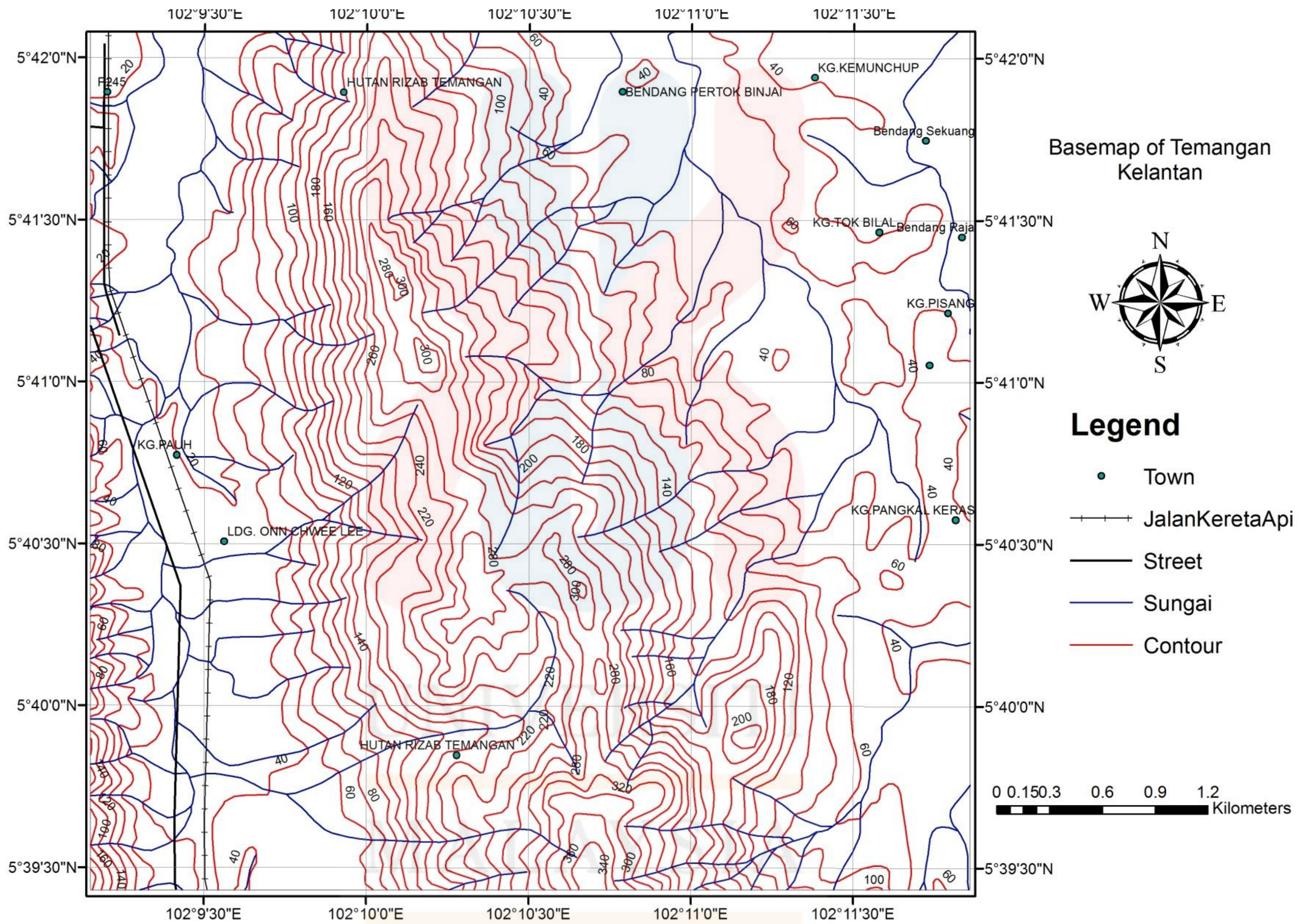


Figure 1.1: Basemap of Study Area

1.4.1 Demography

a. People Distribution

According to the Department of National Statistics, the total population in Temangan is 5,786 people based on the 2010 census report. These number of population is comprised of Malaysian citizens which are Bumiputera (Malay), non-Bumiputera (Chinese, Indians and others) and also some non-Malaysian citizens. The table below shows the population by ethnic group of Temangan, Machang.

Table 1.1: Distribution of People in Temangan, Machang

(Source:Department of National Statistics)

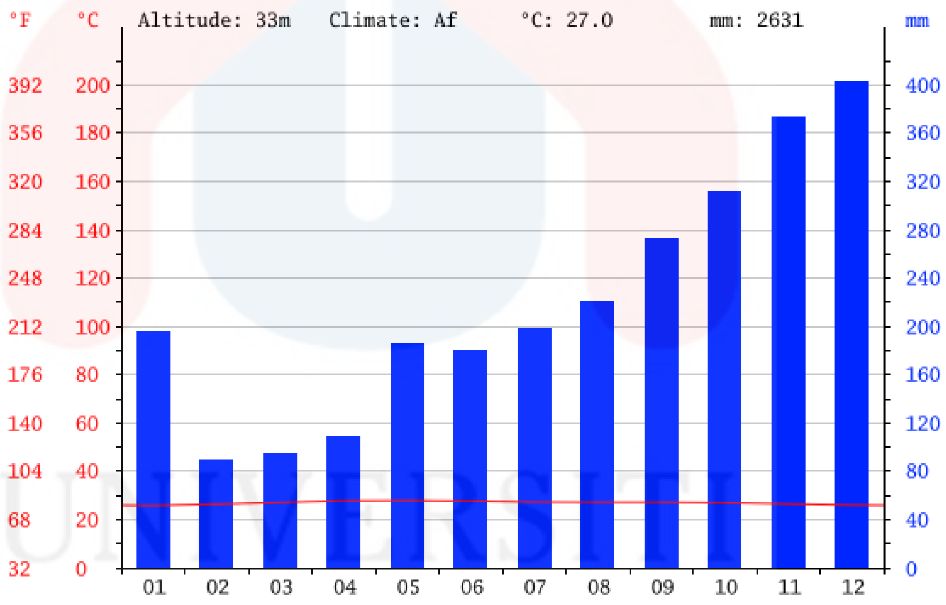
District/Mukim	Total	Malaysian Citizens					Non-Malaysian Citizens
		Bumiputera		Non-Bumiputera			
		Malay	Other Bumiputera	Chinese	Indian	Others	
Temangan	5,786	4,897	11	601	61	20	196
Bandar Temangan	1,840	1,446	3	375	13	3	49
Kuala Kerak	1,328	1,190	-	127	9	2	48
Kerilla	1,731	1,585	-	99	38	9	54

b. Rainfall

The average annual temperature in Temangan is 26.9 °C. The average annual rainfall is 2725 mm. The driest month is on April. Whereas in December, it is reached the peak with an average 491 mm. The table shows the total rain distribution.

Figure 1.2: Total Rain Distribution in Temangan

(Source: climate-data.org)



c. Land used

Land use is the exploitation of land for the purpose of agriculture, industrial and residential. Land use of Temangan area is dominated by agriculture (47%), environmental preserve (46%), residential (7%).

The agriculture in Temangan includes of oil palm plantation, rubber plantation and other. The environmental preserve is included Temangan forest reserve. The residential included the resident's house and town. From the Figure 1.4, it shows that at the centre of the study area is forestry whereby, the rubber plantation is the major landuse covered in Temangan.

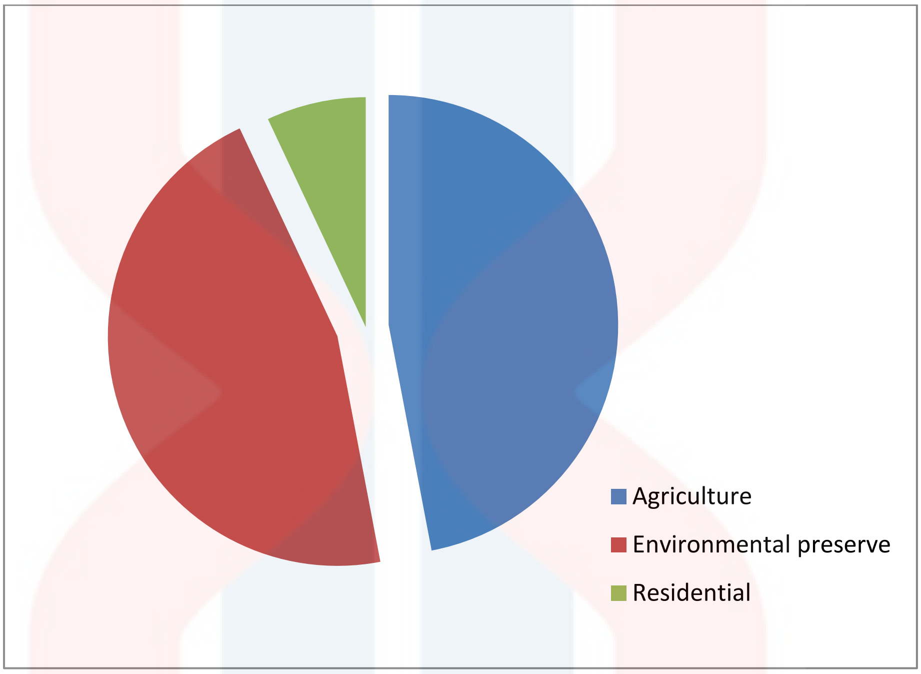


Figure 1.3: Pie chart of land use in Temangan

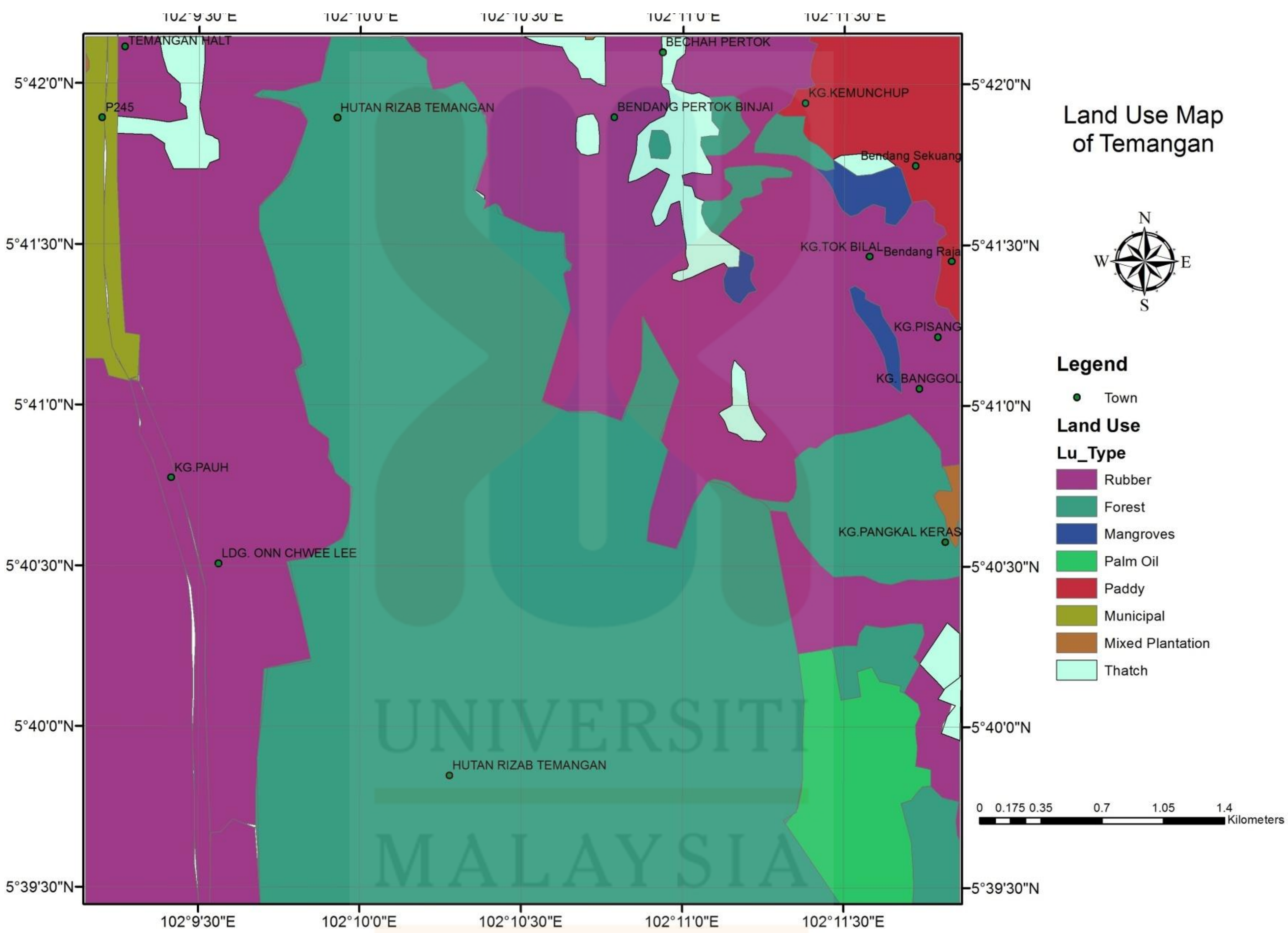


Figure 1.4: Land Use Map of study area

d. Social economic

In Temangan, the most active economic activities by the residents here is based on the agriculture sector. Mainly actively participated in rubber plantation and palm plantation.

Besides, some of the residents there also running small business such as grocery store and food stall. Moreover, there are also the residents who working at iron ore quarry.

Figure 1.5: The rubber plantation area in the study area

e. Road connection

The accessibility of this study area can be classified into the main road and railway. The residents in Temangan area used both routes to carry out their daily routine activities.

There are two types of roads in the study area which are bituminous road and non-bituminous road (Figure 1.6 A & B). The main road in this area connects the study area to the town. Meanwhile, the non-bituminous road connects the main road to the plantation area. In the study area, it also consists of Tumpat-Gemas railway.

Figure 1.6 (A): The main road to access to the town

Figure 1.6 (B): Non-bituminous road

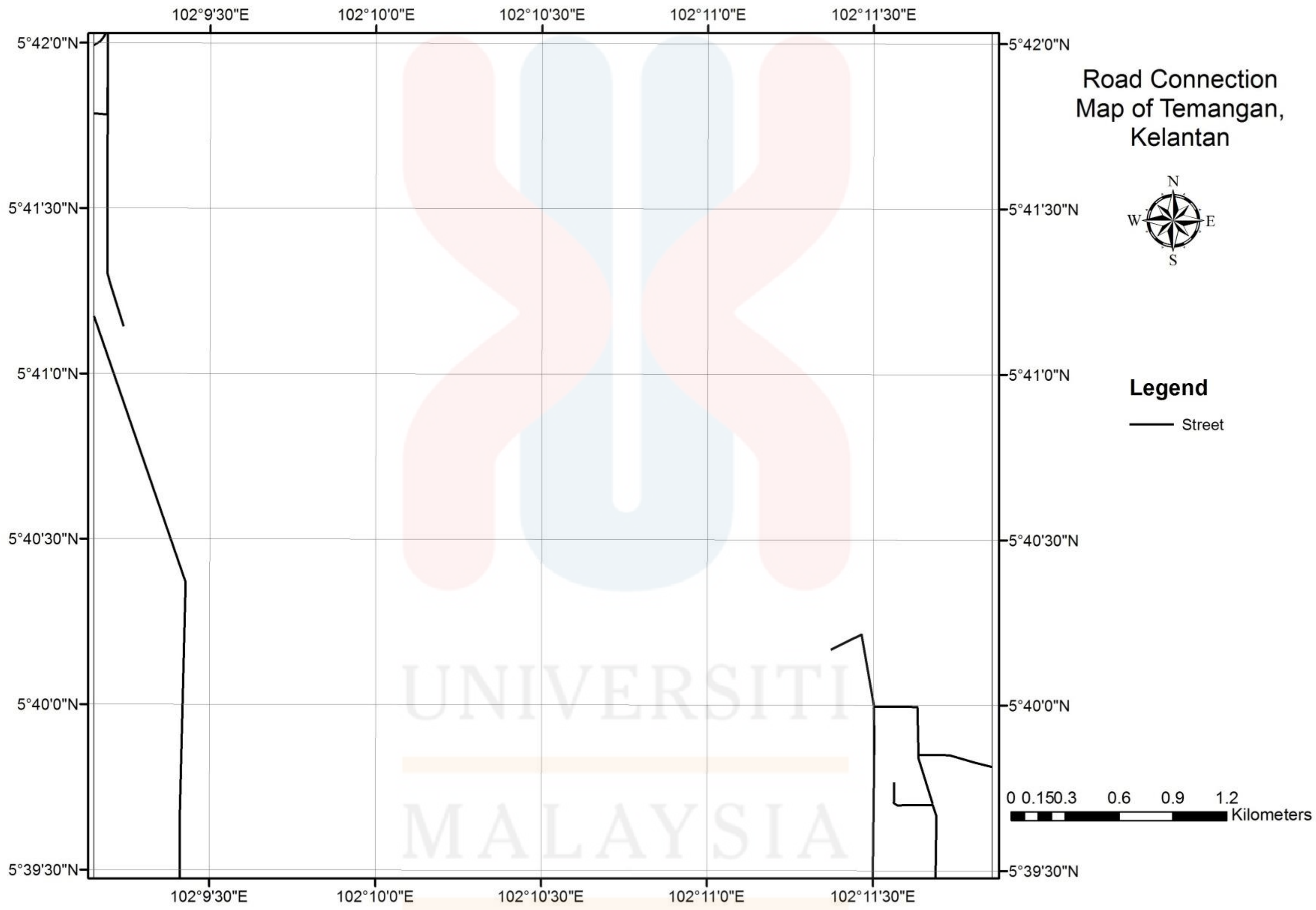


Figure 1.7: Road Connection Map

1.5 Scope of Study

This study concerned about the general geology of Temangan, in Machang, Kelantan which encompassed the geomorphology, lithology, stratigraphy, and structural geology in order to produce a geological map of the area.. The second focus of this research is for characterization of iron oxide's properties using instruments like XRD and XRF. The petrography of iron oxide's samples also were done using optical microscope to observe the mineral associations that normally found in the iron oxide deposit.

1.6 Research Importance

In terms of general geology, this study is helpful to highlight the geological features and it can be used as reference or future. A full mapping of the study area was carried out accordingly to generate a geological map using ArcGIS with scale 1:25000. Furthermore, it also helps in the development of knowledge regarding about geological and physical and chemical properties of iron oxide in the study area.

1.7 Chapter's Summary/Thesis outlines

This thesis contains a total of 5 chapters. Chapter 1 presents the general background, problem statements, research objectives and research importance. Chapter 2 consists of a review from several previous studies about general geology of the study area as well as the iron oxide's properties. Chapter 3 elaborates the methods employed in this research especially for mapping and sample characterization. Chapter 4 discusses the main results of the study as well as discussion. Chapter 5 is the final chapter of this thesis to conclude the findings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter focuses on previous studies and work that have been done before by doing some readings through out the journals, articles and published paper. By doing a literature review, all the related information can be useful as the reference in this study.

2.2 Geological Review

2.2.1 Regional Geology and Tectonic Setting

The Malay Peninsular may be divided into two tectono-stratigraphic terranes which form part of the Sunda shelf, which is namely the East Malaysia and Sibumasu terranes respectively. The Eurasian terrane has been interpreted as Permo-Triassic island arc system which never been far separated from ShanTai block. Stratigraphic, palaeontological and paleomanetic evidences suggest a possible origin of these terranes by the riftin of north-east margin of the ancient Gondwanaland landmass in the Late Permian to Late Triassic that responsible for the formation of the Central Belt and Raub-Bentong Suture (Cocks *et al.*, 2005). Kelantan lies on the eastern belt of Peninsular Malaysia. The sediments are from Carboniferous to Permian age and distribution from east of Kelantan through Terengganu and east Pahang until east Johor in the south. The central belt start from Kelantan to Johor between east of the foothills from the main range formed the western boundary, to its eastern boundary significant by Lebir Fault in the North down to western boundary of Dohol Formation in the south. Carboniferous limestone form Mesozoic sediments on both edge of the belt which is central belt and eastern belt. In the central of upper Paleozoic rock are Gua Musang and Aring Formation at south, while Taku schist at east, and south are the Raub group in west Pahang (Hutchison, 2009).

The location of the research is located in Kelantan which are underlain by Gua Musang Formation or Telong Formation with the age of Middle Permian to Upper Triassic (Yin, 1988). The term Telong Formation was introduced by Aw (1990) after the rock sequence cropping out along part of Sungai Telong in Sungai Aring area in Kelantan. Telong Formation is also known as Gua Musang Formation. This is because sediments are similar to rocks of Gua Musang as suggested by Foo (1983) that both of the formation is synonymous each other.

According to Bean (1969), it consists of quartz-porphyry dyke lie on contact to the east which follows the regional strike and bedding, meanwhile east of the dyke; the shale formation have interbedded with volcanic. Quartz-porphyry dyke also called as ignimbrite. The ignimbrite process occurs from turbulent mixture of fragmented rocks, hot magma, crystal and ash that flow down in slope density current (Petford,2011).

2.2.2 Historical Geology

Kelantan lies on the eastern belt of Peninsular Malaysia. The sediments are from Carboniferous to Permian age and distribution from east of Kelantan through Terengganu and east Pahang until east Johor in the south. The central belt start from Kelantan to Johor between east of the foothills from the main range formed the western boundary, to its eastern boundary significant by Lebir Fault in the North down to western boundary of Dohol Formation in the south. Carboniferous limestone form Mesozoic sediments on both edge of the belt which is central belt and eastern belt. In the central of upper Paleozoic rock are Gua Musang and Aring Formation at south, while Taku schist at east, and south are the Raub group in west Pahang (Hutchison, 2009).

2.2.3 Regional Stratigraphy

The location of this research is located in Kelantan which is underlain by Gua Musang Formation or Telong Formation with age from Middle Permian to Upper Triassic (Yin, 1988). This formation is composed of predominantly by argillaceous and calcareous rocks with subordinate arenite, pyroclastic and lava flow. Finding of poorly-preserved fossils from Gua Musang give a Permian age to Lower Triassic by finding of Scythian ammonoids also found from limestone nearby (Mohd, 2004).

The formation is also estimated to be 650 metres of thickness which is composed of crystalline limestone, interbedded with thin bed of shale, tuff, chert nodules and subordinate sandstone and volcanic (Yin, 1965). The argillaceous outcrops are much more extensive than the limestone. The facies consists of greenish to reddish grey to black slate, phyllite, schist and hornfels. Pyrite is abundant in carbonaceous rocks (Foo,1983).

2.2.4 Structural Geology

Kemahang Granite occupied the northern part of the schist body with cataclastic porpyhritic biotite granite which the outcrop extends across the border of Thailand as Buke Platon (Hutchison, 2009). He also mentioned that the granite in the area also injected the Taku Schist and incorporates large schist enclaves.

There are at least four tectonic activities that has been subjected on land mass of Peninsular Malaysia during era of Paleozoic and Mesozoic. These tectonic activities have prominently occurred during Triassic period. The main forces subjecting on the land mass was compressional resulting from the formation of joints folds and faults in sedimentary rocks and formation of joints and folds in granitic rocks. Most of the rocks in Paleozoic and Mesozoic era have been subjected to medium forces of regional metamorphism with older rocks are experienced higher deformation and displaying more foliation (Osborn & Chappel, 2003).

According to The Malaysian-Thailand Border Joint Geological Survey Committee (2006), Peninsular Malaysia was formed as a result of collision between two blocks which are Sinoburmalaya and Eastmall-Indosinia. The collision zone is represented by the Bentong-Raub Suture which can be traced northward into Thailand and southward into the Banka and Billiton Islands. This collision accompanied by the major tectonic event during Late Triassic has resulted in rock deformation in the Malay-Thai Peninsula. Pre-orogeny sedimentary succession are generally folded into a series of synclines and anticlines. Folding is characterized by tight, asymmetric and open folds, which cause the repeated and overturn sequence in the older sedimentary rock.

2.2.5 Petrography

Peninsular Malaysia was a major producer of iron ore with a peek exceeding 7 million tons in 1964. All major deposits have been worked out. The mined ore deposits age is of Permian-Triassic (Bean, 1969). A common feature of all the ore bodies is the strong supergene enrichment by tropical weathering processes, as at Pelepah Kanan in the Kota Tinggi district of Johor, where magnetite ore is capped by a thick crystalline martite deposit. The Pelepah Kanan deposit is an excellent example of a contact pyrometasomatic iron deposit which has been rendered commercially useless by high tin contents. Most Eastern Belt iron-ore mines have ceased its production because of increased tin contents. Total iron production from Malaysia was around 100 Mt. No major ore bodies remain. The eastern Belt iron deposits were classified as ‘stanniferous-iron skarns by Hosking (1973), a classification subsequently followed by Chu *et al.* (1988).

Aw (1967) stated that Ignimbrite rock at Temangan mine do not have pure lava characteristics, normal pyroclastic rock or middle rock. Furthermore, the track is thick ignimbrite mine like insert a plug in old fractured. It is extrusive igneous rocks. Temangan dyke named as ignimbrite based on certain characteristics present and called the volcanic rocks as pyroxene basalt (Roslina Bakar, 1988).

James (1954) identified four important facies of banded iron formation. The first one is oxide facies. This is the most important facies and can be divided into hematite and mangnetite subfacies according to which iron oxide is dominant. It is typically averages 30-35% of Fe and the rocks are mineable provided. Next, is the carbonate facies which commonly consists of interbanded chert and siderite that is in equal proportions. Furthermore, iron silicate facies is generally associated with magnetite, siderite and chert which form layers alternating to each other. Lastly, is the sulphide facies. It consists of pyritic carbonaceous argilities.

Morris (1998) mentioned of three based models; syngenetic, supergene and hypogene model. Syngenetic model originally based on a classic origin for banded iron formation. Supergene model is where an iron ore deposit formed near or at the surface, commonly by descend fluids. Meanwhile, an iron ore deposit formed below the surface; commonly by ascending fluids is the hypogene model.

The major Mg-mineral phases in the ore deposit are pyrolusite, cryptomelane, polianite and groutite. From the previous research, it had been reported mainly low temperature minerals in the ores of the present area such as pyrolusite, psilomelane, manganite,rhodochrosite,cryptomelane,lithiophorite,chalcophanite,goethite, todorokite, and braunite and they had been considered that these minerals were formed in near-surface conditions under relatively high oxidizing environment (Mishra *et al.* 2006) .

Guilbert *et.al* (2007) discovered that abundant organic matter in a weathering regime allows cold water to extract, chelate or compel and transport enough iron and silica to build up large deposits of iron formation. Furthermore, they said that iron and silica travel and precipitate as colloids protected by organic matter. Their experiments showed that a mixture of these soils will form banded sediment with an iron-rich layer at the base and nearly pure silica at the top.

2.3. Iron Ore Properties

BSC Inc., (2002) defined that iron is the fourth most abundant and common element in the Earth's crust and the second most abundant metal. Iron occurs mostly in iron-oxide ores. Some ores are a mixture of minerals rich in iron. Other iron ores are less rich and have larger number of impurities. The most important iron ore-forming minerals are magnetite, hematite, goethite and limonite.

The majority of interpretations of the origin of iron ore deposit focused on the igneous iron oxides deposits which either having formed by magmatic liquid immiscibility or by hydrothermal alteration and replacement. The hydrothermal iron deposits are commercially far less important as global source of iron than banded iron formations and igneous iron deposits (Rajabzadeh *et al.* 2014).

Andrey *et. al* (2012) described that texturally iron formation is divided into two groups that is banded iron formation (BIF) dominant in Archean to earliest Paleoproterozoic successions and granular iron formation (GIF) is much more common in Paleoproterozoic successions. It is theorized that the Earth's primitive atmosphere had little or no free oxygen. In addition, Proterozoic rocks exposed at the surface had a high level of iron, which was released at the surface upon weathering. Since there wasn't any oxygen to combine with it at the surface, the iron entered the ocean as iron ions. At the same time, primitive photosynthetic blue/green algae was beginning to proliferate in the near surface waters. As the algae would produce O2 as a waste product of photosynthesis, the free oxygen would combine with the iron ions to form magnetite (Fe_3O_4), which is an iron oxide.

Sinha *et. al* (2015) also mentioned that iron is found in many mineralogical forms, but only a few used as commercial sources, the most important of which are oxides (Hematite; $Fe_2\,O_3$,Magnetite; $Fe_3\,O_4$ and Limonite; $Fe_2\,O_3\,.\,2H_2\,O$ & Geothite; $Fe_2\,O_3\,.H_2\,O$). Other less important sources are carbonates ($FeCO_3$), Sulphides (Pyrite FeS_2) and Silicates like Chamosite. The main impurities in iron ore are SiO_2, Al_2O_3, S, P, TiO_2 and Na_2O & K_2O. The mineralogy of iron ore varies from simple hematite and quartzite with little of aluminium mineral to hydrated hematite along with complex gangue minerals. Iron is a shiny, bright white metal which is soft, malleable, ductile and strong. At room temperature, iron is in form of ferrite or α-iron, with cubic structure. The iron metals are very good conductors for electricity and heat. Iron is chemically active and forms two major series of chemical compounds which are the bivalent iron (II) or ferrous compound and the trivalent iron (III) or also ferric compounds.

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 Introduction

This chapter discusses on how to gather information and data needed to produce geological. It also explains the method on the geological mapping and producing the maps. Methods that are carried out for this study are illustrated in the figure below.

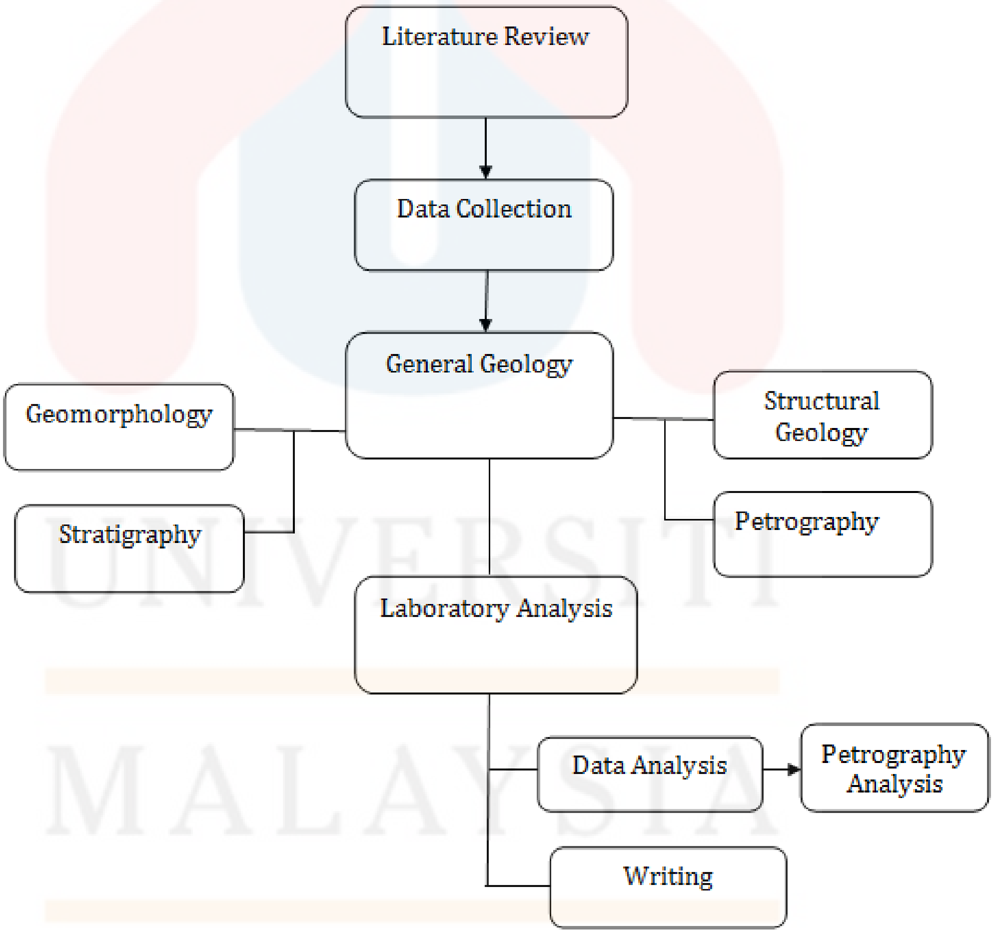


Figure 3.1: Flowchart of project methodology

3.2 Preliminary Researches

In order to acquire more knowledge to collect the data of the study area and to get a better understanding on study area. A study has been done to familiarize with the research topic by obtain information from previous related research journals. These activities are includes the map study and literature review.

Map study is conducted by obtained the latest geological map from the Google Earth and Geosciences Department of Malaysia while other base maps are obtained by generating from GIS software. Other information on map is also provided from Google Earth software.

Literature review was done by searching some findings of these research journals by using the Universiti Malaysia Kelantan Library database and also including Google research database.

3.3 Materials and Methods

In order to do a research, there are a few materials and equipments that are crucial in order to get the data. The materials used are as follows:

3.3.1 Global Positioning System (GPS)

GPS (Geographic Positioning System) is a satellite based navigation system comprising three basic parts; the satellites in space, monitoring stations on earth and the GPS receivers. A GPS device receives Global Positioning System (GPS) signals to ascertain the device's location on Earth.

GPS devices provide latitude and longitude information, and some may also calculate altitude. This equipment is used in geological field mapping for finding ones position, mapping lithologies, tracking structures, measuring elevation, storing sampling points and descriptions of formations when samples are collected.

Figure 3.2 : GPS

(Source: Google Image)

3.3.2 Rock Hammer / Geologist's Hammer

Rock hammer is often called a paleontologist hammer or a fossil hammer. It is used for splitting and breaking rocks. They are used to obtain a fresh surface of a rock in order to determine its composition, nature, mineralogy, history and field estimate of rock strength. In fossil and mineral collecting, they are employed to break rocks to reveal fossils inside. Geologist's hammers are also sometimes used for scale in a photograph. Geologist's hammers have two heads; it consists of a flat head and a chisel head at the other end.

The hammer is the basic thing for geologists for collecting samples and data during the geological mapping. It is made by hardened steel and chisel that is better to break the hardened outcrop into pieces which can be taken for sampling. Besides, rubber coated shock reduction, increased the friction and handling for geologists.

Figure 3.3 : Hammer

(Source: Google Image)

3.3.3 Brunton Compass

Brunton compass is a type of precision compass. Unlike most modern compasses, the Brunton compass utilizes magnetic induction damping rather than fluid to damp needle oscillation. Brunton compass is a specialized instrument used widely by those needing to make accurate degree and angle measurements in the field. These people are primarily geologists, but archaeologists, environmental engineer's use of the Brunton's capabilities.

The Brunton compass is used by geologists for field mapping of geological objects. Brunton provides a precise sighting-clinometer and hand level capability, and can be used at both waist and eye levels. Detailed measurement of geological objects, such as fold hingeline, axial trace, and axial plane, and geological mapping becomes essentially impractical without the use of the compass.

Brunton compass can be adjusted for declination angle according to one's location on the Earth. It is used to get directional degree measurements with use of the magnetic field. The most frequent use for the Brunton in the field is the calculation of the strike and dip of geological features (faults, contacts, foliation, sedimentary strata). Brunton compass is also used to measure the attitude of linear and planar geological objects, to measure vertical angles, height, and distance and in measuring the bearing of a line between two points.

Figure 3.4: Brunton Compass

(Source: Google Image)

3.3.4 Sample Bags

Sample bags are used to collect samples from the field. Self-seal plastic bags are suitable for most rocks, though tough cloth bags may be better for hard sharp edged specimens. The details need to be written on the bags and also on a piece of paper, which should be placed in the bag with the sample. Wrap delicate specimens in newspaper.

Figure 3.5 : Sample Bags

(Source: Google Image)

3.3.5 Hand lens

Hand held lens is used to make the first analysis of rock samples in the field before further analysis is performed in the laboratories. The analysis needs to be detailed and descriptive giving all properties of the sample: rock type, colour, texture, identifiable mineralogy, alteration as well as the physical properties such as folding, foliation, intrusions, layering.

Figure 3.6 : Hand Lens

(Source: Google Image)

3.4 Field Studies

A field study encompasses two types that are geological mapping and also geomorphology mapping. Geomorphology mapping is for specification and it is divided into fluvial, weathering and landform.

3.4.1 Geological Mappings

GPS are used to provide the information such as the coordinate of the sampling taken place and the study area for the report use. Fieldworks were carried out to collect the following criteria such as outcrop sketching, lithology, and mapping. GPS are also used to mark locations of various landforms in the field.

A field notebook and board were used to jot down the geomorphology description of the processes and formations. Sketches are included to support the geomorphic information. Outcrop sketching were conducted when the outcrop was sketched in a notebook for personal use only and these information that were obtained helps to achieve a better picture of the structure. The sketching has included the geological structures such as bedding, faults, and joints.

The lithology, geological structural and fossil content were observed and the pictures of that also taken using cameras for further studies. Other structural geology features such as strike and dip were determined using left-hand rule and a Brunton compass. Sketching the outcrops in one of the methods for personal use that will aid the information obtained from the cameras. Cameras used to picture a geological structure, geomorphology, location, activity and more.

3.4.2. Geomorphological Mapping

a) Weathering

Geomorphological mapping for weathering section are conducted by observing weathering rocks or outcrops found. These findings were then recorded using a camera for further analysis. The surface of the rock can determine its weather surrounding.

b) Fluvial

For this section, streams, river, pond were searched and studied. For each streams found, the depth of the stream and the wide of the stream is measured. Also, its flood plain also be measured with a person scale. The type of soil around it are observed and pictures of the streams were taken with a camera.

c) Landform

Landform is the study of the topography of the study area. The methods carried out are mostly observing the landform and taking pictures of the landform using a camera.

3.4.3. Sampling

The sampling in this research is focusing on the sediment. The sediment sample is being collected in this study area. It is about three samples of the iron oxide is collected from several different places within the study area. Around 250 grams of each samples are collected for the laboratory analysis. The sediments is keep in the sample bags, sampling locality data such as latitude, longitude and number of sample is marked on the sample bags.

3.5 Laboratory Investigation

3.5.1 Thin Section Analysis

In this method, the thin section need to be prepared before analysis under the polarized microscope. Firstly, the rock sample is marked for the size and the required area to be produced as thin section. The rock sample is cut on a plane perpendicular to planar fabric. Then, the sample that has been cut will be grind with 120 micron polisher. Next, the sample is washed to remove the dust before it is heated on the hot plate for 15 minutes to remove all the water. After the rock chip is dried, Canada Balsam is applied on the hot rock chip and left for 30 minutes.

The rock is applied on glass plate with 3F powder in order to produce smooth and even surface. The rock is heated again about 30 minutes to remove the water content. Then, the dried smooth surface of rock is applied with Laker Cement (lake cement) and attached with mounting slide. it is left for 30 minutes to ensure the rock and slide is properly attached. The glued rock chip is thinned until it achieves thickness about 0.03 milimeters and observed under microscope. If the desired thickness cannot be achieved by using diamond grinder, manual thinning is done on glass surface using 3F (600) caborundum powder. This process must be done with care to prevent loss of the sample due to the over thinning and over pressure. After that, the cover slip is added to protect the section from damaged and increase the clarity observed under the microscope. After the thin section is prepared, the mineralogical content is observed.

3.5.2 Geochemistry Analysis

Besides, X-Ray Diffraction (XRD) is also used in order to obtain the information about the structure of crystalline materials which relies on the nature of X rays. The primary use of this technique is through the identification and characterization of compounds based on their diffraction pattern. This technique uses high energy X-Ray photons from X-Ray generation analyzer to excite secondary fluorescence characteristics X-Ray from the sample. The preparation of sample is divided into two which is powder sample and solid sample. Then the sample is placed in free position in the 9-sample charger for data collection. For the powder sample, a few tenth grams of the sample is obtained as pure as possible. Then, the sample is grind to a finer powder, typically in a fluid in order to minimize inducing extra strain (surface energy). The fine powder is placed into sample holder by smearing uniformly on the glass surface and has to ensure the upper surface is flat. The sample is hold at angle of 45 degrees. The more crystalline the sample, the better results will be.

In addition X- Ray Fluoresence (XRF) is useful for this research. This instrument is a technique for major and minor elemental analysis in complex mineralization. This method is intended to quantify the essential major and minor oxide components of iron ore sample. This is includes the most important elements such as Sulphur (S), Phosphorus (P) and Titanium (Ti). XRF is a bulk analysis technique with the depth of sample analyzed varying from less than 1 milimeter (mm) to 1 centimetres (cm) depending on the energy of the emitted x-ray and the sample composition.

3.5.3 Petrography Analysis

The petrographic analysis is based on the thin section of the rock specimen. The thin sections are made from the selected samples. By using polarized microscope, the minerals content in the rock sample can be determined using point counting method. The pictures of the thin section is taken for each rock type and compared with textbook.

3.6 Data Analysis and Interpretations

The collected data is analyzed and discussed with the supervisor to observe the study area in order to correlate with the lithology. Furthermore, additional informations can be added from other sources such as journals, articles, bulletins and Internet.

The petrographic analysis is analysed after the thin section has been completed for the mineral identification. XRD and XRF are used for estimating the composition of the compound and elements in the iron oxide samples.

3.7 Report Writing

The final step of this research is writing the report and collecting the result to be analyzed and interpreted the collected data. With the collected data, the research will be proceeded with writing the report. After the report writing completed, the report will be send to the supervisor for final check before the report will be submit to the evaluator for the marking evaluation.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

General geology is a survey of the many facets of geology and Earth science from the formation of the universe and solar system to rocks and minerals and geologic processes and hazards. General geology is based on Earth cycle such as rock cycle and hydrologic cycle.

The main study area is located at Temangan. This study area is dissected by numerous contour or elevation. Some place is very dangerous area so that some of elevation cannot be explore since there are no accessibility.

Figure 4.1: The site view of Hutan Rizab Temangan

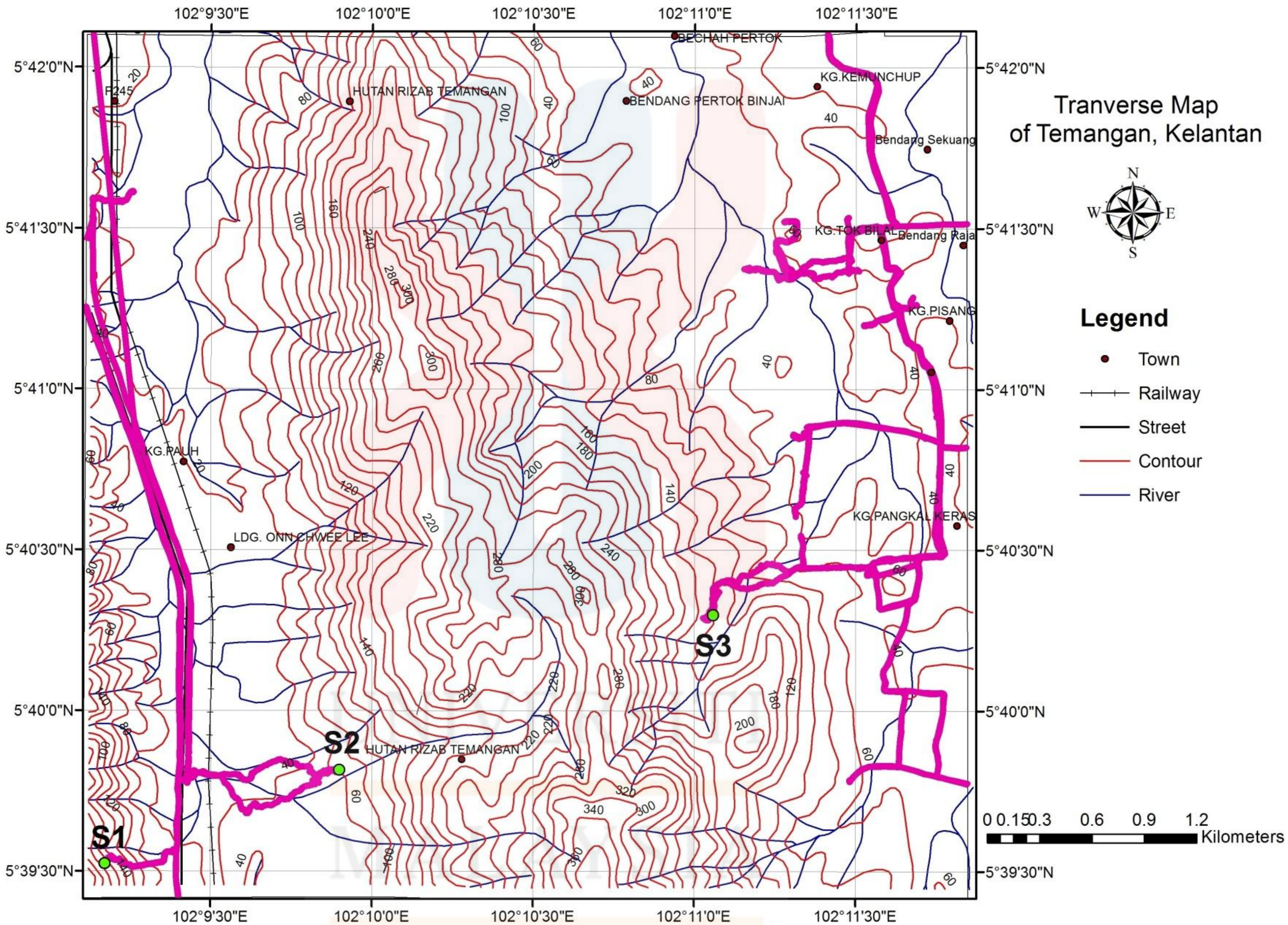


Figure 4.2: Tranverse Map

4.2 Geomorphology

Geomorphology is the scientific study of the terrain shape (geometry) and the processes involved in the formation and its development. Terrain shape is influenced by the exogenic process (external) and endogenic process (internal). Geomorphological processes that occur in the study area are very important to know the physical changes that occur on the earth surface in the study area.

4.2.1 Topography

Topography is a term that used to describe the Earth surface that includes the variety features which known as landform. It is measured at the difference elevation across the Earth surface where the difference between high and low elevation. This is referred as the changes in relief. There are five types of classes in topographic unit which is showing different in elevations. Table below shows the summary of topographic units.

Table 4.1: Topographic unit classifications

Topographic Unit	Mean Elevation (m above sea level)
Lowland	<5
Low-Lying Plain	5-100
Low Hills	100-200
Hills	200-500
High Hills	500-1500
Mountains	1500-3000
High Mountains	>3000

(Source: Van Zuidam, 1985)

In this study area, the topography is divided into three units; starting from low-lying plain, low hills and hills. The lowest elevation in this research area is starting from 20m and the highest elevation is 360m (Figure 4.1). Based on the landform map, 85% of the study areas are low hills area and low-lying plain and other 15% are hills area (Figure 4.1). Elevation ranging from 20m is located at the east part whereby for the elevation of 360m, it can be found at the south part of the study area.

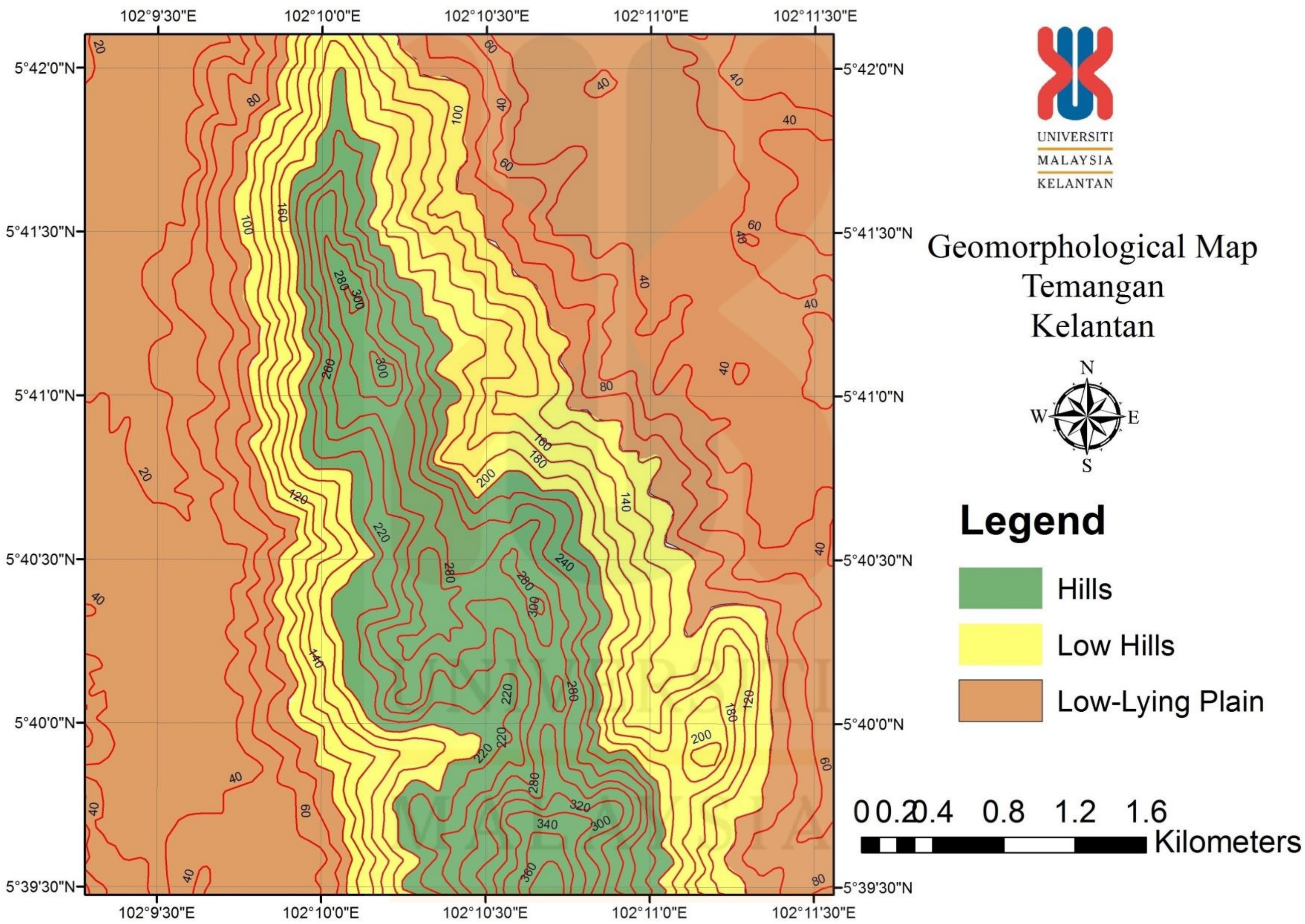


Figure 4.3: Geomorphological Map

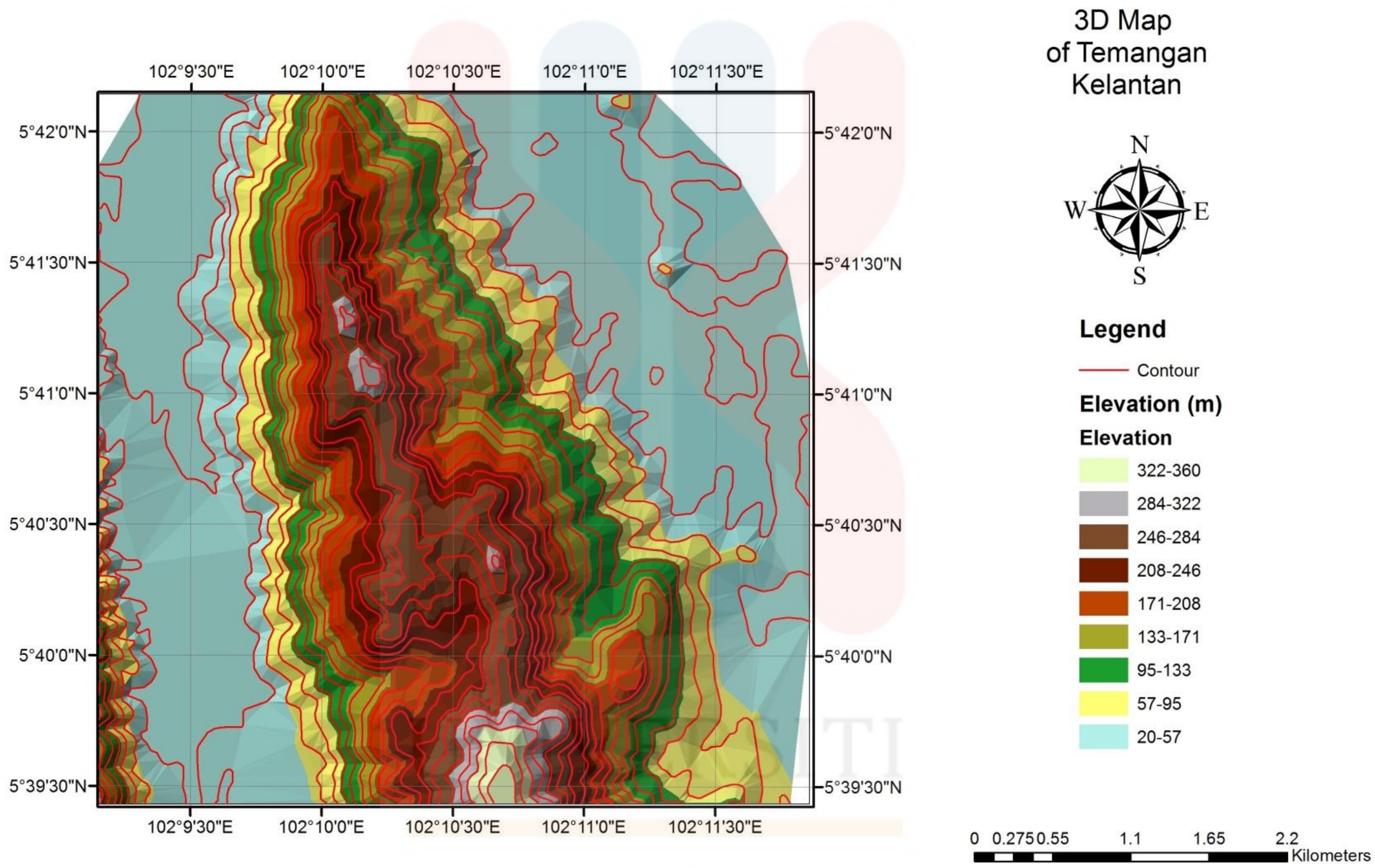


Figure 4.4: 3D Map of the study area

4.2.2 Drainage System

Drainage system is the patterns formed by the streams, rivers, and lakes in a particular drainage basin. This is governed by the topography of the land; either the particular region is dominated by hard or soft rocks and the gradient of the land. Meanwhile, drainage basin is a land area surrounded by divides which contributes water to a river. Divide is a ridge of high ground which separates two drainage basins. It is divided the continents into large drainage basins. Drainage basins are divided from each other by topographic barriers called watershed. A watershed represents all of the stream tributaries that flow to some location along the stream channel. In this study area, there is no main river but there are some tributaries such as Sg. Pauh, Sg. Jibok and Sg. Panyit.

Based on the drainage map below, the types of drainage pattern present in this study area are dendritic and rectangular patterns. Particularly in the both side of the regions which flows towards northeast of the map. This small river will combined into tributaries of the main river which is Sg. Kelantan. According to K.M. Bangar (1995), the dendritic pattern develops in terrains covered with uniform rock types such as horizontal sedimentary rocks or massive igneous rocks or metamorphic rocks. Ignimbrite was present in the east part of study area where this type of pattern mostly covered. Meanwhile, the rectangular pattern is due to the differential weathering of joint system in bedrocks localizes the stream flow. This is strongly proved with the discovery of the joints at the area.

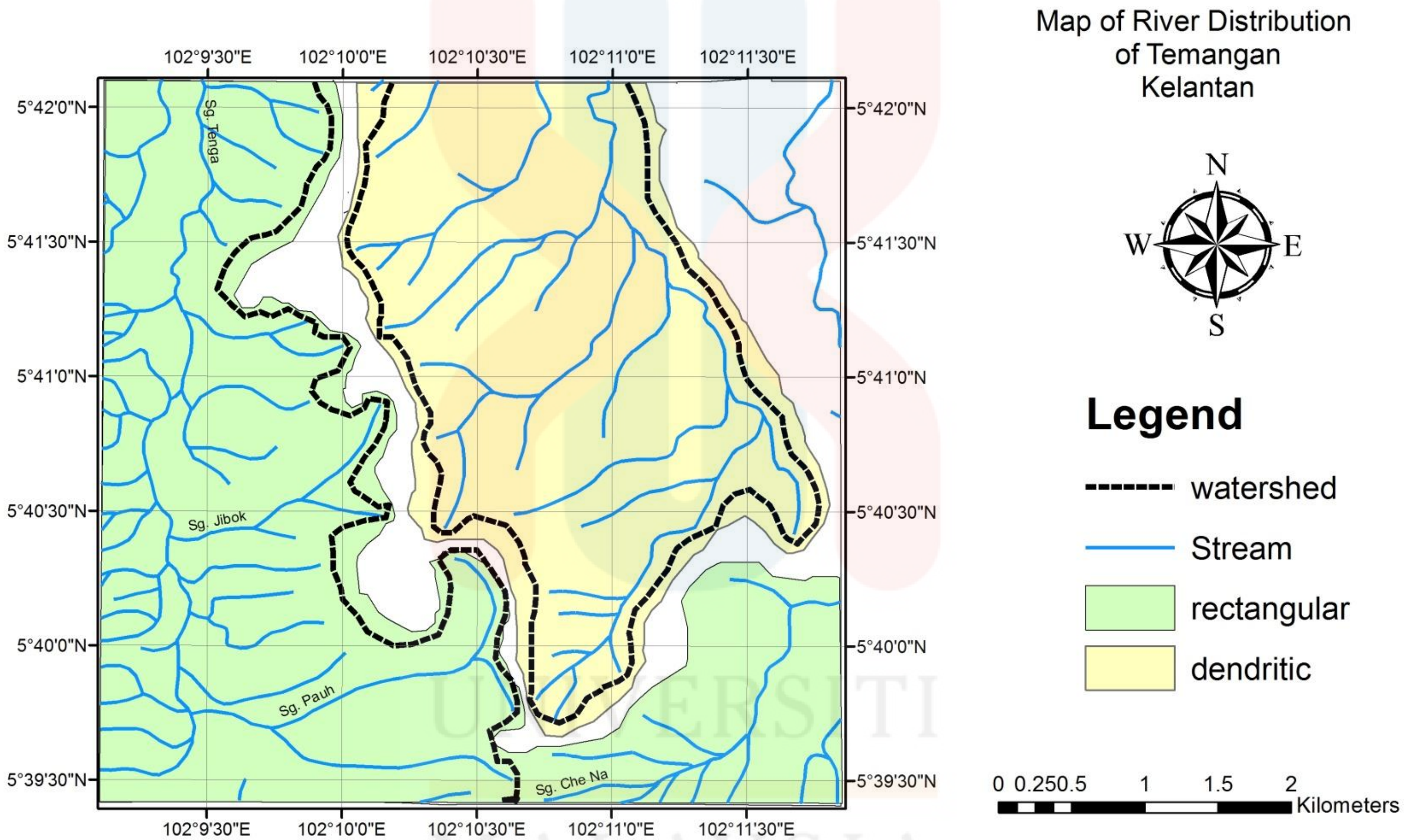


Figure 4.5: Drainage Map of the study area

Figure 4.6: Tributaries at N 05° 41’ 15.26” E 102° 11’ 39.20”

4.2.3 Weathering Process

Weathering is the process of the rocks break and undergoes decay under the influence of the atmospheric agents like wind, sun, frost, water and organisms and produce soil. Weathering process can be divided into three types which are physical weathering, chemical weathering and biological weathering. In this study area, the weathering process occurs in two major ways which are physical weathering and biological weathering.

a) Physical Weathering

Physical weathering or disintegration involves application of mechanical forces. The rock breaks into smaller pieces without any chemical change. Biological factor may contribute to the physical weathering by causing the fracture to the rock. Furthermore, due to the physical action acts on the rocks can affect the weathering process. The examples of the physical actions are change in temperature, expansion and contraction caused by the change in volume of crystal and body expansion. In the study area, it can be seen clearly the top surface of the outcrop were almost become the topsoil (Figure 4.7). The change of climate and temperature were the main factors increasing the rate of weathering process in this area.

Figure 4.7: Physical weathering processes in the study area

a) Biological Weathering

Biological weathering is resulting from physical weathering or chemical weathering in the environment. In the study area, the biological weathering can be seen as the growing plants roots give pressure and stress on rock and cause them to break. Apart from that, there was also microbial activity such as algae on the surface of the outcrop. This organism led to bio-chemical weathering.

Figure 4.8 (A): Plant roots exert pressure and stress on ignimbrite

Figure 4.8(B): Algae on the outcrop surface

4.3 Stratigraphy

Stratigraphy is the science of rock strata, their relative and absolute ages and the relationships between strata. This can be used to infer the past environments based on the physical characteristics of the rocks and changes in environment over time. Lithology refers to the study and description of the physical characteristics of rocks particularly in hand specimen and outcrop (Bates and Jackson, 1980).

4.3.1 Lithology

a) Ignimbrite (Sample 1)

Figure 4.9: Outcrop Sample 1 which is mostly weathered

The outcrop is located at N 05° 39’ 31.4” E 102° 09’ 10.25” which is behind the farm of the residents there. The size of the outcrop is about 3m and most of the outcrop from the bottom part as it is a hilly area. The outcrop can be seen undergoes weathering process. At the surrounding of the outcrop, there are also vegetation areas which are with cocoa trees, rubber trees and also thatch.

Figure 4.10: Hand sample 1

The texture shows that it is moderately smooth and brittle surface. Besides, it is also shown aphanitic texture which has small mineral grains size and cannot be seen through the visible eyes. The rock is almost highly weathered when it is found. The colour of the hand sample is pinkish brown with some iron ore associate with it.

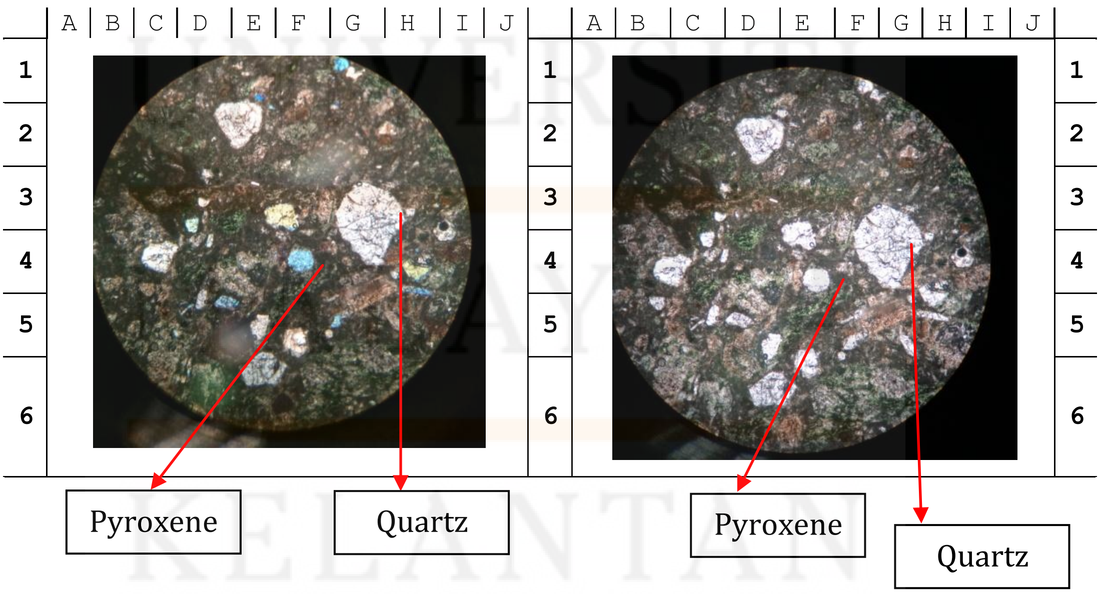


Figure 4.11: Thin section of Sample 1 (4×10 magnification power)

The petrography analysis as shown in Figure 4.11 roughly consist of quartz (40%), pyroxene (25%) feldspar (20%) and biotite (15%). Pyroxene has blue interference colour and biotite whereby biotite is black in colour. Pyroxene has subhedral shape but biotite and feldspar are anhedral. Biotite has cleavage and is moderate to high relief. Quartz is colourless as it shows low relief.

b) Andesite (Sample 2)

Figure 4.12: Outcrop of Andesite at N 05° 39'46.6" E 102° 09' 49.8"

The outcrop is located at 55 metres above the sea level. This andesite rock is found as a waterfall and the rock sample is distributed along at one of the tributaries in the study area. Some of the rock sample found is already weathered.

Figure 4.13: Hand specimen 2 (andesite) that was found at the waterfall

The texture of andesite shown moderate rough surface with aphanitic texture which is very fined grain size that cannot be seen clearly by the naked eyes and only could be seen under the microscope. The rock has black and gray in color (Figure 4.12).

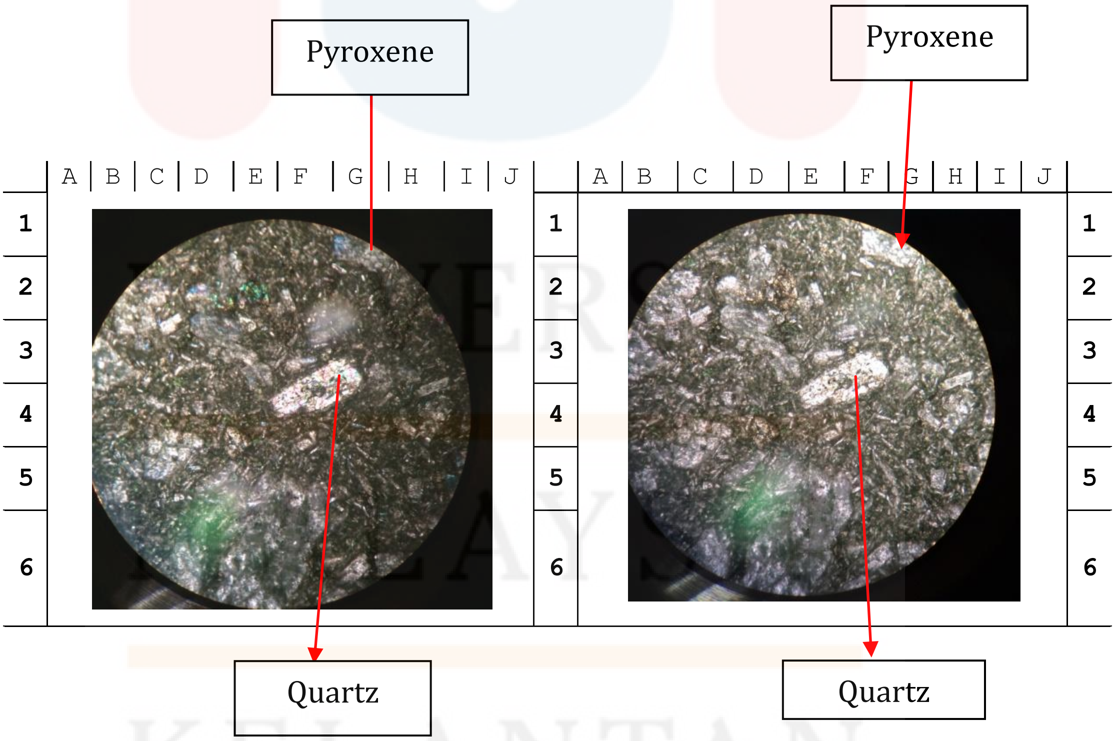


Figure 4.14: Thin section of Sample 2 (4×10 magnification power)

The rock composed of quartz (15%), pyroxene (15%), plagioclase (65%) and feldspar (5%). Feldspar and quartz show white colour in the interference colour but white colour of quartz under the plain polarized is more milky than feldspar. Pyroxene shows black colour twins and cleavage intersects near 90°.

c) Andesite (Sample 3)

Figure 4.15: Andesite outcrop at the waterfall

The outcrop is located at N 05° 40’ 17.9” E 102° 11’ 13.4” and 111 metres above the sea level. At the surrounding of the waterfall, there is a vegetation area with few types of forest plants. Most of the rock there is also weathered.

Figure 4.16: Hand Specimen of Sample 3

The texture of the andesite rock is quite rough and the colour is varies from grey to black. This hand specimen has aphanitic texture which has fined grain sized and cannot be seen through the naked eyes. The condition of the hand specimen is weathered.

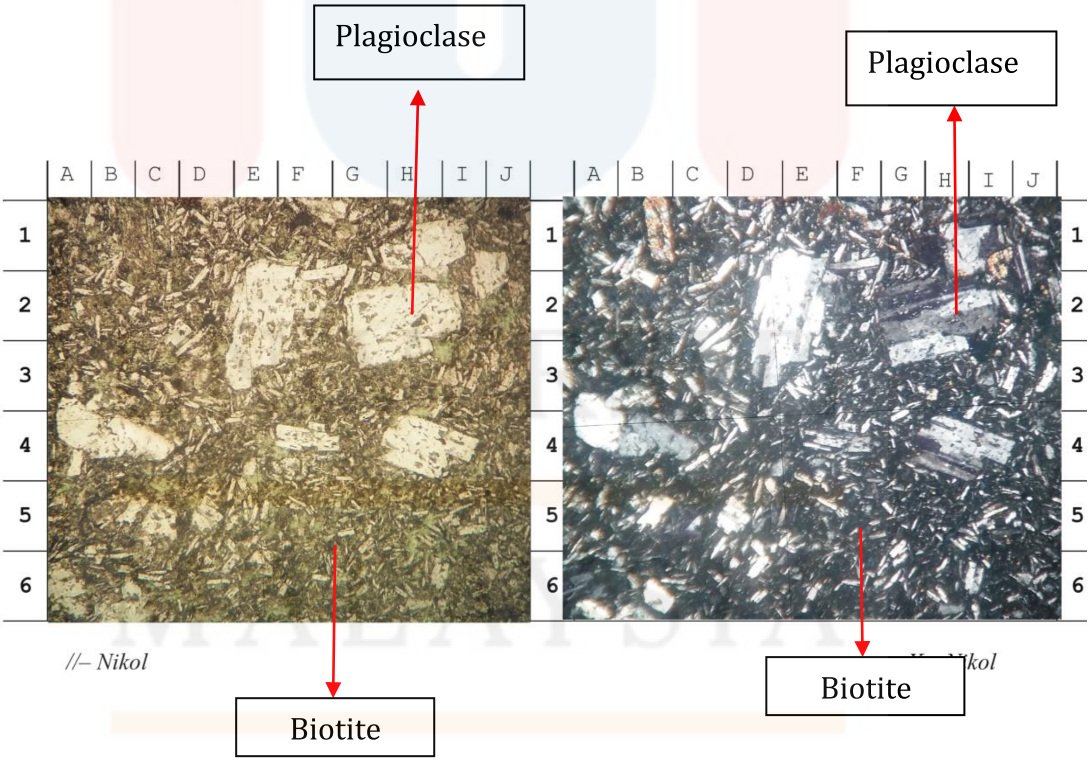


Figure 4.17: Thin section of Sample 3 (4×10 magnification power)

This Andesite rock composed of plagioclase (86%), feldspar (5%) and quartz (8%). Quartz, plagioclase and feldspar show gray to white interference colour but plagioclase and feldspar is slightly lower than quartz of the true colour. Plagioclase shows perfect cleavage and has twinning whereby quartz do not have cleavage. The shape of plagioclase is euhedral, meanwhile quartz and feldspar are anhedral. Biotite mineral is randomly distributed in this sample.

d) Ignimbrite (Sample 4)

Figure 4.18: Ignimbrite outcrop found at the residential area

This outcrop is situated at the residential area at the coordinate of N 05° 41’ 23.7” and E 102° 09’ 1.6”. There is also boulder with the same rock type there. At the outcrop also, the iron ore can be found. Around the area, there is also vegetation area and the outcrop is weathered as algae can be found within the outcrop.

Figure 4.19: Hand sample of Sample 4

The texture of ignimbrite (sample 4) shows that it has brittle and rough surface. Besides, it is also exhibit aphanitic texture which has small mineral grains size and cannot be seen through the visible eyes. The rock is almost highly weathered when it is found.

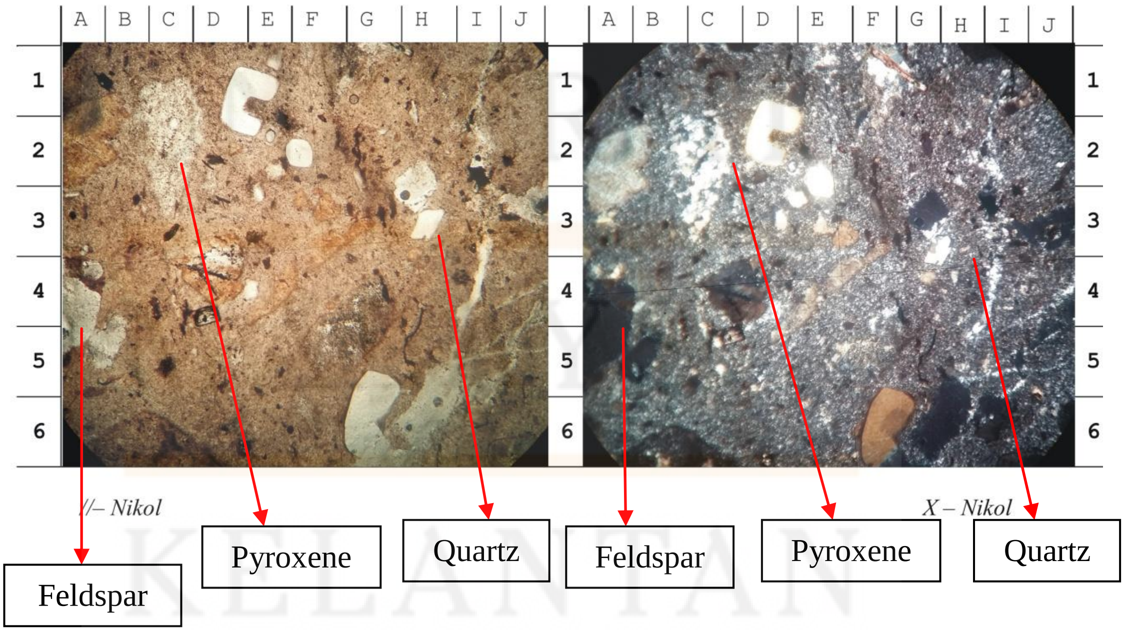


Figure 4.20:Thin section of rock sample 4 (4×10 magnification power)

This Ignimbrite rock composed of minerals Feldspar (40%), Quartz (15%) and Biotite (25%) and Pyroxene (20%). These three minerals are mostly anhedral and subhedral in shape. Both Quartz and Feldspar are white in colour under plain polarized but Felspar has much darker colour and the texture is more scattered randomly than Quartz.

4.3.2 Lithostratigraphy

Lithostratigraphy is the study about the organization of rock strata into units based on their lithology characteristics. In the study area, it comprises rock of the periods from Permian until Jurassic. Based on the lithology map and field observations, the study area are composed of extrusive igneous rock such as andesite and ignimbrite which is involve in certain part of Gua Musang Formation or Telong Formation that deposited from Middle Permian to Upper Triassic. The lithostratigraphic column is shown in Table 4.2.

Table 4.2: Lithostratigraphy Column

Era	Period	Lithology	Formation	Description
Mesozoic	Jurassic	Ignimbrite	Gua Musang Formation	It is brownish pink colour and has smooth surface
Paleozoic	Permian	Andesite	Gua Musang Formation	Intermediate igneous rocks

All the rocks exist from Permian period which is in the Paleozoic era and also period of Jurassic which is in Cenozoic era.

4.4 Structural Geology

Structural geology is concerned about the study of the processes that resulting in the formation of geologic structures. Within the geologic structure, it affects the rock formation. Structural deformation is happened when stress place upon them exceed the strength of rock. In this study area, there is only secondary structural which represent by joint reading.

4.4.1 Lineament Analysis

Lineament is a straight linear structure which can be identified from aerial photographs and it is controlled by the structures such as ridge, joints, fault, inconsistency and boundaries of rock. For this research, Google Earth image is used for the lineament analysis. There are two classifications of lineament which are positive lineament and negative lineament. The distribution of lineament is shown in the lineament analysis and the orientation of each lineament is measured and plot into the rose diagram. In Figure 4.21, it shows the rose diagram analysis for the lineament in the study area. The orientation is indicated by North-East direction and the value of force direction is 30° NE based on Figure 4.22, for the lineament analysis.

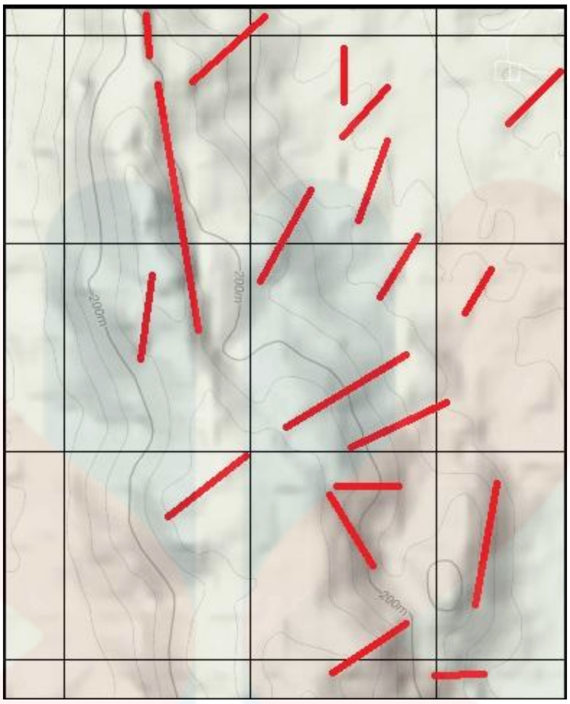


Figure 4.21: Lineament in the study area

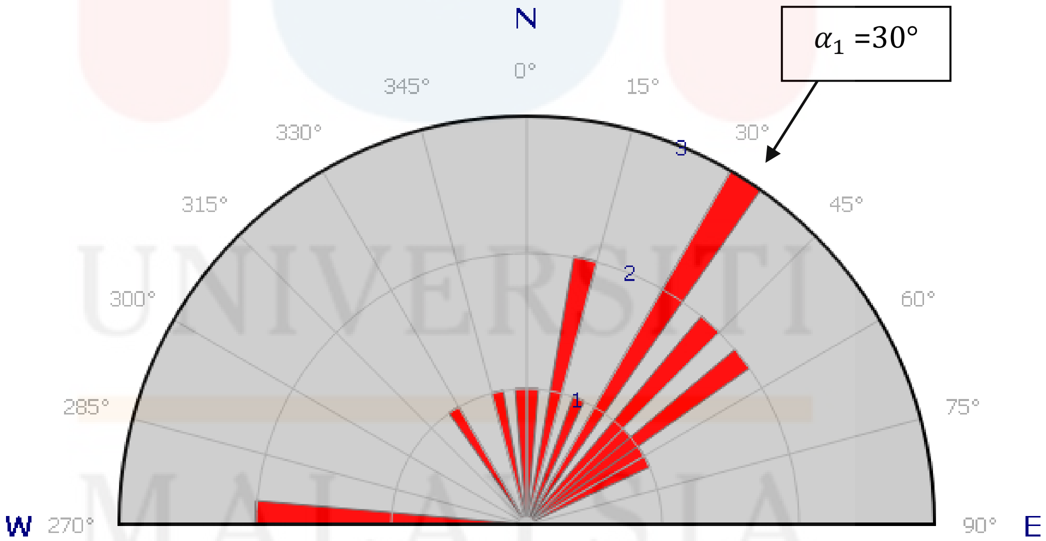


Figure 4.22: Rose Diagram of the Lineament Analysis

4.4.2 Joint Analysis

Joint is resulting from the fracture of rock or mineral broken. Joint do not involve any displacement or movement. A group of joint is called a joint set. Joint is important part of the structural geology that needs to be analyzing as joint lead to the pathway of water flow. There are two types of joints which are shear joint and extensional joints. The extensional joint in the study area is shown in Figure 4.23 and Figure 4.24. In this study area, these extensional joints are obvious to be seen that they are randomly distributed within the outcrop. The length of each the joints are averagely is not the same.

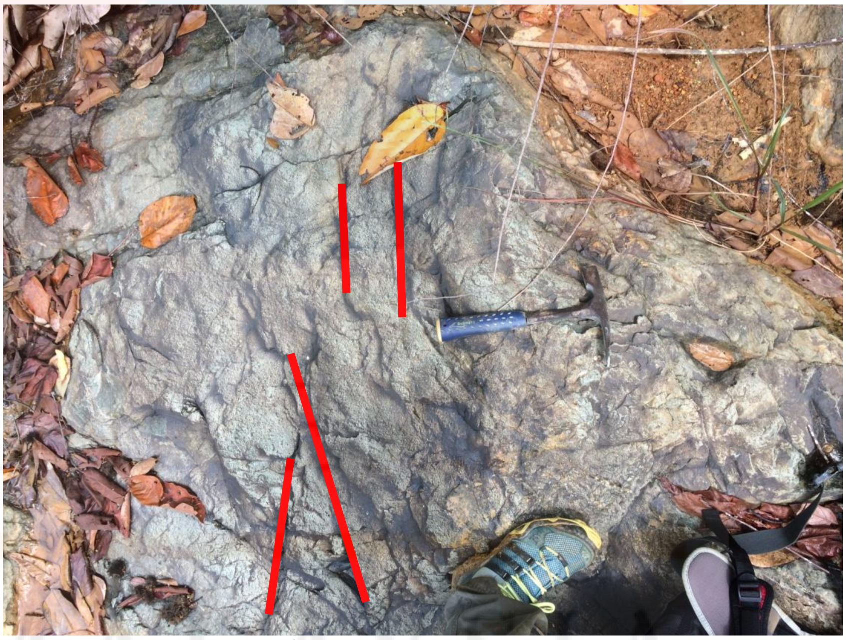


Figure 4.23: The joint found at N 05° 39’ 48.73” and E 102° 09’ 53.70

Figure 4.24: The extensional joints

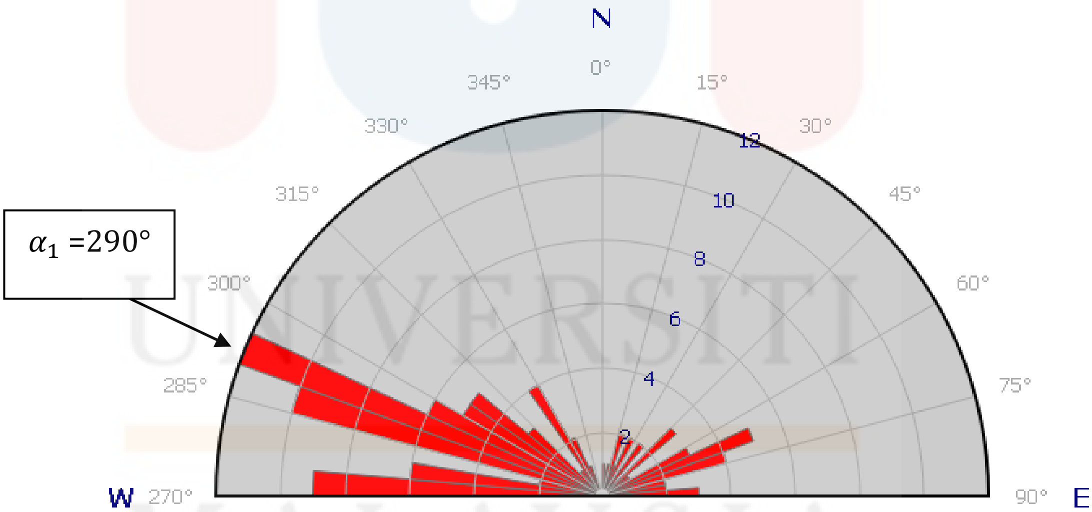
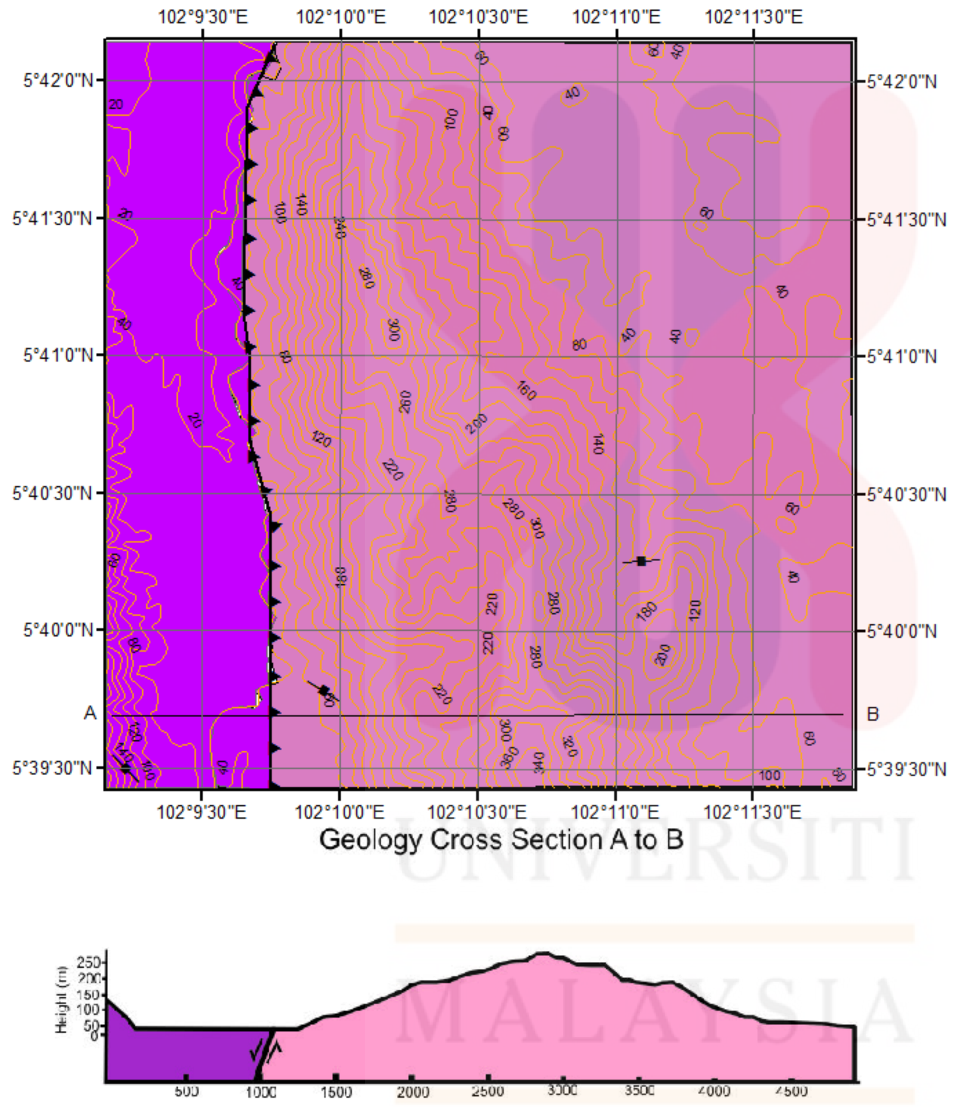


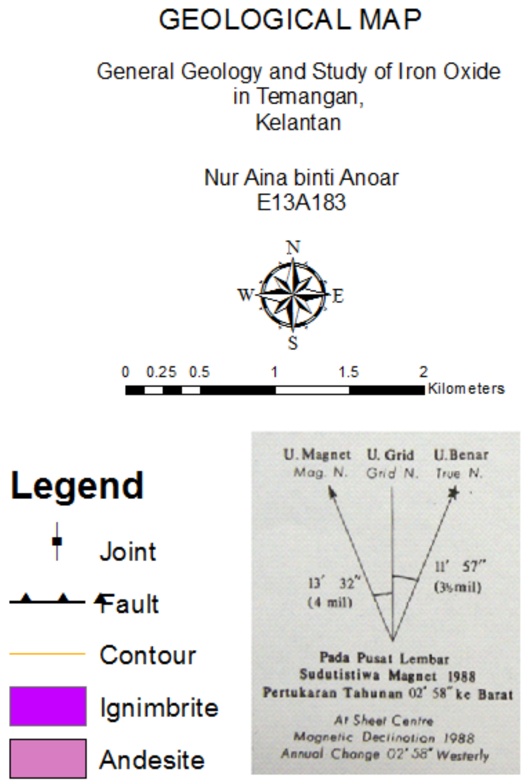
Figure 4.25: Rose Diagram for the joint analysis

The set of orientation is dominat of North-West oriented. Meanwhile, the direction of the force is 290°.

4.5 Historical Geology

The rock sample founds in the study area composed of extrusive igneous rocks type. The ignimbrite rock found at the northern-west part of which is covered 25% of the study area. Whereby, the andesite rock was collected mostly at the center of the study area by the percentage of the coverage is about 60% within the study area. The volcanic igneous rocks in the study area are involved in the eastern belt of Peninsular Malaysia and are believed in the Gua Musang Formation. According to Mohd (2004), this formation is composed of predominantly by argillaceous and calcareous rocks with subordinate arenite, pyroclastic and lava flow. And also Aw (1967) stated that Ignimbrite rock at Temangan mine do not have pure lava characteristics, normal pyroclastic rock or middle rock.





Era	Period	Lithology	Formation	Description
Mesozoic	Jurassic	Ignimbrite	Gua Musang Formation	It is brownish pink colour and has smooth surface
Paleozoic	Permian	Andesite	Gua Musang Formation	Intermediate igneous rocks

Figure 4.26 Geological Map

CHAPTER 5

STUDY OF IRON OXIDE AT TEMANGAN

5.1 Introduction

The iron ore deposit in Kelantan is believed to have been first discovered in 1921 and was prospected in the early 1930's. The ore occurs along the contact of the schist and the sedimentary rocks in a long narrow belt. The iron ore generally occurs on or near to the crest of the north-south aligned ridges, and where undisturbed by precious mining, takes the form of massive outcrops, large boulders and nodules in the soil (MacDonald, 1967).

The location of this research is located in Kelantan which is underlain by Gua Musang Formation or Telong Formation with age from Middle Permian to Upper Triassic (Yin, 1988). This formation is composed of predominantly by argillaceous and calcareous rocks with subordinate arenite, pyroclastic and lava flow.

5.2 Geochemistry Analysis

The detailed studies were conducted to establish the composition and properties of the samples obtained in the study area. After collecting sample from the field mapping, there are three iron oxide samples were powdered to 100 micron size to be analyzed with geochemistry parameter. This was included X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF) and Petrography microscopy.

5.2.1 X-Ray Diffraction (XRD)

X-Ray Diffraction method is able to measure the average spacing between layers or rows of atoms. It is also able to determine the orientation of a single crystal or grain and find out the crystal structure of unknown material. XRD technique was used to show the phases that iron presented and other mineral phases present especially the silica and provide the quantification of all phases.

In this analysis, three samples of iron oxides in Temangan have been crushed into powder and put into XRD machine. The typical results of X-ray diffraction analysis of the different iron samples are shown in Figure 5.1, Figure 5.2 and Figure 5.3.

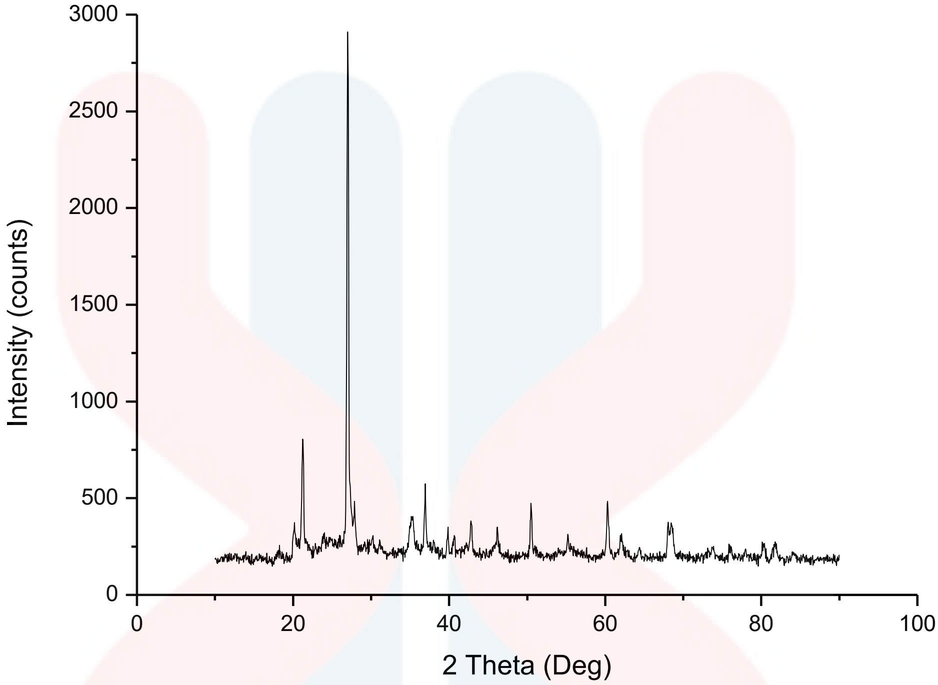


Figure 5.1: Sample 1

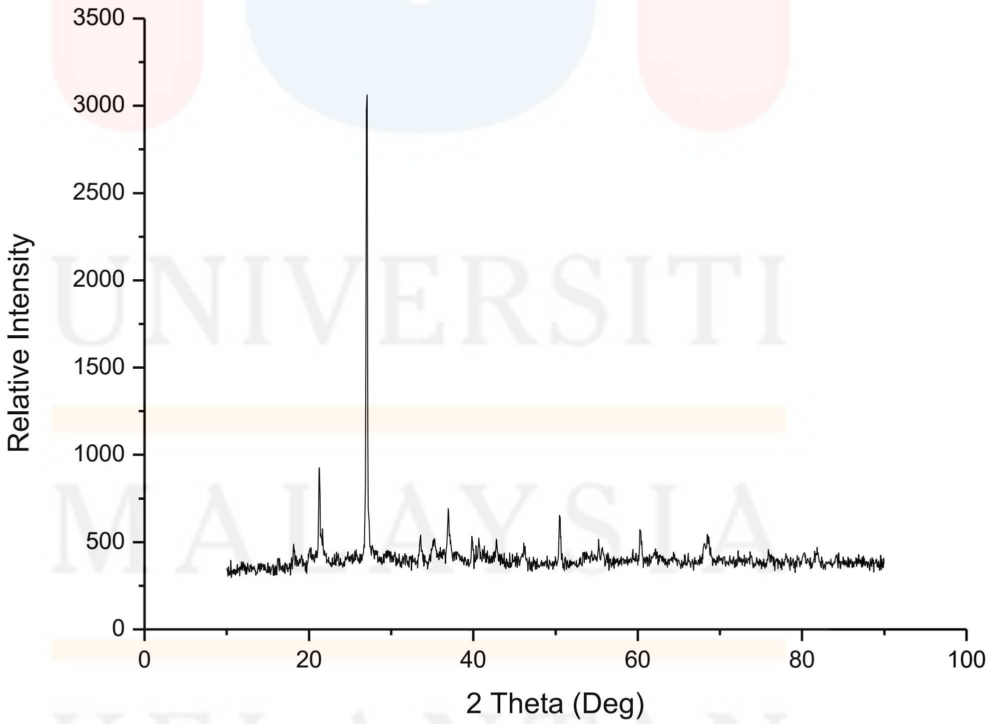


Figure 5.2: Sample 2

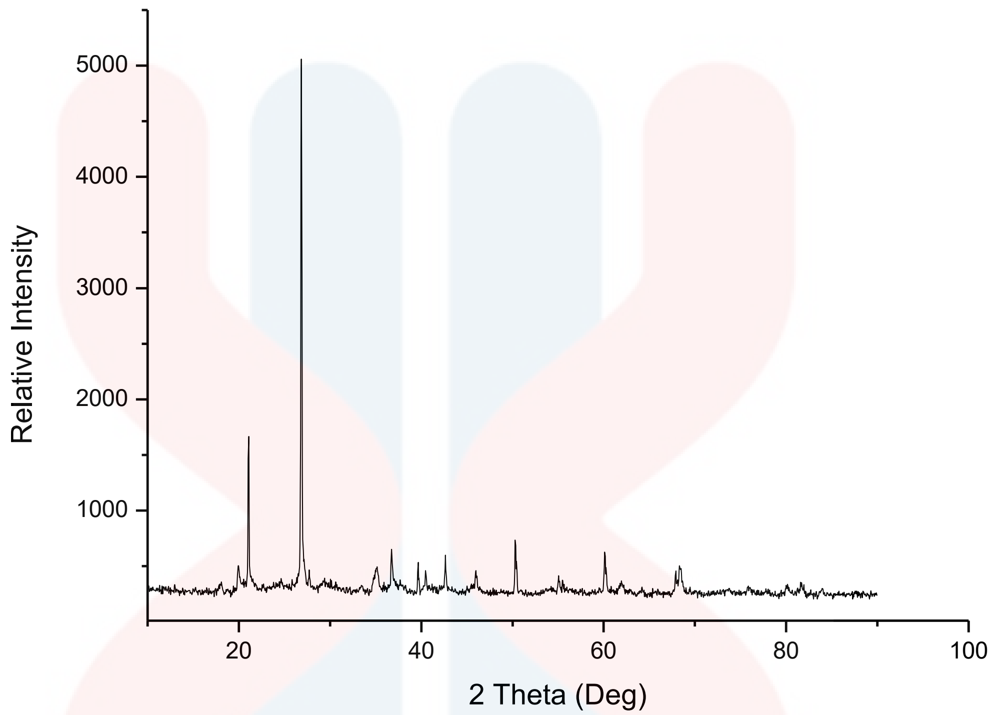


Figure 5.3: Sample 3

After the analysis of result by using a DiffracEva software and OriginPro8.5.0, the analyzed result as shown in the figures above. From the observation, it is noticeably showing that the three graphs show the similarity in the graph patterns. Even the highest peak value of the relative intensity is in average of 2500-5000. This is influenced by the content of each sample and these three samples are possible to contain the same associated minerals which are quartz and feldspar. It is also come together with the abundance of calcite and aluminium minerals.

5.2.2 X-Ray Fluorescence (XRF)

The results of X-Ray Fluorescence (XRF) analysis of iron oxide from the three different locations within the study area which is Temangan area are as shown in Table 5.1 of Sample 1, 2 and 3 respectively.

Table 5.1: Chemical Composition of Temangan Iron Oxide

Chemical Composition (mass %)	Sample 1 N 05° 39’ 31.4” E 102° 09’ 10.25”	Sample 2 N 05° 39’ 48.9” E 102° 09’ 53.84”	Sample 3 N 05° 40’ 17.89” E 102° 11’ 3.38”
Al_2O_3	14.8	10.3	13.2
SiO_2	49.2	38.4	47.3
P_2O_5	0.968	1.31	0.996
So_3	0.607	0.707	0.618
Cl	0.561	0.444	0.525
K_2O	10.5	5.10	8.74
CaO	0.311	0.275	0.295
TiO_2	0.340	0.605	0.280
MnO	1.90	7.93	3.03
Fe_2O_3	19.2	32.5	23.3
Rb_2O	0.149	-	0.131
ZrO_2	0.142	-	0.136
BaO	0.685	1.63	0.949

La_2O_3	0.226	-	0.140
CeO_2	0.102	0.113	-

According to the result obtained from the XRF analysis in Table 5.1, it can be pointed out that Sample 2 has the highest percentage of Fe_2O_3 (32.5%) compared to Sample 1 which has the lowest; 19.2%.

In the study area, the iron oxide of Sample 1 tends to have the composition of Silicate Oxide (SiO_2) of 49.1%. Meanwhile the composition of Aluminium oxide is 14.8%. Other major element that is contains in this sample is Calcium oxide (CaO) with 0.311%. The minor elements in this sample are Titanium oxide with 0.340% and Barium oxide with 0.685%. Meanwhile, the trace elements are Manganese oxide, Rubidium oxide, Zircon oxide and Sulphate oxide with 1.90%, 0.149%, 0.142% and 0.607% respectively.

From the Table 5.1, the iron oxide of Sample 2 shows that the major elements are Silicate oxide, Aluminium oxide, Calcium oxide and Potassium oxide which have the percentage value of 38.4%, 10.3%, 0.275% and 5.10% respectively. For the minor elements, the value of Titanium dioxide is 0.605% and Phosphorus pentoxide is 1.31%. The trace elements that are present in S2 are Manganese oxide (7.93%), Barium oxide (1.63%) and Cobaltous oxide (0.158%).

For the third locality, Sample 3 shows that the major elements Silicate oxide, Aluminium oxide, Calcium oxide and Potassium oxide are 47.3%, 13.2%, 0.295% and 8.74%. Titanium oxide with 0.280%, Phosphorus pentoxide with 0.996%, Barium oxide with 0.949%, Zircon oxide with 0.136% and Manganese oxide with

3.03%. The difference in the chemical composition of Barium oxide (BaO) in all three samples is due to the trace element of Ba which is from the feldspar mineral.

5.2.3 Petrography Microscopy

The petrography analysis was applied to study and determine the transparent constituents of various samples of Temangan iron oxides. The results of petrography microscopy of three different iron oxide of the rock samples are shown in Figure 5.4, Figure 5.5 and Figure 5.6.

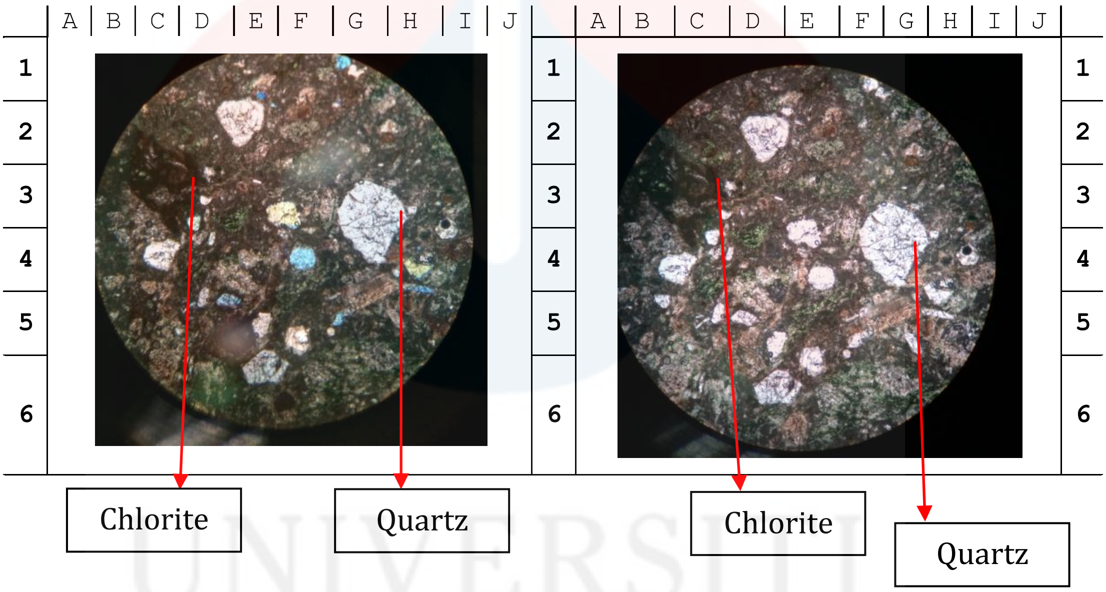


Figure 5.4: Thin Section of Sample 1 consists of quartz, feldspar, biotite and chlorite (4×10 magnification).

From the Figure 5.4, it shows that Sample 1 of Ignimbrite rock sample consists of alkali feldspar and quartz as the phenocryst while for the groundmass consists of biotite, chlorite and alkali feldspar. Biotite is black in colour. Quartz has subhedral shape but biotite and feldspar are anhedral. Biotite has cleavage and is moderate to high relief. Quartz is colourless as it shows low relief. The brown color indicates the weathered sides of the sample. The black colour indicate chlorite mineral.

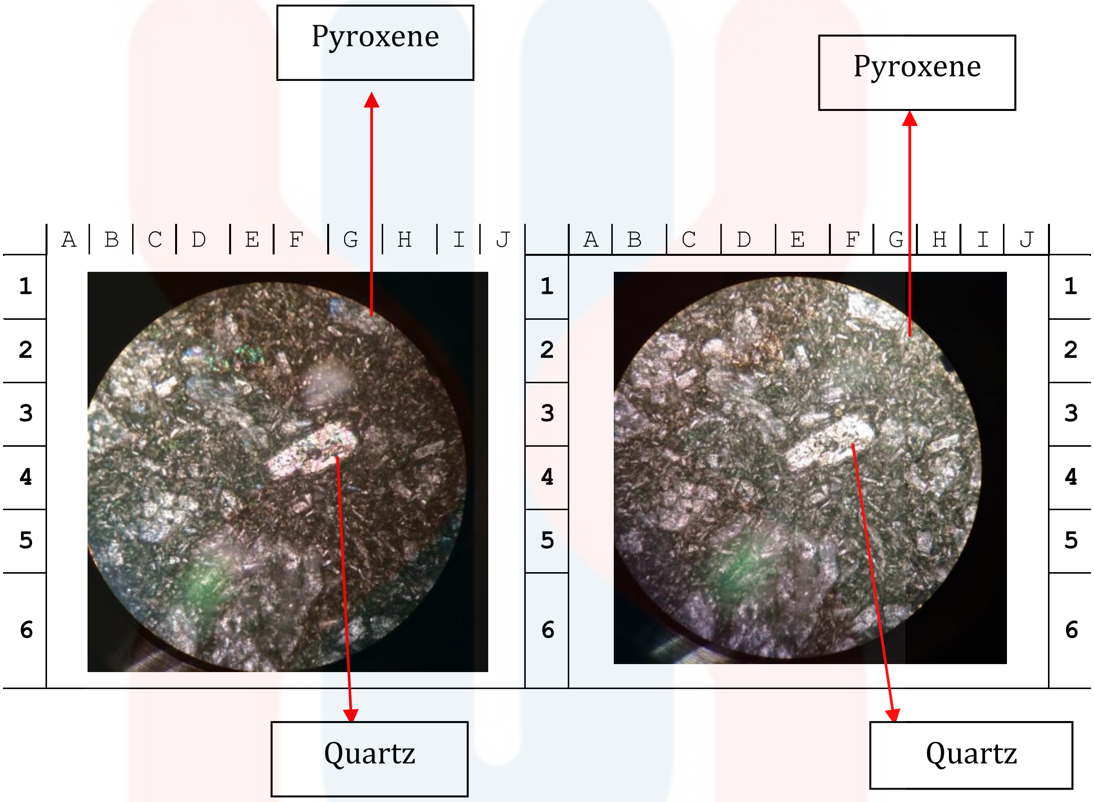


Figure 5.5: Thin Section of Sample 2 (4×10 magnification power)

This Sample 2 of Andesite rock sample is composed of quartz (15%), pyroxene (15%), plagioclase (65%) and feldspar (5%). Feldspar and quartz show white colour in the interference colour but white colour of quartz under the plain polarized is more milky than feldspar. Pyroxene shows black colour twins and cleavage intersects near 90°.

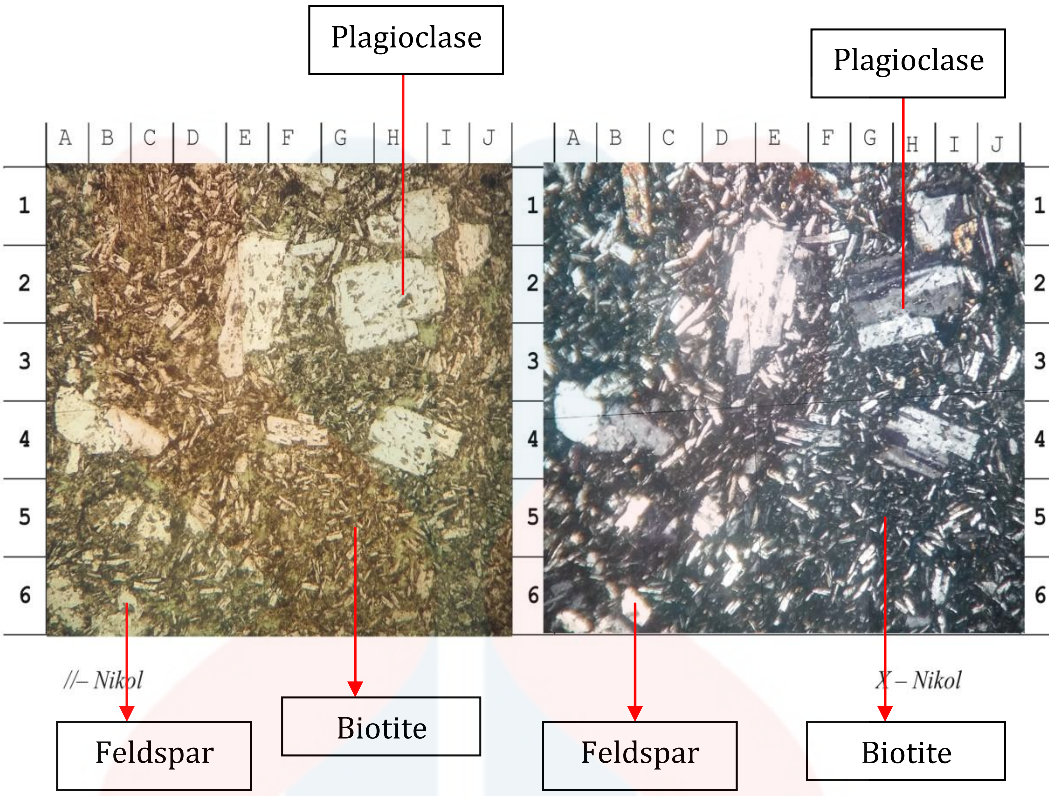


Figure 5.6: Thin Section of Sample 3 (4×10 magnification power)

Lastly, for Sample 3 of Andesite rock sample, it is containing minerals Feldspar (40%), Quartz (15%) and Biotite (25%) and Pyroxene (20%). Quartz, Plagioclase and Feldspar show gray to white interference colour but plagioclase and feldspar is slightly lower than Quartz of the true colour. Plagioclase shows perfect cleavage and has twinning whereby Quartz do not have cleavage. The shape of Plagioclase is euhedral, meanwhile Quartz and Feldspar are anhedral. Biotite is filling up the space between the other minerals.

5.3 Discussion

The observations made from all three geochemistry analysis of the iron oxide in the study area. For the X-ray Diffraction analysis, the graphs patterns of all three samples are almost have the similarity. The majority associated minerals that are found in all samples are quartz and feldspar. It is also come together with the abundance of calcite and aluminium minerals.

From the result of the X-ray Fluorescence analysis, it has been cleared that the concentration of the elements in each sample is controlled by the structural and geomorphological setting of the locality, which is even just a slightly different from one another.

From the association of iron oxide percentage of each sample with the structural and geomorphological pattern, it is observed that Sample 2 and Sample 3 have an average of 32.5% and 23.3% of iron oxide respectively. Both of these localities are structural hills such as the presence of joints and fractures with undulating surface. The elevations of both localities are between 90 meters and 110 meters. The flank of the hill is deeper and steeper hence many valleys and drainages can be seen. Whereby for Sample 1 possesses 19.2% of iron oxide content only which the elevation of this locality is less than the 90 meters. Even though at this locality the presence of fractures and joints can be seen but the weathering has been the factor of low iron oxide content. Most of the outcrop at this locality has undergone weathering process as the rock sample is highly weathered.

From the microscopy images, it is revealed out that out of the three samples analyzed, quartz and feldspar are the dominant minerals that found in the samples with minor amounts of pyroxene, plagioclase, olivine and biotite. But, the percentage of quartz in the Sample 2 and 3 somewhat is lower than Sample 1 due to the type of rock. As Sample 2 and 3 are found at Andesite rock where the present of quartz mineral in this rock is absent or very least. There is slightly weathered side of minerals in the thin section as it can be a mistake during the process of thin section preparation. The ore is characterized by the mutual grain boundaries between the individual minerals.

In the Figure 5.7, it shows the spatial distribution of the iron oxide samples within the study area. Even all the three samples do not show much difference of the chemical composition of $Fe_2\,O_3, Al_2\,O_3$ and SiO_2 but it is clearly influenced by the structural and geomorphological settings.

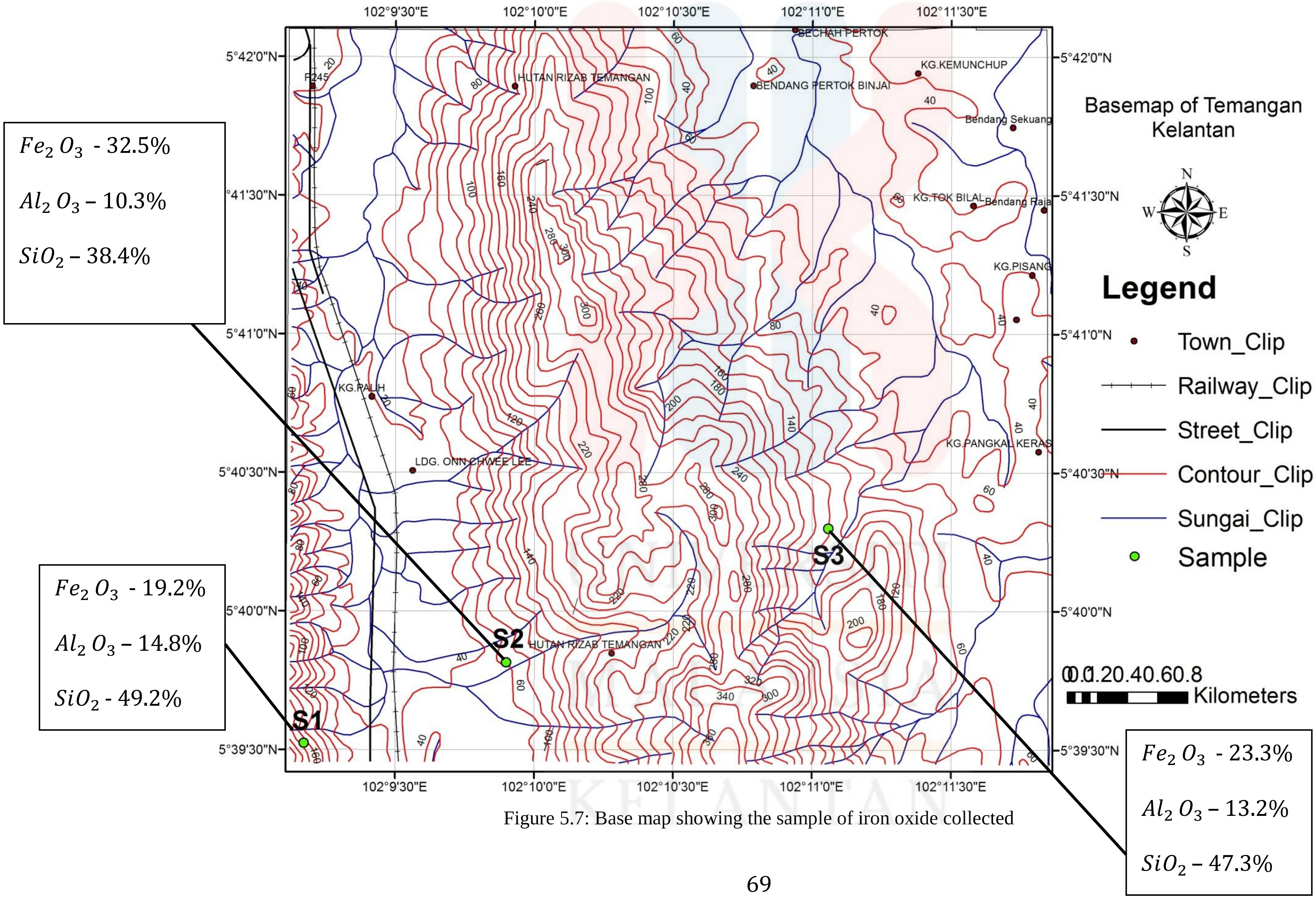


Figure 5.7: Base map showing the sample of iron oxide collected

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In the end of this research, the objective of the study to produce geological map with scale 1:25,000 has been achieved. This geological map could not be done without mapping and field observations. The updated geological mapping can be used as a reference in the future by geologists or researchers. From the petrography study using optical microscope, the iron minerals could not be clearly identified under optical microscope as it opaque and not transparent for light to go through. Others common minerals such as feldspar, biotite, quartz, chlorite and other common rock forming minerals could be seen associated together with iron minerals based on thin section observation. In addition, the physical and chemical characterization of the iron oxide in the study area have shown the composition of iron oxide are not really in high concentration to be exploited or mined. The distribution of iron oxides is found scattered in some part of the study area and no pattern can be determined spatially. From this research, it can be concluded that the physical and chemical characteristics of iron oxide in Temangan is determined and described.

6.2 Recommendation

For the lineament analysis, it is important to use a better sources image such as aerial photograph to give an accurate interpretation of the lineaments. A clearer image can give us to analyze and interpret the lineaments accurately. In addition, with the new technology by using ArcGis software, it is good enough to identify structural geology such as fault and folding in the urban area. It is also indirectly can save time. Besides, in the geochemistry analysis, it is suggested to provide better and appropriate laboratory equipments. In order to avoid or minimize the parallax error in the research, hence the conditions of the equipments is definitely should be concern mostly about. Furthermore, for the further detailed observation and description about the properties of iron oxide, it is suggested to do Scanning-Electron Microscopy to reveal the information about the iron oxide regarding the external morphology (texture), chemical composition and crystalline structure and also the orientation of materials making up the sample.

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