GENERAL GEOLOGY AND GOLD OCCURRENCE AT KATOK BATU, GUA MUSANG

By

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

FACULTY OF EARTH SCIENCE

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DECLARATION

I hereby declare that the work embodied in this Report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

_____

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Date :

I certify that the report of this final year project entitled **"General geology and gold occurrence at Katok Batu, Gua Musang"** by Ahmad Ridhwan Bin Mohammad, matric number E13A008 has been examined and all the correction recommended by examiners for the degree of Bachelor of Applied Science (Geoscience) with Honors, Faculty Earth Science , University Malaysia Kelantan.

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%	Percentage
Km	Kilometre
Mm	Millimetre
N	North
E	East
S	South
W	West
Au	Aurum

GENERAL GEOLOGY AND GOLD OCCURRENCE AT KATOK BATU, GUA MUSANG

ABSTRACT

This study encompasses the area of Katok Batu, Gua Musang in identifying and conducting geological research about geomorphology, lithology, petrography and structural geology. The geological research project is located 4°53'24.81"N and 101°54'35.59"E. The objectives of the research are to produce the geological map of Katok Batu at scale 1:25000, to investigate the gold concentration in Katok Batu and to create an distribution map associated to the concentration of gold that has investigated. The research project was undergoes by doing fieldwork mapping, sampling and laboratory analysis. In fieldwork mapping, the important thing needs to be considered is the reflection of geomorphology, structural geology, and lithology for the rocks. The rock lithology that was found in the research area is the granite, limestone and shale. Besides that, the fieldwork mapping is also conducted to update the drainage pattern and road access by traverse through the study area. Furthermore, in laboratory analysis it covers from hand specimen, petrography observation and mineral identification. Next, the laboratory analysis also includes the sampling at the stream and investigated it the sample by using Flame Atomic Absorption machine (AAnalyst 200) to show the concentration for gold. Additionally, the distribution map is use to show the concentration and location of the sample. Based on the distribution map, it can discover the source of gold metal in a research area. The distribution map is important as it showed for the arrangement of the highest gold concentration for probable location or main deposits location.

GEOLOGI AM DAN KEJADIAN EMAS DI KATOK BATU, GUA MUSANG

ABSTRAK

Kajian ini meliputi kawasan Katok Batu, Gua Musang dalam mengenal pasti dan dijalankan penyelidikan geologi tentang geomorfologi, litologi, petrografi dan geologi struktur. Projek kajian geologi ini terletak di 4°53'24.81"N dan 101°54'35.59"E. Objektif kajian ini adalah untuk menghasilkan peta geologi di Katok Batu dalam scala 1:25000, untuk mengenal pasti kepekatan emas di Katok Batu dan untuk menghasilkan peta penyebaran berkaitan dengan kepekatan emas yang dikenal pasti. Projek kajian telah dijalankan dengan melakukan pemetaan kerja lapangan, persampelan dan analisis makmal. Dalam pemetaan kerja lapangan, perkara penting yang perlu di ambil kira ialah pemerhatian terhadap geomorfologi, geologi struktur, dan litologi batuan. Litologi batuan yang dijumpai di kawasan kajian adalah granit, batu kapur dan syal. Selain daripada itu, pemetaan kerja lapangan turut dijalankan untuk mengemaskini corak saliran dan akses jalan dengan merentasi kawasan kajian. Tambahan pula, dalam analisis makmal merangkumi daripada spesimen tangan, pemerhatian petrografi dan pengenalan mineral. Seterusnya, analisis makmal turut termasuk persampelan di aliran sungai dan menentukannya sampel tersebut dengan menggunakan Flame Atomic Absorption machine (AAnalyst 200) untuk menunjukkan kepekatan emas. Tambahan lagi, peta penyebaran digunakan untuk menunjukkan kepekatan dan lokasi sampel. Berdasarkan peta penyebaran, sumber besi emas boleh diketahui di kawasan kajian . Peta penyebaran sangat penting kerana menunjukkan corak untuk kepekatan emas yang tinggi untuk lokasi kemungkinan atau lokasi deposit utama.

CHAPTER 1

INTRODUCTION

1.1 General background

In the earlier Peninsular Malaysia was a significant gold producer before the exposure of goldfield in South Africa and Australia (Becher, 1983). Dependable geosciences data in the form of geological and gold probable maps is very significant for study and improvement of gold resources. This research was completed by doing preparation of mapping and laboratory sample analysis. Malaysia has abundant natural resources in agriculture, forestry and minerals. Mineral resources are major importance in the Malaysia economy because Malaysia is a gold producer, copper, bauxite and ilmenite (Pui-Kwan Tse, 2010). In Malaysia, gold is primarily linked with gold belts or ranges. These gold belts were created alongside tensional fracture or shear zones alongside subduction zones.

Malaysia has a predominant antiquity of extensive small-scale gold mining all through the country, mostly in the Central Belt of Peninsular Malaysia and highly prospective province for gold mining industry. Malaysia Central Gold Belt hosts the majority of peninsular Malaysia gold occurrences. The Central Gold Belt runs up the spine of the Malaysia peninsular into Thailand and hosts a number of structurally controlled quartz veins in a sequence of old and folded slates. According to Yeap (1993), the Central Gold Belt is a 20 km wide-ranging, a major N-S trend of gold mining regions that shows the vital role of hydrothermal fluids in the expansion of gold in Peninsular Malaysia, particularly in the North Pahang and Kelantan area.

In Kelantan, gold mineralization is located in the central part of the state that is surrounded by Stong Igneous Complex and Senting Granite on the west, Kemahang Granite in the north and Boundary Range Granite in the east (Goh Swee Heng et al., 2006). The widely held of the gold production seemingly arose from the states of Pahang and Kelantan within the Central Belt as seen in Figure 1.1 that also show the Central Belt of Peninsular Malaysia. The gold mineralization period seems to be correlated to the intermediate intrusive rather than acid Triassic granites. In most cases the host rocks for the mineralization are volcano-clastics, limestone and metasedimentary rocks (Wan Fuad Wan Hassan & Heru Sigit Purwanto, 2002).

Besides that, the aim of this research was to determine the gold occurrences, petrography, structure and geological features at the Katok Batu. By doing this research project, it can investigate the gold occurrences, types of rock present at the study area and also mineralogy of the rock.

Furthermore, this research can study the general geology of the study area. To construct an updated geological map of 1:25000, it were obtained from the field by doing mapping and also from the laboratory study for explaining the gold occurrences. By constructing the geological map it updated the road connection that was included in the map and also the lithology boundaries.

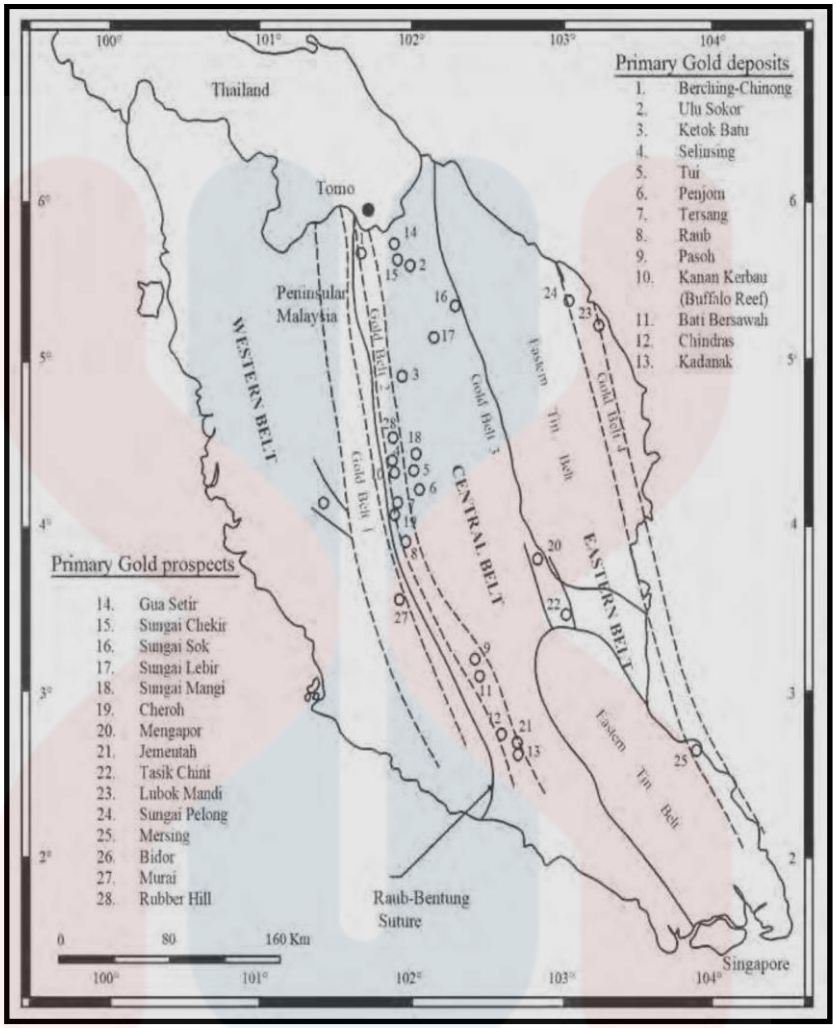

Figure 1.1 Peninsular Malaysia showing Central Belts and Primary Gold Production. (Yeap, 1993)

1.2 Problem statement

No investigation of gold occurrence at Katok Batu, Gua Musang that has been conducted yet. Firstly the information that was required to complete this research was very limited. Although the map of the locality can be found in the Google Earth application but it was not sufficient in information such as the lithology, minerals distribution and also the structural analysis of the area. Hence, the information about the geographical information was very limited. Next, the number of journals and articles that have been publish also small in number. Besides that, the

map such as topographic map provided by the Jabatan Ukur dan Pemetaan (JUPEM) was not updated.

Several method will be carried out to solve the problem which include by constructed the latest geological maps of areas by mapping, laboratory survey, data analysis and soon.

1.3 Research objectives

i) To produce an updated geological map at this study area at scale 1:25,000.

ii) To study the gold occurrence at Katok Batu, Gua Musang.

iii) To create an distribution map associate to the concentration of gold.

1.4 Study area

The study area is Katok Batu that is located at the Gua Musang, Kelantan. The study area is located within latitude of $4^{O}52'0''N$ to $4^{O}54'30''N$ and longitude of $101^{O}52'30''E$ and $101^{O}54'30''E$ with the map scale 1:25000. In Kelantan, Gua musang is the largest district. Gua Musang is managed by the Gua Musang District Committee. Katok Batu is located west from the town of Gua Musang which can be seen in Figure 1.2. The study area that was covered is 5 km width x 5 km height with the total area of 25 km as showed in Figure 1.3. At this study area there are three main rivers that is Chalong River, Katok Batu River and Kundur River. The river is located near to the road and vegetation. Most of the study area landform is covered with vegetation such as rubber tree and palm oil. The study area also covered settlement area of villagers. The village settlement area is Batu Kasim, Batu Chempedak, Pulau Besar, and Batu Rimau Jatoh. The accessibility at the study area was highly accessible since there were main road that across the study area and also

the unpaved roads that is highly widespread across the plantation in the study area. This road can be seen in Figure 1.4 that shows the imagery map of the study area.

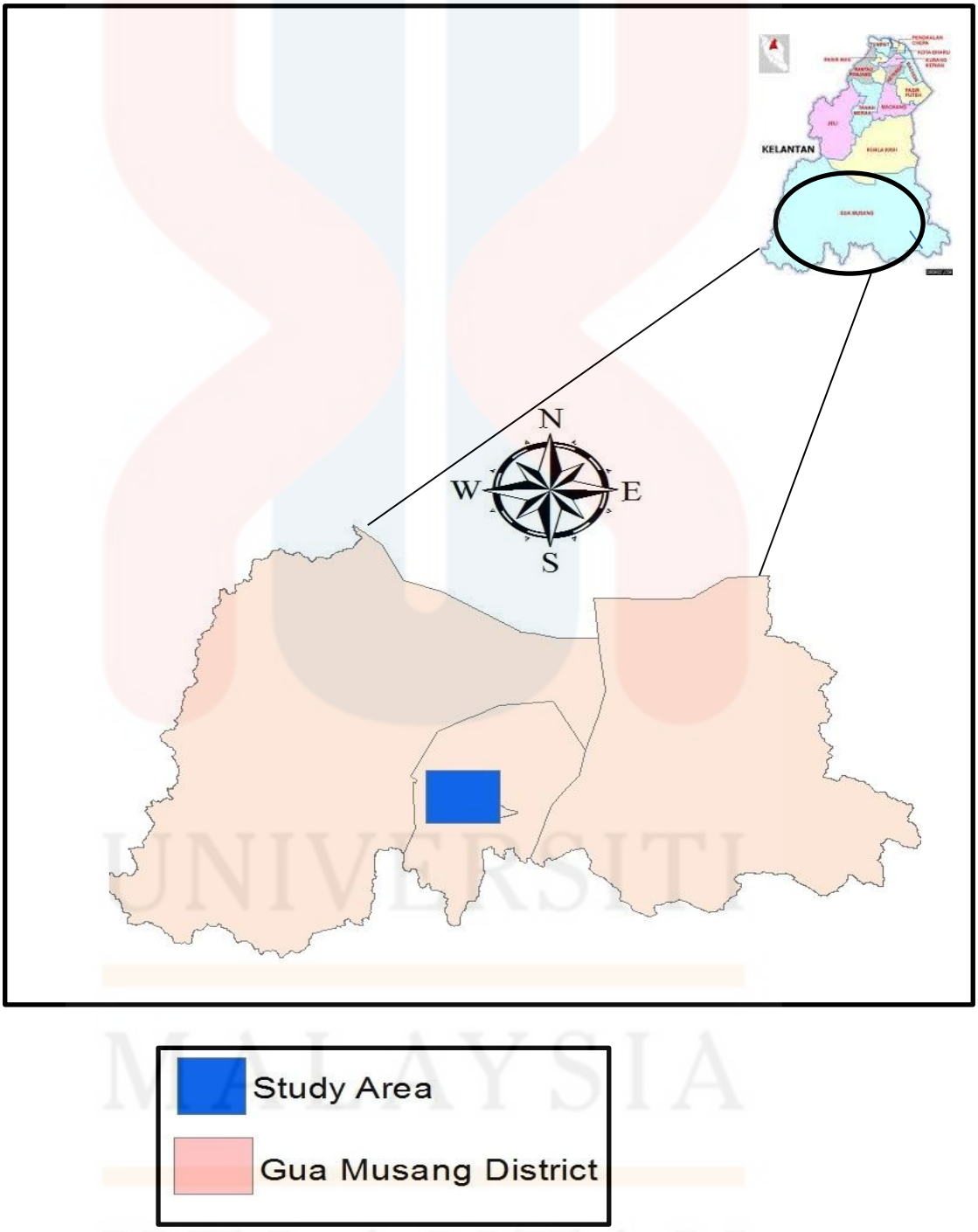

Figure 1.2 Location of Katok Batu in Gua Musang district.

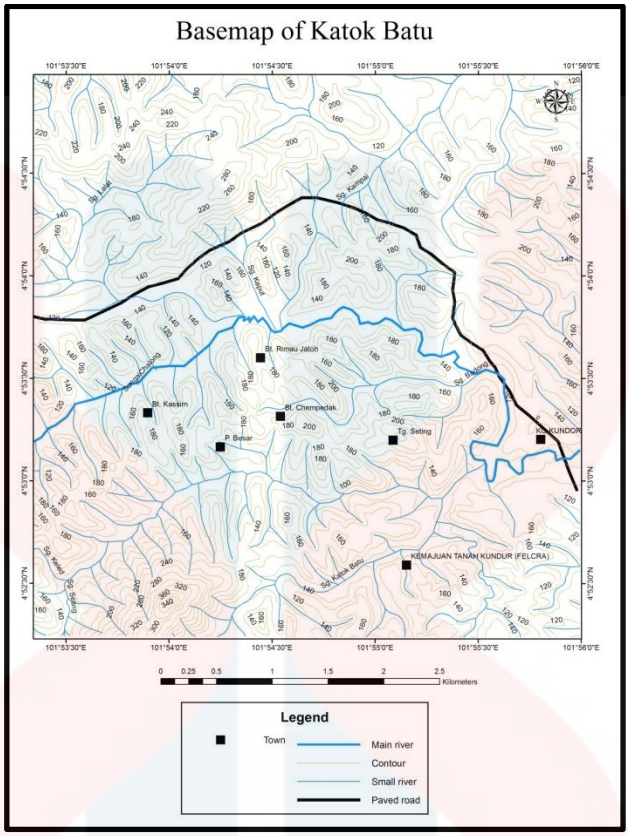

Figure 1.3 Basemap of Katok Batu

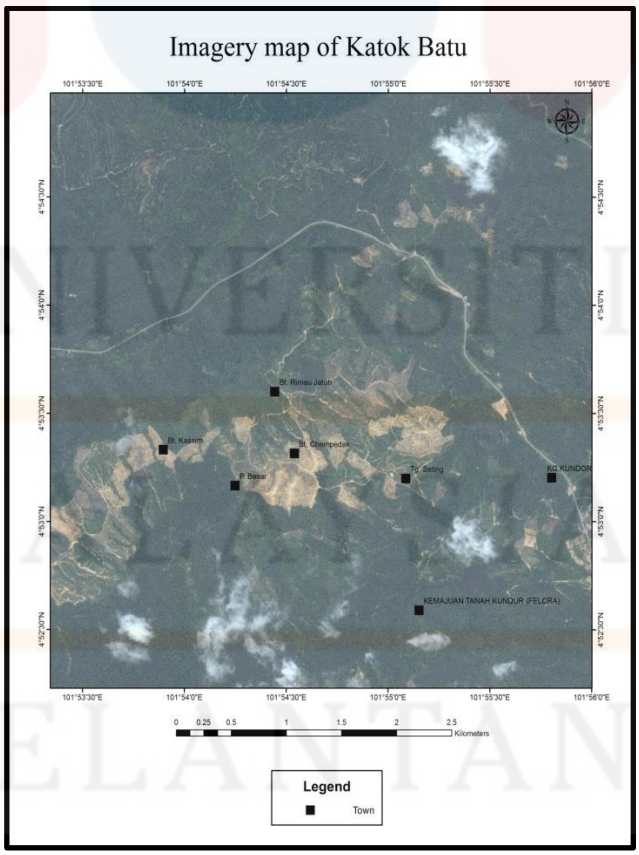

Figure 1.4 Imagery map of study area using GIS

1.4.1 Geography

1.4.1.1 People distribution

Table 1.1 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

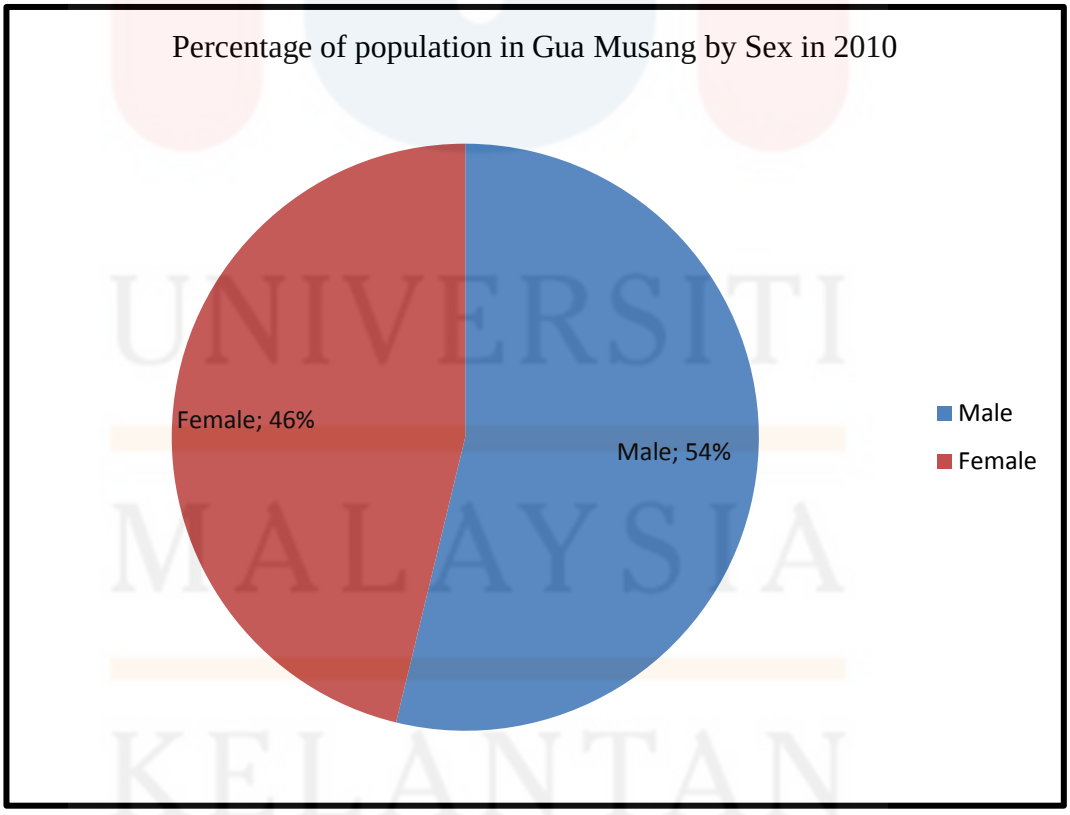

Figure 1.5 Percentage of populations in Gua Musang by sex.

Based on the table 1.1 above it shows the total population in Gua Musang by sex where the male is 46 359 whereas for female is 39 830. It also shows that the male is the dominant gender in the Gua Musang District which is slightly higher than the female. Next, the combination of male and female amount gives in the total population in Gua Musang which is 86 189. Besides that, based on the figure 1.5 the percentage for male is 54% and the female is 46%. This indicate that the male constitute the most in the Gua Musang District.

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

Total Population in Gua Musang by Ethnic						
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

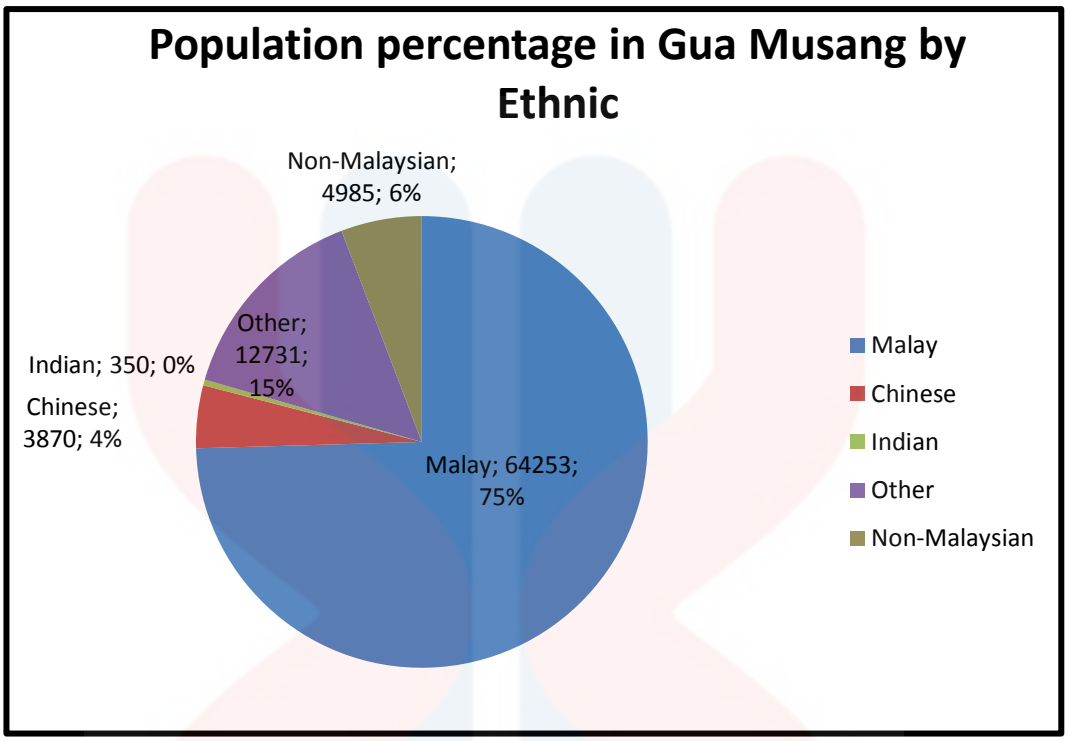

Figure 1.6 Population percentages in Gua Musang by Ethnic

Based on the table 1.2 above it shows the total population in Gua Musang by ethnic where the Malay ethnics has the highest value that is 64 253 whereas Indian ethnics has the lowest value that is 350. The Other ethnics are in the second and is higher than the Non-Malaysian ethnics which is 12731and 4985 respectively. Next, the Chinese ethnics are slightly higher than the Indian ethnics that have 3520 more. Furthermore, in figure 1.6 the highest percentage ethnics is the Malay that is 75% and the lowest percentage is the Indian that is almost 0%. This indicates that the Malay is the most dominant ethnics in Gua Musang whereas the Indian is the most minor ethnic. The Other, Non Malaysian and Chinese ethnics has percentage of 15%, 6%, and 4% respectively.

1.4.1.2 Rain distribution

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

(Department of Irrigation and Drainage Malaysia, 2015)

Rainfall Distribution at Kuala Betis region, 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

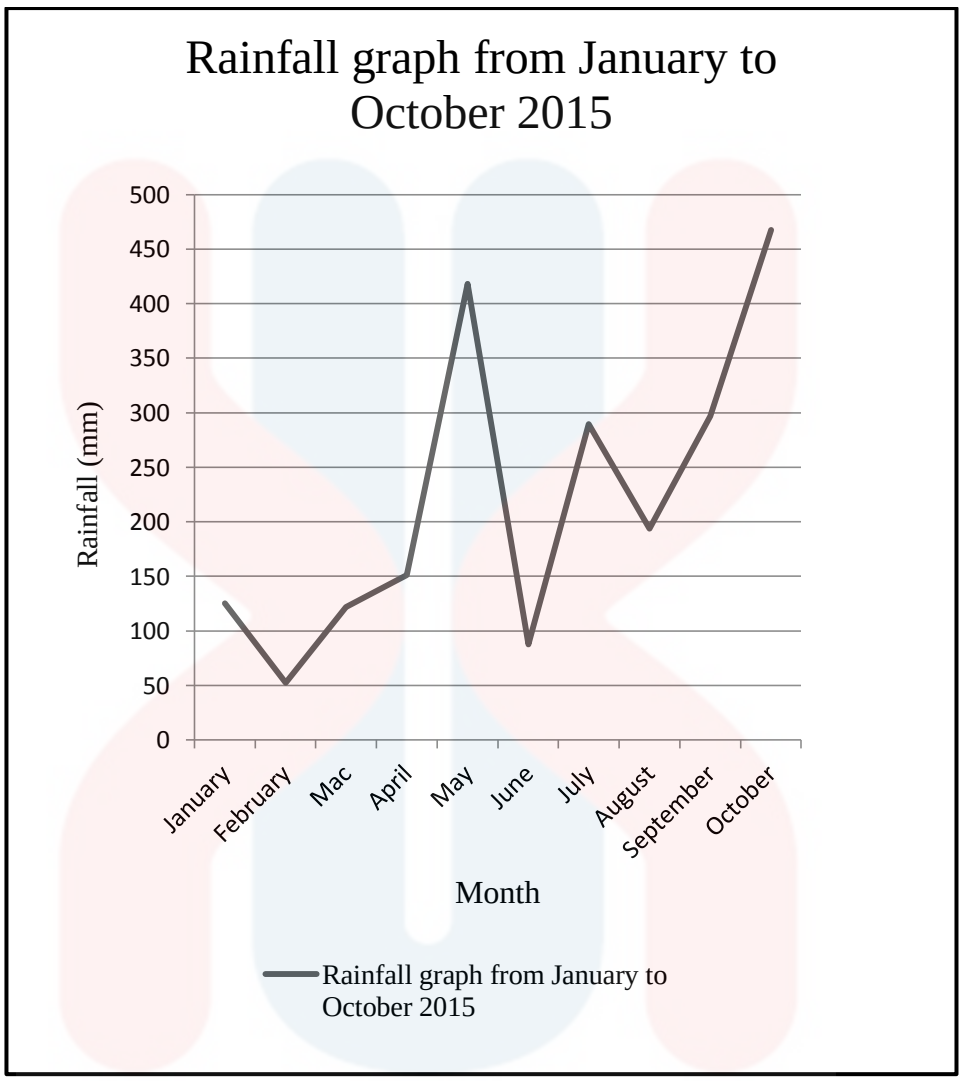

Figure 1.7 Rainfall distributions from January to October 2015

Based on the table 1.3 it shows the daily rainfall distribution at Kuala Betis from January to October where the amounts of rainfall are decreasing to the end of month. The highest value of rainfall is 88.6 mm that is in the 4th day month of September and the lowest value of rainfall is 0 that is the most in every month. Next, the average rainfall from January to October 2015 is 220.34 mm. Besides that, based on figure 1.7 the trends show the fluctuation of rainfall with the October month has the highest rainfall that is 467.5 whereas the February has the lowest rainfall that is 52.5.

1.4.1.3 Land use

At the study area, the land used is largely covered by the vegetation. The vegetation are the most widely spread across the area of Gua Musang until to the top of the hill. The main vegetation is rubber tree plantation and palm oil. This vegetation is widely spread since the villagers are very depending on plantation and agriculture as their source of income. Another land used is the settlement area in which the villagers live. There are 4 settlement areas in which covered the study area. This can be seen in Figure 1.8 by using the GIS software. The data is achieved from the Jabatan Ukur dan Pemetaan (JUPEM).

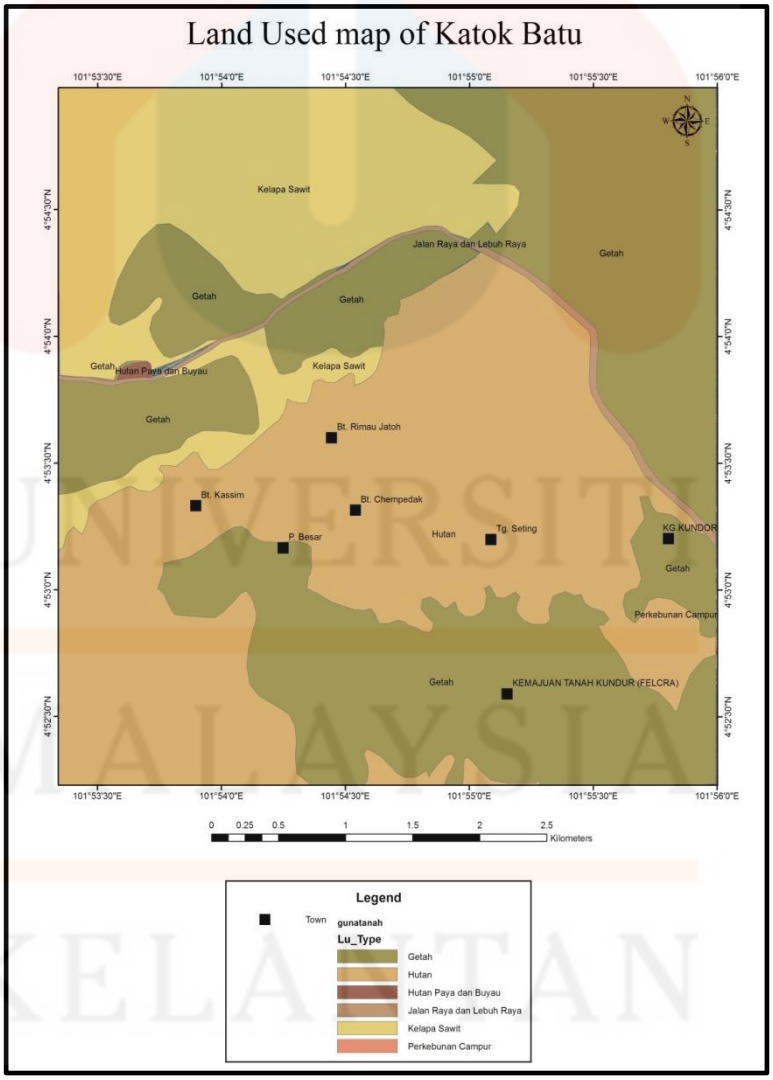

Figure 1.8 Land Used Map

1.4.1.4 Social economic

Social economic to the people at the study area are mainly the plantation and agriculture. This is because the people own large land which is useful for plantation. So people depending on the plantation as their main source of income and due to the demanding market for the palm oil and rubber it makes the people to open more plantations to increase the production. Furthermore, another social economic is the business. The business that famous to the people is the food business which means the people open their restaurant and stalls as their source of income. Balance of people is working with the government or unemployed. Figure 1.9 for vegetation and Figure 1.10 for business that show the social economic of the people at the study area.

Figure 1.9 Plantations as the source of economy

Figure 1.10 Businesses that is conducted by villagers

1.4.1.5 Road connection

The road connection at the study area location is accessible with the main road across the study area. The main road is paved road which is easier to mapping and traverse the study area. There are also unpaved road or off-road that is use by the villagers to their plantation. The unpaved road connection is widely spread across the study area this can be seen in figure 1.11

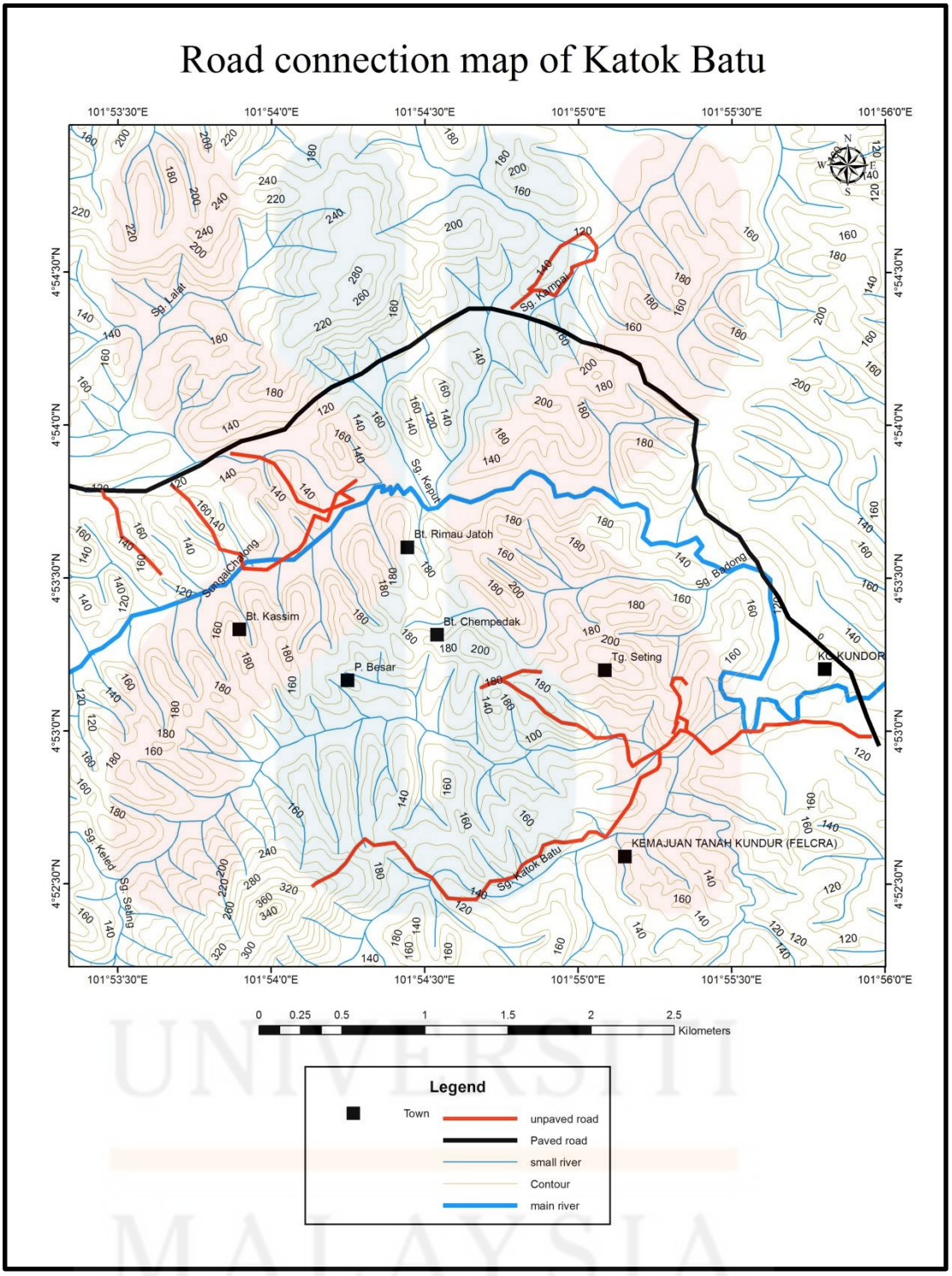

Figure 1.11 Road connection map

1.5 Scope of study

The scope of study at this study area is to produce a geological map at the Katok Batu by field work. The field work geological mapping is focused on making

traverse at the study area with the total area of 25 km². Besides that, the study of gold occurrences is more focused by taking sediment from the river stream which then followed by the laboratory analysis. The study of other heavy metal is not conducted as it beyond from the scope of study. Furthermore, the scope of study is to know the petrography of the study area. The petrography investigation can be done by taking hand specimen and making thin section which then can be observed under the microscope. Lastly, the concentration of mineral pyrite can help to know the source of the gold and can be completed by taking randomly stream sampling at different location within the study area.

1.6 Research importance

The importance of the research is to provide the accurate geology information and geological maps of Katok Batu. This can be achieved by conducting a mapping at the study area and also by making field observation or field sampling to obtain the data. However, the study is more focuses on the general geology of Katok Batu and the gold occurrences. Furthermore, it is also important to construct the geological map and topographic map to the update the road connection, building and lithology at the study area. Next, the study of occurrences of gold deposit, petrography and structural analysis at Katok Batu, Gua Musang can help to describe the distribution of gold, composition of rocks and the structural presence which causes the gold to be deposited. For future use, the study of occurrences of gold deposit at Katok Batu can be useful for mining exploration and also to any related geoscience course.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter it will explain about the previous study or research that have been conducted in which correlated with the research that will be conducted. By doing the literature review it can give more information based on the sampling, fieldwork, laboratory analysis and also the best method that is used to conduct research. This chapter can clear all question about the research in which we were confusing. The previous research also can help to give data that cannot be done such as the data of lithology and age of the formation. Occasionally the information provided can give signs to the local condition, including data on the topographies to be encountered and even the types of rocks to be met with. At this chapter it will cover the regional geology and tectonic setting, historical geology, petrography, and gold.

2.2 Geological review

2.2.1 Regional geology and tectonic setting

Kelantan is located in the north-east of Peninsular Malaysia. Titiwangsa Mountains, a mountain range running from north to south through the peninsula has separated Kelantan from the rest of the country. Latitude and longitude of Kelantan respectively spread from $4^{O}33'$ N to 6^{O} 14' N and $101^{O}20'$ E to 102^{O} 41' E respectively. Peninsular Malaysia is positioned on two tectonics-stratigraphic continental terrains, namely the Sibumasu and East Malaya terrain (Jasmi Hafiz Abdul Aziz et Al., 2015). There are many forms of major rock can be found in Kelantan that is unconsolidated sediment, sedimentary and metasedimentary rocks, extrusive rock and also granitic rock. Minor granitic rocks are also established in the

Central Belt. The three belts are the Western Belt, the Central Belt and the Eastern Belt. Because of their dissimilar mode of mineralization, the three belts are also called Western Tin Belt, Central Gold Belt and Eastern Tin Belt, respectively. The Central Belt consists mainly of Permo-Triassic, low-grade metasedimentary rocks, deep to shallow marine clastic rocks and limestone, and widespread volcanic and plutonic rocks (Richardson, 1939; Proctor, 1972; Gobbett and Hutchison, 1973; Leman, 1994, Metcalfe, 2002). Acid and intermediate intrusive rocks were emplaced east and parallel to Raub-Bentong Suture. Batholiths in the Eastern Belt are smaller than those of Sibumasu, but are, in comparison, compositionally expanded. The Jurassic-Late Cretaceous batholiths, dominantly monzogranitic suite are of I-type affinity and carry both precious metal and base metal mineralization. Seting granite, Stong igneous complex and Mahang Granite are the major granite intrusives in Kelantan.

2.2.2 Historical Geology

Palaeozoic Stratigraphy outcrop cover about 25% over the peninsula. In Western Belt, Lower Palaeozoic rocks are limited to the western part of the peninsula, whereas Upper Palaeozoic rocks are found in all three belts. Palaeozoic rocks of the rest of the Western Belt are distributed in the foothills along both side of the Main Range granite batholith extending from the Malaysian-Thai border southwards to Malacca. Furthermore, at the Central Belt it lengthy from Kelantan to Johor between the eastern foothills of the Main Range, the western boundary and eastern boundary divided by the Lebir Fault in the north down to the western boundary of the Dohol Formation in the south (Hutchison & Tan, 2009). 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. The Taku

Schist of anomalous high grade metamorphic lithology, and probable Permian age, is also included among the Palaeozoic rocks of the belt. Argillaceous strata and volcanic rocks are predominantly at the Upper Palaeozoic rocks. Eastern Belt Palaeozoic sediments of predominantly Carboniferous to Permian age are dispersed from east Kelantan through Terengganu (Peng, 2004). Taku Schist Formation gains its name from the river Sungai Taku that is located in central east Kelantan (Hutchinson, 1977). It is expanded from the Thai border near Tanah Merah to central east Kelantan near Manik urai. The age of Taku Schist in unknown, but believed to be Permo-Triassic at the edge near to where Limestone Bodies. Core of the Schist outcrop might be older than outside.

Mesozoic era, a large part of the newly-formed landmass of the Peninsula was elevated and continued sub aerially visible. (Hutchinson, 1977) tells that the Peninsula has given its present form during the Mesozoic era. Central Belt is dominant in Mesozoic that form continuous north- south Belt the Gua Musang Formation in the north and Singapore in the south.

Cenozoic sedimentary rock occur both onshore, mainly along the West Coast and offshore in the straits of Malaccca and the South China Sea. Quarternary sedimentary deposit represent as dominant is Cenozoic (Wan Hasiah Abdullah et al., 2005). It covers part of north Kelantan that consist extensively of unconsolidated to semi-consolidated boulders.

2.2.3 Petrography

Petrography is the science dealing with description, classification, modes of occurrence, and theories of the ancestries of rocks (Anthony R. Philpotts & J.Ague, 2009). Its emphasis is commonly chemical and mineralogical. Its tools range from

the simple hammer and hand lens, to sophisticated devices such as the electron microprobe. Its aim is to offer an understanding of the great diversity of rocks found on the surface of the earth and to provide insight into the nature of those materials within the earth that are not accessible to direct observation but play such important roles in the earth's history.

Petrologic studies fall into two general categories that are the identification and classification of rocks, and the interpretation of these data and the generation of theories on the origin of rocks. Petrology is also known as the subdivision of geology that deals with the origin, structure and composition of rocks (Wayne, 2015). In the nature of things the study is limited to the materials of the accessible crust, although we have in meteorites samples of rocks which must be identical with or analogous to those composing the interior of the earth. The science deals with the modes of occurrence and origin of rocks, and their relations to geologic processes and history (G.W.Tyrrell, 1978). Petrology is thus a essential part of geological science, dealing as it does with the materials the history of which it is the task of geology.

2.3 Research specification review

2.3.1 Gold

Gold is found mainly in the central belt of the peninsular. In the Western Belt, alluvial gold mineralisation occurs in areas close to the foothills of the Main Range. In the Eastern Belt, economic hard rock and alluvial gold deposits have long been known. Field observation and mineralogical studies in the most of the localities indicate that gold present in quartz veins in association with volcanic intrusion and sulphide minerals. Gold mineralisation is structurally controlled and accompanied by intensive wall-rock alteration (Hutchison & Tan, 2009). The formation depth for gold

mineralisation in central belt ranges from 100-700 m. At the central gold belt, the mineralisation takes the form of veins striking 345^{O} to 360^{O}, reefs and lodes in strongly to moderately metamorphosed sediments. In terms of past and present gold is significant at the central belt. The Central Gold Belt is a highly prospective region for gold with a variety of mineralization types and has a long history of widespread small-scale alluvial gold mining throughout Peninsular Malaysia (Bin Li et al., 2014). Due to the Central Gold Belt's tectonic and geologic setting the gold deposits in the Central Gold Belt were categorized as mesothermal lode types and orogenic deposits (Ariffin, 2012). These deposits are associated with an accretionary or a continental margin setting and post-diagenetic deformation and metamorphism to the east of the Raub–Bentong Suture (Makoundi et al., 2014).

The gold mineralization consists of abundant quartz–carbonate veins and surrounding pervasive hydrothermal alteration that is the gold occurs both in veins and disseminated in the altered host rocks and was accompanied by extensive deformation, metamorphism, and magmatic events that created a favourable environment for the source and trap of the gold (Ariffin, 2012). These characteristics are similar to orogeny gold deposits (Goldfarb et al., 2001). Orogeny gold deposits are divided into mesozonal and epizonal mineralisation on the basis of the depth and temperature of gold deposition. Mineralisation is associated with the late stages of regional deformation or in periods of reactivation of older structures.

2.3.2 Flame atomic absorbtion

Flame atomic absorbtion is the quantitative determination in which a metal or metals are separated from impurities by combination processes and analyse in order to determine the amount present in the original sample. Flame atomic absorbtion in

chemical analysis, process of determining proportions of metal, particularly precious metal, in ores and metallurgical products. Metals recovered in flame atomic absorbtion are the metals that emerge from the fusion of the material in an furnace, for gold, usually at temperatures of about 750^{O}C. Furnace method is centuries old, but it is still one of the most reliable methods for performing analysis to determine the metal content of ores that contain precious or noble metals such as gold, silver and platinum. The method of choice for gold analysis through time has been flame atomic absorbtion.

CHAPTER 3

MATERIAL AND METHODOLOGY

3.1 Introduction

In this chapter it will discuss the flow of the material and method that is used to complete the research. This chapter is important to give guidance in doing the procedure to get the result of the research. The method that is use including geological mapping, field study, sampling, laboratory investigation, data analysis and interpretations. Finally, the result and discussion will be written in the report to save the information. This chapter also will explain about the method that will be used in conducting the research for a period of time. The method will involve in the field and also in the laboratory.

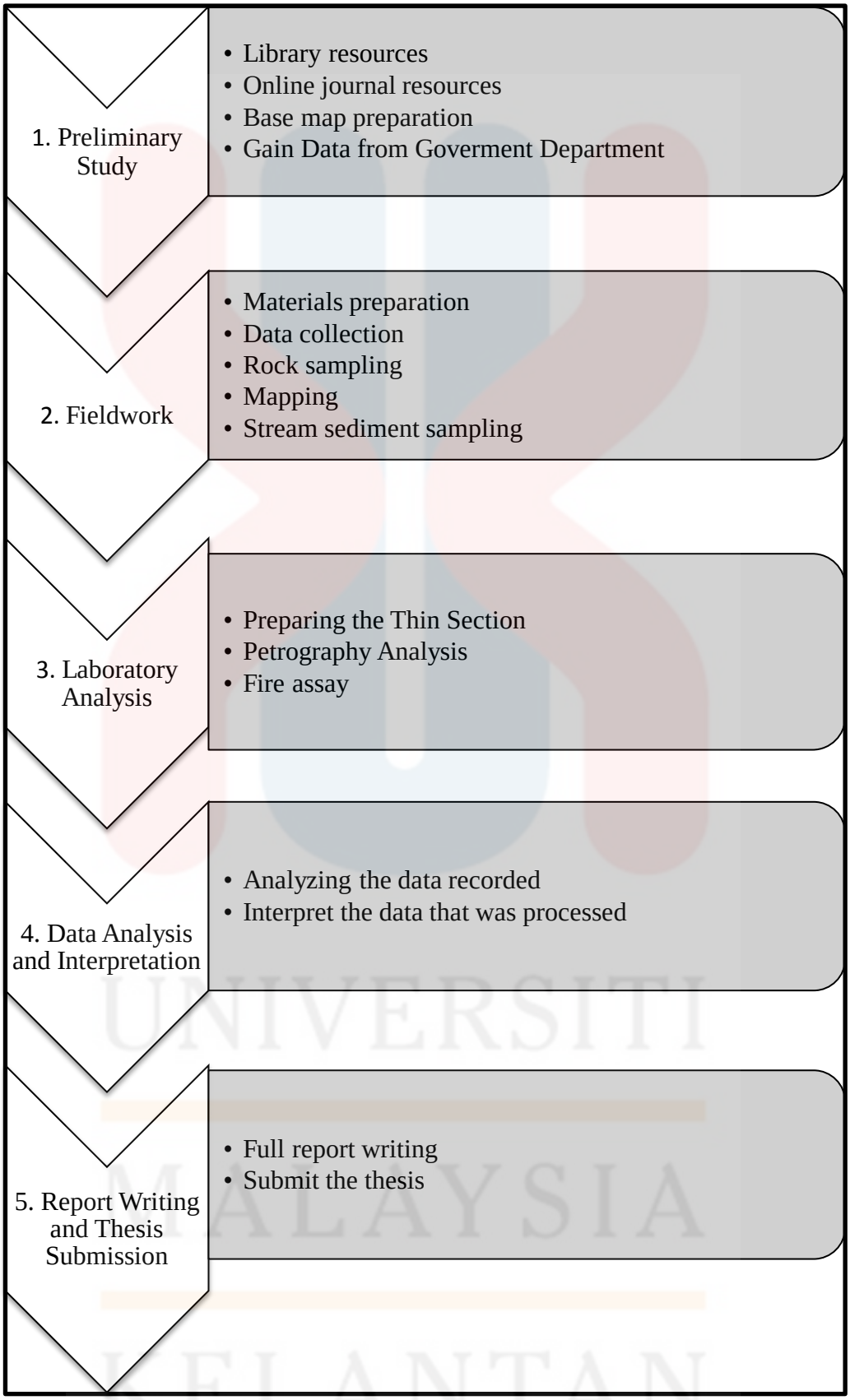

Figure 3.1 Flow Chart

3.2 Preliminary study

The research is focuses on the study area to obtain information in terms of literature review based on the past studies. The study needs to be related with the research or location in which will be conducted. Based on the past studies, the method chosen must be accurate. The data of the research area need to be obtaining such as information about land use, lithology, petrography, mapping, and geography of the area. It can be referred by many sources such as from library, internet and also base map.

3.3 Material and method

The material that is used in this research including the mapping equipment such as geological hammer, hand lenses, global positioning system (GPS Garmin), measuring tape, HCL solution, compass and maps. Next, for the method that will be used in the field is fieldwork and sampling. Furthermore, for the lab activity for petrography study the equipment that will be use is the reflected light microscope and thin section machine.

3.3.1 Geological hammer

The hallmark of a geologist in the field geological hammer to collects rock, mineral and fossil specimens and samples. A geologist's hammer is a hammer used for splitting and breaking rocks. In field geology, they are used to obtain a fresh surface of a rock to determine its composition, nature, mineralogy, history, and field estimate of rock strength. Geologist's hammers are also sometimes used for scale in a photograph. Pointed-Tip Hammers is also known as "rock picks". The pointed-tip hammer is useful in dislodging fossils, minerals and splitting rocks. These are most often used by geologists working in areas of igneous and metamorphic rocks. Chisel-

Tip Hammers is also known as "soft- rock hammers". They are most often used by geologists working in sedimentary rock areas. The length of the handle is generally 25 cm to 30 cm whereas a longer handle of 40 cm to 50 cm is required for breaking samples from outcrops where a wide swing provides the momentum, important to generate the required forces. Although the use of hammer does not require any special training, certain precautions make it safety. There is always the possibility the rock chips flying off so as a precaution wear goggles.

3.3.2 Hand lens

A pocket magnifying lens of 10 times power is generally sufficient for most observation in the field. Lenses of two or three different magnifying powers may be used for more detailed observations. To use hand lens is by hold it as close to the eye as possible and slowly bring the specimen closer until it is in proper focus. Hand lens can help to see the micro mineral or structure that cannot be seen by rough eyes.

3.3.3 Global positioning system (GPS)

The Global Positioning System (GPS) is a satellite-based navigation system. Since the GPS provides location data based on latitude and longitude or regional metric grid coordinates, it is of most value for fixing position or navigating on a published map sheet on which these coordinates are marked (Marjoribanks, 2010). GPS offers cost savings by drastically reducing setup time at the survey site and providing incredible accuracy. It can be projected into ArcGIS that can show the traverse and mark reading.

3.3.4 Hydrochloric acid (HCL)

Hydrochloric acid (HCL) is use for the acid test that means the dropping of 5% to 10% concentration hydrochloric acid onto the rock to determine whether it is contain the calcite mineral or not. It is becomes necessary when calcareous rocks need to be studied in the field. Before applying acid, clean the surface of the rock thoroughly to prevent falsification of the result. If there is vigorous bubble happen, it indicates that the rock is containing the calcite mineral such as limestone and marble.

3.3.5 Compass

It is an instrument for indicating horizontal directions relative to the earth by means of a magnetic needle that swings freely on a pivot to the magnetic North. Compass is used for measuring angles of slopes, elevation or inclination. It also can use to take dip and strike reading. It is widely used to make accurate degree and angle measurements in the field. There are two types of compass that is Brunton compass and Suunto compass. Certain precautions need to be taken while using a compass. It is obvious that a compass cannot give correct readings in locations where highly magnetic iron minerals are present.

3.3.6 Measuring tape

Measuring tape is important if distances are to be measured. The tape is held taut on the ground for correct measurement. It is very useful for the measurement of small features, like inclusions, megacrysts, bed thicknesses, sedimentary structures, veins and soon.

3.3.7 Reflected light microscope

Reflected light microscopy is often referred to as metallurgical microscopy, and is the method of choice for fluorescence and for imaging specimens that remain opaque even when ground to a thickness of 30 microns. The range of specimens falling into this category is enormous and includes most metals and ores.

3.3.8 Map

This is the most important material in conducting the research because it can show the general geology of the area. There are two types of map that will be used in conducting the research that is the topographic map and geological map. Topographic map is a map that visual the contour line of elevation on the earth surface. We can obtain it from the previous research journal and also from the Jabatan Pemetaan Negara. Topographic maps are essential for all types of geological work. Next, the geological map is a graphical presentation of geological observations and interpretations on a horizontal surface (Marjoribanks, 2010). It is maps that represent the geography of the area such as the fault, slope failure, folding, outcrop, and also type of rock. The latitude and longitude are the two coordinates marked on the maps and are used as reference points for the location of every object on the earth's surface.

3.4 Fieldwork

The fieldwork will be conducting in the research area with boundary of 5 km width X 5 km height with the area of 25 km². Fieldwork can be used for making observations of geology in the field and recording them so that one of the several different types of geological information can be produced. The information recorded must be factual, based on objective of rocks and exposures, and made with an open

mind. Fieldwork and the accurate collection of reliable geological data are essential for an understanding of Earth's processes and environments. Fieldwork also is important to find the outcrop and geological features in the research area. The outcrop and geological features then will be taking photo by using the camera with the object besides it as a scale. Furthermore, fieldwork can mapping the study area hence can produce the updated geological and topographical map of the study area. Besides that, doing fieldwork in the study area can give personal discovery of a great deal of geologic information that they can use to solve geologic problems in the present and in the future.

3.4.1 Sampling

The sampling method are undergoes during the geological mapping or the fieldwork, from there a sample of rock is take from the outcrop that is found. The sample that is taken from the field then is put into the sample bag with the labelling of name of collector, coordinates, sample numbers and type of sample. So that it can avoid from the confusion of the sample. Soft materials can be sampled with a geology hammer or chisel, but there is a danger that the harder bands might be under sampled, and soft, easily collected material oversampled (Marjoribanks, 2010). The pointed-tip hammer is use to break the sample from the outcrop and the sample taken must be the fresh outcrop because the sample that has weathered are not suitable for laboratory and petrography analysis due to the changes in colour and chemical composition.

3.5 Laboratory analysis

Laboratory analysis is important in study about the petrography of the study area. The hand specimen rock sample that has taken from the field then undergo

laboratory analysis to identify mineral content on the rock. To produce a perfect thin section for microscope study, the rock sample also will be cut into thin layer. There are three steps in preparing thin section that is sectioning, grinding and lapping. Sectioning is the step where the rock samples are cut into smaller size and thickness by using the rock cutter machine. Next, grinding is step where the rock that had been cut into smaller size was grinded to get flat and smooth surface. After the flat surface of rock, it was then cemented to the glass slide. Last step in preparing thin section is lapping that is the rock chip that has cemented onto the glass slide is then moved on rotary motion against the glass plate with carborundum powder and water. The process undergoes until the mineral composition can be seen under the microscope.

For laboratory analysis it is conducted at Lubuk Mandi gold mine a company of Angka Alam Sdn Bhd. The flame atomic absorbtion can decide whether to perform a solid or liquid analysis of gold. The solid method is the most often used method as it is important to determine the ppm value or amount of gold to consider the true overall concentration. The liquid method of gold assay is equally as important as solid though, because it helps to determine the concentration of the gold that intend to analyze. Flame atomic absorbtion involves taking a small sample of the sediment and placed it in clay dish before put it in a furnace and it removes all other carbon element. When mix the sample with a fluxing agent, digest it at a high temperature and reduce it, the mixture will then cool leaving the agent at the bottom of the beaker. Next, complete a simple technique that involves using an hydrochloric acid to separate fine gold from the other minerals contained in the sediment sample. Then, dissolve the other base metals with nitric acid and commence analyze the gold. Add additional materials to produce a chemical reaction and determine how much gold exists in the stream sediment sample. Depending on the added chemical that is use,

the sample will turn a range of value that indicate the level of purity. Hallmark the sample to set its value. The quality control process includes applying a standard unit to determine and declare the concentration of the gold sample.

3.6 Data Analyses and Interpretations

The data that is obtained from the fieldwork and in the laboratory are analysed and interpreted. The data analysed and interpretations are consisting of geology data, petrography data, hand specimen analysis and chemistry data. The data analysed and interpretations should correlate with the objective of the research.

3.7 Report Writing

Last step in the final year project research is report writing. Report writing is to gather all the result. All new discoveries and results about the research are written into the report. The format of the report should follow the format that had been set by the Faculty. The report covered six chapters that is introduction, literature review, materials and methodologies, general geology, gold occurrences and lastly conclusion and suggestion.

3.8 Flame Atomic Absorbtion analysis

3.8.1 Apparatus used

1) Furnace

2) Precision electronic balance

3) 500 ml beaker

4) Hot plate

5) Test tube

6) Flame Atomic Absorption machine (AAnalyst 200)

7) 25 ml measuring cylinder

8) 50 ml measuring cylinder

9) Pipette

10) Clay dish

11) Dropper

12) Hand glove

13) Lab coat

14) Tray

3.8.2 Material used

1) Superfloc

2) Distilled water

3) 68% Concentrated Hydrochloric acid (HCL) solution

4) 68% Concentrated Nitric acid (HNO_3) solution

5) Diisobutyle ketone (DIBK)

6) The stream sediment sample

3.8.3 Gold analysis

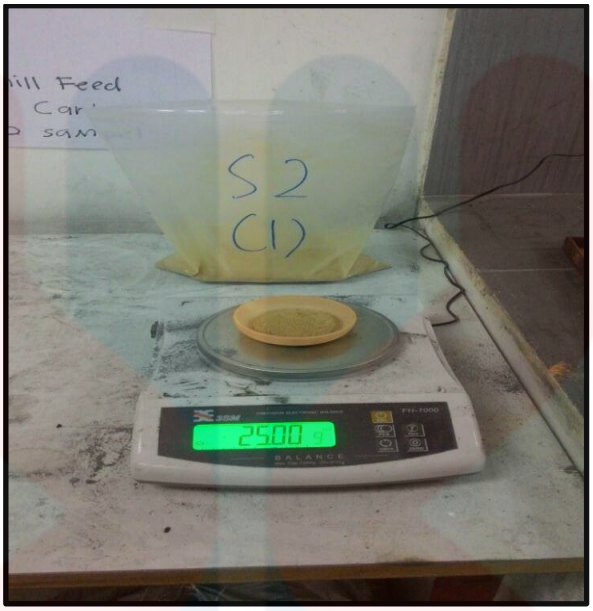

Figure 3.2 Weighing the samples

1) The samples were weighted about 25 gram by using the precision electronic balance that weight it accurately as shown in the figure 3.2. After weighing, the samples is then were placed on the clay dish. The clay dish was then being labelled same as their samples name.

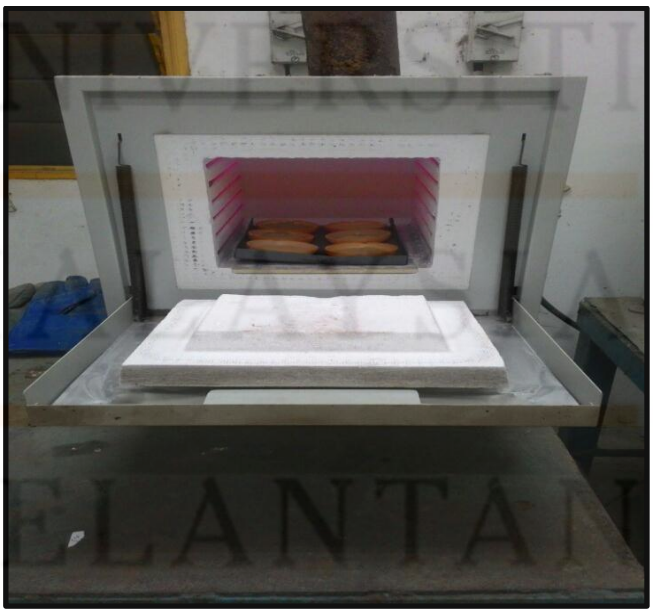

Figure 3.3 The samples inside the furnace

2) Next, the samples is then were placed on the tray which then were putted inside the furnace as shown in figure 3.3. In the furnace the samples were let to burn up to 750^{O} C for 30 minutes. The reason the samples were let to burn is because to destroyed the carbon content in the samples. The carbon can cause false result when being analyse.

Figure 3.4 The samples are transfer to the beaker

3) Furthermore, after 30 minutes inside the furnace the samples were then taken out and were let to cool for a while. After that, the samples were transferred to the 500 ml beaker as shown in figure 3.4.

Figure 3.5 The samples are heat on the hot plate

4) 25 ml 68% concentrated nitric acid and 50 ml 68% hydrochloric acid were added in the sample beakers by using pipette and measured by 50 ml measuring cylinder. Next, the beakers then were placed on the hot plate and were heated up to 90^{O}C for 15 minutes as shown in figure 3.5.

Figure 3.6 The samples are let to cool

5) After the samples were digest by the acid the samples were then is let to cool for a while. Later that the 5 ml Superfloc were added in the beaker but before that the Superfloc need to be brew with the distilled water with the ratio 1000:10.

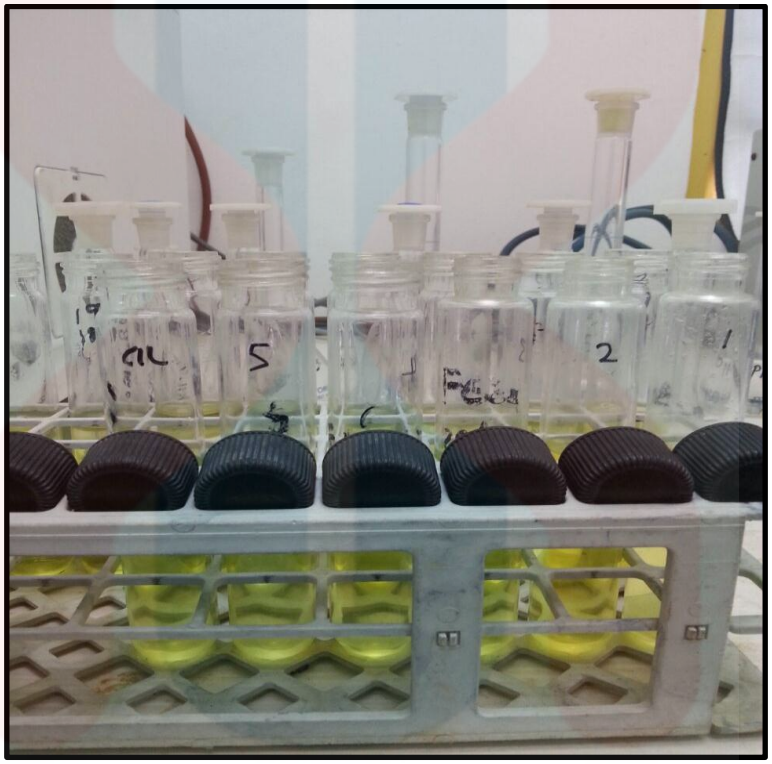

Figure 3.7 The samples in the test tube

6) Next, after mixing the samples with the superfloc, the solution in the beaker is then transferred into the test tube. After that, 5 ml Diisobutyle ketone (DIBK) solutions were added into the test test tube and mixing with the solution. After left the solution for 30 minutes, the precipitation solution will formed at top of the solution.

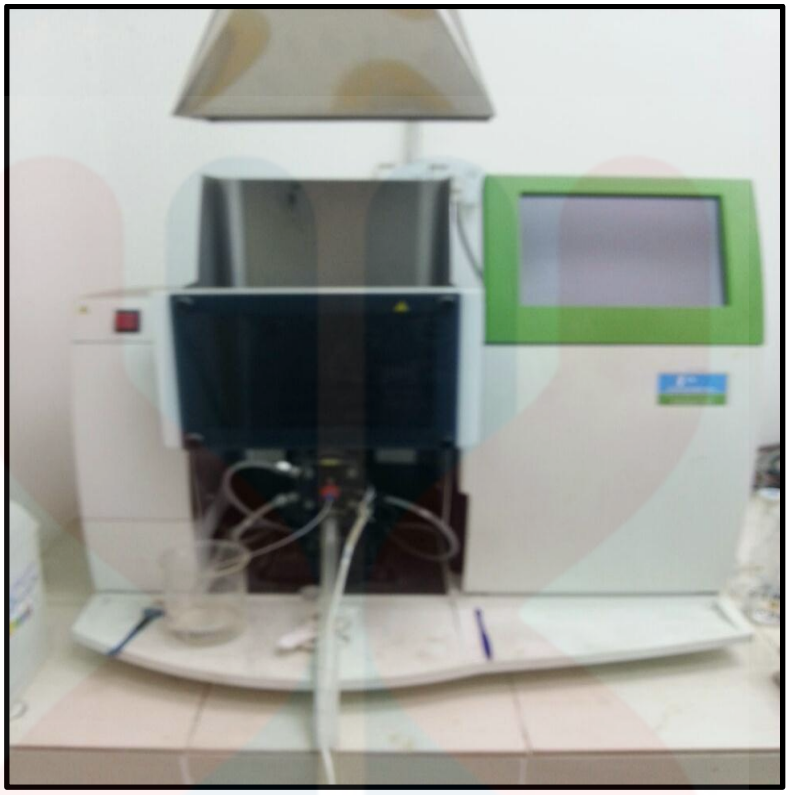

Figure 3.8 Flame Atomic Absorption machine used for sample analysis

7) The precipitation in the test tube solution was then being tested for the result.

Figure 3.9 The results of AAS from 6 samples

8) The gold analysis result was come out on the screen and was recorded.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

In this chapter general geology, it discuss about the geology of the study area. The general geology chapter covers the geomorphology, topography, drainage system, landform, structure geology and also petrography. In a simple word, it covers the geology that present in the study area. It is vital to achieve the information at the field because it can update the geological map as mentioned in research objectives and also might represent valuable pathfinder. The information can be used by the people and the geologist itself for exploration.

Besides that, it is essential to gain the information to relate with the study specification. It is also vital to investigate the geological features such as the stream condition at the study area which help to choose appropriate sampling technique for gold analysis at the study area.

Furthermore, after gain the study area information it is helpful in understanding the geological process at the research area. The information that is gains is such as regional process, weathering process, rock lithology, drainage, landform and structural geology. Lastly, that information can be used by other people either for mining, construction or even agriculture to ensure the people about the land condition and value in the research area.

4.1.1 Traverse

Traverse is the important method in fieldwork mapping. Traverse was conducted for observing and sampling within the research area. During traverse, the

important information needs to be collect is the observation of geomorphology, structural geology, and lithology for the rocks.

In this research, the traverses were conducted for 10 days but not in a row due to limited time available. The traverse was only done during weekend. The traversing at the research area was conducted by walking and riding the motorcycle. Most of the fieldwork traverses were conducted by walking because walking give more time and more scenery to be observed. The more scenes that are observed the more information that can be gathered which can improve the accuracy of data in the report. Traversing by riding the motorcycle also helped a lot because it helps to traverse the hilly area which saves more time.

Next, the traversing were done by followed the unpaved road and the trails that present in the area. There was also the area where the trails need to be created first. Traverses also were done alongside the river to survey the suitable sampling area. Besides that, traversing along the river can observed the outcrop that might present in an area and in explored new thing. As shown in figure 4.3 below, the traversing was mostly cover the hilly area because it represents the landform and geological process in the area. Traversing the highest contour elevation can give the sight view in the study area. The outcrop also mostly located along the hilly area and to confirm the lithology in an area it must be covered.

Furthermore, during traverse there are sand mining conducted at the area as shown in figure 4.1. The present of sand mining indicates that the land has its potential use and value. It also signifies that the deposition of sand at the area is high. There is also hill cutting features at the study area beside the main road as shown in

figure 4.2. The landslide that happened near the road during the monsoon season causes the hill cutting.

Figure 4.1 An accumulate of sand due to sand mining

Figure 4.2 Hill cutting

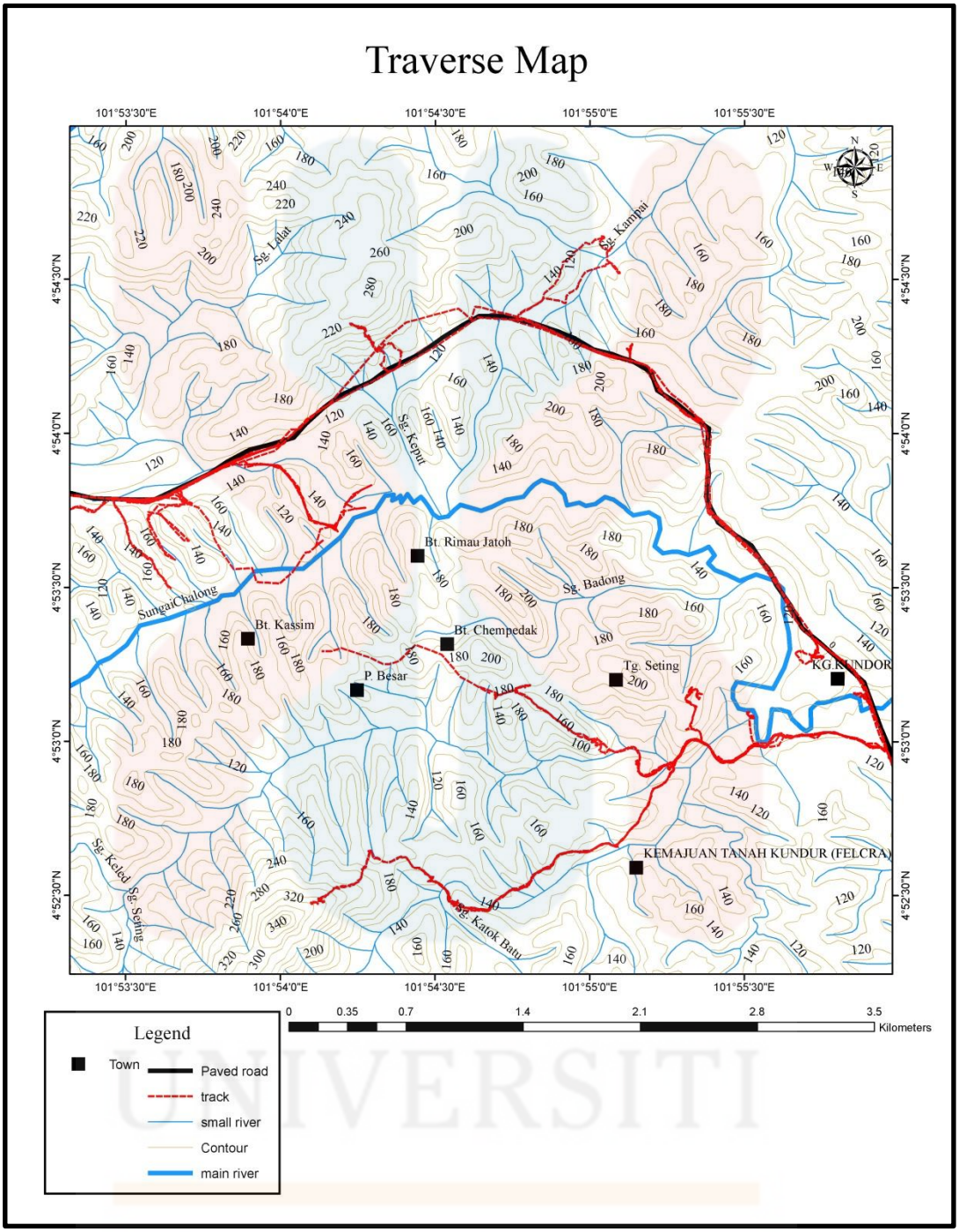

Figure 4.3 Traverse Map

4.2 Geomorphology

Geomorphology is the branch of geology that is concerned with the structure, origin, and development of the topographical features of the earth's surface. The

earth landform may create from the exogenic or endogenic process. Katok Batu is located end of the main range towards the southwest. As it goes towards the Main Range the elevation is increasing due to the mountainous area as shown in figure 4.8.

At the study area, it is mainly composed of hilly environment. It is formed after the formation of land which then been deposited with sediment due to wind or water. This is because landforms are produced by erosion or deposition, as rock and sediment is worn away by these earth-surface processes and transported and deposited to different localities. This is the evidence of the exogenic processes. However, there is also hill feature that represent the intrusion of the magma as the lithology and the elevation were the evidence to it such as the intrusive rock that were found on top of the hill as shown in figure 4.6. Besides that, the different climatic environments produce different suites of landforms. As in Gua Musang the climate is favour to the weathering environment. That is the reason for the present of many rivers within the study area. The river acts as an erosion agent for the deposition process alongside the river. Furthermore, at the Katok Batu the land mostly were used by the villagers for plantation and agriculture as can be seen in figure 4.5. Reserve forestry also covers some land in the study area. The population at the study area are low as mentioned at the chapter 1 so the settlement area is low. In other way, earth-surface processes are establishing landforms today, altering the landscape, although often very slowly. Geomorphological principles can be practical to all environments either aeolian geomorphology or volcanic and tectonic geomorphology.

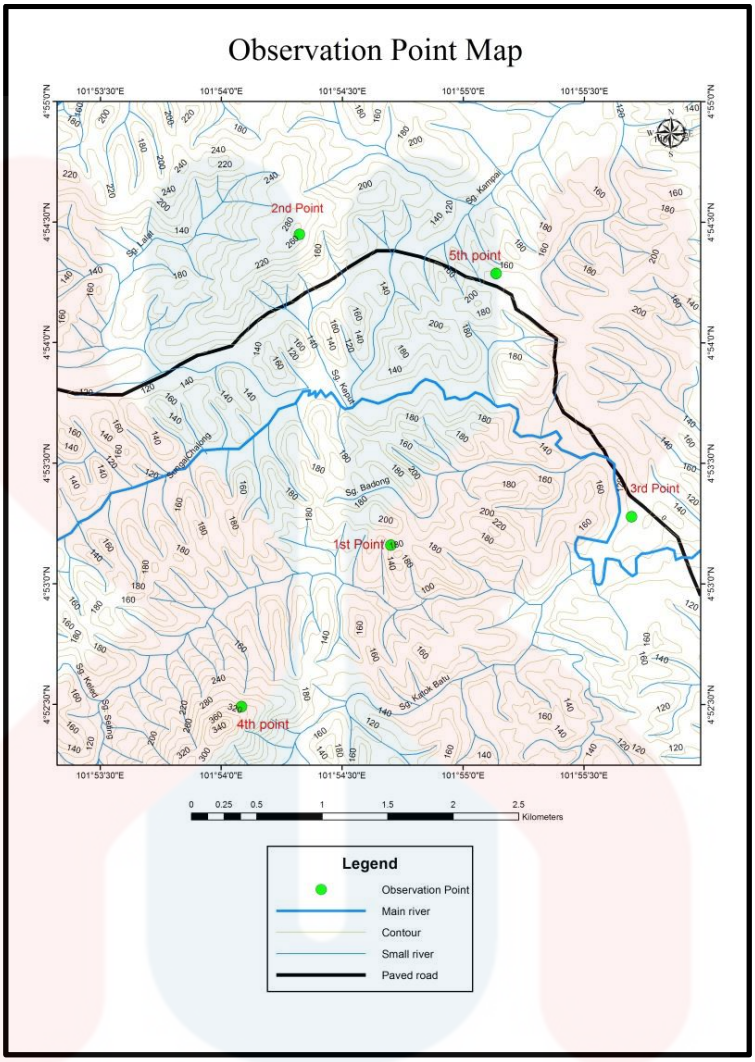

Figure 4.4 Geomorphology Map

Based on Figure 4.4:

Figure 4. 5 First observation point

Figure 4.6 Second observation point

Figure 4.7 Third observation point

Figure 4. 8 Forth observation point

Figure 4.9 fifth observation points

4.2.1 Topography

Topography is a detailed feature at the surface of the earth land. Topography is divided into two features that are natural and artificial features. The natural features are topographies that are happen naturally due to earth process. It includes the mountains, hills, creeks, river and other bumps and lumps on a certain surface of

the earth. The artificial features are the topographies that are created by human or accidentally. The detailed structures are village, plantation and road. These features can be seen in the topographic map as shown in the figure 4.10.

There are many topographic features that covered the 25 km² study area. First topographic features are the elevation. Based on figure 4.11 the 3D topographic map, the elevation at the study area is between ranges 20 metres to 340 metres. Highest contour elevation in the research area is 340 metres and the reason is due to the intrusion of acid intrusive at the area which causes it to be uplifted. Another uplifted area that is causes by the intrusion of acid intrusive has 240 metres elevation. Usually the higher contour elevation indicates that there is intrusion of acid intrusive. Another indication for intrusion is that those high contour elevations mostly have steep slope for its contour as can be seen on figure 4.12 slope map. The karst hill also has higher elevation. The different is that the karst hill usually have very steep slope or does not have slope at all because it form straight upward and its contour area is smaller than intrusion of acid intrusive. However, in the research area no karst hill is present.

Next, the topographic features at the study area are hill. There is slope hill and smooth hill within the study area. The hill at the study area is characterized the last subclass hill because it elevation is less than 600 metres. Besides that, the hill at the study area has low percentage of steep slope and low altitude which can be seen on figure 4.12. The V-shaped valley also infrequent. The form are irregular but is considered as an undulating topography.

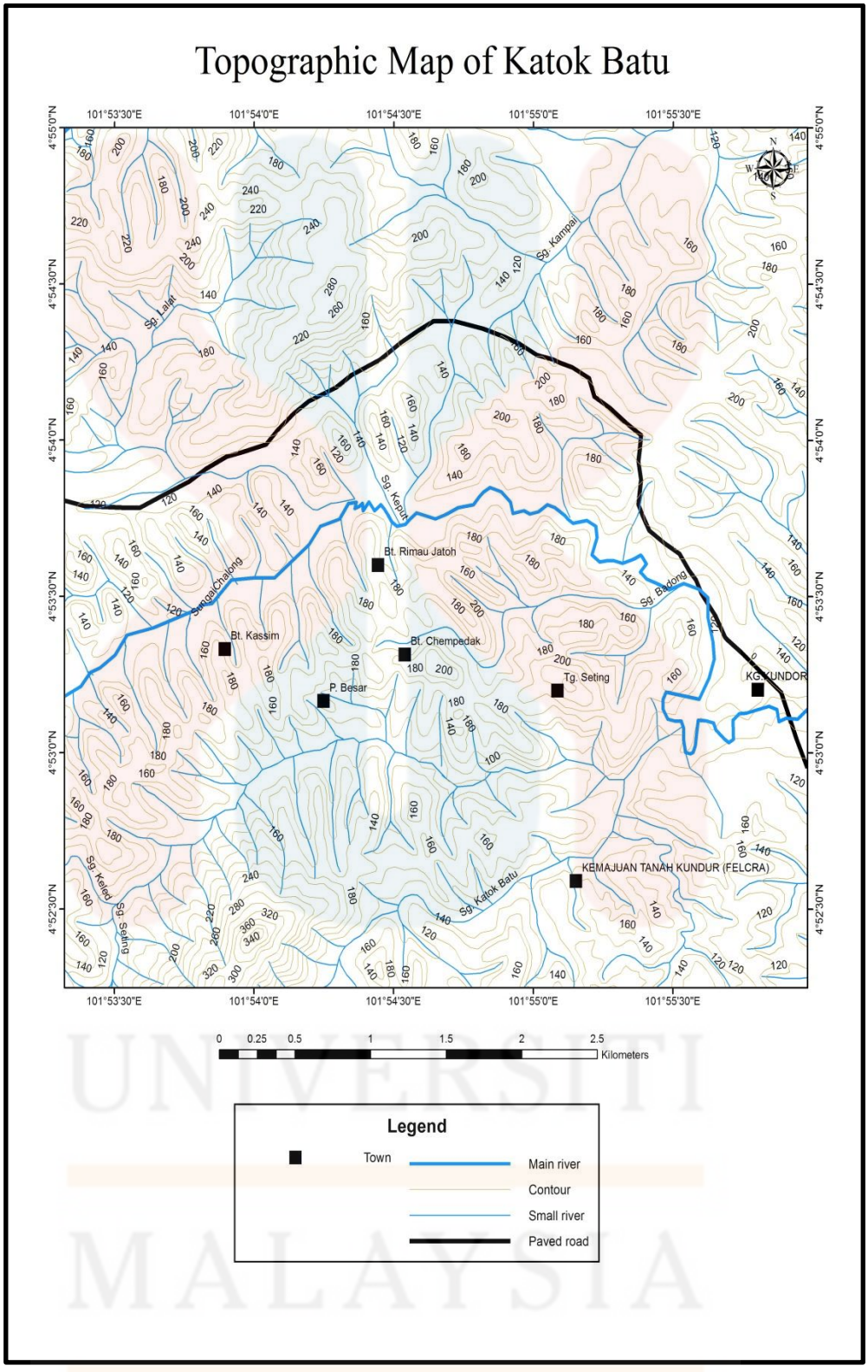

Figure 4.10 Topographic map of Katok Batu, Gua Musang.

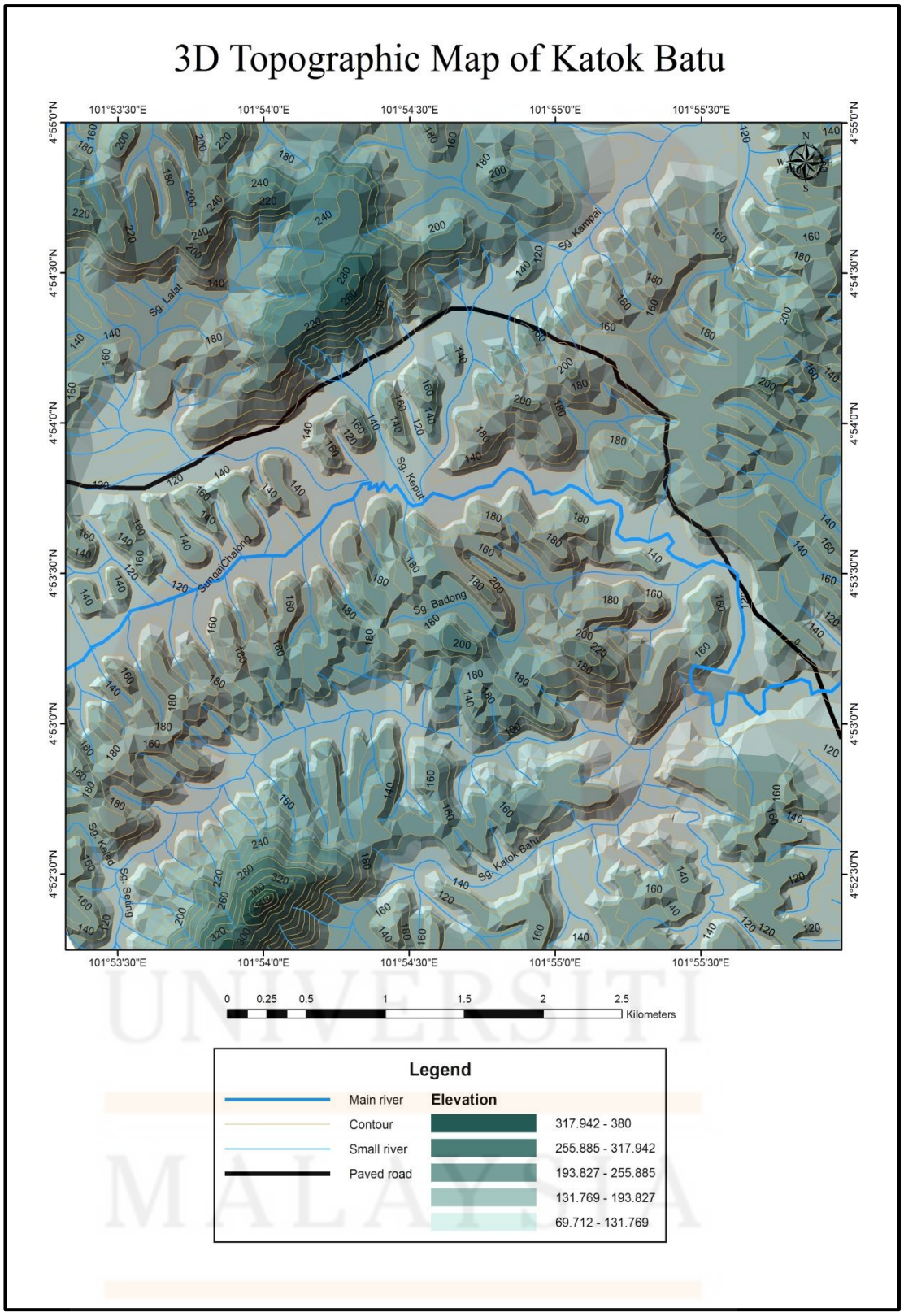

Figure 4.11 3D Topographic map

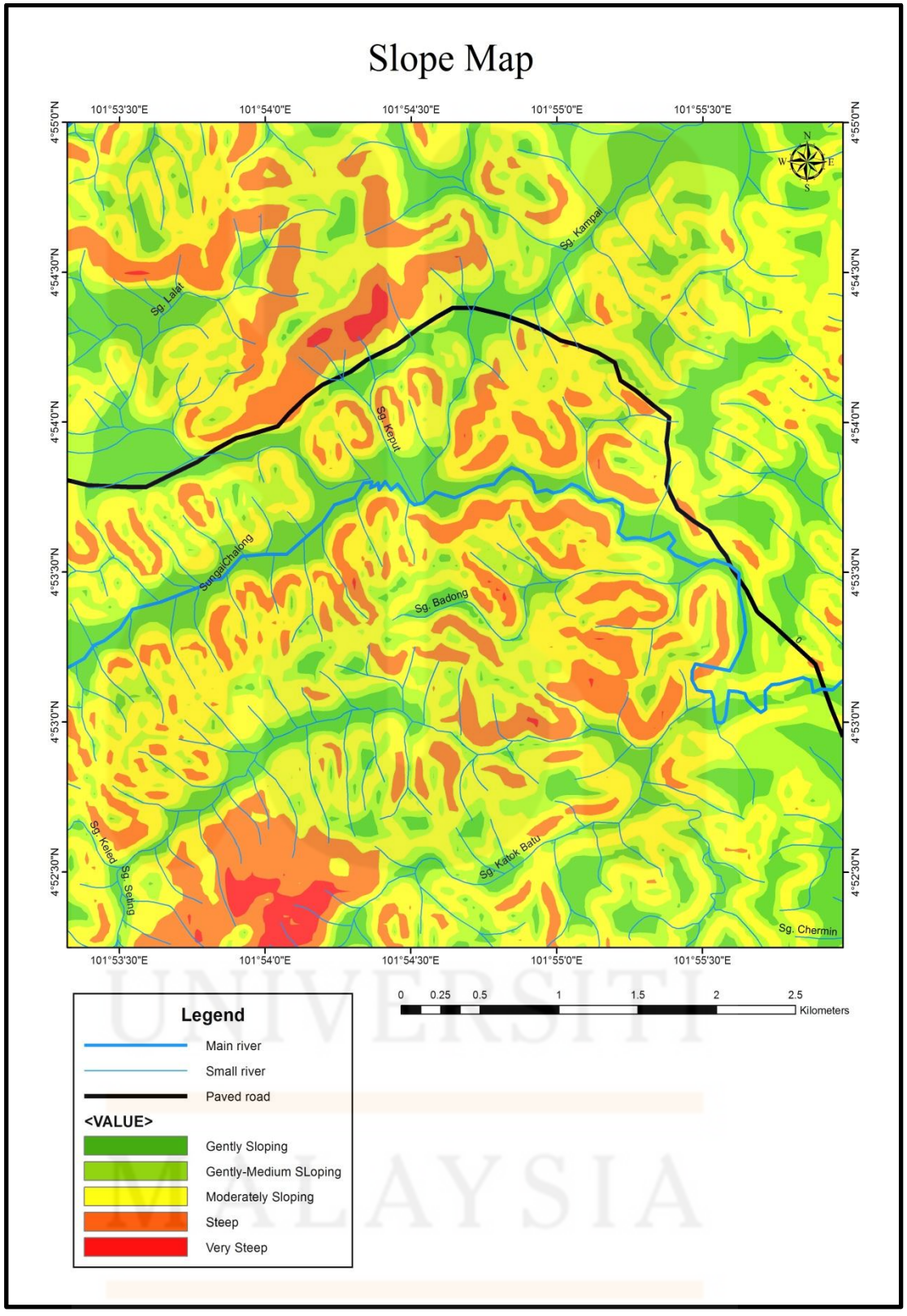

Figure 4.12 Slope Map

4.2.2 Drainage pattern

The watercourses, rivers, and lakes in a certain drainage basis shaped the drainage pattern. The topography of the land controlled it that is the hard or soft rocks dominated at a certain region and the slope of the land. The hard rock are basically the rock such as igneous rock or metamorphic rock whereas the soft rock are composed of sedimentary rock. The hard rock is commonly found at the higher elevation whereas soft rock is commonly found at the lower elevation.

All surface water coming from rain or water meets with another into a single point formed the drainage basin that is known as catchment basin. Hence, forming the river or lake. There are 4 main river located within the study area that is Sungai Kundur, Sungai Chalong, Sungai Lalat and Sungai Katok Batu itself. The rivers at the study area were formed due to the intrusion of acid intrusive that uplifted the ground which then allowed the rain and water basin to be accumulated on the high ground. This is the evidence that the topography of hard rock controlled it pattern has been mentioned before. After that the water followed towards the land gradient which forming the river as can be seen now. At lower elevation the small rivers were connected with each other which will form new and bigger river than the high ground. Thus, formed the new stream order. Besides that, the river is also formed due to the plantation and agriculture activity that present in the study area which new waterways are created for the watering activity to its vegetation. This indicates the exogenic process that present in the study area.

Furthermore, the stream order at the study area are ranging from the first order stream to the forth order stream. The first order stream is the youngest river which has small width and deep. Young river also has more curves compare to the

mature stream. The third and fourth stream can be considered as the mature stream because of its width and deep are bigger than the young. The mature stream also has more curves due to its forced towards the land. However, in the study area the most stream order is the second order. The evidence is that the river is not too small and not too big as can be shown in figure 4.13 Chalong river compared to the forth stream order Kundur river in figure 4.14. This can determine the rivers age.

Figure 4.13 Chalong river

Figure 4.14 Kundur river

Next, the drainage patterns that are exist in the research area are the dendritic pattern and trellis pattern. Dendritic pattern is a haphazardly formed stream. Dendritic pattern shaped is tree like and consists of many small stream combined branching streams and a main stream as can be seen in figure 4.15. The dendritic pattern widely exists in mostly every stream area. It also was characterized by the similar rocks and impervious. The trellis pattern is an improved version of the dendritic pattern which is characterized in areas of folded rock strata. It is form in V-shaped valley which the main streams are parallel following the low slope and the stream branched coming from the adjacent ridges. The map of drainage pattern below shows the shape of each pattern.

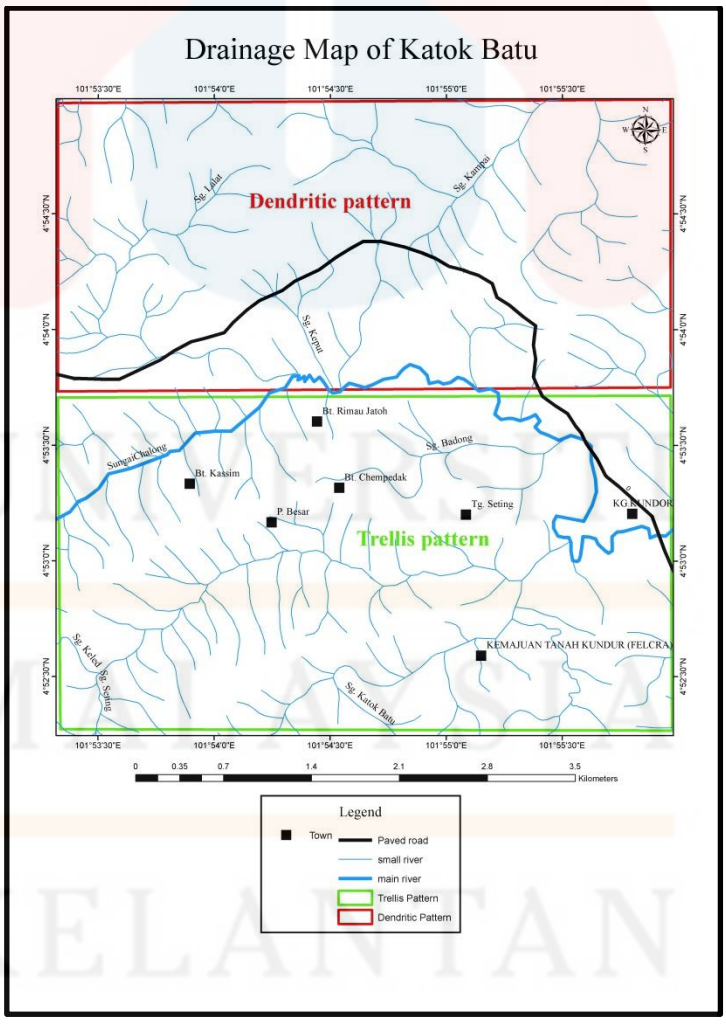

Figure 4.15 Drainage pattern at the study area.

4.2.3 Weathering process

Weathering is the process where rock is dissolved, worn away or broken down into smaller and smaller pieces. There are mechanical, chemical and biological weathering processes. Weathering is influenced by temperature and moisture or climate as the climate at Gua Musang favours to the weathering. During weathering, minerals that were once bound in the rock structure are released. The degree of weathering that occurs depends upon the resistance to weathering of the minerals in the rock, as well as the degree of the mechanical, chemical, and organic stresses. The minerals in rocks that are formed under high temperature and pressure tend to be less resistant to weathering, while minerals formed at low temperature and pressure are more resistant to weathering. Weathering is usually confined to the top few meters of geologic material, because mechanical, chemical, and biological stresses generally decrease with depth. Weathering of rocks occurs in place, but the disintegrated weathering products can be carried by water, wind, or gravity to another location.

Biological weathering happens when plants break up rocks with their growing roots or plant acids help dissolve rock. As shown figure 4.16.

Figure 4.16 Biological weathering of sandstone

Next, the mechanical weathering physically breaks up rock. One example is called frost action or frost shattering. Water gets into cracks and joints in bedrock. When the water freezes it expands and the cracks are opened a little wider. Over time pieces of rock can split off a rock face and big boulders are broken into smaller rocks and gravel. This can be seen in figure 4.17 the deformed shale.

Figure 4.17 Deformed sedimentary rock

Furthermore, chemical weathering is caused by rain water reacting with the mineral grains in rocks to form new minerals and soluble salts. These reactions occur particularly when the water is slightly acidic. These chemical processes need water, and occur more rapidly at higher temperature, so warm, damp climates like at Katok Batu are favour. Chemical weathering especially hydrolysis and oxidation is the first stage in the production of soils. There are three types of chemical weathering that is firstly solution. Solution is the removal of rock in solution by acidic rainwater. In particular, limestone is weathered by rainwater containing dissolved carbon dioxide

and this process is sometimes called carbonation. Secondly, hydrolysis is the breakdown of rock by acidic water to produce clay and soluble salts. Thirdly, oxidation is the breakdown of rock by oxygen and water, often giving iron-rich rocks a rusty-coloured weathered surface. This can be seen in figure 4.18 the chemical weathering to limestone.

Figure 4.18 Chemical weathering of limestone

4.3 Stratigraphy

Stratigraphy is the study of rock lithology or sediment that helps in determines the type of lithology. By conducting the fieldwork mapping and traverse through the study area, lot of information about the study area lithology were acquired. This includes the sampling of rock, type of lithology and the outcrop locality in the study area. After that, the geological map can be constructed.

The data collection about the lithology at the study area is significant as it can indicate the geological process that happened in the area which is can be related with the gold deposition at the Katok Batu. Besides that, the rock distribution in the study area can help in knowing the suitable sampling area because the metal element is related with the rock distribution. Furthermore, the information about the age of lithology can be obtained as it can be projected through the stratigraphy column. The lithology age give information on know the process sequence and the rock sequence happened in the study area. Other than that, the stratigraphy is important as the rocks or minerals might represent valuable information about the study area.

During fieldwork it is vital to determine type and name of the outcrop present in the area to prevent confusion in the future. However, to distinguish it more detail, the petrographic is needed to be conducted. The petrography help in mineral identification by observed it through the microscope as by naked eye the outcrop all looks the same. If the other rock sample has different mineral composition hence the outcrop is different.

4.3.1 Outcrop

1) Granite

Figure 4.19 Massive granite outcrop

For the outcrop granite in the figure 4.19 the location is 101°55'1.34"E 4°52'59.13"N. At that area the outcrops are located in many places mostly at the rivers. The massive outcrop is exposed that way because of the sand mining at the river. That is why only it exposed massive. Others outcrop present in smaller size like boulders. The reason why the outcrop granite is form at that area is because of the acid intrusive also known as magma that intrude the area which causes its rock, land and river to be altered. The evidence for the intrusion can be seen in figure 4.20. It show that there is massive hill bounded at the east of the Katok Batu. The hill have higher elevation than in the study area and that because the hill is the first place the intrusion of acid intrusive takes place. That is why the hill elevation is more higher. Based on the lithology, the granite are the youngest because the other sedimentary

rock does not altered its mineral composition hence showing that the granite is the youngest as sedimentary is formed first.

Figure 4.20 Acid intrusion hill

Granite hand specimen sample

During fieldwork mapping there is two granite hand specimen collected that were located at coordinate of the first granite is 101°54'11.73"E 4°54'19.50"N as shown in figure 4.21 and the second granite is 101°55'1.34"E 4°52'59.13"N as shown in figure 4.22. The colour of granite for the first locality is blackish grey and its grain size is phaneritic whereas the second locality granite is reddish black granite with the large grain size that is also phaneritic. By naked eyes the mineral that present in first locality granite is mainly composed of quartz and it is clast supported whereas for the second locality granite the mineral composition by naked eyes is composed of hornblende and it is more to clast supported. However, more information about the mineral are discuss in petrographic.

Figure 4.21 Granite first locality

Figure 4.22 Granite second locality

2) Limestone

Figure 4.23 Limestone outcrop

Based on the figure 4.23 the limestone is located at 101°55'13.92"E 4°54'54.67"N. The limestones is quite hard to find because it is cover by bushy. The limestone is deposited at the small river towards North of Katok Batu area. The structure like pinnacle and deformed limestones are the effect of the chemical weathering to the limestone. It is easy to undergoes weathering as it contain mineral caclite that is easy to dissolve with water. The recognition for the limestone is by dropped the Hydrochloric Acid at the fresh area of outcrop limestone and see it produced bubble. Limestones is react with the acid since the calcite mineral present in the limestone. Its mineral calcite also has low hardness in the Moh's hardness scale.

Limestone hand specimen sample

Figure 4.24 Limestone hand specimen

This limestone hand specimen were taken at coordinates 101°55'13.92"E 4°54'54.67"N. The limestone rock is mainly composed of mineral calcite. The limestone is a clastic sedimentary rock as it is formed due to the past marine environment that deposited it then become the limestone. The present of limestone at the study area indicates that the area at the once a shallow marine enviroment. This also indicates that the limestone is more older than the granite outcrop that also present in the study area. The sample has grey colour with the white mineral on the surface called as calcite. Further analysis for the limestones are discuss in petrography.

3) Shale

Figure 4.25 Shale

Shale in figure 4.25 is located at the 101°55'1.40"E 4°52'59.51"N at the sungai Seting. The shale is widely distributed along the river at the study area. The shale sample is hard to took for sampling due to its weak structured that is easily to deformed. The shale grain is very fine grain that is need to be identify its mineral by using the petrographic only. The way to differentiate between the shale and slate is that the shale are deformed like a thin paper that has planar surface where as the slate are deformed like a rock chip and the slate usually have tiny stratified. However the slate hardness is more higher than the shale. That is because the slate is the compacted shale that have stronger bond between grains.

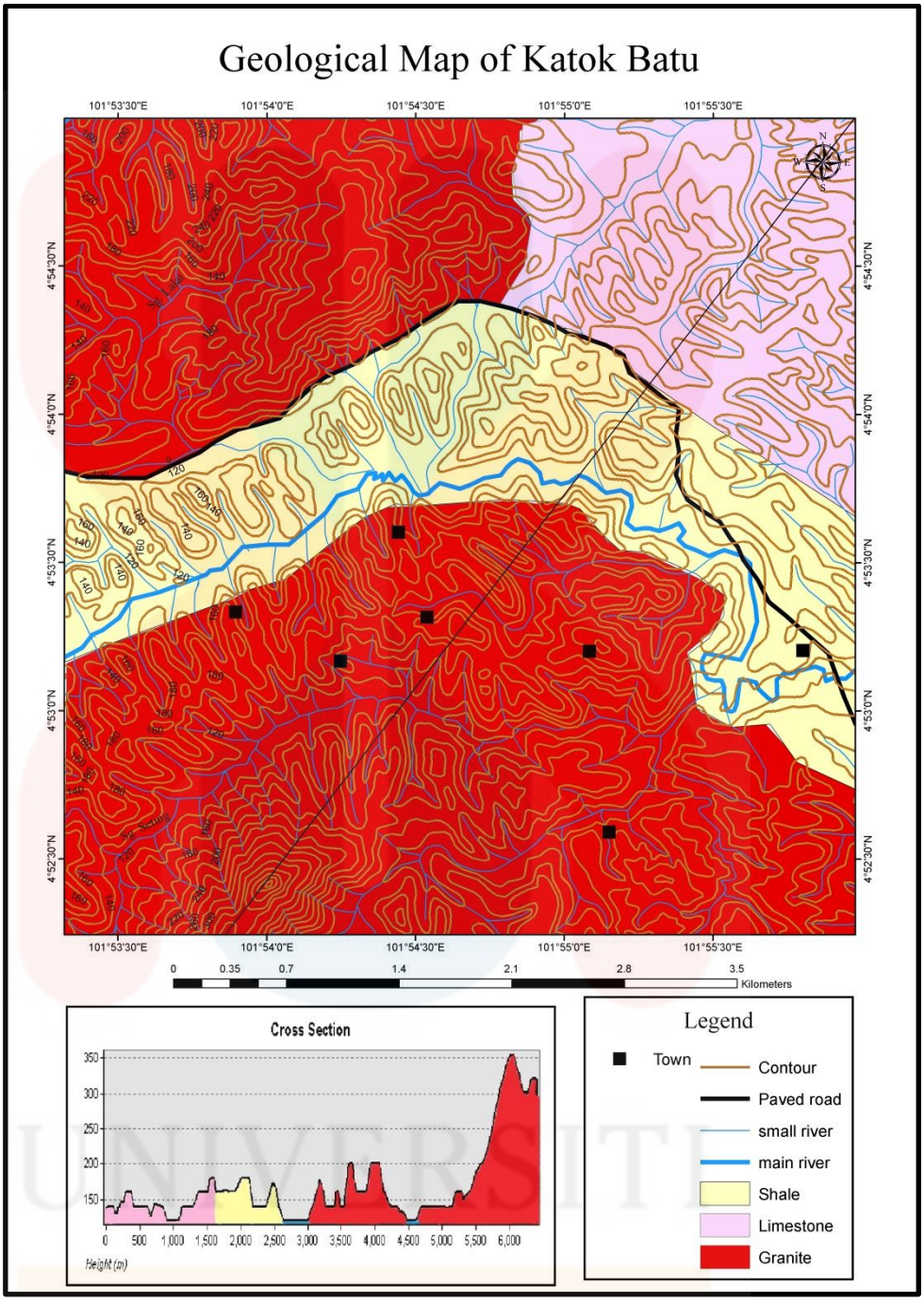

Figure 4.26 Geological Map of Katok Batu

Based on the figure 4.26, it shows that there are two types of rocks that were found in the study area Katok Batu that is igneous rock and Sedimentary Rock. The outcrop that was found is the granite, limestone and shale. The granite is mainly located on the hilly area that has high elevation topography whereas the limestone and shale were located near to the river.

Table 4.1 Stratigraphic Column of Katok Batu

Eon	Era	Period	Lithology	Description
Phanerozoic	Mesozoic	Triassic	Granite	Phanaeritic grain with black greyish colour. Consists of mostly mineral quarz.
	Paleozoic	Permian	Limestone	Fine grain with greyish colour. Mineral content mostly calcite
			Shale	Black colour. Consists of clay and silt.

4.3.2 Petrography analysis

1) Granite first locality. (101°54'11.73"E, 4°54'19.50"N)

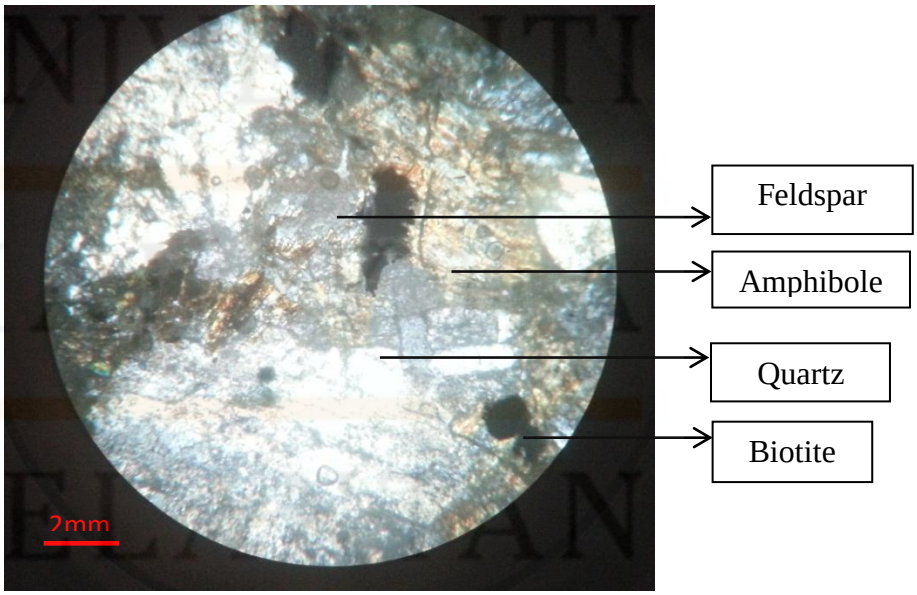

Figure 4.27 Under cross polarized microscope (4x)

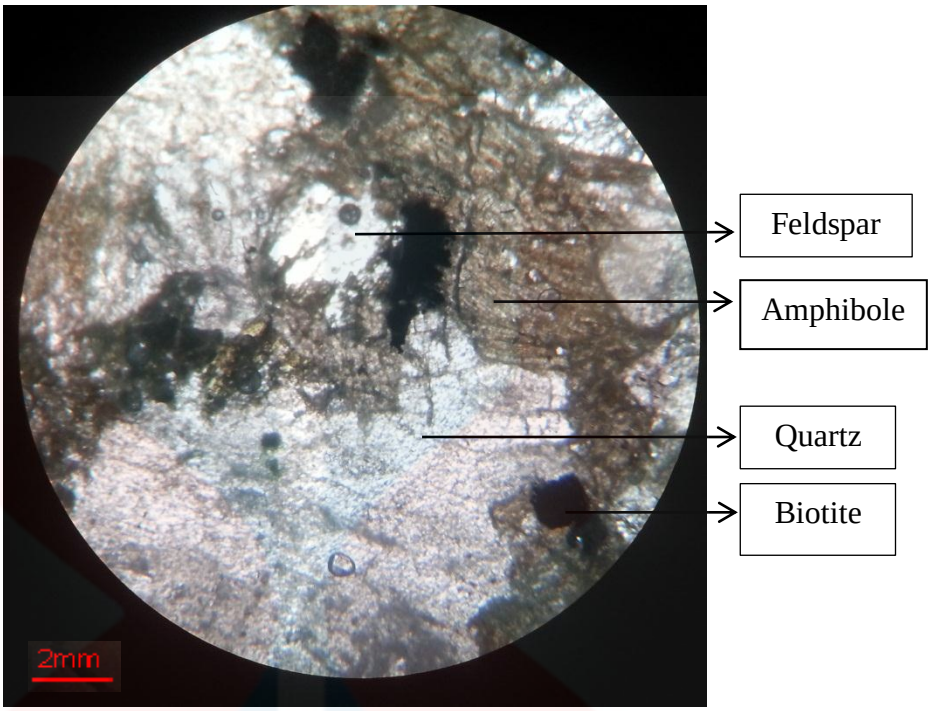

Figure 4.28 Under plane polarized microscope (4x)

2) Granite Second Locality (101°55'1.34"E, 4°52'59.13"N)

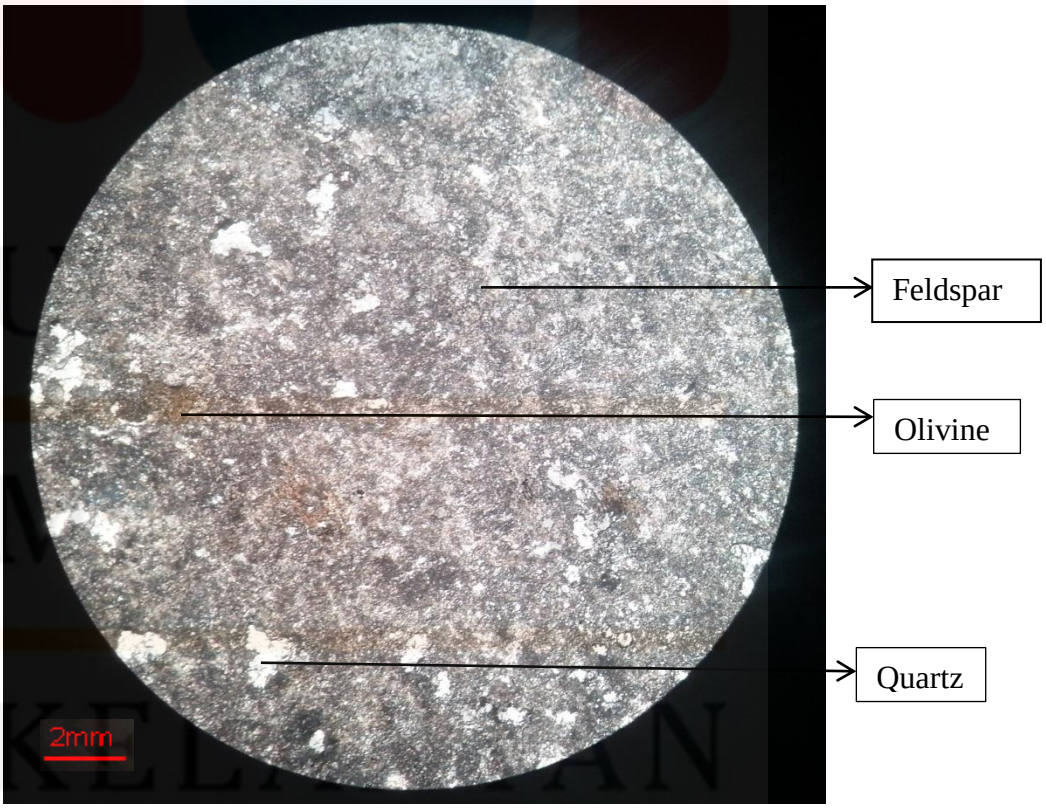

Figure 4.29 Under cross polarized microscope (4x)

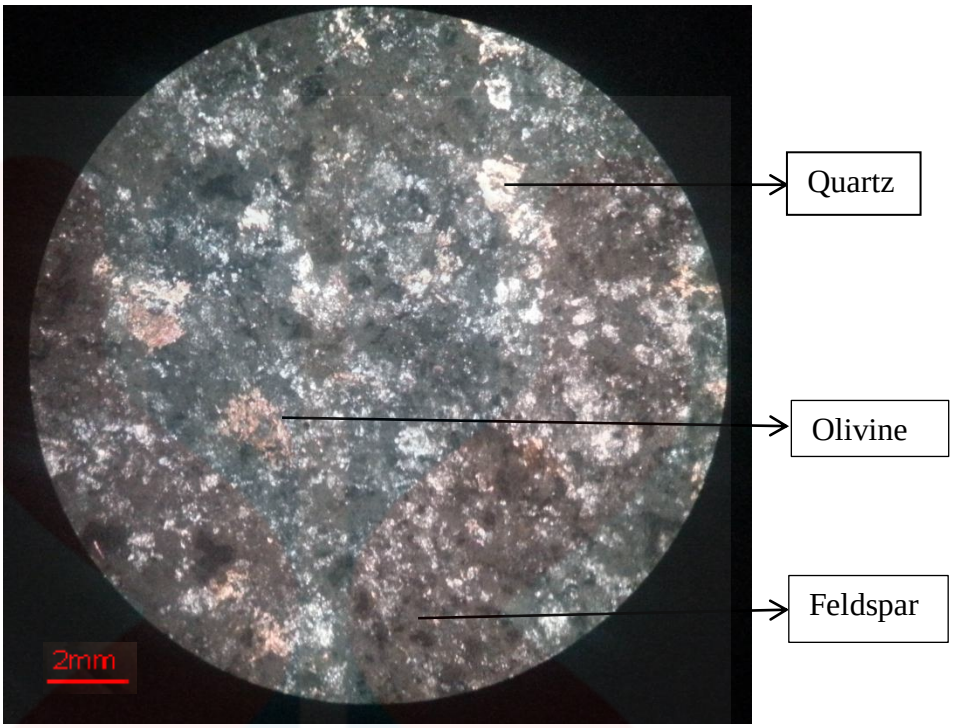

Figure 4.30 Under plane polarized microscope (4x)

3) Limestone (101°55'13.92”E, 4°54'54.67"N)

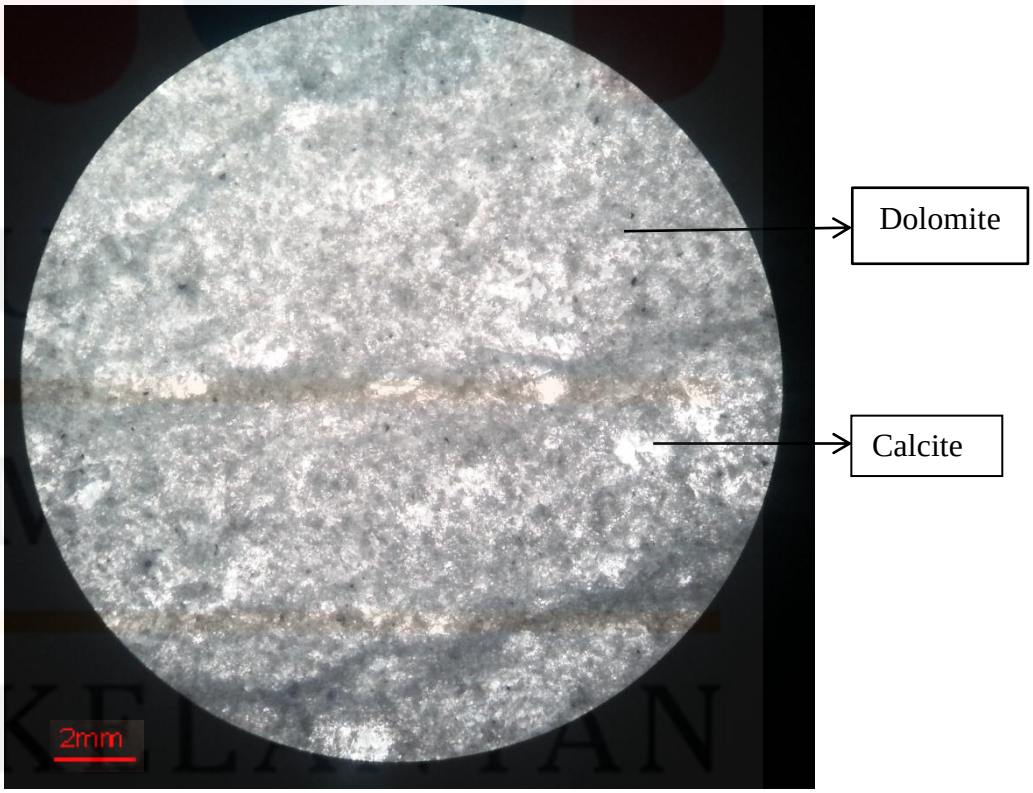

Figure 4.31 Under cross plane polarized microscope (4x)

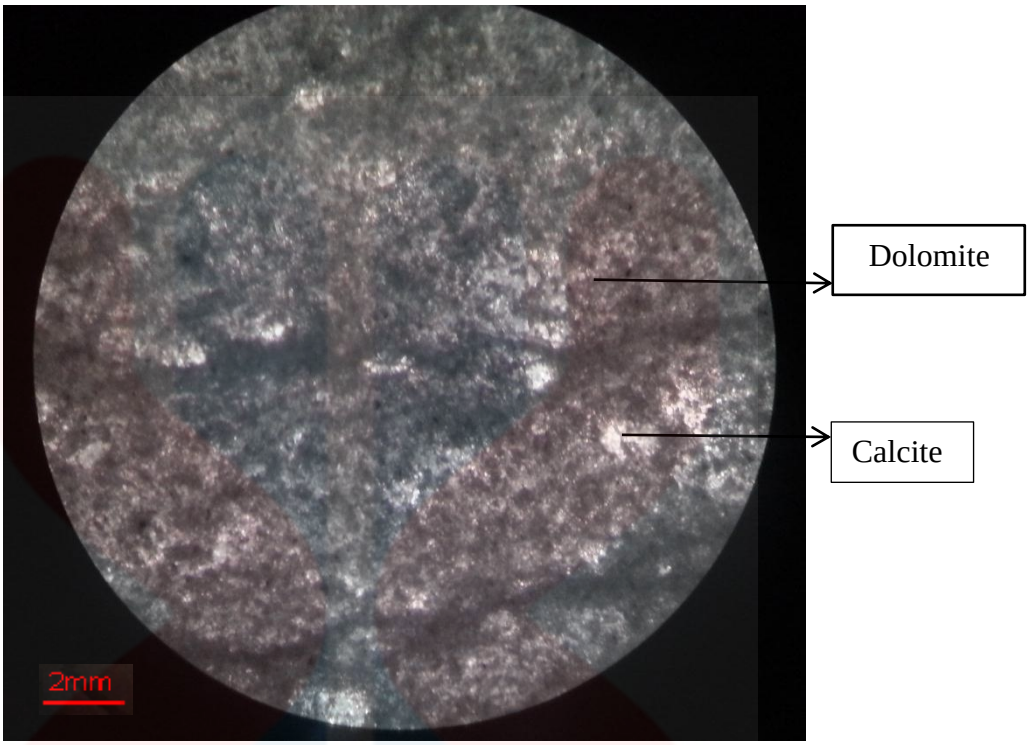

Figure 4.32 Under plane polarized microscope

4.3.3 Discussion

Based on two granite localities, it have mineral quartz, feldspar, amphibole, olivine and biotite. The common mineral found is the feldspar. Feldspar indicates it rich in potassium and sodium. Besides that, the colour of feldspar is whitish to grey. It presents twinning and cleavage. Feldspar that was observed have low relief.

Next, the quartz mineral colour in thin section is white to grey. The quartz mineral has low relief and less cleavage. The shape of quarz seen is anhedral. Lastly, the amphibole is the least mineral in the thin section. The colour for amphibole is brown and its shape is euhedral. It also posses good cleavage and have low relief.

The percentage mineral composition by the petrographic analysis the mineral for first granite locality feldspar is 65%, quartz 22.4% and lastly plagioclase 12.6%.

Next, the percentage mineral for second granite locality consist of matrix 70%, quartz 18.5% and olivine 11.5%.

The petrographic analysis for limestone is it consists of mostly the mineral calcite. Calcite formula is $CaCO_3$. This is why the reaction to acid is vigorously. It colour is grey to white and dissimilar cleavage. The percentage mineral for limestone is 65% dominated by calcite mineral whereas dolomite 35%.

4.4 Structural Geology

4.4.1 Lineament analysis

Lineament is features that form as linear on a surface of the earth. It can be either positive lineament or negative lineament based on the features such as hill, valley, mountain and river. Characteristically a lineament contains a fault-aligned valley, a series of fault or fold-aligned hills, a or certainly a combination of these features. Fracture zones, shear zones and igneous intrusions such as dykes can also give rise to lineaments. Lineaments frequently seem in geological or topographic maps and can look observable on aerial or satellite photographs. The lineament cannot be seen by ground because of the sediments that deposited onto it. By taking the lineament reading and do the analysis by using software Georose, it can show the forces of faulting, folding coming from which direction that form the landform today.

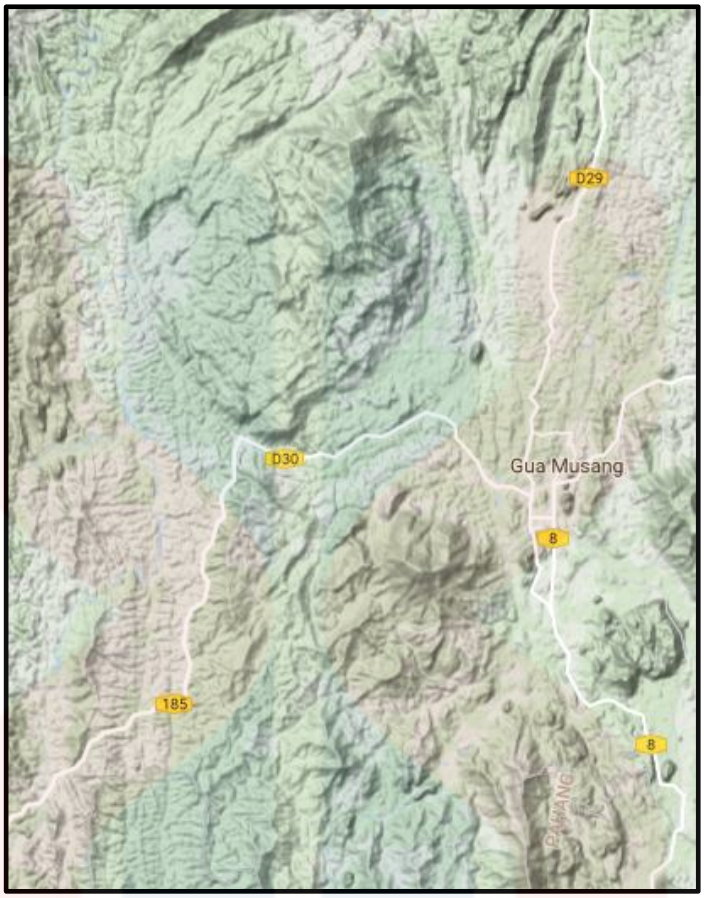

Figure 4.33 Lineament Map

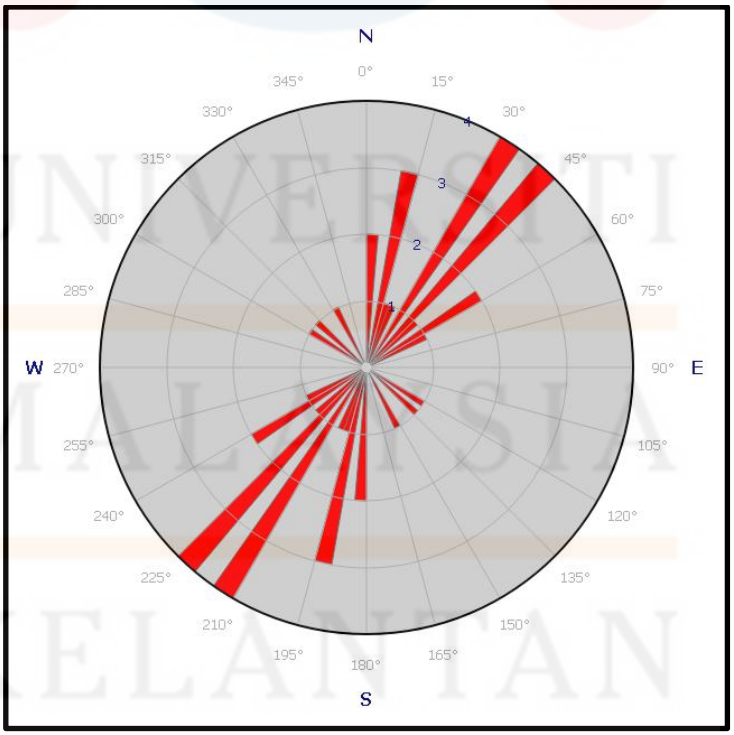

Figure 4.34 Lineament rose diagram

Based on figure 4.34 it can be conclude that forces direction are coming from the Northeast of the study area whereas the direction of stress are from the Northwest and Southeast towards the Southwest.

4.4.2 Joint analysis

A joint is a crack whichever a layer or body of rock that deficiencies any observable or measurable movement parallel to the plane of the fracture. They most commonly happen as joint sets and systems. A joint set is a family of parallel, evenly spaced joints that can be recognized through fieldwork and analysis of the orientations. Joints are between the most worldwide geologic structures as they are originating in most every disclosure of rock.

1) First Locality (101°55'19.02"E, 4°54'3.43"N)

Figure 4.35 First locality joint

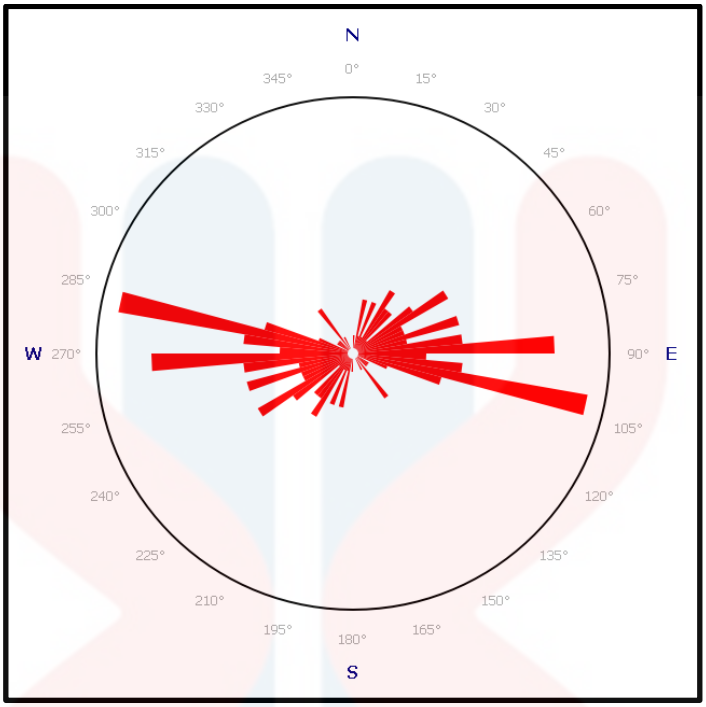

Figure 4.36 First locality rose diagram

Based on figure 4.36 the forces at the first locality is proceeded are in the direction of Northwest and southeast whereas the stress are from the course of Northeast and Southwest. The N is equal to 100.

2) Second Locality (101°55'43.52"E, 4°53'16.42"N)

Figure 4.37 Second locality joint

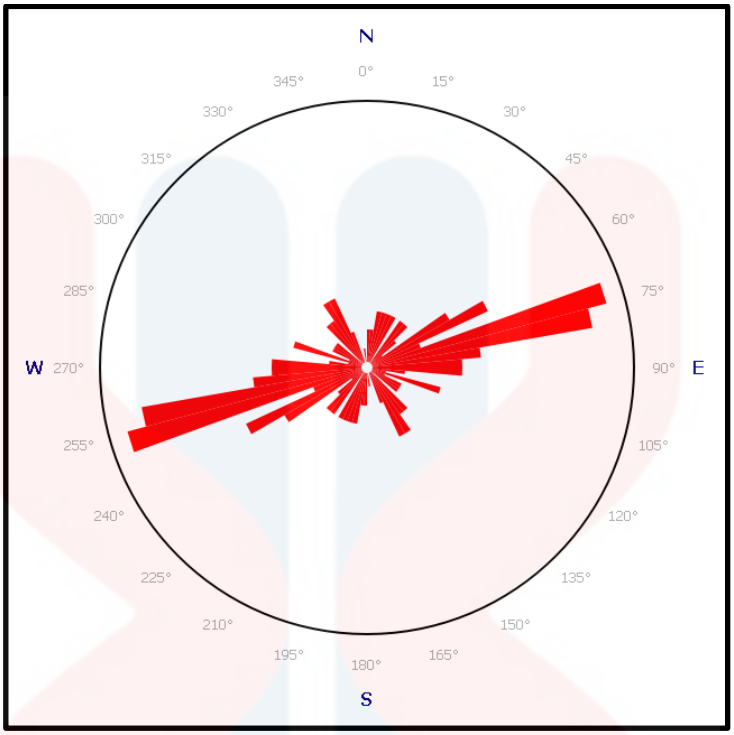

Figure 4.38 Second locality rose diagram

Based on figure 4.38 the forces are acted direction of first locality from the direction of Northeast and Southwest whereas the stress is from the direction of Northwest and Southeast. The N is equal to72.

3) Third locality (101°55'53.43"E, 4°53'7.92"N)

Figure 4.39 Third locality joint

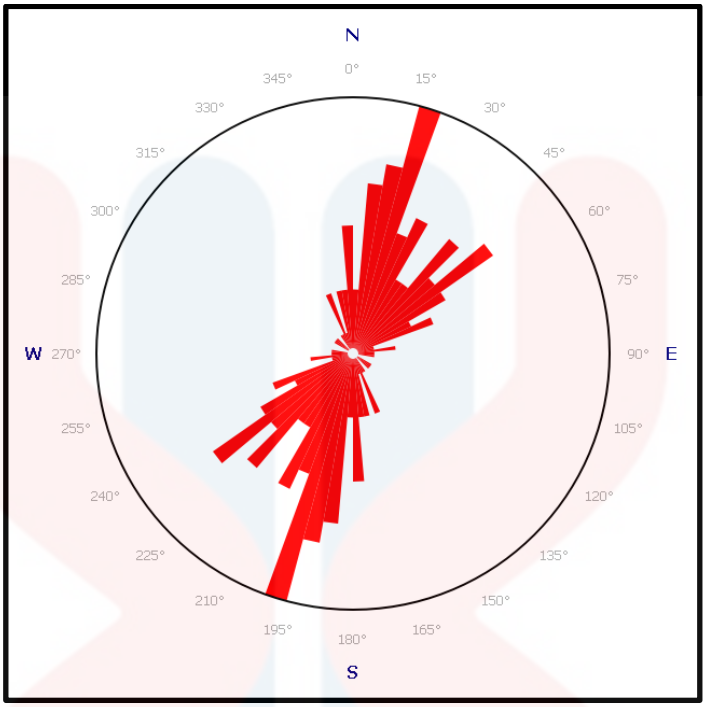

Figure 4.40 Third locality rose diagram

Based on figure 4.40 the forces are in direction from the Northeast and Southwest whereas the stress is acted from the course of Northwest and Southeast. N is equal to 20.

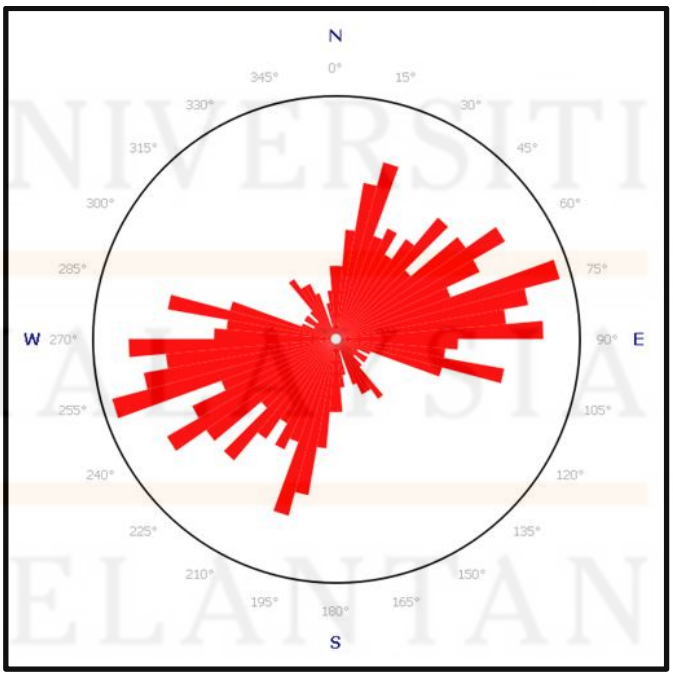

Figure 4.41 All localities rose diagram

Based on figure 4.41 the forces performed in the direction of the localities are mostly from the Northeast and Southwest whereas the stress is acted from the course of Northwest and Southeast.

4.5 Historical geology

Historical geology at the study area is from the two era of time. That is firstly from paleozoic to Mesozoic era. At paleozoic era, the geology are form from the period of Permian. The lithology that is formed during Permian is the limestone and shale rock. During Permian it is consist mainly sedimentary rock. This is because during Permian the land is mostly sink under the sea level. This factor causes the sediment to be deposited before it form the landform. The evidence for this factor can be seen from the limestone rock. Limestone are sedimentary rock that was deposited from the shallow marine environment. At someplace it form karst morphology as the deposition is higher. The other evidence that can be seen is the marine fossil that were found on the body of the limestone. Most of the limestone contain marine fossil as the dead body of organism are buried with the sediment before it forming the limestone. That is why the limestone contain the marine fossil.

Next, during era Mesozoic at period of Triassic, the volcanic eruption and intrusion of acid intrusive causes the landform to change it shape and it lithology. As the intrusion happen it causes the magma to be cooled on the surface of earth thus forming the igneous rock called as granite. The granite texture consist of large grain size are the evidence for the magma intrusion as the magma cool slowly thus forming certain mineral at certain temperature. The evidence for this geology is the Katok Batu area are bounded by the Main Range at the Northeast of the area. Besides that, the contour elevation also increases towards to the northeast.

CHAPTER 5

GOLD OCCURRENCE AT KATOK BATU, GUA MUSANG

5.1 Introduction

Gold occurrence is important process as it can investigate the concentration of gold metal or also known as gold that takes place in a specific area. Analysis is important because it can express valued information which can be used by other geologist whether in exploration or prospecting mineral. It is also can give information for the land owners to know the economic value of their land.

The main reasons of how the gold can be deposited at the stream in the study area are because the intrusion of magma intrudes into the other body of rock. The magma is coming from underneath the earth surface due to the different in pressure. As I mentioned in Chapter 1, the gold mineralization is correlated to the intermediate intrusive rather than acid Triassic granites. The intrusion of magma that intruded the body of rock will altered the rock properties physically and chemically, changed from its original condition. The mineral composition also can be altered. In some cases it can cause the rock that it intrudes to become the metamorphic rock. The high in temperature and pressure causes the modification. The processes that cause the rock to change are called metamorphism.

Furthermore, as the intrusion happens, there is hot fluid originated below the earth crust that is high in pressure and temperature. The hot fluid are rich in minerals and metals content that it carry from the earth crust which then passes through the cracks and spaces between the rock. The hot fluid then will deposit its rich mineral and metal along the cracks and spaces between the rocks. It occurs like that because the hot fluid is unstable due to the high in pressure so it going up to the atmosphere

to gain equilibrium pressure states. Next, after a period of time, as the magma start to crystallize, the rock that is rich with minerals and metals such as gold is formed.

Besides that, as the time goes by the rock that is rich minerals and metals will undergoes weathering and erosion. There is three type of weathering that is mechanical weathering that change the rock physically by deformed it, chemical weathering that change its colour and mineral content and the biological weathering that can cause the rock to crack due to the plant growth. Those weathering will takes place on the rock that is exposed on the surface hence weakening the rock structure and bonding between the mineral and metal that contain inside it. As the minerals and metals such as gold are breaking away from their host rock due to weathering, it then transported to the deposition area by wind or water. This process is called as erosion. The erosion of metals and minerals then can be deposited at deposition area whether on land or stream. So that is why most of exploration and geochemical analysis taking samples from the stream.

The granite rock that was found in the research area as I mentioned in chapter 4 are the evidence for the intrusion that happened in the study area. Granite rock is the rock that is originated from the magma and also known as intrusive rock. Hence, it show that the area once have been intruded by magma long time ago. By that it can support the point that the area is rich in minerals and metals such as gold. So the gold occurrence analysis can be conducted at the area.

5.2 Sampling

The sampling for sample was taken from the stream sediment located in the research area. To succeed as a stream it must be whichever recurrent or persistent. Recurrent streams have water in the waterway for at least part of the year. A stream of the first order as shown in Figure 5.1 is a stream which does not have any other recurrent or persistent stream going into it also known as young stream. This indicates that the stream is less attenuation compared to the flood plain stream or greater than forth-order. The stream that contain flood plain and greater than forth-order was also known as the mature or old stream. This type of river were need to be avoided as it is not effective for sampling due to its stream condition that is low or insipid in minerals or metals content. So the sample was taken from the second-order and third-order stream as shown in Figure 5.2 and 5.3 respectively only in the study area.

Figure 5.1 The first-order stream

Figure 5.2 The second-order stream

Figure 5.3 The third-order stream

The samples were taken from the stream at the river turning, junction that join two different rivers and also underneath the rock. This is because those areas characterize low force setting which means the metal or mineral is highly placed with the sediment. The mineral or metal deposited more on river curves and below the rock because low force environment can attract and stuck it between the sediments.

Next, while conducting the sampling at stream sediment there is precaution that needs to be followed such as the sample taken from the collapsed bank is forbidden to take because it will contaminate the sample. Secondly, the stream must have to dig about 1 meter before sampling in order to get the fresh sediment not the weathered or contaminate sediment plus the gold is more denser than other sediment so it must be buried more deeper than normal level. Thirdly, the precaution that must be taken is avoided taking too much rock in sampling because the purities will be decrease as the fine sediment will be too smallest amount. That is why we use pan to panning up the sample before putting it into the sample bag. The best method to sampling is taken it from the cut banks and where the stream is running slowly. The sample bag was marked with the marker pen to differ it from other sample and the sampling position is marked on Global Positioning System.

Although the precaution step has been followed there is still has chance the sample to get carbon and metal contamination from industrial, agricultural, and lumbering action. The stream is contaminating due to the bugs spray, fertilization and water flow that mix with the stream. The contamination can widespread from a meter to many kilometres dependent on the contamination concentration. Hence, in order to get the fresh sample or less contaminate, avoid gathered the sample stream from roads, settlements, and plantation. If not avoid it can affect the results.

The samples gathered is weighted about 1 kg for each sample location. The reason is because in case the impurities are too many and if the need of sample arises. The range size of sediment that is gathered are from large sand size to very fine sand size since finer size might be contain more gold because the gold are usually very fine in the stream. Next, a precaution is taken by panning the rough sample to get the pure fine sand sediment before putting it into the sample bag for the reason that to avoid impurities and bigger size rock or sand. As have been mentioned before, the samples are gathered underneath the rock and stream curves or called as point bar.

First step is the stream were dig by using the shovels at the locality about 1 meter deep as shown in figure 5.4. After the stream deep achieves the target, the sediment then is put onto the wood pan for the panning process. As shown in figure 5.5, the panning of stream sediment is conducted to eliminate the impurities and bigger rock that is not significant for the research, cause difficulties during crushing the sample and might contaminate the result. While panning the sample, make sure that the fine sand sediment is not going out of the pan because that fine sand might represent valuable information for gold analysis. Next, after panning the stream sediment, the stream sample that is taken is look like in the figure 5.6. Before putting the sample, the sample bag is marked with the sample name, coordinate of the sample and sample number. This is because once the sample bags are filled up with the stream sample, it is difficult to write on the sample bag. Furthermore, as the sample is collected, it is important to minimize the water content in the sample bag. The water can contaminate and makes the sample heavier. Thus, cause problem for gold analysis. The last step is the sample bag is then seal with the sealer to prevent the sample from come off and to protect it from others impurities material.

Figure 5.4 The stream is dig up to1 meter

Figure 5.5 The gold extraction

Figure 5.6 The stream sample

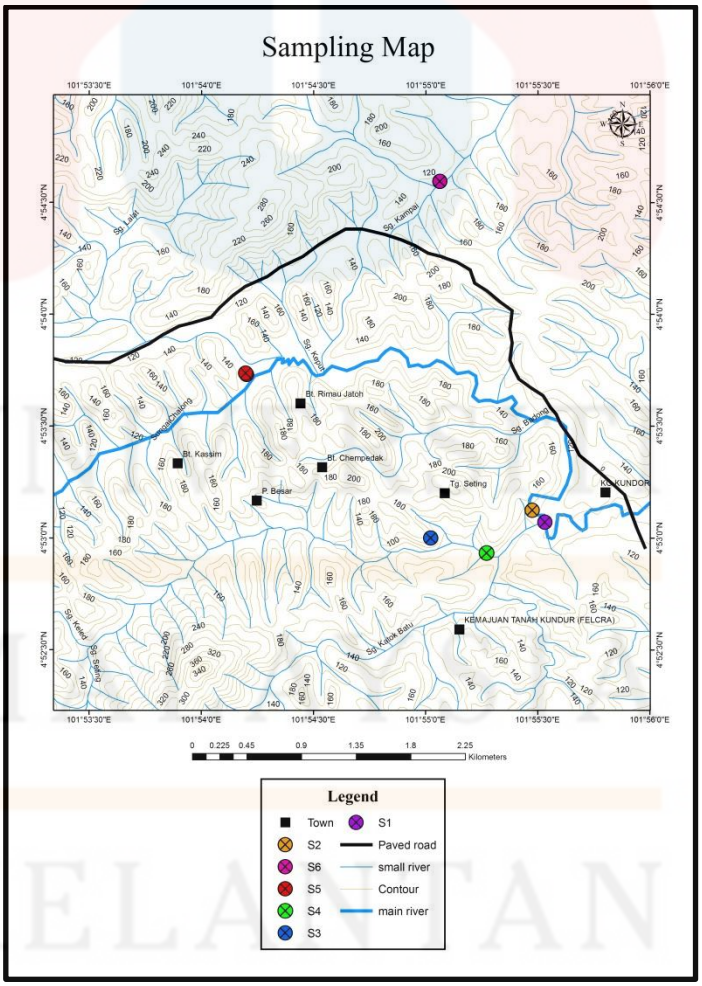

Figure 5.7 Sampling area map

5.3 Results and Interpretation

Table 5.1 Gold result concentration (ppm)

Sample Number	Coordinate sample	Gold (Au) concentration (ppm)
S1	101°55'31.67"E 4°53'4.67"N	0.018
S2	101°55'30.45"E 4°53'5.41"N	0.028
S3	101°55'12.65"E 4°52'49.49"N	0.14
S4	101°55'15.34"E 4°52'54.96"N	0.106
S5	101°54'12.53"E 4°53'43.78"N	8.116
S6	101°55'16.28"E 4°54'35.23"N	-0.014

i) Based on Table 5.1, sample vs gold (Au) concentration (ppm) graph is plotted.

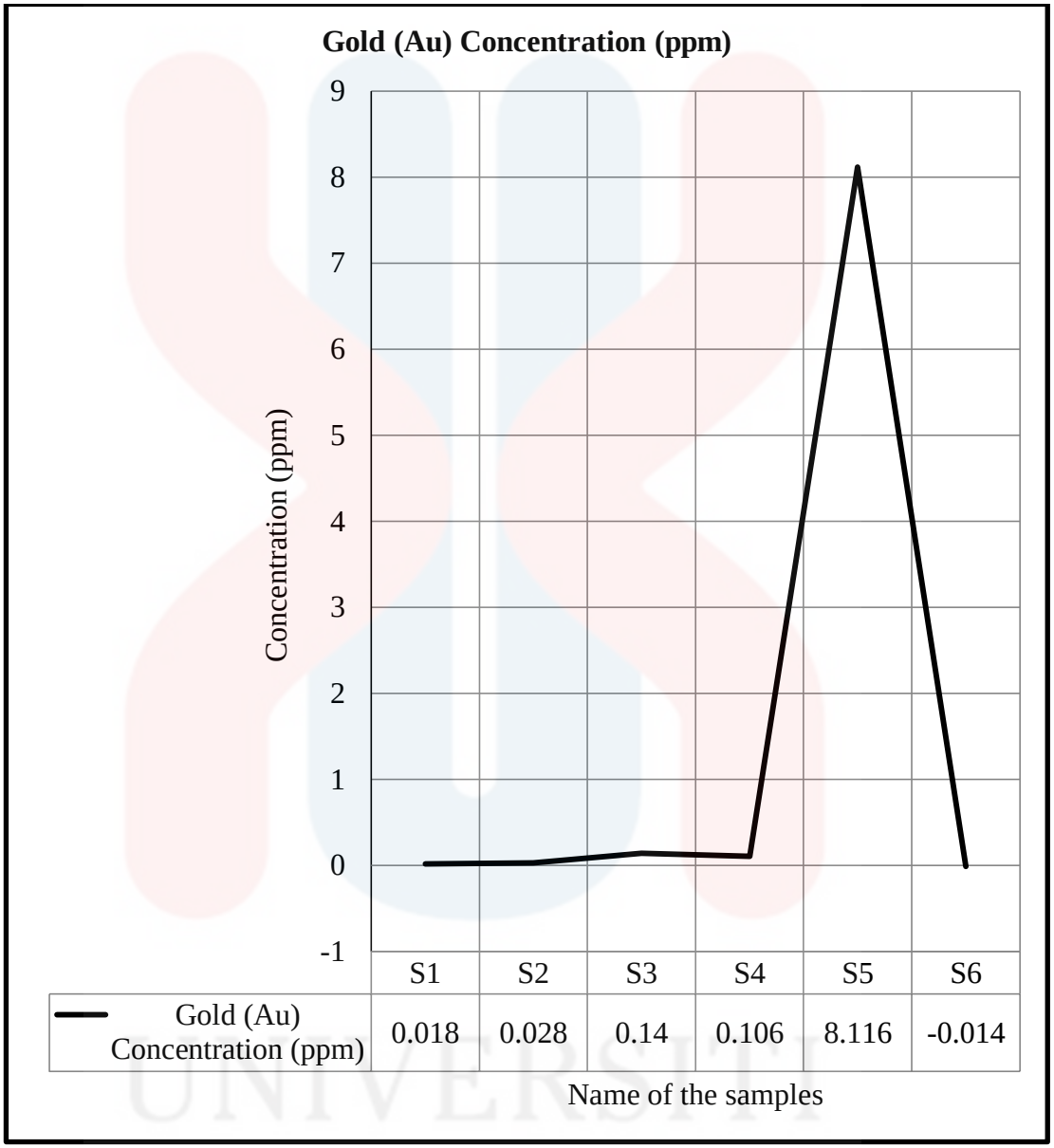

Figure 5.8 Graph sample vs gold (Au) concentration (ppm)

The graph shows the concentration that was found at each sampling locality within the study area. Based on the Figure 5.8, it shows that the samples are mostly have low gold (Au) concentration and the lowest value of gold concentration is the sample S6 with the value of -0.014 ppm. Next, the highest value of gold concentration is 8.116 ppm for the sample S5. The value for the sample S1, S2, S3, and S4 are 0.018, 0.028, 0.14, 0.106 respectively.

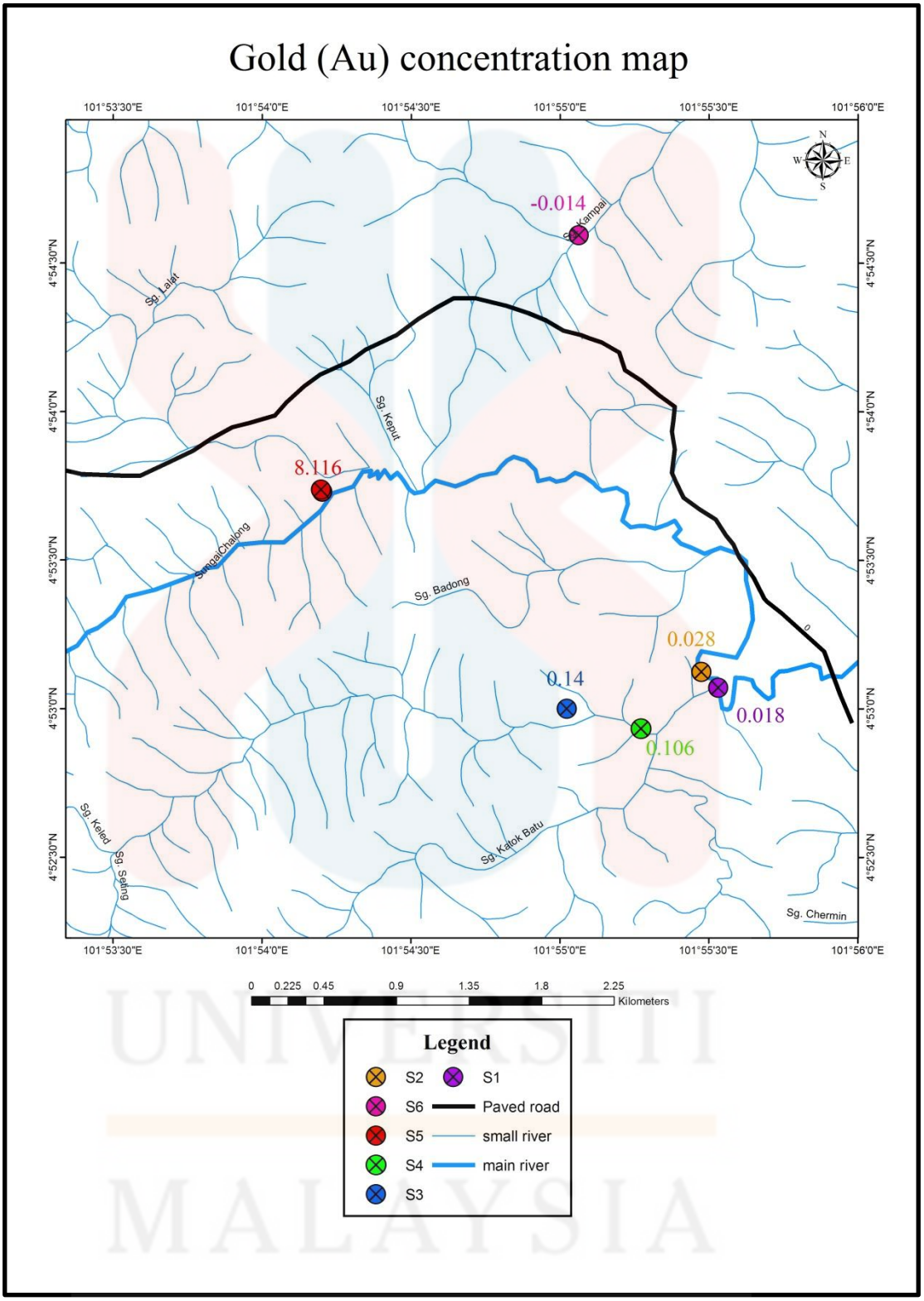

Figure 5.9 Gold (Au) concentration map

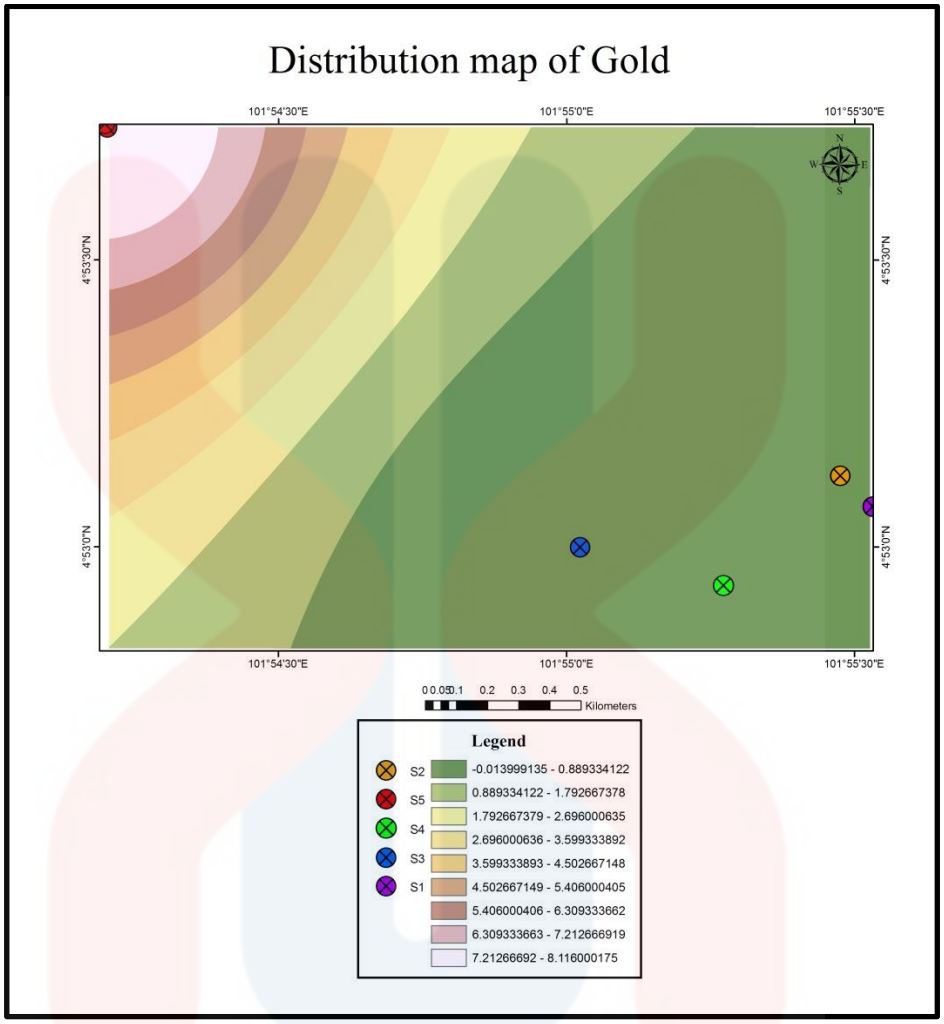

Figure 5.10 Distribution Map of Gold (Au)

Based on the gold concentration map figure 5.9, it shows that the gold analysis results that were collected. The data is display in graph and map to shows the result from different sampling locality. The gold analysis result for sample S1 is 0.018 ppm. If look on the result monitor it displayed 0.009 mg/l. The reason why the final result is 0.018 is because it is multiply by two due to the Diisobutyle ketone (DIBK) solution that is too concentrated. So each sample results were needed to multiply by two, that is why the final result of each sample is higher than it display on monitor. Next, the S2 result is 0.028 which is compared to the S1 is slightly higher even the location is near. The reason is because the S2 sample was taken at the mixing point of two rivers whereas the S1 is gathered at the river point bar. This

shows that the concentration of gold element deposited at point bar is higher than the mixing point of the river. That is why the result is slightly different even the location is near.

Furthermore, the result for the S3 is 0.14 whereas the result of S4 is 0.106 that is also a little higher. This is because the S3 and S4 sample were collected at different river. It shows that S3 river contain more gold element deposited in its stream compared to the S4 river even the different is little. The reason why S3 river contain slightly higher is because the river are linked with the small river located on the acid intrusive hill. As mentioned before the gold are produced due to the intrusion of acid intrusive which then undergoes weathering that causes it to be erode with the river.

Besides that, the result for the S5 is showing the highest gold concentration compared to all of the results that is 8.116 ppm. The reason is because S5 sample were collected at second order stream that is the youngest than the other rivers. The second order stream or young river usually contain more metal or Au element as the young river is small and less sediment deposited onto it. The young river also contained more metal or Au element because it is new river and usually does not contaminate. That is why the S5 has the highest gold concentration. If the result is more than 1 ppm, it can be confirming that the gold present there. However, for the S6 sample is the lowest or no gold concentration recorded. This is because the S6 sample is taken from the contaminated river due to the plantation and construction near to the river. The plantation and construction contaminate the river as the pesticide and other element flow into the river which altered the river composition. Hence, cause the water pollution and false result.

Based on the figure 5.10, it shows the distribution map for gold concentration. The distribution map is important because it shows the concentration layer and the source of gold element in the study area. The distribution map is related with the location of the results. Since it is related with the locality of the results the distribution map only shows the area that is covered by the sampling locality. The result is the distribution map within the sampling area as in shows in figure 5.18. Next, the distribution map shows the gold concentration is increasing towards the northwest of the sampling area. As it goes towards southeast the gold concentration is decreasing. However, this does not indicate that it is valuable for mining. This is because there are many things need to be considered such as the cost of operation, the size of the deposit area and also the amount of gold deposit at the area.

CHAPTER 6

CONCLUSION AND SUGGESTION

6.1 Conclusion

After the research studies in Katok Batu, Gua Musang were finish, the conclusion that can be made is that the stratigraphy present in the study area is composed of igneous and sedimentary rock. The rock is consisting of granite, limestone and shale. The granite was mostly found at the higher elevation topography and some along the river whereas the limestone and shale were mostly found along the river. The highest elevation in study area is 340 metres. The limestone and shale are the oldest rock at the study area whereas the granite is youngest. The granite is formed because of the intrusion of magma towards the study area which then altered the landform and rock distribution. It causes the higher topographic elevation and steep slope.

Besides that, the drainage pattern present within the study area is the dendritic and trellis pattern. This is also due to the intrusion of granite. Next, the structural geology at the study area based on the joint analysis and lineament analysis shows that the force is acted from the course of Northeast and Southwest and the stress are directed from Northwest and Southeast. Furthermore, the land use at the study area are mostly been used for the plantation, agriculture and sand mining. The road connection at the study area also is accessible across the plantation.

For the research specification, the gold (Au) element is present in the research area. In terms of concentration, there is only one sample locality that contains high gold concentration that is S5 with the ppm value of 8.116. As mentioned in chapter 5, if the ppm value is more than 1 ppm, it can be confirmed that the area are present

with gold. The other locality also presents the gold concentration but low in ppm value. However, there is also sample locality that does not contain gold concentration that is S6 sample with the negative value of ppm. Based on the distribution map, it can be confirmed that the gold concentration are increasing towards the northeast of study area. Lastly, it can be conclude that all three objectives of the study are achieved.

6.2 Suggestion

The suggestion is for the gold analysis, the samples obtained for gold analysis are need to be many as can because many sample can cover the other contaminate sample. Next, the suggestion is to take samples from different streams within the study area as the data collected can differentiate which streams contain and source for the gold. It also can improve the result accuracy. Furthermore suggestion is the samples are need to take at many localities across the research area and the distance need to be further away. This is because many sample localities, it can cover the distribution map across the study area which is more wide cover area. This can improve the distribution map accuracy which will be used by other people. In terms of the laboratory analysis suggest that to use modern day technology in determining the gold concentration as now can detect until parts per billion instead using parts per million right now which is more accurate. Additionally, the sample taken also need to be analyse for other element such as iron, copper, aluminium as this element also represent significant value for gold exploration and might represent valuable pathfinder for mining.

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APPENDIXES

Total Population in Gua Musang by Households, Living Quarters and Sex					
Area	Households	Living Quarters	Sex		Total Population by Sex
			Male	Female	
Batu Papan	623	644	1,355	1,239	2,594
Bertam	245	300	570	572	1,142
Chegar Bongor	114	121	269	225	494
Gua Musang	4,084	4,791	9,743	8,677	18,420
Kerinting	30	32	84	73	157
Limau Kasturi	223	235	503	472	975
Paya Tupai	75	83	182	155	337
Other area in Gua Musang	12,730	14,111	33,653	28,417	62,070
Total	18,124	20,317	46,359	39830	86,189

Total Population in Gua Musang by Age Group (Toddlers and Teenage) in 2010					
Area\Age Group	(0-4)	(5-9)	(10-14)	(15-19)	Total
Batu Papan	203	304	250	285	1042
Bertam	100	130	177	138	545
Chegar Bongor	63	73	47	41	224
Gua Musang	2205	2386	2047	1856	8494
Kerinting	19	17	24	22	82
Limau Kasturi	86	96	119	107	408
Paya Tupai	30	35	4	49	118
Other area in Gua Musang	7052	7105	7773	7492	29422
Total Population					40335