GENERAL GEOLOGY AND GEOCHEMICAL ANALYSIS OF ARING 10, GUA MUSANG, KELANTAN.

By

DAFYE TONY PAYAH

A research thesis submitted in fulfillment of the requirements for the degree of Bachelor of Applied Science (Geoscience)

FACULTY OF EARTH SCIENCE

UNIVERSITI MALAYSIA KELANTAN

2017

DECLARATION

I declare that this thesis entitled “title of the thesis”is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ________________________________

Name : ________________________________

Date : ________________________________

ACKNOWLEDGMENT

Thanks to the merciful Lord for giving me the strength and all the blessings you have given to me before, during and after completing this research. Thank you for the endless support, encouragement, attention from my family enabling me to complete my research and finishing my thesis writing.

It is a great pleasure to acknowledge my deepest gratitude to my supervisor, Sir Syakir Bin Sulaiman for he's never ending motivation and dedication is supervising me to achieve the objectives of my research. It is an honor to work under his supervision. I would also like to thank all Geoscience department lecturers who had helped me with sharing their knowledge and concern for me to finish the writing of my thesis.

I would like to express my deepest thanks and appreciation to my friends who have helped me in terms of time and energy during the process of completing my research. Without their help I wouldn't be able to finish the research.

A very special thanks to Universiti Malaysia Kelantan staff that was involved in helping me to run laboratory works and sharing their knowledge to me enabling me to run my projects and achieving research objectives successfully.

My sincere thanks to everyone who are directly and indirectly involved with me to complete my final year project with success.

General Geology and Geochemical Analaysis of Stream Sediment in Aring 10, Gua Musang, Kelantan.

ABSTRACT

The geochemical analysis of stream sediment of Felda Aring 10, Gua Musang was mainly focused at two of main rivers within the area and its tributaries. The study area has two main rivers which are Sungai Lebir and Sungai Antia. The study area is located in Felda Aring 10, Gua Musang with coordinate of 102°26'52.908''E, 4°55'56.802''N. The study area covered 25 km^2 which includes the entire palm plantation, hills and alluvial plain. The objectives of the research are to produce an updated map of Aring 10, Gua Musang, to perform the geochemical analysis of stream sediments in the study area, and to generate a geochemical map of the study area. The geology of the study area was determined by carrying out ground mapping to construct geological map. The study area is mostly covered by 4 types of lithology which are sandstone, sandstone interbedded with mudstone, limestone, and metasedimentary rocks. In order to carry out geochemical analysis, ten samples of stream sediment were collected to analyze five types of elements which are iron, barium, zirconium, manganese, and aluminum. The elements were all analyzed by X-ray Fluorescent machine. The most significant elements are iron with the highest concentration of 42.9 ppm followed by aluminium with the highest concentration of 8.45. The overall concentration of barium, zirconium, and manganese are low ranging from 0.20 ppm – 1.40 ppm. The high concentration of iron indicates that the study area is mainly covered by sediment iron bearing rocks.

Geologi dan Analisi Kimia Sedimen Aliran di Aring 10, Gua Musang, Kelantan

ABSTRAK

Analisis geokimia aliran sedimen Felda Aring 10, Gua Musang telah tertumpu di dua sungai utama dan sungai-sungai kecil dalam kawasan kajian. Kawasan kajian mempunyai dua sungai utama iaitu Sungai Lebir dan Sungai Antia. Kawasan kajian terletak di Felda Aring 10, Gua Musang dengan koordinat 102 ° 26'52.908 ''E, 4 ° 55'56.802'' N. Kawasan kajian adalah sebesar 25 km2 yang diliputi oleh perladangan sawit, bukit dan dataran aluvium. Objektif kajian ini adalah untuk menghasilkan peta terkini Aring 10, Gua Musang, untuk melaksanakan analisis geokimia sedimen sungai di kawasan kajian, dan untuk menjana peta geokimia kawasan kajian. Geologi kawasan kajian ditentukan dengan menjalankan pemetaan tanah dan menghasilkan peta dan litologi lajur struktur. Kawasan kajian kebanyakannya diliputi oleh 4 jenis litologi iaitu batu pasir, batu pasir berlapis dengan batu batu lumpur, batu kapur, dan metasedimen. Untuk menjalankan analisis geokimia, sepuluh sampel aliran sedimen telah dikumpulkan untuk menganalisis lima jenis elemen iaitu besi, barium, zirconium, mangan, dan aluminium. Semua unsur-unsur elemen dianalisis oleh X-ray Fluorescent. Elemen yang paling dominan adalah elemen besi dengan kepekatan tertinggi 42.9 ppm diikuti oleh elemen aluminium dengan kepekatan tertinggi 8.45. Kepekatan keseluruhan barium, zirconium, dan mangan adalah rendah antara 0.20 ppm - 1.40 ppm. Kepekatan yang tinggi besi menunjukkan bahawa kawasan kajian diliputi oleh sedimen batu yang mempunyai besi.

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NE	North-East
SW	South-West
NW	North-West
SE	South-East
GPS	Global Positioning System
HCL	Hydrochloric acid
E	East
N	North
Mn	Manganese
Al	Aluminum
Fe	Iron
Ba	Barium
Zr	Zirconium

LIST OF SYMBOLS

“	Second
‘	Minute
º	Degree
ºC	Temperature
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 General Background

Gua Musang is a town or territory or is best known as a jajahan in Kelantan, Malaysia. The Central Belt of the Peninsular Malaysia is extended from Kelantan to Johor with the Western part of the Central Belt are the upper Paleozoic rocks of the Gua Musang and Aring Formation in south Kelantan state and some Taku Schist at east of Kelantan. Gua Musang formation is limestone that forms a karst topography that is very easy to identify. There are a few formations that can be found in Gua Musang such as Gua Musang Formation, Aring Formation, Taku Schist Formation, Gunung Rabong Formation and Telong Formation. Gua Musang is identified as a potential geosite for geological activities because of its unique formations and also its distributions of rocks.

Aring Formation is correlated with Gua Musang Formation and is deposited in the deep sea environment. Aring Formation consists of a sequence of pyroclastic rocks. The given study area is Aring 10, Gua Musang and the research focused on the general geology and geochemical analysis of stream sediments that are distributed in Aring 10, Gua Musang. Geochemistry is the science that uses chemistry tools and principles in explaining the mechanism of major geological systems. Geochemical analysis is used to describe the elements contained in rocks or soils. Elements are determined to an intermediate level of accuracy. The use of this type of analysis is dependent on the digestion used and the intended application on the data. It also explains the mechanism major geological system. The most used instrument to carry out the analysis is X-ray Fluorescent (XRF). Each instruments used for geochemical analysis have their own advantages. The XRF is relatively simple, cheap and analyses quickly compared to other instruments. It also analyses the element accurately by using minimal sample preparation. Base map are produced with the lithology data collected where we can see the distribution of different types of rocks, this different type of rocks gives more information about the rocks that might be beneficial for other mineral exploration.

1.2 Problem Statement

There was still no research on the geochemistry of stream sediments in that area, Aring 10, Gua Musang. The data that has been collected for Gua Musang has not been updated therefore the map that contains the lithology, streets, river, buildings and some other features are not visible in the base map. The study of the geochemistry of rocks in this area also needs to be carried out as it is important information as it correlates with the types of rocks in the area that contributes to the formation of the area. The data collected also needs to be updated as the geological settings of the area might be different from the past.

1.3 Research Objectives

These are the objectives of the research:

1. To produce an updated map of Aring 10, Gua Musang in a scale of 1:25000.
2. To perform the geochemical analysis of stream sediments in the study area.
3. To generate a geochemical map of the study area.

1.4 Study Area

1.4.1 Location

The location of the study area is shown is figure 1.1 whereas the base map of the study area is in figure 1.12. Aring is mostly a palm oil estate and some of it is still covered by thick forest. There is one felda located in the study area which is Felda Aring 10. The study area is mostly covered by various plantations especially oil palms. Felda Aring 10 office is located at the coordinate of 102^0 26' 48.293'' E, 4^0 55' 4.586'' N. The size of the study area is 5 km x 5 km which equals to 25 km^2.

Aring is located far from Gua Musang town therefore it does not have many infrastructure and there is only one road to access to Felda Aring 10. The main rivers and rivers show a very good drainage system for the plantation. The main river in the study area is Sungai Lebir.

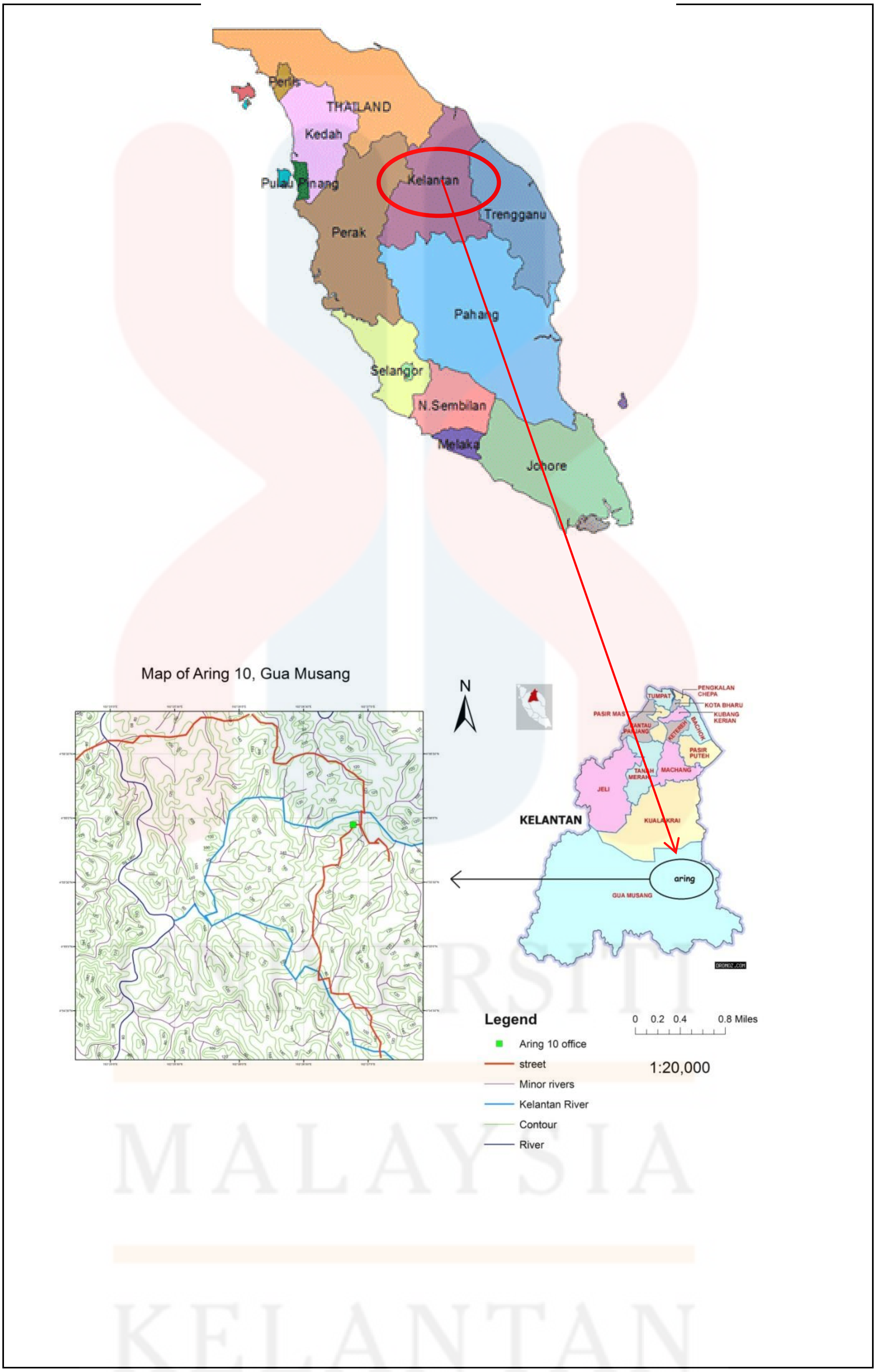


Figure 1.1: Location of study area

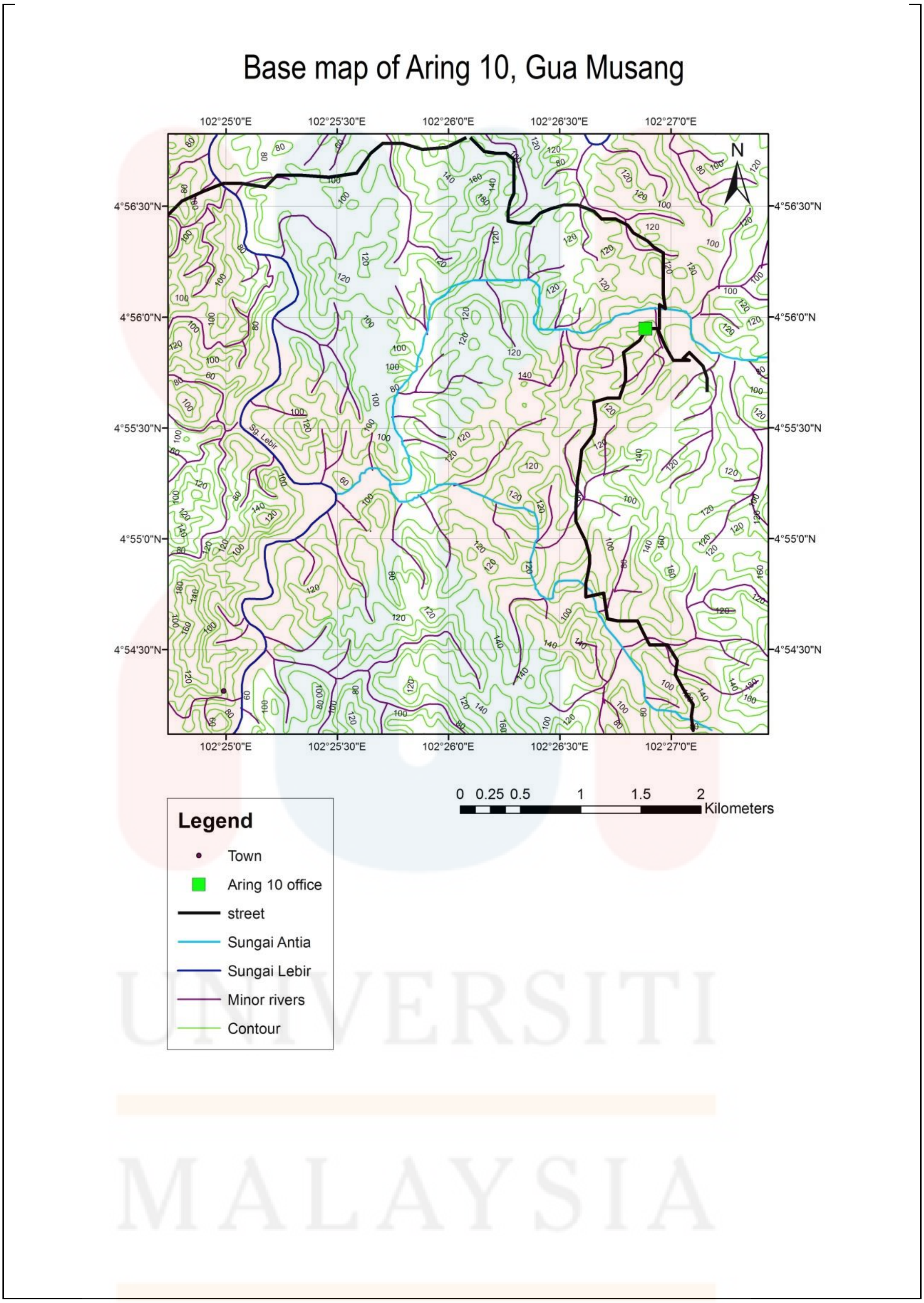


Figure 1.2: Base map of study area

1.4.2 Demography

People distribution is the pattern of where and how the society lives in a particular area. The data that are related to the people distribution includes their race, sex and major income resource. The uneven distribution of people on Earth is due to the different ethnicity of the places. The population for Kelantan as of July 2010 is about 1 539 601 people. Kelantan comprises of 10 districts as shown in Table 1.1. According to the table, about 90 057 populated Gua Musang as of July 2010. Another table of Gua Musang population comprises of the main city in Gua Musang is shown in Table 1.2.

Table 1.1: The population of development in Kelantan

Source: Department of statistic Malaysia (Web)

Name	Status	Population (2010-07-06)
Kelantan	State	1 539 601
Bachok	District	133 152
Gua Musang	District	90 057
Jeli	District	40 637
Kota Bharu	District	491 237
Kuala Krai	District	109 461
Machang	District	93 087
Pasir Mas	District	189 292
Pasir Puteh	District	117 383
Tanah Merah	District	121 319
Tumpat	District	153 976

Table 1.2: Total population in Gua Musang by ethnic in 2010

Source: Jabatan Ukur dan Pemetaan Kelantan

Total Population in Gua Musang by Ethnic in 2010						
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

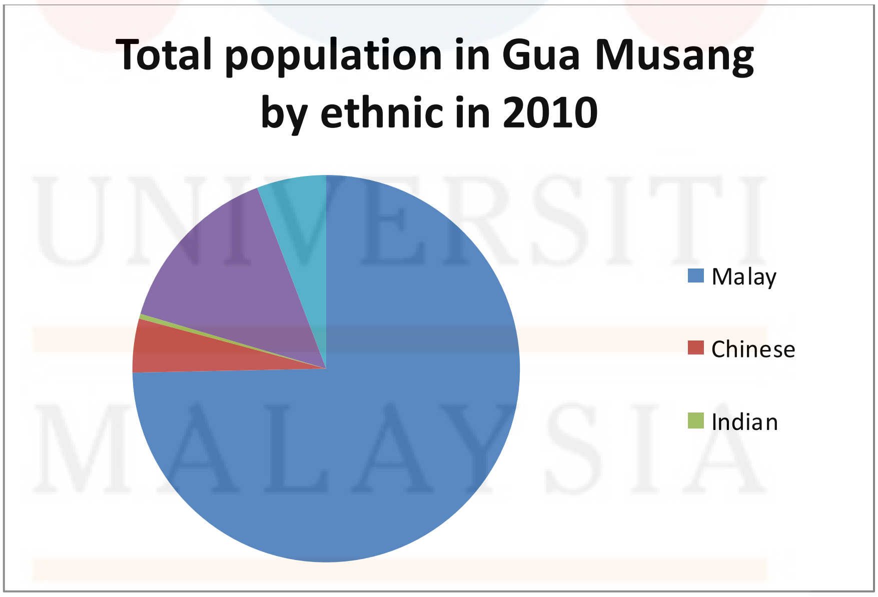


Figure 1.3: Chart of total population in Gua Musang by ethnic in 2010

Table 1.3: Total population in Gua Musang by households, living quarters and sex

Source: Jabatan Ukur dan Pemetaan Kelantan

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

1.4.3 Rainfall Distribution

Peninsular Malaysia is located in equatorial latitudes. Monsoon winds greatly influenced the climate within this latitude. Monsoon season may occur seasonally due to the semi-annual reversal of the wind system. There are two types of monsoon season which are the North East Monsoon and South West Monsoon. The North East Monsoon season ranges from November to February while the South West Monsoon season ranges from May to September.

Kelantan is usually highly affected by the monsoon season especially North East Monsoon season where the rain distribution is higher and can lead to big flood. Figure 1.4 shows the rainfall distribution in Kota Bharu, Kelantan for year 2015 whereas Table 1.4 shows the rainfall distribution in Gua Musang, Kelantan for year 2015 followed by Figure 1.5 by showing the chart of rainfall distribution in Gua Musang, Kelantan for year 2015.

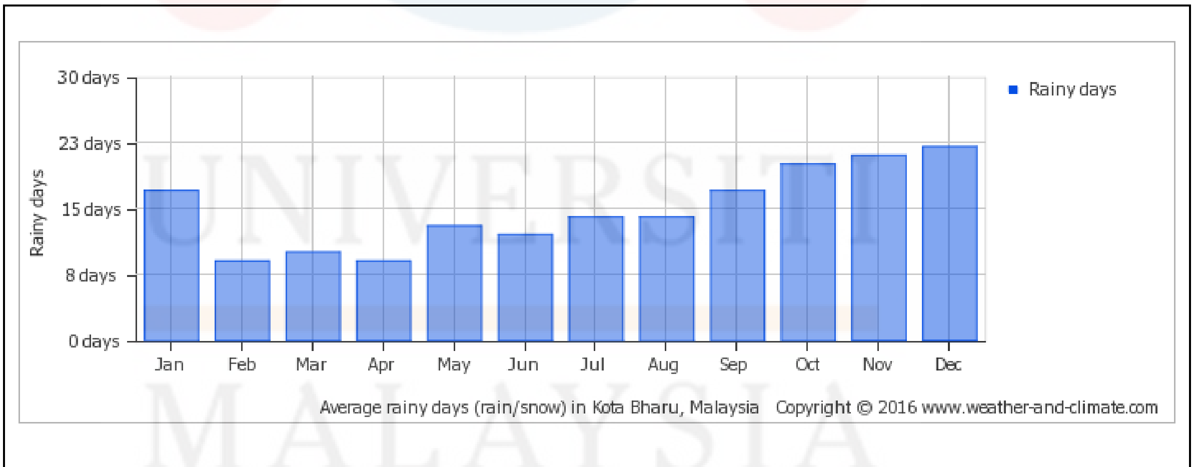


Figure 1.4: Rainfall distribution of Kota Bharu, Kelantan (2015)

Table 1.4: Rainfall distribution in Gua Musang, Year 2015

Source: Jabatan Ukur dan Pemetaan Kelantan

Rainfall Distribution at Gua Musang region, Kelantan District Year 2015 (mm)										
Day	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
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	0	2.1	5.9	18.5	0	0	0.2	32	33.5
30	0.7	0	5.4	15	0	0	5.5	10.5	44	28.5
31	0.1	0	19		27.5		19.5	2.5	0	0
Total	125	52.5	122	151	418	87.4	289.5	193.5	297	467.5

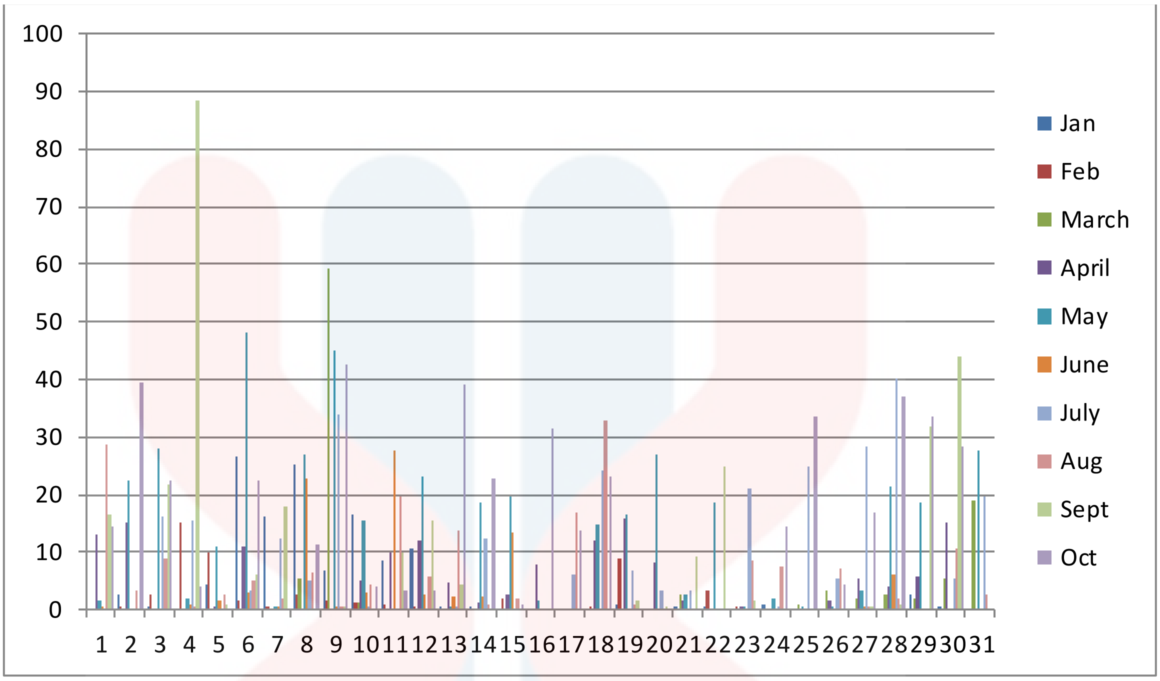


Figure 1.5: Chart of rainfall distribution in Gua Musang

1.4.4 Landuse

Land use planning is an essential tool for pollution prevention and control. Land uses are a category that focuses to the different socioeconomic activities occurring in a particular area, the human behaviour patterns they create, and their effects on the environment. Different place have different land use planning, means they have their own agenda to improve their economic activities as their income. The management practice in the area of intensive agricultural as they want the variety according to the soil formation such as topography, parent material and climate (Orhan Dengiz et.al, 2012).

In Aring 10, Gua Musang the main land use is for agricultural activities. The map of landuse of study area can be seen in figure 1.6. Most of the plants are palm oil. Aring 10 is a Felda of palm oil estate. Therefore, the soil is alluvial and almost 80% of the area was used for agricultural activities. Alluvium consists of silt, sand, clay and gravel and also contains a good deal of organic material. The materials that were deposited by rivers and usually extensive in the lower part of the river course cause a lot of sedimentation. The sedimentation along the river might contain a lot of heavy metals or other elements due to the agricultural activities such as the use of fertilizers. The three main ingredients or macronutrients in fertilizer are nitrogen, phosphorous and potassium. Heavy metals occur naturally in soils and in source materials used to manufacture fertilizers. In addition, heavy metals occur in products as a result of blending fertilizers with recycled industrial wastes.

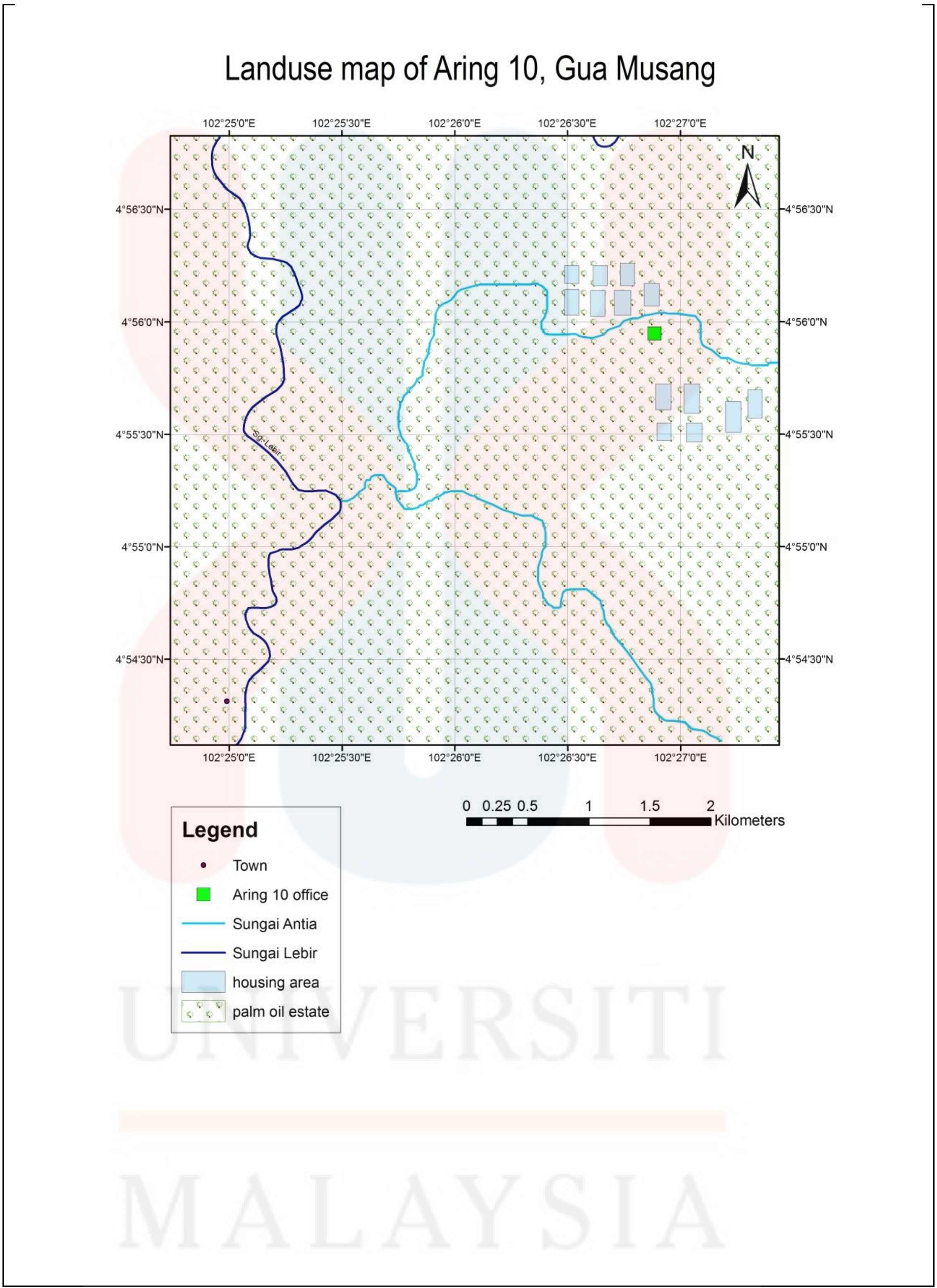


Figure 1.6: Landuse map of study area

1.4.5 Social economy

Social economic is the relationship of social behaviour and economic activities of a particular place. Social economy is a very important aspect for a place that needs an upgrade in their daily life. Social economy affects the process of human's daily life. For example, in the rural area, people often open a small stall and sells all kinds of foods to earn income in order to sustain their living. Most of the people in Aring 10, Gua Musang are involved in agricultural activities, business, and also industrial activities.

The people in Aring get extra income from their plantations or to be specific from their oil palm estate that is handle by Felda. Apart from receiving income from their palm oil business, they also open some small restaurant as the Felda is quite far from town therefore, small restaurants or small medium size business will give a lot income to the society.

1.4.6 Road Connection

Gua Musang is a district in Kelantan and can be access from all parts of Malaysia by train, car or bus. Universiti Malaysia Kelantan, Kampus Jeli is located about 110 km away from Gua Musang and accessible by car. The route to reach Gua Musang from Jeli is through Tanah Merah to Machang to Kuala Krai and finally Gua Musang. The study area is located at Felda Aring 10 in Gua Musang which is about 74 km from the city of Gua Musang. There is only one road to access into Felda Aring 10 which is Jalan Felda Aring. The roads in Aring are all small roads that connect the plantation estate to the main road. Figure 1.7 shows the road connection map of the study area whereas figure 1.8 and figure 1.9 shows the main road of Jalan Felda Aring and also the small roads in the felda respectively.

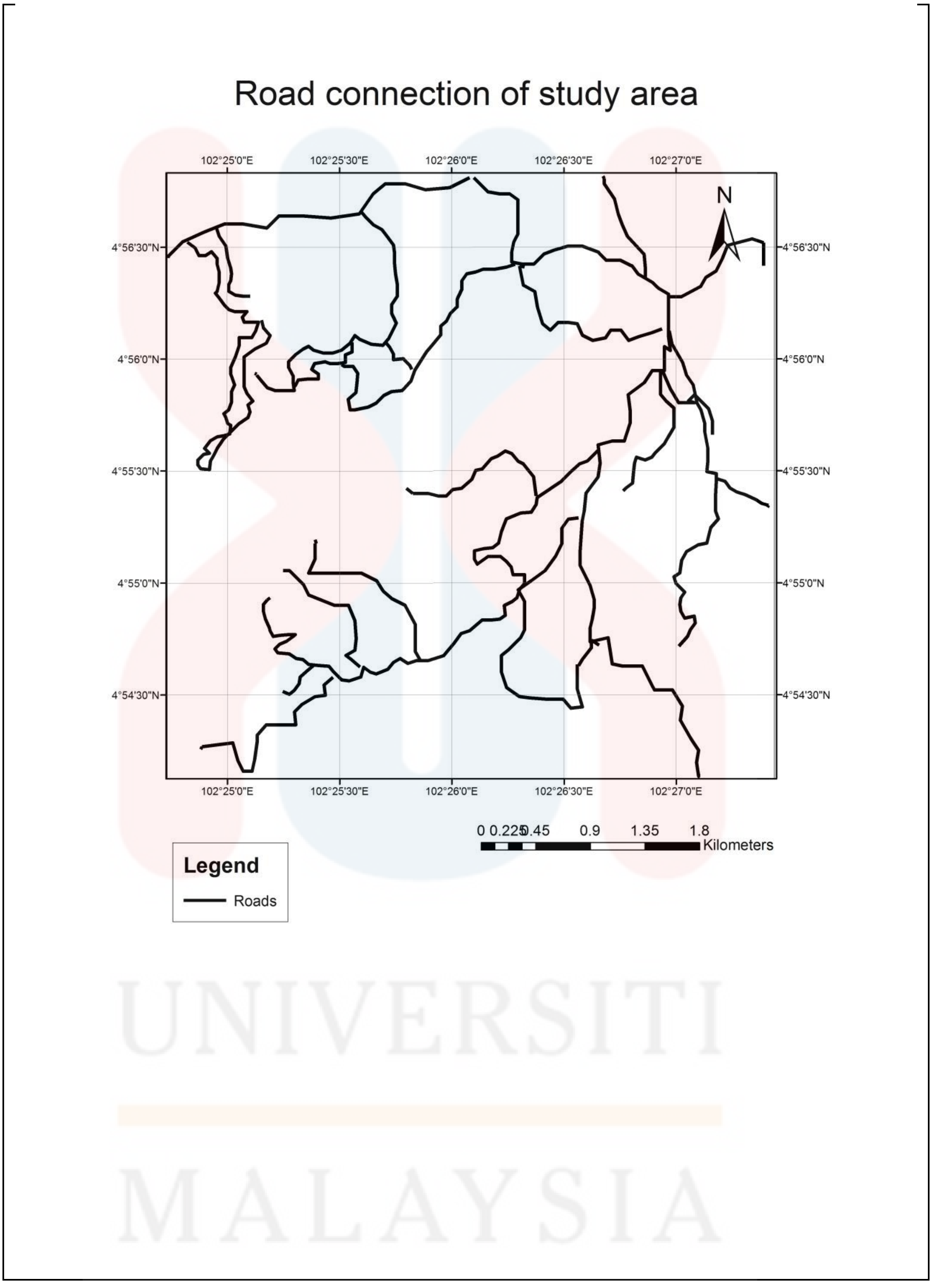


Figure 1.7: Road connection map of study area

Figure 1.8: Main road outside Felda Aring 10

Figure 1.9: Small roads inside the felda

1.5 Scope of Study

The scope of the study is to carry out mapping in the study area to produce an updated geological map of the study area that includes the lithology, geomorphology and structural geology. The other focus of this study is to investigate the geochemistry of the stream sediments obtaining samples and through a laboratory work. The research area is 5 km x 5 km which equals to 25 km^2 area.

1.6 Research Importances

The analysis can predict metals and other valuable minerals, besides that it can also predict toxic leakages from waste disposal sites. By carrying out this research, more information about Aring 10, Gua Musang, Kelantan can be gathered which are very important for geological studies such as aqueous geochemistry where we will be able to know the mineral constitution or study the role of various elements in watersheds and studies of regional, environmental and exploration geochemistry includes applications to environmental and hydrological. Furthermore, the new finding that is collected can be used to update the current geological map of Aring 10, Gua Musang. Last but not least, the research is a very valuable instrument that acts as a reference for the future geologist.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is a text of scholarly paper and is secondary sources that do not report a new or original experimental work. It includes the current knowledge including substantive findings and as well as theoretical and methodological contributions to a particular topic, in this case for general geology and geochemical analysis on stream sediments. Literature review is crucial before starting a thesis, it enables us to gather some knowledge about our topic of studies. It is mostly associated with academic oriented literature. The sources that were used for literature review are academic journals whether in soft copy or hard copy. A narrow scope of literature review may be included as part of a peer reviewed journal article that will present new research. It will situate the current study within the body of the relevant literature and provides context for all readers. The literature reviews usually precedes the methodology and results section of the research. In this paper, the literature review focuses on the general geology of Gua Musang and Aring. Other than that, it also focuses on the geochemical analysis of stream sediments.

2.2 Regional Geology and Tectonic Settings

Regional geology is the geological study of large-scale regions. Usually, it encompasses multiple geological disciplines to piece together the history of an area. It is the geologic equivalent of regional geography (Roberts and Bally, 2012) whereas plate tectonics is the large scale movement of Earth's crust, and results in a number of distinct geologic settings. Oceanic plate and continental plate are the two major components of tectonic plates which drives the tectonic setting of our earth. Each plate is topped by its own kind of crust (Scalera and Lavecchia 2006). Plate tectonics is a scientific theory that describes the large-scale motion of Earth's lithosphere (Little fowler and Coulson 1993). The plates of our earth is moving continuously without us knowing it, therefore the position of the plates will not be the same over the years and will eventually affect our geological structure. The lithosphere, which is the rigid outermost shell of a planet is broken up into tectonic plates which also known as oceanic crust and continental crust. On Earth, there are seven or eight major plates and many minor plates. When the plates meet, their relative motion determines the type of boundary occurred whether it is convergent, divergent, or transform. Earthquakes, volcanic activity, mountain-building, and oceanic trench formation occur along these plate boundaries (Read and Watson 1975).

Peninsular Malaysia can be divided into three longitudinal belts which are the Western Belt, Central Belt and Eastern Belt. Each of the belts has its own different characteristic and is also different in their geological environment. On the other hand, Western Belt can be subdivided into two sectors which are northwest sector and Kinta-Malacca sector. Both of the sectors also have different characteristic and geological environment. Northwest sector is underlain by clastic, limestone and minor volcanism. In the early Palaeozoic there was a deposition of argillaceous and calcareous sediments and soon followed by limestone deposition at the Kinta region specifically in Kuala Lumpur area. The Central Belt is underlain by Permian-Triassic clastic, limestone and volcanic rocks. At the northern part of the Central Belt, it is occupied by Taku schist and exposed mainly of schist, amphibolite and phyllites. Lastly, the Eastern Belt is underlain by Carboniferous and Permian clastic and volcanics. The similarities between all the three belts are they experienced volcanism (Koo and Tan, 1983)

The uplifting of the blocks crafts the two areas of marine sedimentation, namely the Northwestern Kodian-Semanggol Depocenter and the Gua Musang – Semantang Depocenter in the Central Belt. The Gua Musang –Semantang Depocenter was more extensive and developed on Upper Paleozoic shelf deposits of the Eastern Province and made up of a Central Belt and Eastern Belt of Peninsular Malaysia (Lee, 2004)

The oldest rock in the Kelantan state are the Lower Paleozoic age, outcropping northerly-trending belt bordering the foothills of the Main Range and extending eastwards up to Sungai Nenggiri (MacDonald, 1968).

Volcanic-sedimentary rocks occurs extensively and primarily as Permian volcanic rocks on the eastern side of the lower Paleozoic sequence in south-west Kelantan. In the other hand, Triassic rocks are limited mainly to the central and the southern Kelantan state (MacDonald, 1968).

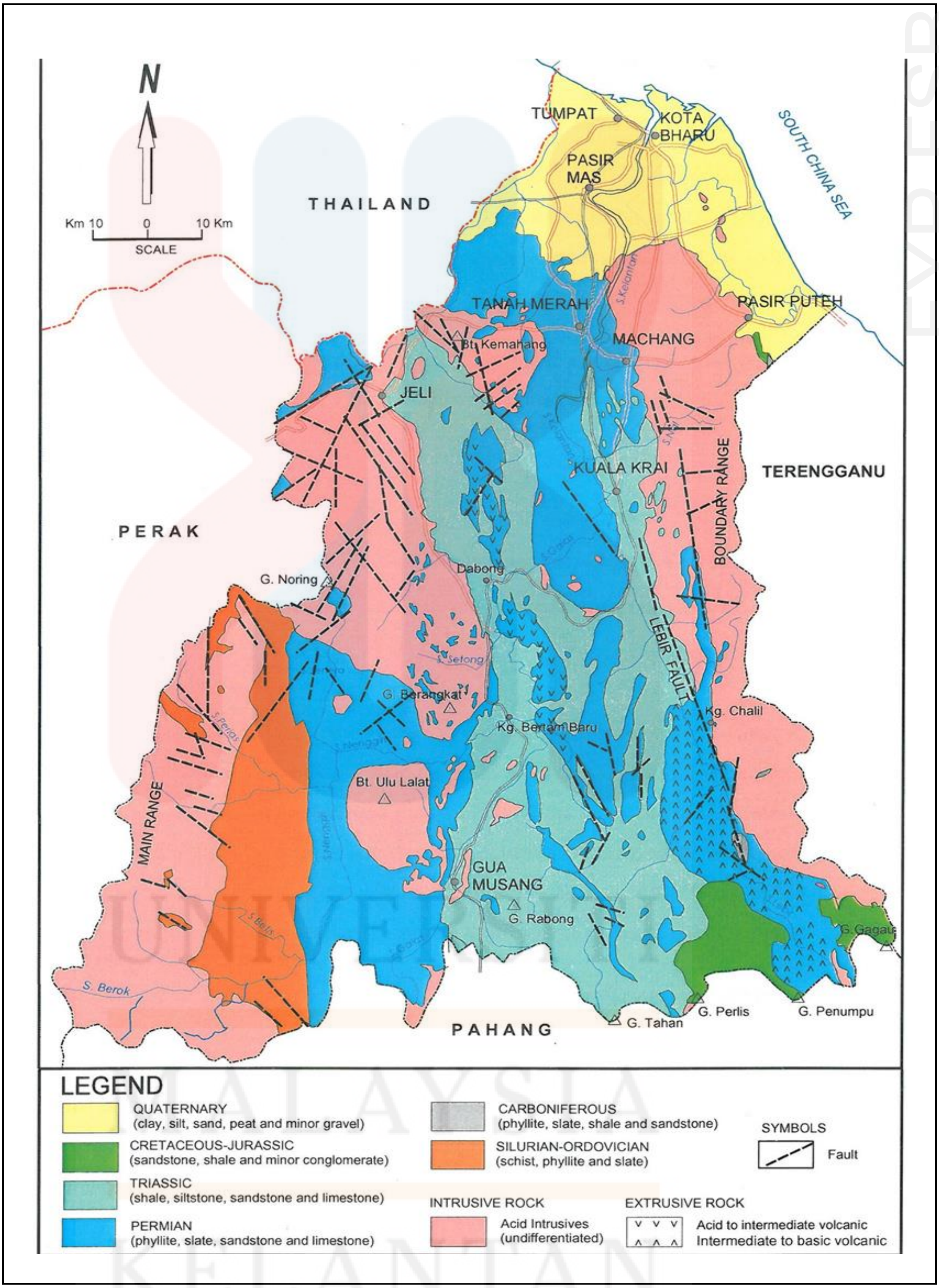


Figure 2.1: Regional Geology Map of Kelantan

Source: International Journal of Geosciences

2.2.1 Stratigraphy

Palaeozoic rocks underlay the whole tract of Western Belt from the Kinta Valley southwards to Malacca. Thick limestone predominate Kinta Valley and their geological age range is from Silurian – Permian. In the eastern part of Kedah and North Perak, Lower Palaeozoic rocks of limestones and metasediments occur. In north Perak, volcanics, and quartzites also occur.

Rocks of the Calcereous Series were renamed the Raub Group by Alexander (1959). These rocks of Carbos-Permian age were mapped as a continuous belt from Kelantan to Bentong in south Pahang. The formations included in Kelantan are the Gua Musang Formation and Aring Formation (Hutchison and Tan, 1983)

South of Kelantan the Gua Musang formation comes from age of Middle Permian to upper Triassic (Shafeea, 2004). During 1983, found fossils of ammonoid and pelecypods (Khoo, 1983). This finding concluded and pin point the age of the Gua Musang formation is from age of Middle Permian to upper Triassic.

Khoo (1983) and Lee (2004) declared that the upper part of Gua Musang Formation is interfingering with the Gunung Rabong Formation, Telong Formation and Semantan Formation. Aw (1974) discovered the Kuala Betis area that located to the West of Gua Musang have lithology similar with the Gua Musang Formation. It overlies conglomerate-sandstone sequence known as The Gunung Ayam Conglomerate, this sequence is interpreted as a basal conglomerate.

2.2.2 Structural Geology

The structural geology of the Western Belt, Central Belt and Eastern Belt are in general and their interpretations are made up of lack of exposure therefore are very hard to determine. Structures such as fault are hard to be identified even in the field. According to the Malaysia-Thailand Border Joint Geological Survey Committee (MT-JGSC)(2006), Peninsular Malaysia was formed by collision between Sinoburmalaya to the west and Eastmal-Indonesia blocks to the east. It collision zone is known as Bentong-Raub Suture which can be traced northward into Thailand and Southward into Bank and Billiton Island. The major tectonic event during Late Triassic in rock deformation in the Malay-Thai Peninsular is the reason of the collision to happen or in other words co-existed.

Based on Yin (1965) the overall pattern of the major tectonics follows the minor affects which consist of tight concentric fold, asymmetric, recumbent and overfolds. The general structural orientation of the strata is North to North-Westerly, consist of a series of tight folds with no present marked of anticlinical and synclinical axial trends. The folding varies in term of degree intensity and depend on the lithology and thickness of the individual bed which indicated by the attitude of the strata.

Folding is characterized by tight, asymmetric and open folds. This fold deformation can cause repeated and overturns sequence in the older sedimentary rocks. From the folds we can determine the direction of the dip and dip angles. The trend of the fold can be determined whether it dips towards the west or east. (T.T. Koo and B. K. Tan, 1983)

2.2.3 Historical Geology

The principles and techniques of geology to reconstruct and to understand the geological history of the Earth is called historical geology. Historical geology focuses on geological processes that alter the Earth's subsurface and surface, which includes the Earth's stratigraphy, structural geology and paleontology that enables us to know the sequence of Earth's events. Other than that, by studying historical geology of the Earth we will also be able to know the evolution of Earth's flora and fauna according to the geological time scale (Levin and Harold, 2003)

Hutchson (2007) states that the Central Belt of the Peninsular Malaysia is extended from Kelantan to Johor with the Western part of the Central Belt are the upper Paleozoic rocks of the Gua Musang and Aring Formation in south Kelantan state and some Taku Schist at east of Kelantan.

The Gua Musang name came from the olden times as the discovered from the civets that can be found in the vast limestone. Gua Musang has a potential for urbanization and a fascinating with recreational park for tourists destination. From his statement, today it was proven that the myth was enchanting the tourist from overseas and domestics to come and explore the thousands of cave at Gua Musang.

2.3 Geological Review

2.3.1 Geology of Kelantan

The Geological map of Kelantan shows that there are several of rocks distributed in Kelantan that indicates different geological age of the areas in Kelantan. One of the biggest formations in Kelanatan is the Gua Musang Formation which associates with several other formations. The sediment and meta-sediment can be found at the north-south central portion of Kelantan.

Most of Kelantan is covered by central belts including Centre and West of Pahang, East of Negeri Sembilan and West of Johor. In research, Permo-Triassic has a high amount distribution of rock and the rest is in Jurassic-Cretaceous. The eastern belts are covered by Terengganu, Eastern of Pahang and Johor. The upper Paleozoic which is sedimentary rock dominant perm-Carbon with volcanoclastic, siliclastics, less carbonate can be found (Kamal Roslan Mohamed, 1996).

2.3.2 Gua Musang Formation

Gua Musang is a town or territory or is best known as a jajahan in Kelantan, Malaysia. The Central Belt of the Peninsular Malaysia is extended from Kelantan to Johor with the Western part of the Central Belt are the upper Paleozoic rocks of the Gua Musang and Aring Formation in south Kelantan state and some Taku Schist at east of Kelantan. Gua Musang formation is limestone that forms a karst topography that is very easy to identify. There are a few formations that can be found in Gua Musang such as Gua Musang Formation, Aring Formation, Taku Schist Formation, Gunung Rabong Formation and Telong Formation. Gua Musang is identified as a potential geosite for geological activities because of its unique formations and also its distributions of rocks.

Gua Musang formation is estimated to be 650m thick and it is made up from crystalline limestone, interbedded with thin beds of shale, tuff, chert nodules and subordinate sandstones and volcanic (Foo, 1983)

Gua Musang Formation shows variation of crystallization degree of limestone with different colours. The colour of the formation is from light to dark grey which indicates the carbonaceous material amount content. The structure of the limestone in Gua Musang formation can either be massive or with beddings. The abundance of different facies can be determined in Gua Musang formation such as wackestone, packstone and oolitic grainstone (Azhar, 1990)

2.3.3 Aring Formation

Aring is a plantation area located at Gua Musang district in southern part of Kelantan, Malaysia. Aring formation consists of dominantly a sequence of pyroclastic rocks with argillite thin layer or rock and dolomite marble at the bottom of the sequence. Numerous small-sized of marine invertebrate fossils have been discovered at Aring area. Aring is located within the Central Belt of Peninsular Malaysia. The similarity in lithology and age are believed that the rock units in Aring area are considerably a part of Gua Musang formation. Aw (1990) has mapped four rocks units in Aring area named, Aring Formation, Telong Formation, Nilam Marble Formation and Koh Formation.

Aring formation has been dated Upper Carboniferous to Lower Triassic using foraminifera and bivalves (Foo, 1983). It is stratigraphic equivalent of the calcareous-argillaceous Gua Musang Formation and similar rocks to the south in the northwest and western parts of Pahang.

2.2 Research Specification Review

2.2.1 Geochemistry Study

Geochemistry is the study of the chemical composition of Earth and the cycles of matter and energy that transport the Earth's chemical components in time and space. Other than that, it also studies the chemical processes and reactions that controls the rocks, water and soils composition on Earth (Pacific Centre for Isotopic and Geochemical Research in pdf). Problems that are related to the fundamental of geochemical such as the origin of mineral deposits and fossil fuels were solved by doing a geochemical research and analytical results. Geochemists also study the composition, structure, processes, and other physical aspects of the Earth. They examine the distribution of chemical elements in rocks and minerals, as well as the movement of these elements into soil and water systems (The Geological Society, 2001)

There are so many methods that can be used to carry out the geochemical analysis such as direct-current arc emission spectrography and spectrometry, induction of coupled plasma-atomic emission spectrometry, atomic absorption methods, chemical methods of separation for optical emission, wavelength-dispersive X-ray fluorescence spectrometry, energy-dispersive X-ray fluorescence spectrometry, major and minor elements requiring individual determination, classical whole rock analysis, and rapid rock analysis, instrumental neutron activation analysis of geochemical samples, delayed neutron counting, radiochemical neutron activation analysis of geologic materials and, isotope-dilution mass spectrometry. All of the mentioned methods were used to determine the distributions of elements on earth and their impact to our environment (Baedecker, 1770)

2.2.2 Geochemistry of Stream Sediments

The research aims at the characterisation of geochemical analysis in stream in order to identify possible mineralisation that is related to the geology structure of rocks in Aring area. Geochemical analysis of stream can be carry out to determine the anomalous concentrations of elements. Stream sediments are a mixture of sediments, soils and rocks from the drainage basin upstream of the collection site (Mikoshiba et al., 2006). Hyporheic zone term refers to the adjacent zone and beneath to a stream or a river in which surface water interacts with groundwater (Smith, 2005).

The analysis of stream sediments can determine the degree of contamination and also assist us in describing the surface hyporheic stream sediment geochemical variations in relation to geology (Alexakis, 2008). There are so many methods that can be used to carry this research analysis such as chemical analysis, pH evaluation, mineralogical analysis, cumulative probability plots, factor analysis, GIS database and the comparison of the stream sediment content.

2.2.3 Heavy Metals

Heavy metals are called heavy because of their high relative atomic mass which persist in nature and can cause damage or fatal in animals, humans, and plants even at low concentration. It is usually used in industrial processes and were transported by air and water and discharged in the environment.

The research focuses on the concentration of heavy metals in stream sediment of the all the water bodies and drainages in the study area. The production of variety of compounds and chemicals are due to the industrial activities at the area, it is a palm oil estate where they used a lot of chemicals and fertilizer that contributes to the heavy metals in the stream sediments.

The concentration of heavy metals will be different in different part of the streams or any water bodies. Besides that, the concentrations of heavy metals in top sediments or lower sediments will also. The degree of pollution of these stream sediments by these heavy metals was evaluated by calculating such parameters as enrichment factors, as well as pollution load and geo-accumulation indices.

Previous research was conducted and Cd contamination in 53 rivers in Malaysia's river system, iron (Fe) in 44 rivers, Pb in 36 rivers, Hg and copper (Cu) in 24 rivers, and Cr and Zn in 4 rivers have been discovered (Kadaruddin, 2000). Another study found that heavy metals such as Pb, Zn, Cu and Cd were present at low concentration s in sediments of the Kelantan River (Ahmad et al., 2009).

Other than geological factors that alter the concentrations of heavy metals in stream sediments, some human factors especially in agriculture also contributes in heavy metal contaminations. Plants take up several important metals that are necessary for their metabolism but also several unnecessary metals, these unnecessary metals are mostly heavy metals. Most of the effects of metals accumulation in plants are due to the interactions between metals. Such interactions depend on the type of sludge being applied and also the sludge treatment processes. Each plants species accumulates different level of elements concentration. High contents of lead in soil will cause cadmium concentration to increase in the plant, soil that is rich with cadmium will reduce the lead uptake by plants (Fazeli et al., 1998). The accumulations of heavy metals are influenced by metal species and plant available forms of heavy metals (Lokeshwari and Chandrappa, 2006). Different amounts and types of exudates which are produced by plants is one of the reason that contribute to the variations in metal tolerance and uptake between plant species (Zheljazkov et al., 2006)

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

Materials and methods are crucial in any research analysis. It is the key of carrying out a research and is very important to be taken note before starting a research. In this research of Geochemical Analysis of stream sediments in Aring 10, Gua Musang, several materials are needed to be used to be able to carry out the investigation thoroughly. Some methods with several stages are also important to be closely followed to ensure the completion of the research. The workflow of the research is shown in Figure 3.1.

3.2 Materials

Materials are the equipment that will be used in carrying out the research. The materials used are different for general geology and geochemical analysis. For general geology, an updated geological map must be produced whereas for geochemical analysis, samples must be collected to run few experiments in the laboratory.

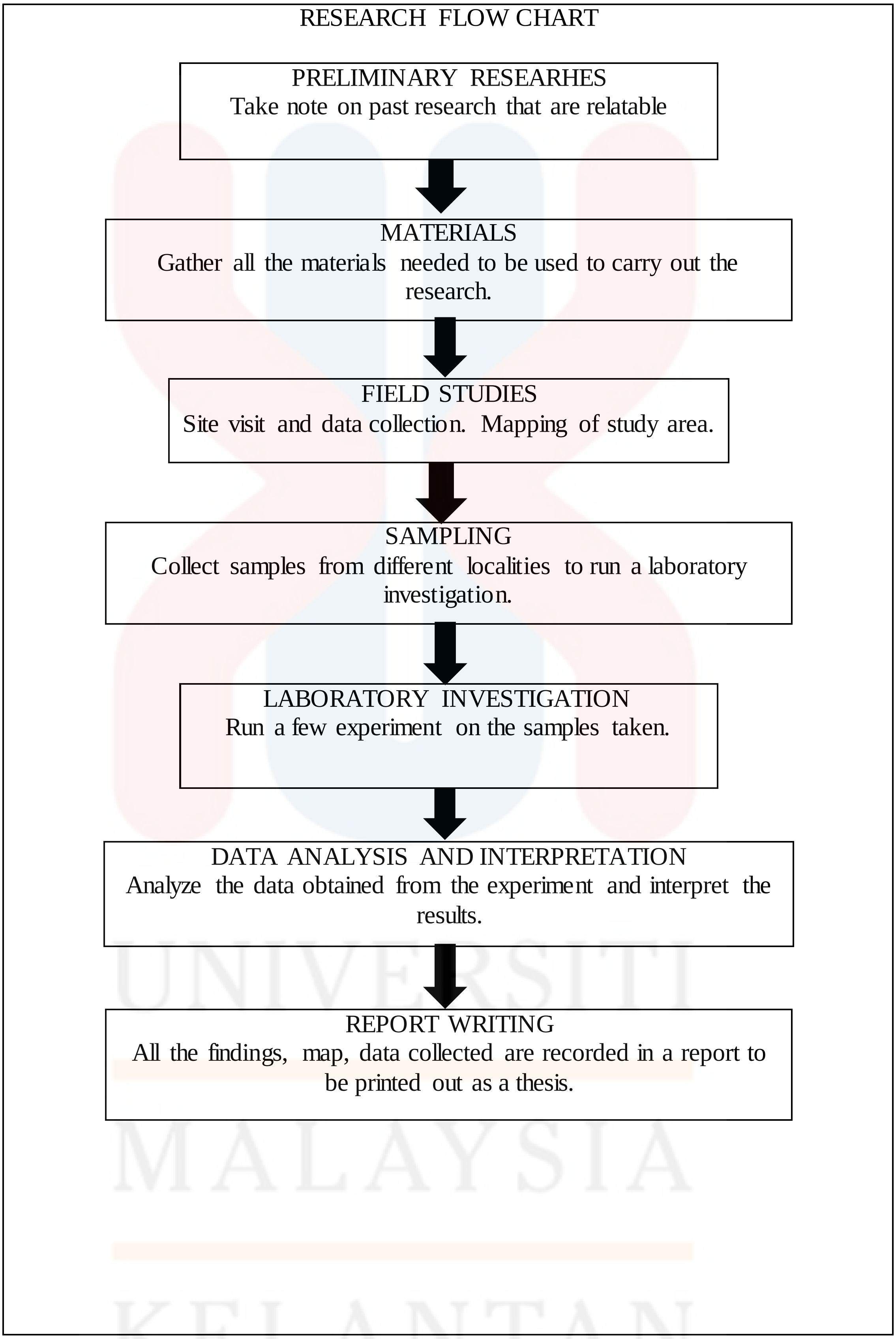


Figure 3.1: Workflow of research

3.2.1 Geological Field Mapping

Geological field mapping comprises of different stages in order to get the results of research data. Survey of the area must be done to find out the geomorphological data of the study area. Next is to observe and take note of the entire visible outcrop within the study area.

After surveying the study area, all readings of structures must be taken to be used in data interpretation for further discussion and as a result of the research. The readings that need to be recorded are strike and dip of beddings, fault, fold and also cracking of rocks. The data is then used in rose diagram software that enables the determination of force direction that forms the structures.

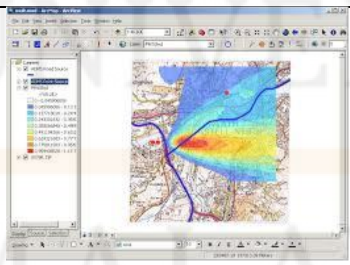
Rock mapping were carried out in order to gather the information of different types of rock within the study area. The method used for rock mapping is by traversing the whole study area with the size of 25 km^2. The study area were mapped by following all the main roads and small roads inside the felda and also by following the river as most of the outcrop can be seen in a river.

Mapping activities were carried out for sampling purpose where sample were taken from outcrops encountered within the study area. Other than that, stream sediments samples were also taken to fulfil the specification of the research.

The materials that were used for mapping:

Table 3.1: Equipment used for geological mapping.

EQUIPMENTS	FUNCTIONS
	Global Positioning System Gives location, point to point navigation, allows us to plot navigation, and to keep track of our tracking activities.
	Geological hammer Used to split and break rocks. Used to obtain fresh surface of rocks to determine composition, nature and mineralogy.
	Suunto compass Used to measure the orientation of geological structures that were observed in field. Can be used to obtain direction and navigation.
	Hydrochloric solution Used for acid test for rocks. Hcl will be pour onto rock surface to see if there's any reaction of carbon dioxide released.

	Hand lens Used to closely examine rocks, sediments, soils, sand, minerals and any small features.
	Sample bags Used to store samples that were collected within the study area.
	Measuring tape Used to measure the thickness of bedding and scale of outcrops in the field.
	arcGis software Used to produce different types of maps.

3.2.2 Geochemistry Analysis

1) X-Ray Fluorescence (XRF)

X-Ray Fluorescence (XRF) is a method used to analyse the major and minor elements that existed in rock samples. Before starting the analysis, the rocks must first be clean and let dry. After that, by using a rock crusher the sample is crushed and powdered. Make sure that the sample powder is in homogenous state. A suitable amount of crushed samples is then analysed by the XRF machine. The method took about 20 minutes to 20 minutes and it gave a very straight forward results.

The freshness of the samples was taken into account because weathered samples will give incorrect results, therefore make sure the samples are fresh in order to get a good value as the results of the analysis. Furthermore, the method has a limitation of ability, as it has a low ability to give precise and accurate values. It cannot detect element that have value lower than 5 ppm.

The equipment that were used for laboratory analysis:

1. Microscope
2. X-Ray Fluorescence Spectroscopy (XRF)
3. Rock crusher

Table 3.2: Equipment used for geochemical analysis.

EQUIPMENTS	FUNCTIONS
	Polarised microscope Used to examine the minerals that are present in rocks.
	X-ray Fluorescent Used to determine the elemental composition of the materials in rocks.
	Rock crusher Used to crush the samples taken (stream sediments) before sending it to be analysed with XRF machine.

3.3 Methodology

3.3.1 Preliminary Research

Preliminary research means denoting an action or event preceding or done in preparation for something fuller or more important. To know if there is any previous research at the same area in other words the past research of the area. After doing so readings of several journals and some meeting with the supervisor, there is no previous research that had been done in Aring 10, Gua Musang.

In addition, the method chosen to be used for analysis must be accurate and suitable to accomplish the objectives of this research. The compulsory method to carry out this research is mapping. Other than that, for the analysis it is crucial to collect samples from study area. Laboratory uses are for thin section preparation and X-Ray Fluorescence. The reference that had been used for some source of information is the library, internet, journals and books.

3.3.2 Field Studies

Field study is the observation of the study area. This research aims to find more information about the general geology of the study area and also the geochemistry of stream sediments and rocks in the study area. A base map is first produced to make the observation and field work easier. Throughout the fieldwork, rock and stream sediments are collected and will be used to run a few experiment for various index and geochemistry parameters. Other than that, the samples will also help to determine the geological condition represented by the study area.

During the fieldwork, the study area was traversed and some rocks samples were collected from different types of outcrop within the study area. The samples collected are important for petrology studies. Other than collecting samples while traversing the area, the geomorphology and structures are also observed and recorded with their coordinates accordingly to be map in geological map of the area. Pictures and sketching of the outcrop is compulsory during carrying out the fieldwork.

The research focuses on stream sediments within the study area, therefore stream sediments were collected from different localities whether it is an active channel or non-active channel. The samples were collected randomly but within $25km^2$ of the area.

Table 3.3: Stages of field studies

Field studies were divided into three stages:

Stages	Action
Before	The equipment or tools were prepared for mapping purpose and also sampling purpose
While	The study area was visited and samples were collected from different localities. Pictures were taken as a prove as well as GPS detail while traversing the study area were recorded.
After	A;; samples were sent to the laboratory for geochemical analysis purpose.

3.3.3 Sampling

Sampling is the action of taking samples from the outcrop in the study area. There are two types of sampling which are rock sampling and stream sediment sampling. Rock samples were collected throughout the mapping activities as often as a different type of rock was encountered. Stream sediments were collected a long a river or streams randomly within the study area to obtain the distribution of heavy metals within the study area. The stream sediments were collected randomly to obtain the value of distribution of heavy metal throughout the study area rather than a single river.

This research focused on the geochemical analysis of stream sediments and the occurrence of heavy metals. Therefore, samplings were done at different localities within the study area. Samples taken from the outcrop or the area must be fresh or not weathered. The stream sediments that were collected were dig about 2 feet deep to avoid the top sediments as samples. The samples that were collected were kept inside sample bags and description such as its location, number of sample, date and some short information were recorded. The samples taken are for geochemical analysis.

Other than stream sediments samples, samples of rocks were also collected. Different outcrops within the study area provide different samples of rocks. Geological hammer were used to crack and separate the rocks to be taken as a sample and sent to laboratory to continue with thin section.

3.6 Laboratory investigation

3.6.1 Geochemical Analysis

1) X-Ray Fluorescence (XRF)

XRF analysis is one of the most common non-destructive methods for qualitative as well as quantitative determination of elemental composition of materials. In this case, it is to investigate the elements existed in the sediments and rocks samples. The sample must be in powder form before sending it to the lab for XRF analysis.

There are two main method in XRF which are wavelength dispersive analysis (WD-XRF) and energy dispersive analysis (ED-XRF), the spectra were collected simultaneously in a wide energy range. The concentration of elements will be recorded in ppm value. Heavier elements will have a higher detection limit.

The sample collected must be prepared before it was sent to the lab for stream sediment analysis using XRF machine. The stream sediments collected were air dried in room temperature. About 100 grams of the sample were taken and crushed by using a crusher machine as shown if figure 3.2. Figure 3.3 (a) and (b) shows the before and after picture of stream sediments sample going through the crusher machine. The prepared samples were all sent to the lab for geochemical analysis to be done as shown in figure 3.4. The result from the XRF machine will show the amount of metal and elements present in the sample.

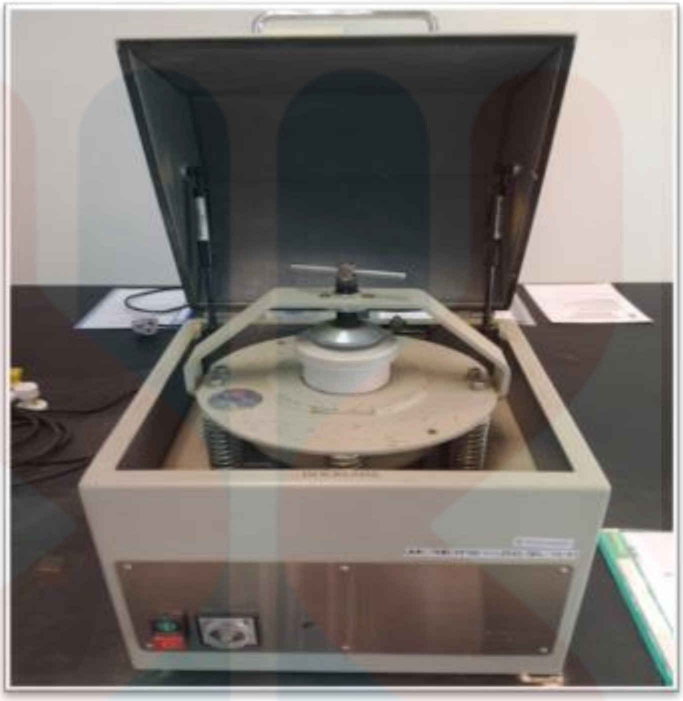


Figure 3.2: Crusher machine

(a) (b)

Figure 3.3: (a) stream sediments sample before crushing (b) crushed stream sediments.

Figure 3.4: Prepared samples to be sent to the lab for XRF analysis

3.6.2 pH Analysis of Stream Sediments

pH analysis of stream sediment was done to determine the pH value for each of the sample taken. 20 grams of fresh stream sediment were weighed and put into a 150 ml beaker as in figure 3.7. After that 100 ml of distilled water was added into the beaker and was shake for 5 minutes. These steps were all repeated for all 10 samples and were left overnight as shown in figure 3.6. The sample was shaken again the next day for 5 minutes and was allowed to settle for 20 minutes. The settled samples were all strained into a polystyrene cup. The pH values for each sample were determined using a pH meter. More accurate values were obtained by calibrating the pH meter.

The buffer of the pH is dependence on the temperature, therefore in the process of calibration of instrument, pH meter will automatically calibrate to the pH value correspond to temperature value. To get the value, the electrode tip and the temperature probe was submerged together into the sample and gently stirred. The reading of pH value were recorded when both of the value is stabilized. The figure 3.8 shows the pH meter determining the pH value of the stream sediments.

Figure 3.5: Stream sediments left overnight with 100ml of distilled water

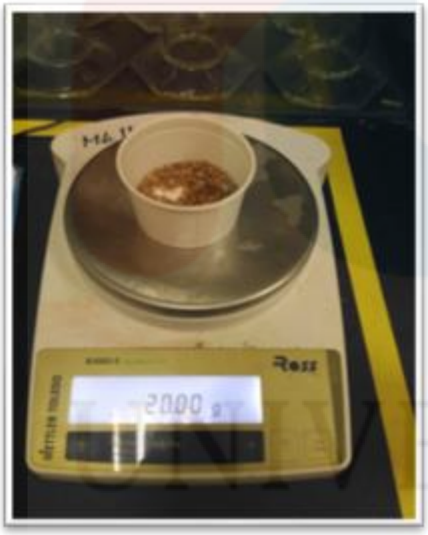


Figure 3.6: 20 grams of weighed sample

Figure 3.7: pH value analysis

3.6.2 Thin Section Analysis

Thin section analysis requires a hand specimen sample or even bigger to be carried out. The sample will be cut by using a grinder. Before grinding the sample, it is crucial to be sure of where and what is the area of the samples that needs to be cut so that the mineral identification under the microscope will be easier. For the cementing of the sample to the glass slide, make sure the sample is dried out on the hotplate.

Canada balsam will be used at the surface of the sample to make sure the mineral sample to be cemented together. As to flatten the sample at the surface, whetstone will be use. After the sample is dry, it is cemented together with the glass slide. When the thin section is done and ready, it will be observed under the microscope. The results of this analysis will show the overview of the rock formation including the composition of the rock minerals. Thin section preparation involves three steps.

The steps are shown below:

1) Sectioning

A rock cutter is use to cut the rock to our desirable size and thickness which is suitable for thin section analysis as shown in figure 3.9.

2) Grinding

After a desirable size and thickness is obtained, the rock is then grind in order to get a flat and smooth surface of the rock. Grinding process was used to remove any deformation that occurred during sectioning process. The flat surface was then cemented to the glass slide.

3) Lapping

After the flat surface of the rock is cemented to the glass slide, it undergoes the final surface preparation. The rock chip was moved on rotary motion against the glass plate together with carborundum powder and water as shown in figure 3.10. This process is called lapping process which is done until the composition on the mineral can be seen under the microscope. This process must be done carefully, as if it overdo the minerals of the rock might be not visible even or deform.

Figure 3.8: Sectioning rock process

Figure 3.9: Lapping process

3.6.3 Petrography Analysis

Petrography analysis is based on the thin section that we made from our rock samples. Photographs of the thin section are taken. In order to do the analysis, the thin section must be analyse under a polarised microscope. Other than that, point counting must be done so that the mineral composition of the rock will be identified.

3.7 Data Analysis and Interpretation

All the date that had been collected from mapping and also experiments were carefully revised to ensure the accuracy of the results. The data were all submitted to the supervisor to be discussed together. The data that were collected throughout the research whether it is from the field work, laboratory investigations, or some readings from journal, book or the internet need to be finalized. The interpretation of the results from the research is best discussed with a lecturer majoring in the research specification and also the supervisor.

The data was arranged carefully so that the reader of the thesis will understand all the outcomes that were obtained from the research. It is best to present the results of the analysis using tables or graphs and also include some pictures for further understanding.

Below are the data that are compulsory to be interpret for this research:

i) Geology data

The geological data that have been gathered during mapping were all recorded in arcGis software. The data was transferred from GPS into the software in order to be interpret easier.

ii) Petrography data

The name and type of the rock will be determined by the mineral content on the rock. The thin section were analyse under a polarised microscope.

iii) Hand specimen analysis

The determination of rock type specifically will be done by calculating the mineral content on the hand specimen. The abundance and lacking of minerals will give the rock type information.

iv) Geochemistry data

The specification of the research is geochemical analysis, therefore the mineral were analysed. Other than that, the major and minor element in the sediment type was also observed.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

Science that deals with the physical structure and substance of the earth is called geology. It also studies the history and the processes that act on the formation of the Earth's structures. Stratigraphy is one of geology branches of studies. Stratigraphy focuses on the order and relative position of strata and their relationship to the geological time scale. From the fieldwork that had been done, the geomorphological process and geography are able to be identified.

In general geology, information of the geological site can be determined based on geomorphology, lithostratigraphy, structural geology and historical geology .These information are important for Geologist to know what actually happened at geological site during billion years ago. The geomorphology is the scientific study of the surface of a planet and those processes responsible for forming it. Geologist involved in this field often study historical changes, through events such as erosion, in order to understand how a particular geographical region came into existence. Lithostratigraphy is a sub-discipline of stratigraphy, the geological science associated with the study of strata or rock layers. In general a stratum will be primarily igneous or sedimentary relating to how the rock was formed. The structural geology is the study of the Earth's deformation. The past deformation of the Earth, on-going deformation, and the mechanics and materials governing this deformation can be identified. Lastly, historical geology is a discipline that uses the principles and techniques of geology to reconstruct and understand the geological history of Earth.

Gua Musang is a district in Kelantan and can be access from all parts of Malaysia by train, car or bus. Universiti Malaysia Kelantan, Kampus Jeli is located about 110 km away from Gua Musang and accessible by car. The route to reach Gua Musang from Jeli is through Tanah Merah to Machang to Kuala Krai and finally Gua Musang. The study area is located at Felda Aring 10 in Gua Musang which is about 74 km from the city of Gua Musang. There is only one road to access into Felda Aring 10 which is Jalan Felda Aring. The roads in Aring are all small roads that connect the plantation estate to the main road.

Figure 4.1 shows the traverse map of study area. The map basically shows the tracks from day one until the last day ground mapping were carried out. The study area was traversed wholly in order to gather all the information. The information and data collected were used to update the geological map of study area and also to fulfil the specification of the research. Figure 4.2 shows the location of collected samples for rock samples and stream sediment samples. The stream sediment samples were collected randomly within the study area and all were either in a river or small streams. The rock samples were collected every time a different type of rock was encountered. Figure 4.3 shows the landuse map of study area. The study area was mostly covered with palm oil plantation and some housing area. There are two rivers named Sungai Lebir and Sungai Antia.

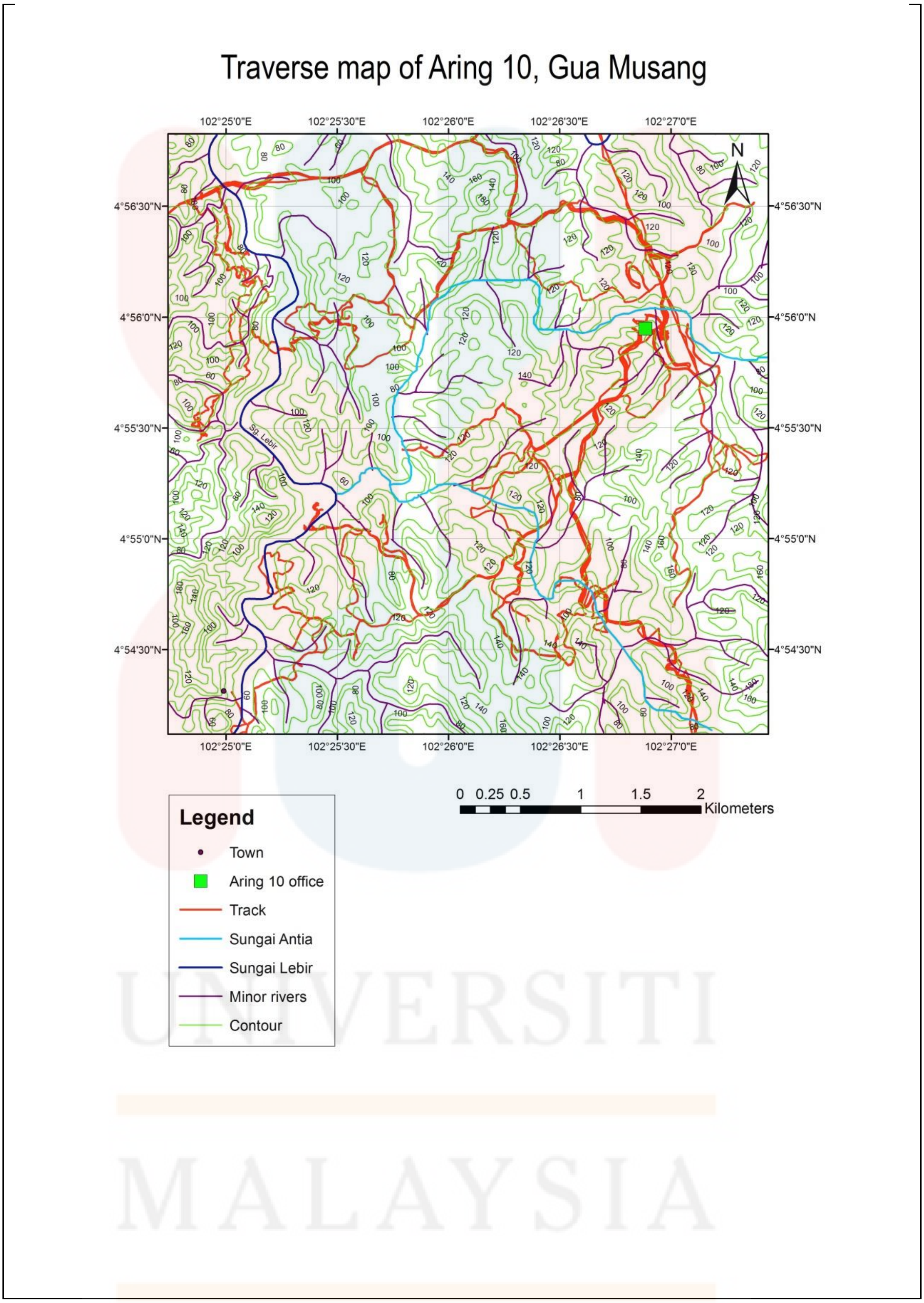


Figure 4.1: Traverse map of study area

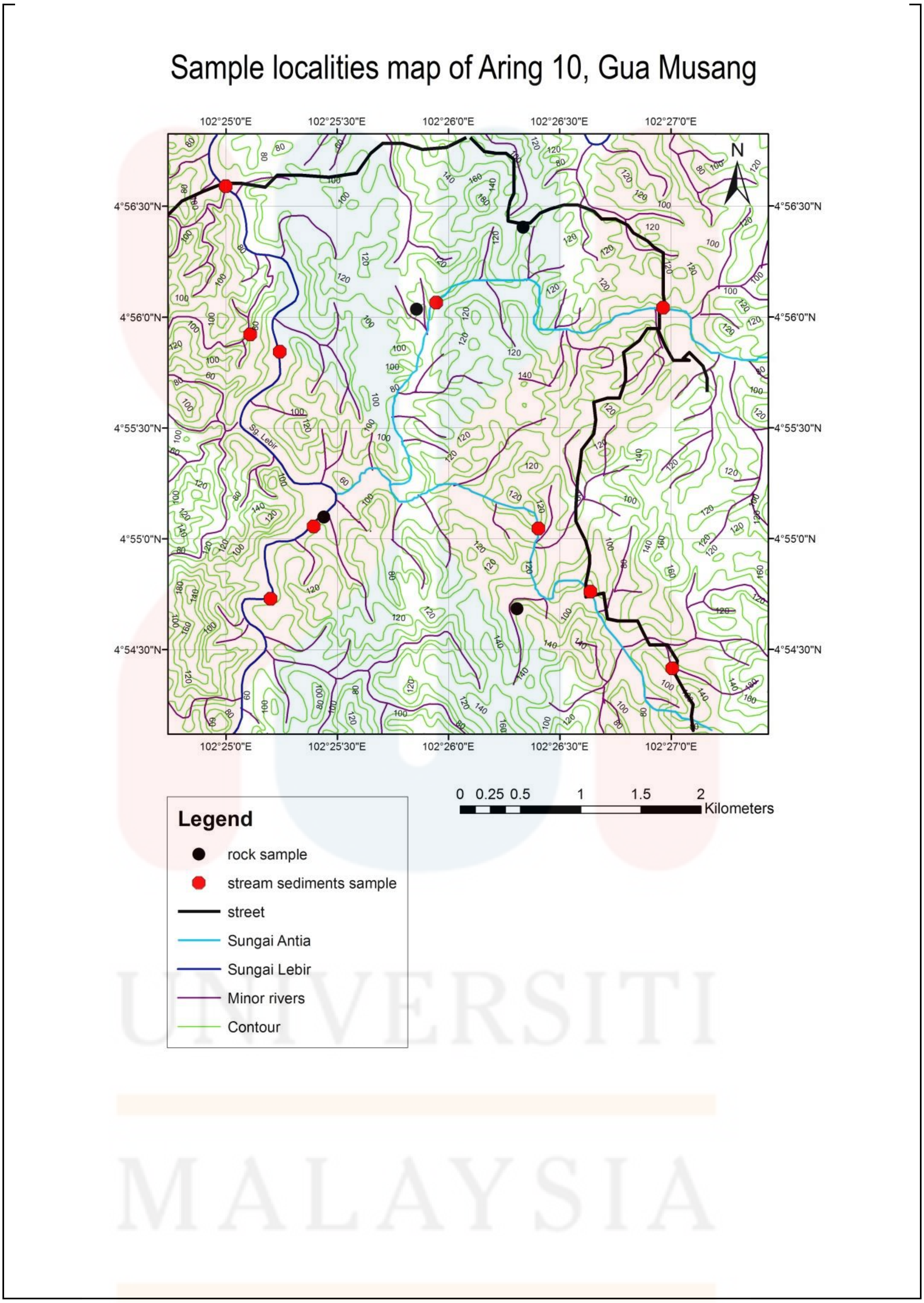


Figure 4.2: Sample localities map of study area

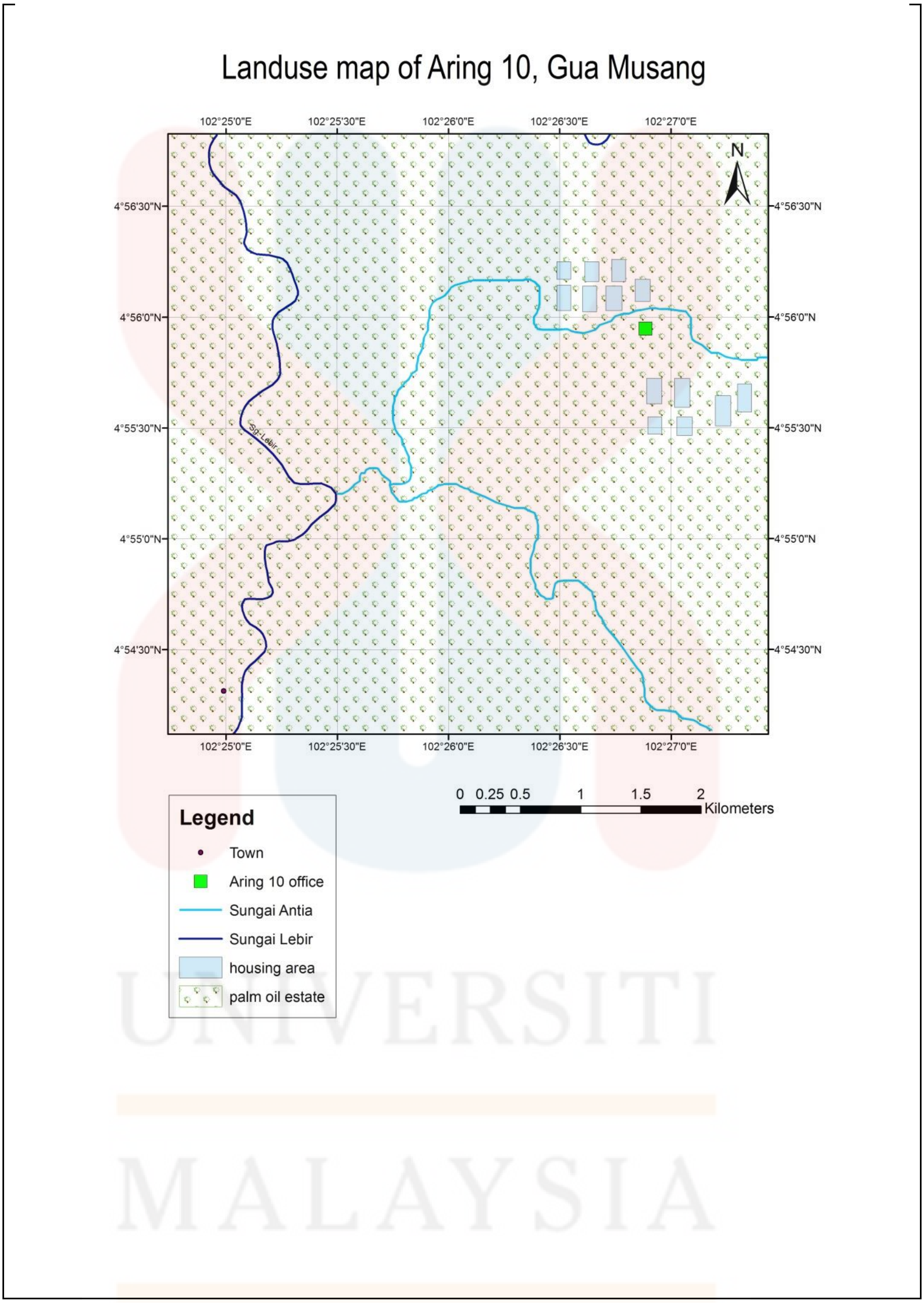


Figure 4.3: Landuse map of study area

4.2 Geomorphological Processes

4.2.1 Landforms

A landform is a natural feature of the Earth's surface. Landforms together make up a given terrain, and their arrangement on the landscape or the study of same is known as topography. Typical landforms include hills, mountains, plateaus, canyons, valleys, as well as shoreline features such as bays, peninsulas, and seas, including submerged features such as mid-ocean ridges, volcanoes, and the great ocean basins. Landforms are categorized by characteristic physical attributes such as elevation, slope, orientation, stratification, rock exposure, and soil type. Gross physical features or landforms include intuitive elements such as berms, mounds, hills, ridges, cliffs, valleys, rivers, peninsulas and numerous other structural and size-scaled elements including various kinds of inland and oceanic water bodies and sub-surface features.

Figure 4.4: Geomorphology of study area

Figure 4.5: Hills in study area

Figure 4.6: Small river in study area with limestone outcrop

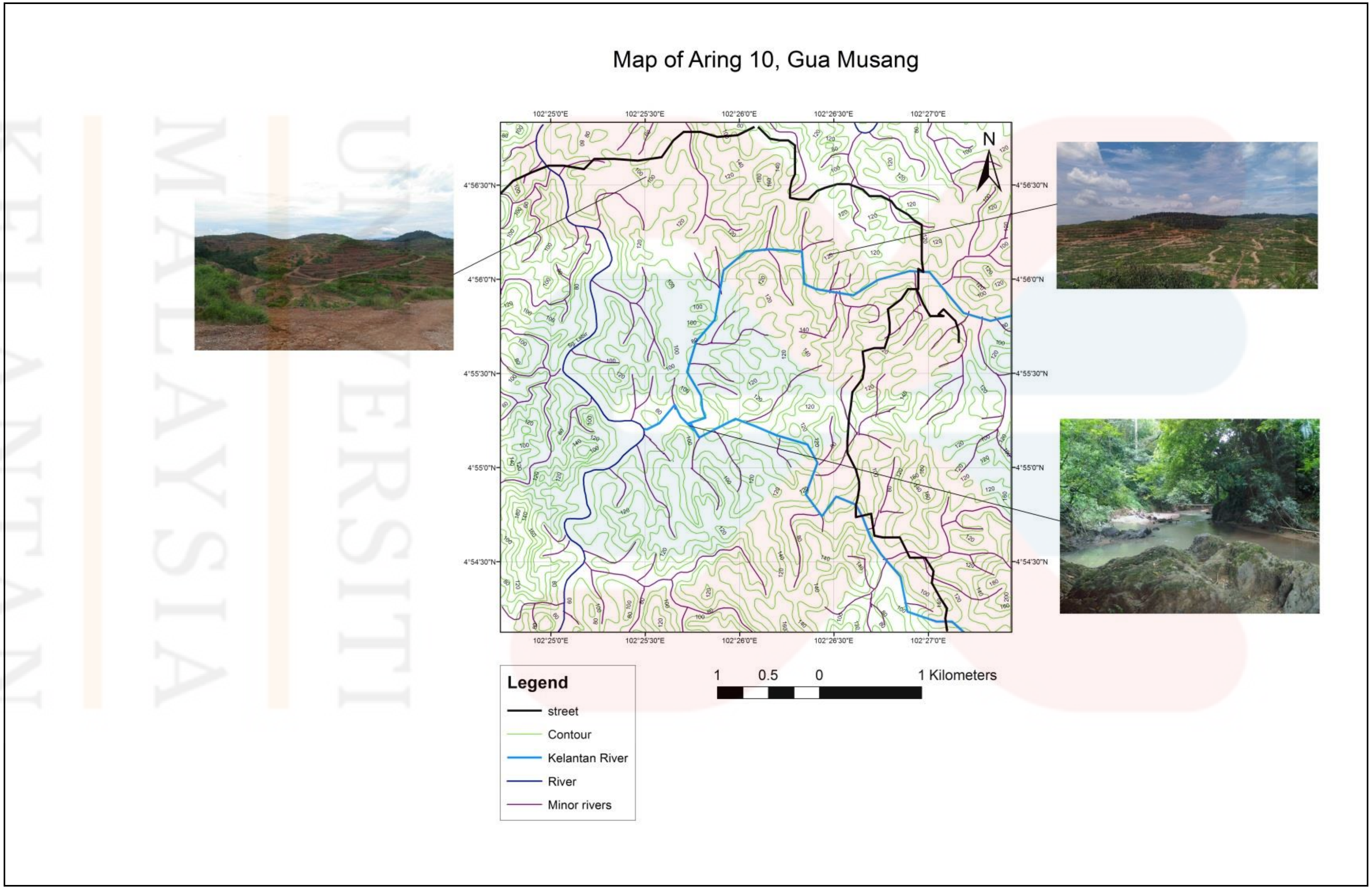


Figure 4.7: Observation point of landforms

4.2.2 Topography

The topography map in Figure 4.8 shows the features at the study area through contour lines. The contour lines represent the shape and elevation of the land such as ridges, valleys and hills. Other than that the map also shows the vegetation, water bodies, road and boundaries.

Table 4.1 shows the topographic units based on mean elevation for peninsular Malaysia. From the table the topographic features in Figure 4.8 can be determined. The lowest range of elevation showed on map is 60 m to 75 m which means it is an undulating topographic feature. The highest elevation is in the range of 184 m to 200 m which means it is a hilly topographic feature. Throughout the topographic map, the feature is mostly hilly.

a) Undulating topographic feature

An undulating topography is made up of unconsolidated materials sufficiently thick to mask the surface irregularities of the underlying material. Undulating topography is distinguished from hummocky topography on the basis of the predominantly gentler slopes.

b) Hilly topographic feature

Hill is a landform that extends above the surrounding terrains. A hill is known to be less tall and also less steep than a mountain. Hills may form through geomorphic phenomena such as faulting, erosion of larger landforms, such as mountains and movement and deposition of sediment by glaciers.

The study area is surrounded with palm oil plantation because it is a felda. It is a protected area for all authorise. There are residential areas in the felda where the workers and also the owner for each palm oil plantation lives.

Table 4.1: Topographic units based on mean elevation

Source: Geology Peninsular Malaysia

	Topographical Unit	Mean elevation
1	Low lying	<15
2	Rolling	16-30
3	Undulating	31-75
4	Hilly	76-300
5	Mountainous	>301

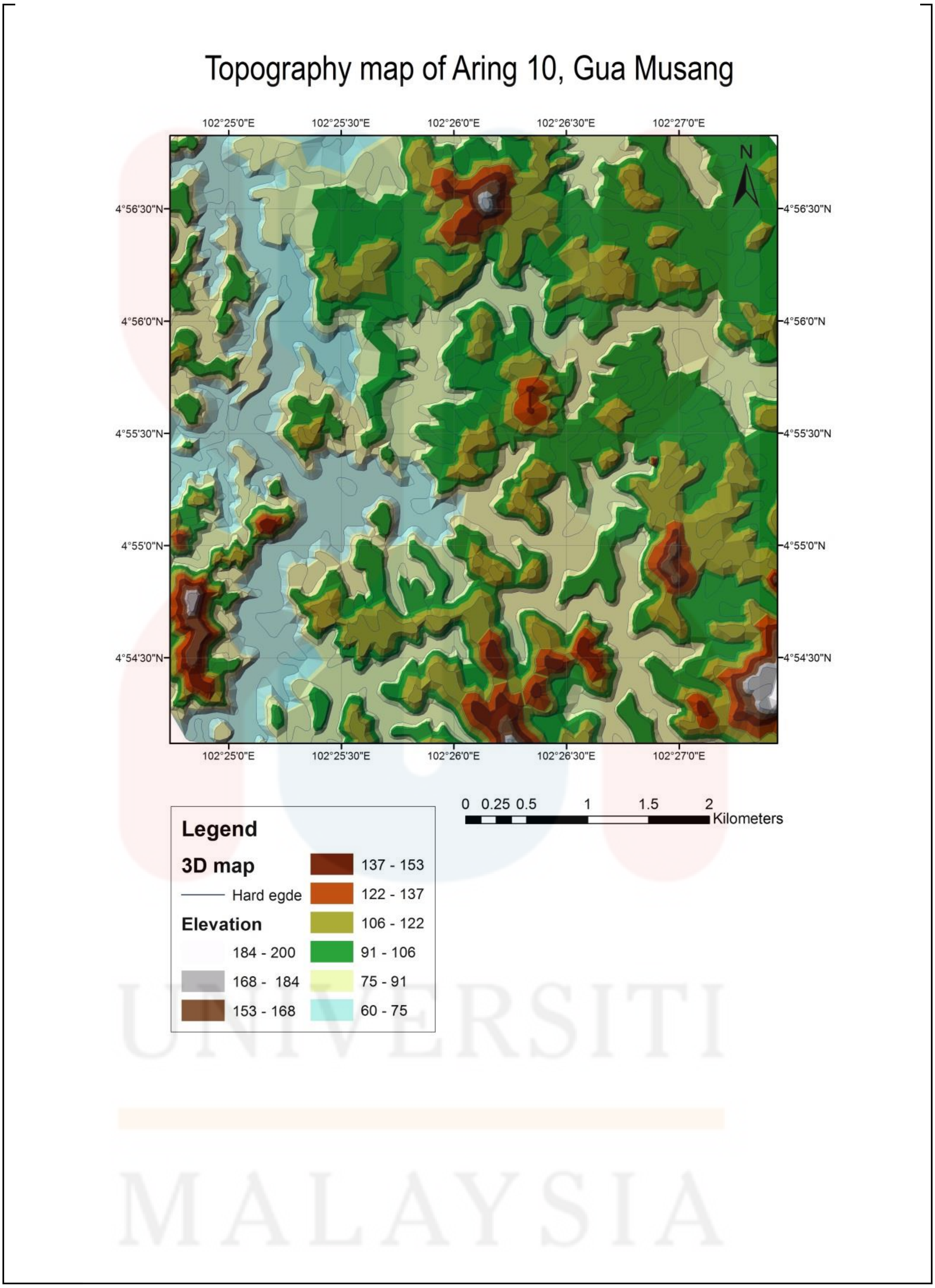


Figure 4.8: Topographic map of study area

4.2.3 Lineaments

A lineament is a linear feature in a landscape which is an expression of an underlying geological structure such as a fault. Typically a lineament will comprise a fault-aligned valley, a series of fault or fold-aligned hills, a straight coastline or indeed a combination of these features. Fracture zones, shear zones and igneous intrusions such as dykes can also give rise to lineaments. a lineament is a pattern or "figure" in a factual representation of either the earth's surface or a subsurface datum and the figure must be linear , continuous, reasonably well expressed, and be related to features of the solid earth. Figures are not lineaments by this definition if they represent cultural features, superficial geomorphic features or transient climatic or hydrographic unless these features are in fact controlled by geologic trends. Some linear stream channels, lines of vegetation, soil and relief breaks, and other surface alignments do coincide with patterns in the geologic substrate; these features can, therefore, be recognized as lineaments in photographs, maps, or scanner images.

Figure 4.9 shows the lineaments of study area which were used to do a lineament analysis. The lineaments showed in the map were all basically from the formation of hill and small valley and streams or river.

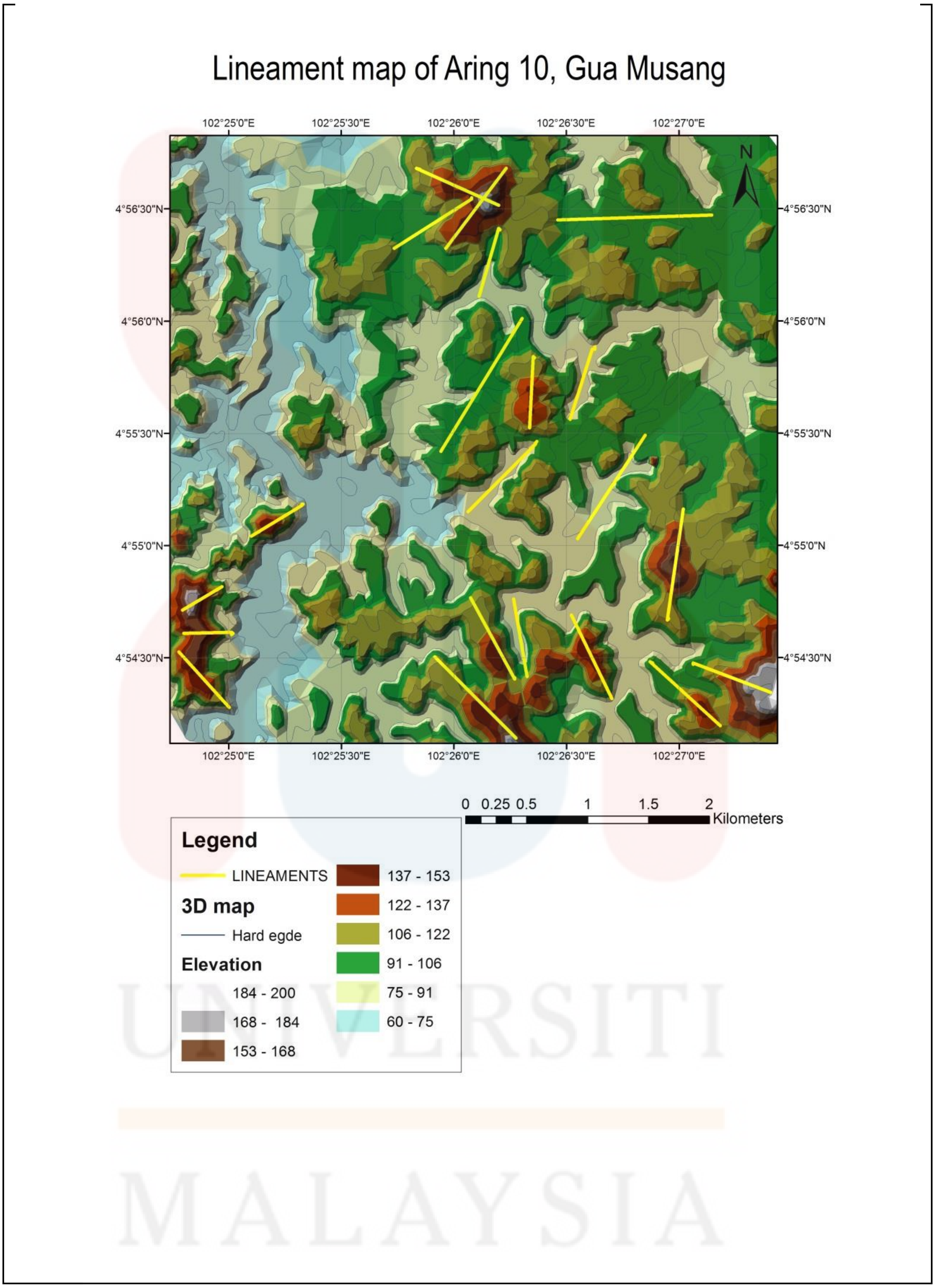


Figure 4.9: Lineaments of study area

4.2.4 Drainage System

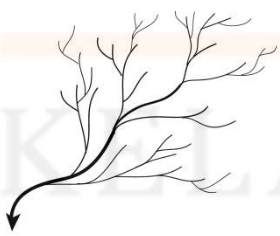
Drainage system is the pattern that formed from all water bodies found in the study area. Example of water bodies in the study area is rivers, stream and also small drainage scattered in the estate. The drainage can be either natural or artificial. The drainage can be dominated by soft rocks and hard rocks of the land. There are a few artificial drainages for agriculture purpose.

Natural drainage is often not enough for an agriculture culture and so artificial drainage is needed. The artificial drainage helps in water irrigation for any agricultural production. Rivers and stream usually follow unexpected patterns that are not likely to reflect in topography map. River and stream contributes to the underlying structure and to the chronology of the events on that particular area (Twidale, 2004).

There are several types of drainage pattern that can be classified. Table 4.2 shows the types of drainage pattern or river system such as dendritic pattern, parallel pattern, trellis pattern, rectangular pattern, radial pattern and annular pattern. The number, size, and shape of the drainage basins found in an area vary.

Table 4.2: Drainage pattern types

Source: en.wikipedia.org/wiki/Drainage_system_(geomorphology)

Drainage pattern	Description
Dendritic pattern 	The most common pattern of drainage system. This pattern has several contributing streams that joined together into the tributaries of main river. Rivers channel follow the slope of terrain.

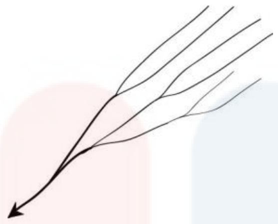
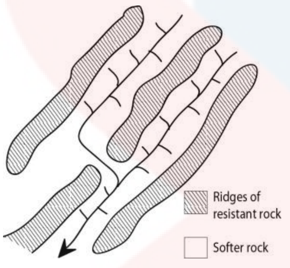
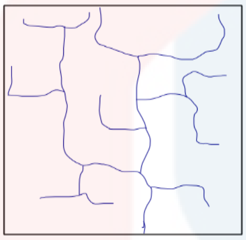
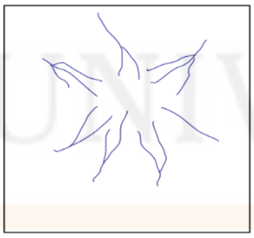
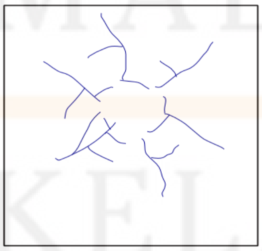
Parallel pattern 	This pattern has very few tributaries and flows all at the same direction. The streams are straight and usually formed on uniformly sloping surfaces.
Trellis pattern 	River flows along a strike valley resulting in smaller tributaries feed into it from the steep slopes on the sides.
Rectangular pattern 	A modified pattern of dendritic pattern system. Usually formed due to jointing or faulting of the underlying bedrock and associated with massive igneous and metamorphic rocks.
Radial pattern 	This pattern composed of streams radiating outward from a central peak.
Annular pattern 	Flows of tributaries are controlled by the presence of fractures. Primary streams develop in concentric, circular joints surrounding uplifted sedimentary rocks.

Figure 4.10 shows the drainage pattern within the study area. From the drainage pattern map we can conclude that the study area have a dendritic pattern of drainage system. The drainage has channels that oriented in varieties of direction. Dendritic drainage systems are the most common form of drainage system. In a dendritic system, there are many contributing which are then joined together into the tributaries of the main river. They develop where the river channel follows the slope of the terrain.

Figure 4.11 shows the watersheds that exist within the study area. Watershed is an area or ridge of land that separates waters flowing to different rivers, basins, or seas. There are four different watersheds due to different direction of river flow. The streams flow differently due to the different of elevation, streams always flow from higher elevation to lower elevation. Small streams always flow to a bigger river and therefore as in figure 4.9 the boundary of watershed always include the main river or a bigger river that receive water flows from small tributaries.

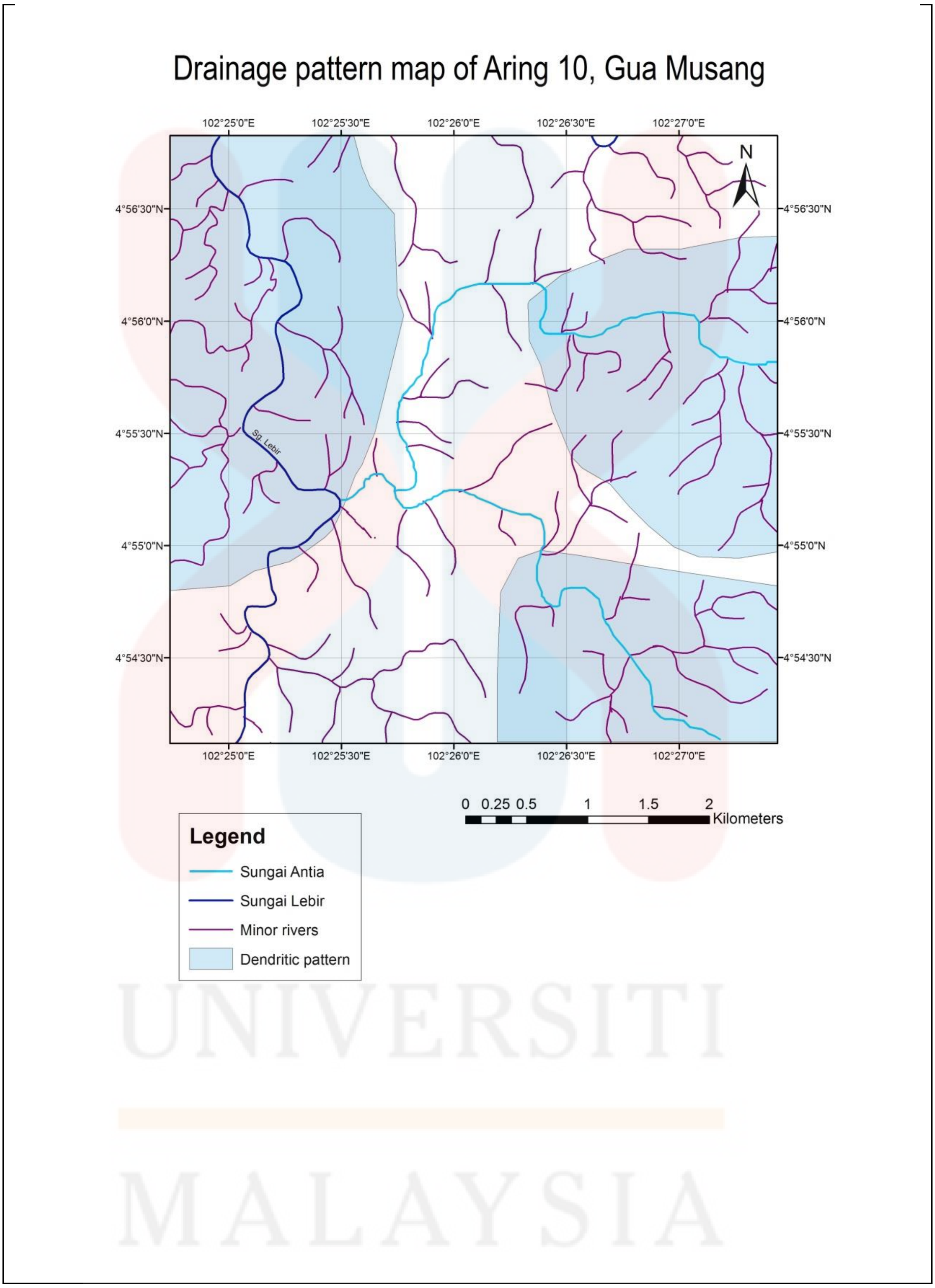


Figure 4.10: Drainage pattern of study area

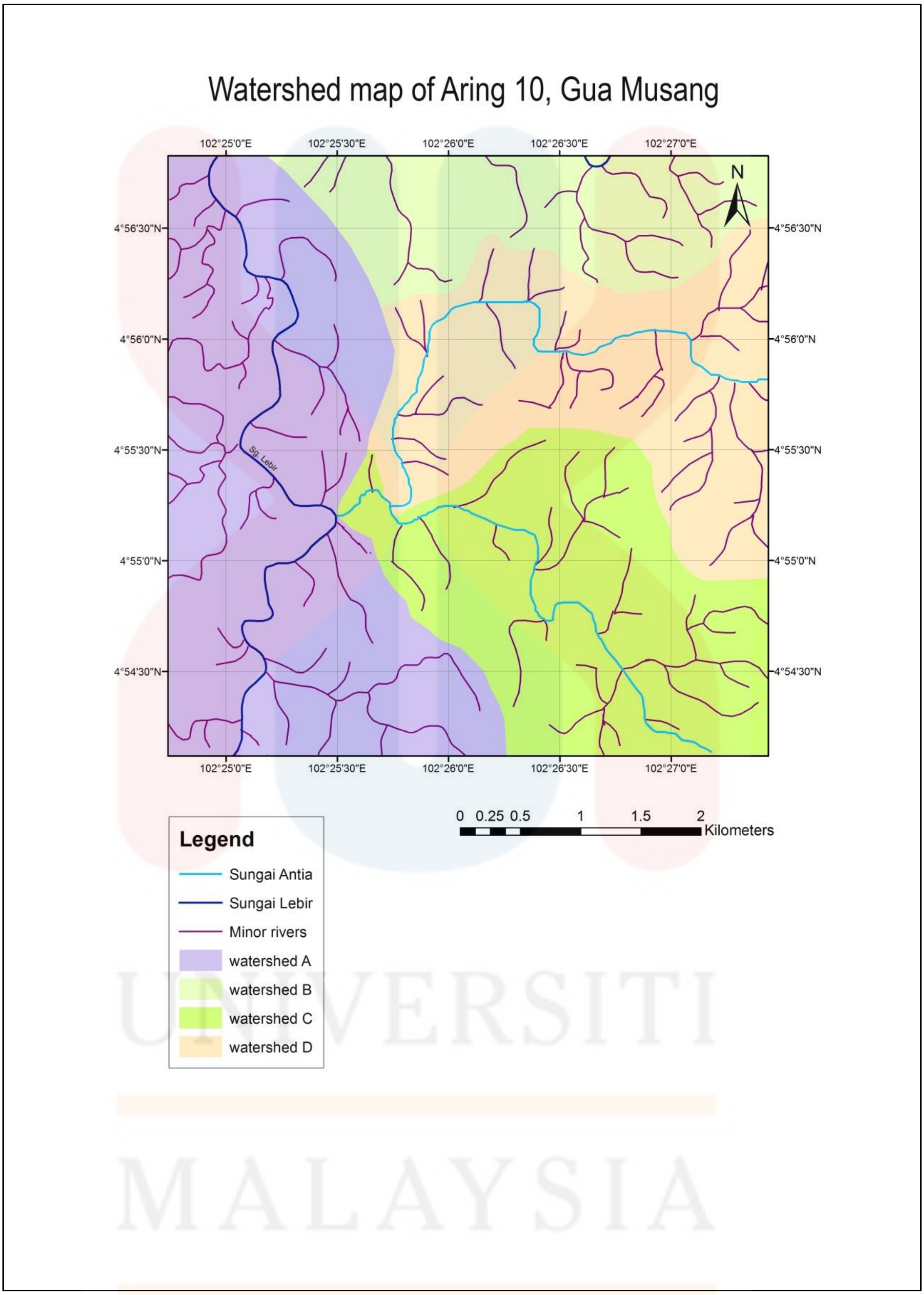


Figure 4.11: Watershed boundary of study area

4.2.5 Geologial Map

Geological map is a map that is made up to show the geological features of a certain area. The symbols and colours on the map represent the rock units and geological strata, other than that it also show exposed area. Earth's structure such as bedding planes, faults, folds, foliations, and lineaments are also shown with their respective strike and dip value. This information on a geological map gives a three dimensional orientations.

The figure 4.12 shows the geological map of the study area. It shows the elevation and also the different kinds of lithology that can be found within the area. Different lithology is represented with different colours. From figure 4.9 it is concluded that the study area have four different types of lithology which are limestone, metasedimentary rocks, sandstone and alluvium.

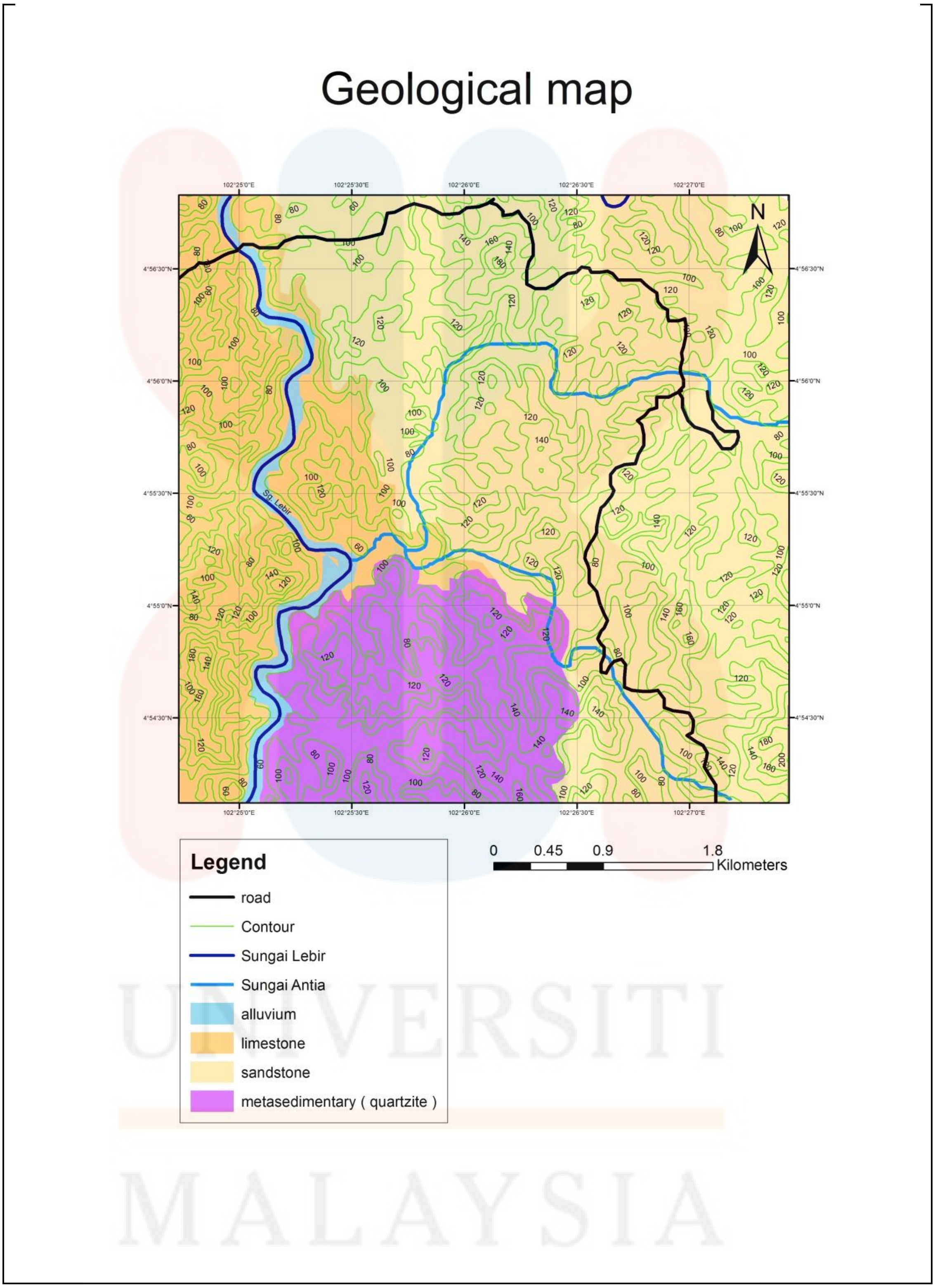


Figure 4.12: Geological map of study area

4.2.6 Weathering Process

The Earth's surface is not static, it changes through time due to its dynamic environment. The process that involves in forming the earth's surface depends on the tectonic plate movement of the earth's crust. The chemical and physical changes combine with rainfall, ice, snow, wind and gravity will wears away some of the formations made due to the tectonic movements. The process that breaks the formation or rocks is called weathering process.

Weathering process is the act of erosion or breaking down of rocks and other formations on earth's surface. There are three types of weathering process that constitute of biological, chemical and also physical weathering. All of the weathering process can act together at the same time.

One of the factor that contributes to weathering process is geological resistance is a measure of how well minerals resist erosive factors, and is primarily based on hardness, chemical reactivity and cohesion. The more hardness, less reactivity and more cohesion a mineral has, the less susceptible it will be to erosion. Differences in geological resistance in the same geological formation can lead, over time, to the formation of columns and arches.

Based on the study area, some of the contour pattern is close to each other and some of it is far from each other. From that it can conclude that the contour pattern that close together have steep slope of elevation while the contour pattern that far from each other is have gentle slope of elevation. The area that has steep slope of elevation has high resistance material. The area that has gentle slope of elevation have low resistance material such as softer rocks that are easily to undergoes erosion and weathering. In general, rocks differ in their resistance to weathering and erosion.

A process that weathered rocks without changing its mineral composition is called physical weathering. Physical weathering will result in the mechanical disruption of the rocks such as granular disintegration, exfoliation, joint block separation, shattering by the changes in pressure and temperature. This type of weathering can be seen in the study area especially outcrops along the river where water erodes the rocks and alter its shapes.

Figure 4.10 shows a limestone located in a small river that has undergone a physical weathering mostly from water erosion. Other than that, the weathering process is also influenced by the weather. Each rock was physically altered along the river as is Figure 3.11 and Figure 4.15.

Figure 4.13: Limestone that undergone a physical weathering

Figure 4.14: Outcrop eroded by stream flows

Figure 4.15: Physical change of rock due to weathering

4.3 Stratigraphy

Stratigraphy is the geological science associated with the study of strata or rock layers. Major focuses include geochronology, comparative geology, and petrology. In general a stratum will be primarily igneous or sedimentary relating to how the rock was formed. There are a number of principles that are used to explain the appearance of stratum. When an igneous rock cuts across a formation of sedimentary rock, then we can say that the igneous intrusion is younger than the sedimentary rock. The principle of superposition states that a sedimentary rock layer in a tectonically undisturbed stratum is younger than the one beneath and older than the one above it. The principle of original horizontality states that the deposition of sediments occurs as essentially horizontal beds.

Felda Aring 10, Gua Musang is an agriculture area that was mostly covered with palm oil plantation and thick forest. The outcrops were not exposed and were covered with thick bushes. Some of the outcrops were exposed due to excavating activities. During mapping period, there were some rocks encountered such as sandstone, sandstone interbedded with mudstone, metasedimentary rock and sandstone that interbedds with clayish silt. There is also some part of the study area that shows an occurrence of thin layer of black shale that contains iron ore. Figure 4.16 until figure 4.17 shows the outcrops found within the study area. Large part of Aring 10 is covered by sandstone, mudstone and limestones.

Felda Aring 10 is mostly dominated by sedimentary rocks such as limestone and sandstone. The age of the limestone is believed to be Carboniferous and sandstone is from lower Permian. There is an intrusion of quartz dyke where the age of the dyke is not determined. The sandstone in the study area does not occur alone, they usually interbedded with mudstone. Weathering process that happened to the sandstone caused the joints of some outcrops were filled with clay. Clay also can be seen at almost road side especially the small roads that connects felda to the main road of Jalan Felda Aring.

Other than that, some part of the study area, metasedimentary rock type of sandstone can be seen. The process of metamorphism changes the physical and composition of sandstone. Weathering also causes some of the sandstone contains iron ore.

Figure 4.16: Metasedimentary rock (Quartzite)

Figure 4.17: Thin layer of black shale

Table 4.3: Stratigraphy column of study area, Aring 10, Gua musang

PERIOD	LITHOLOGY	DESCRIPTION
Quartenary	Alluvium	- The alluvial materials which flow down from mountains, accumulates at foothills where the stream enter the plain. - The deposition of alluvium still continues until this day.
Permian-Triassic	Quartz dyke Sandstone Mudstone	- Aring Fomation - Intrusion of igneous rock into sandstone. Younger in age. - Sandstones and mudstone interbedds.
Carboniferous	Limestone	- Koh Formation - Occurrence of invertebrates fossils.

4.3.1 Petrography

Petrography studies the detailed descriptions of all types of rocks whether it is an igneous, metamorphic or sedimentary rock. Studying petrography will allow us to know the mineral content and the textural relationship within the rocks in detail. The details were obtained by doing petrography analysis.

A petrographic analysis was carried out to determine the mineral contain in the rocks to know the specific name of the rocks found within the study area. There are four different thin sections for their minerals to be determined.

A) Sandstone

Sedimentary rocks such as sandstone were exposed along the outcrop of river and at the side of road of study area. The outcrop is not obvious in thick forest and hilly area because it is mostly covered with thick bushes. Sandstone covered almost 35% of study area as can be consider as the dominant type of rock in the study area. The sandstones were usually greyish in colour resulting from extensive weathering. The main composition of sandstone is quartz. Figure 4.18 shows the hand sample of sandstone, which are grey in colour and composed of fine-grained texture.

B) Limestone

Limestone is a sedimentary rock and is composed of mostly calcium carbonate in the form of calcite mineral. The depositional environment of limestone is usually in shallow and calm marine water. Organisms in that particular environment are able to form carbonate shells. Limestone is also distributed widely in the study area especially along the river and can be consider as one of dominant rocks. Figure 4.19 shows the hand sample of limestone.

Figure 4.18: Sandstone sample

Location: 102°26'19.392" E 4°56'24.692" N Name of Rock : *Sandstone*

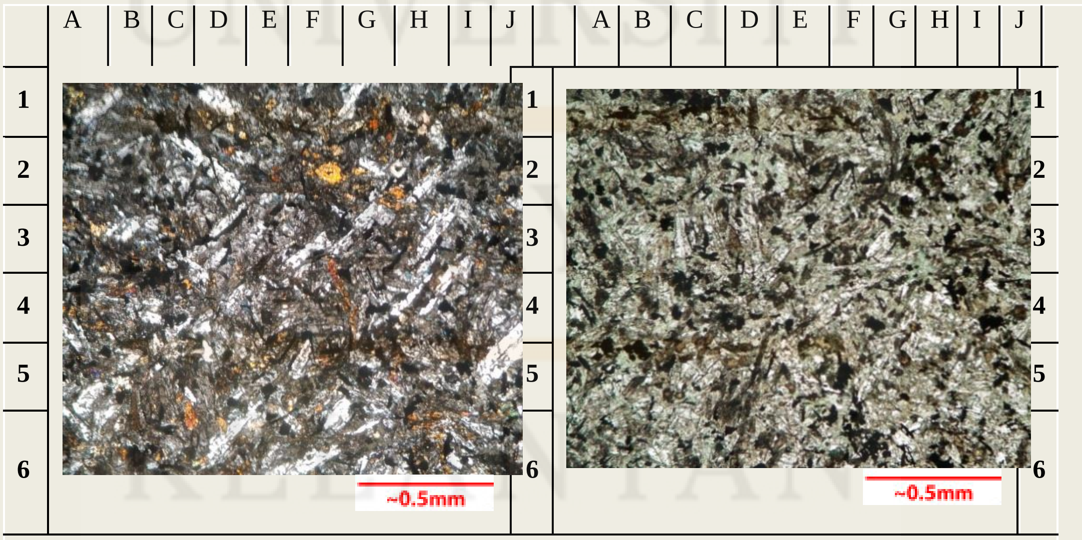
***Rock Type* :** Clastic sedimentary Rock

***Classification* : Wenworth scale**

***Microscopic* :** Thin section is composed of quartz, biotite, plagioclase and rock fragments in dark color.

Mineral composition	***Amount (%)***	***Description of Optical Mineralogy***
Biotite (2F)	**15**	It is seen now in plain polarized light as a brown to tan color. Under cross-polarized light, the biotite thin section appears darker brown.
Plagioclase (5I)	**30**	Black and white in colour and shows twinning extinction from cross polarised to plain polarised.
Quartz (4C)	**55**	Higher relief in cross polarised than in plain polarised. Pleochroism of quartz present.

<u>Photo</u>

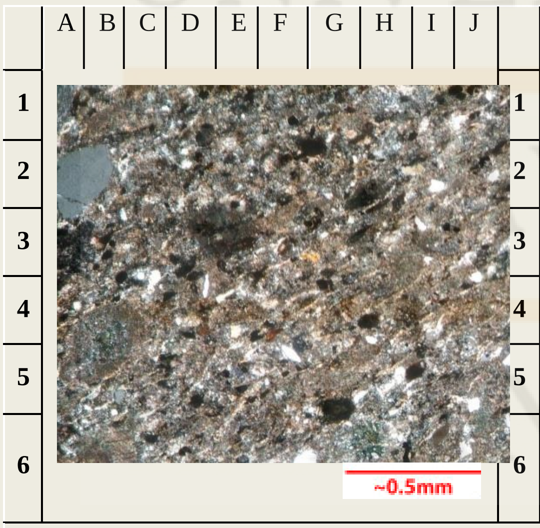


Cross-polarised *Plain-polarised*

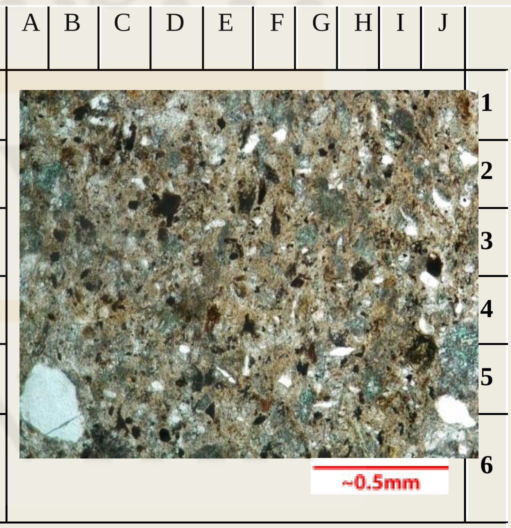
Figure 4.19: Limestone sample

Location : 102°25'26.063" E 4°55'6.542" N		Name of Rock: *Limestone(oolitic)*
***Rock Type* :** Carbonate Sedimentary Rock		
***Classification* : Dunham (1962)**		
***Microscopic* :** Contains open pore spaces. Rounded shape minerals. Thin section is composed of calcite, hornblende and matrix. The rock is a matrix supported rock.		
Mineral composition	***Amount (%)***	***Description of Optical Mineralogy***
Calcite (5G)	**15**	Calcite will be in darker colour in cross polarised and white in plain polarised. Twinning is visible in cross polarised light.
Hornblende (5B)	**10**	Greenish brown in colour. The plechroism is intensed when changing cross polarised to plain polarised.
Matrix	**75**	Due to matrix supported condition, there are not many minerals can be seen and identified.

Photo



Cross-polarised



Plain-polarised

4.4 Structural Geology

Field work is carried out to collect data that will be able to help for structural analysis. The data collected then were analyzed by using software for example the rose diagram software to produce rose diagram. This joint analysis was carried out to determine the orientation of tectonic stresses. Joints are planes of separation on which no shear displacement has taken place. The two walls of the resulting opening typically remain in tight contact. Joints may result from regional tectonics, folding, faulting, or internal stress release during uplift or cooling. They often form under high fluid pressure perpendicular to the smallest principal of stress.

Figure 4.20 shows one of the geological structures in the study area. The picture was taken along the road entering Aring 10 office. The outcrop is basically mudstone and is intruded with a quartz dyke. The outcrop was exposed by hill cutting activities. The close-up picture of the quartz dyke can be seen in Figure 4.21. Figure 4.22 shows the joint of an outcrop that were used for joint analysis.

Figure 4.20: Sandstone with quartz vein intrusion
Coordinate: 102°26'19.678" E 4°56'24.692" N

Figure 4.21: Close-up of quartz vein
Coordinate: 102°26'19.678" E 4°56'24.692" N

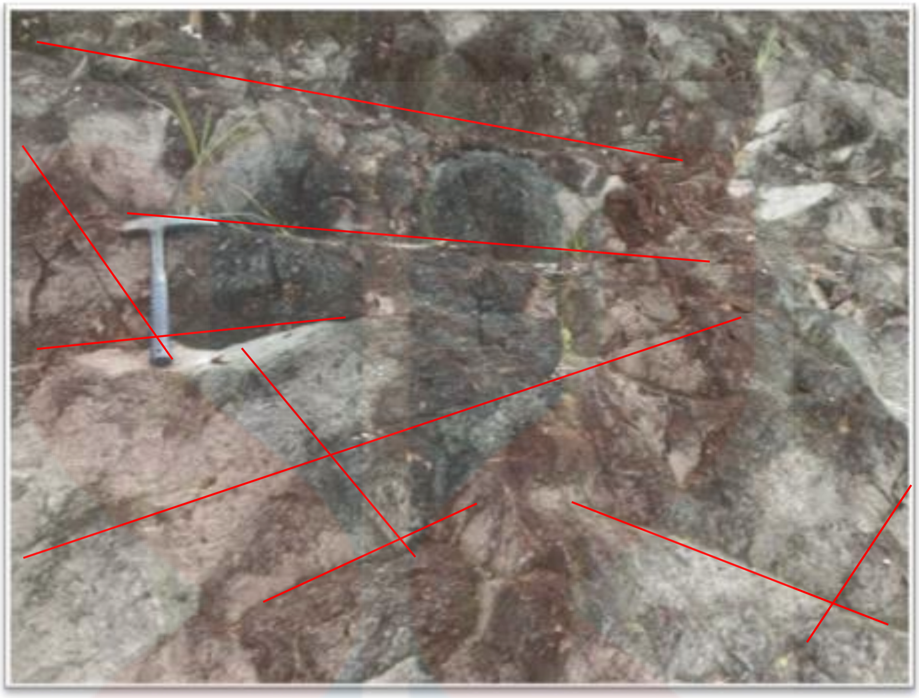


Figure 4.22: Joint on an outcrop
Coordinate: 102°26'3.918" E 4°56'27.284" N

4.4.1 Joint Analysis

A fracture of natural origin in the continuity of a body of rock is called a joint. They usually lacks of any visible or measurable movement parallel to the surface of the fracture. Joints can be found in most of exposure rocks as they are the most universal geologic structures. Joints are all different in their forms of appearance, dimensions, and arrangement. A joint analysis can be defined through mapping and by analysing their orientations. Joints are prominently occur in sandstone, limestone, quartzite, and granite. Dikes and veins are both considered as joints because they are a fracture that was filled with other minerals.

During mapping, two joint analyses were done at different locations. One of the outcrops has an intrusion of a dike as shown in previous Figure of 4.21. 100 readings of joints were taken at both location and were inserted in GeoRose software to obtain their rock force by determining sigma 1 and sigma 3. Sigma 1 is the biggest source of rock whereas sigma 3 is perpendicular to sigma 1.

Table 4.4: Joints readings for joint analysis 1

74	203	167	83	99	105	106	76	99	57
80	210	179	94	91	129	88	75	92	47
213	209	95	72	93	110	107	41	48	71
75	215	97	78	84	358	100	37	67	24
88	150	95	86	71	2	88	26	72	184
85	146	174	92	30	84	79	24	77	123
165	165	175	90	123	100	72	46	78	88
179	126	175	52	124	83	27	49	93	76
187	177	110	64	125	36	76	36	94	93
198	111	145	182	107	94	90	94	62	97

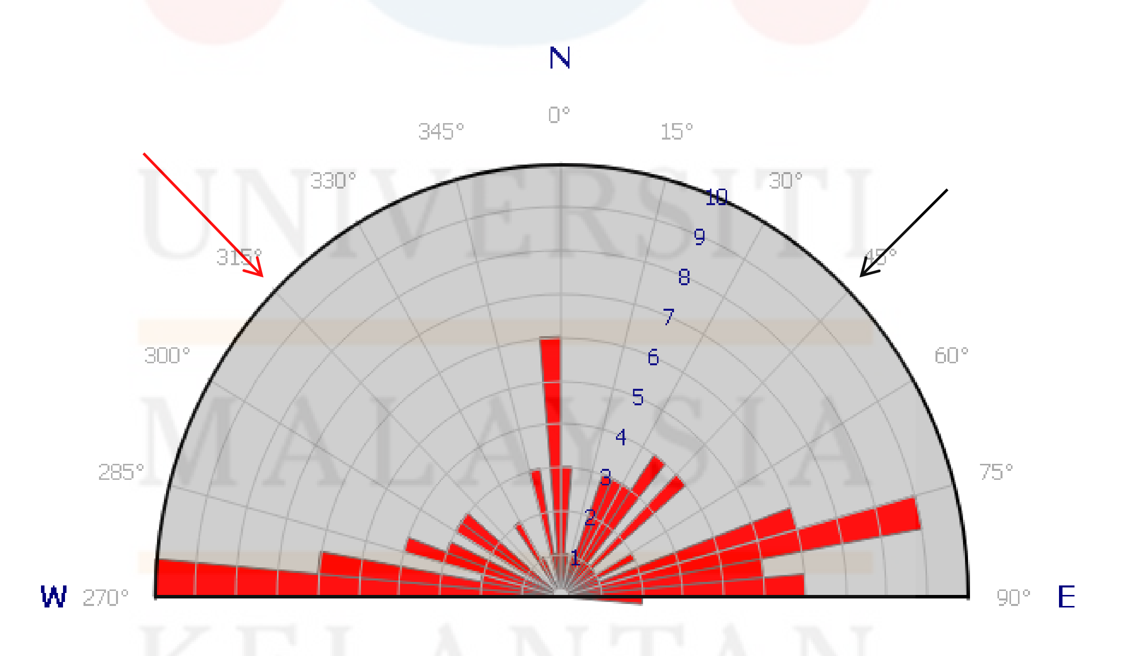


Figure 4.23: Rose diagram for joint analysis 1

Table 4.5: Joint readings for joint analysis 2

179	288	167	204	194	220	153	197	136	139
190	288	199	214	179	208	123	124	162	121
198	282	278	214	227	203	141	131	153	126
183	252	181	208	192	215	62	206	144	111
322	255	182	206	185	249	125	175	145	130
353	270	182	196	215	299	188	151	117	95
259	276	183	208	319	288	179	144	102	72
185	307	187	209	244	332	146	146	116	155
271	317	157	218	186	171	153	177	110	160
258	189	181	210	225	281	145	126	110	157

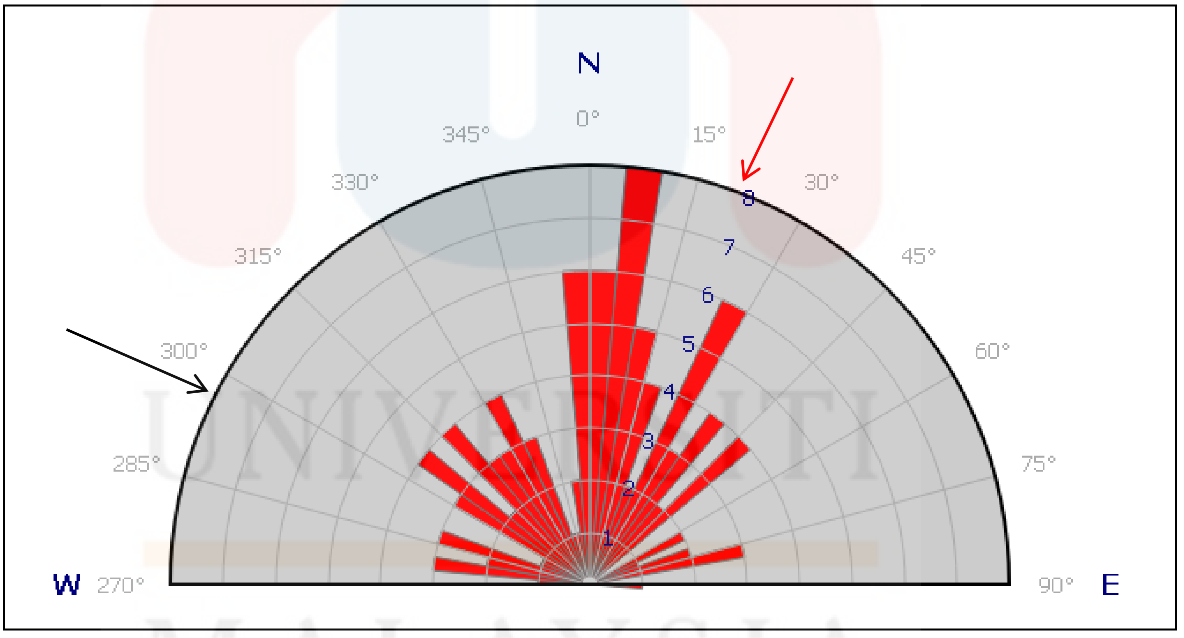


Figure 4.24: Rose diagram for joint analysis 2

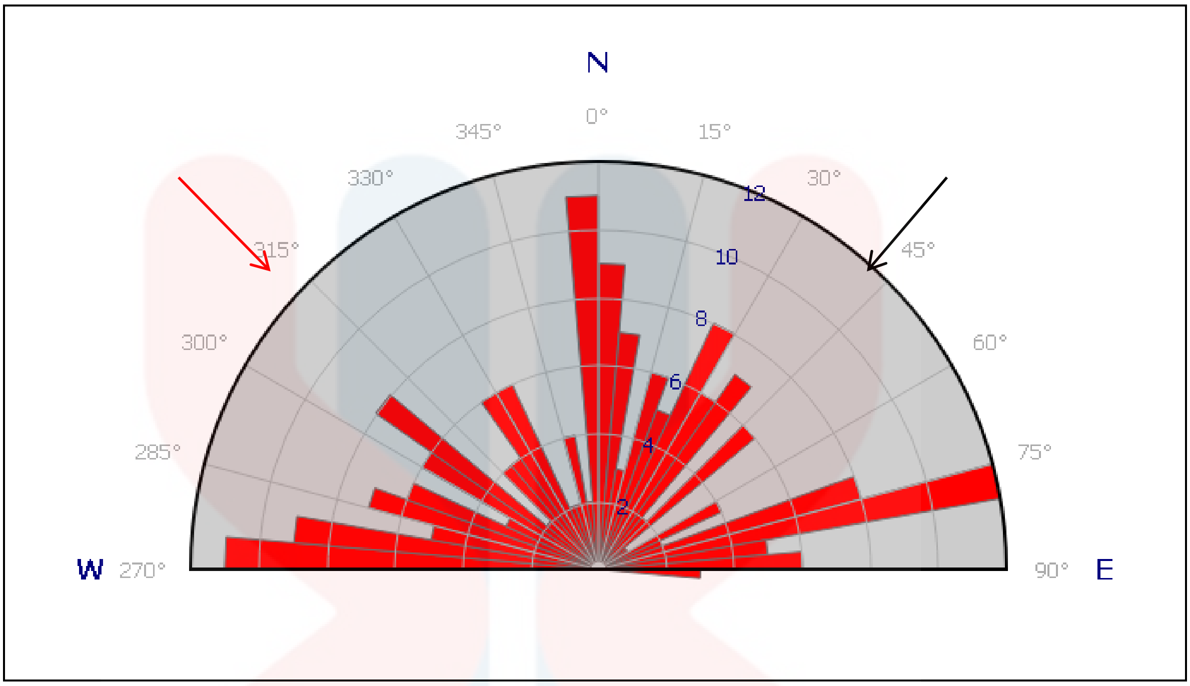


Figure 4.25: Rose diagram for both joint analyses

The rose diagram in Figure 4.23, 4.24 and 4.25 shows the direction of the force acting on the rock. The red arrow indicates sigma 1, which is the biggest force acting on the rock. The black arrow indicates sigma 3, which is a force that acts perpendicularly to sigma 1. From Figure 4.23, the biggest force comes from N 315° E and the force that acts perpendicular to the biggest force is from N 45° E. Figure 4.24 shows the biggest force came from N 20° E and the force that acts perpendicular to the biggest force is from N 298° E. The combination of both of the joint analysis can be concluded in figure 4.25. Figure 4.25 shows the biggest force came from N 318° W, whereas the force that acts perpendicular to the biggest force came from N 42° E. All the joints formed are due to all the forces acting on the rock from different directions.

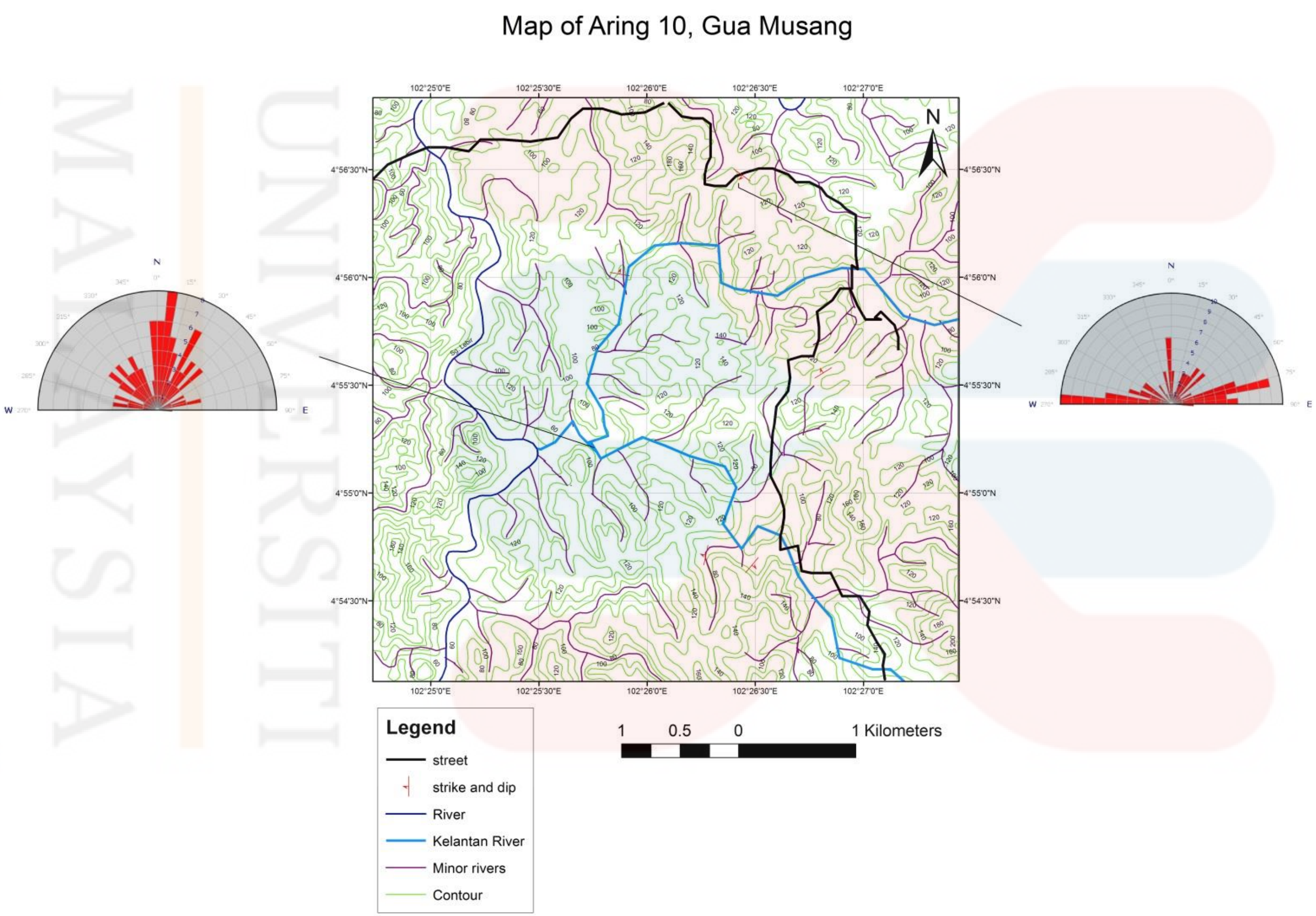


Figure 4.27: Structural map of study area

4.4.2 Lineament Analysis

A linear feature in a landscape is called a lineament. It is an indication of an underlying geological structure such as faulting. There are many geological structures that give rises to lineament such as fault-aligned valley, fold-aligned hills, and straight coastline. Other than that, fracture zones, shear zones and intrusion of igneous also give rises to lineament. Lineaments can be determined by using geological or topographic maps. A 3D topographic map was used to calculate the bearing of all the visible lineaments as shown in previous Figure of 4.9.

Table 4.6: Lineaments readings

60	142	96	66	37	126	56	11	34	19
20	48	40	6	131	166	185	154	131	119

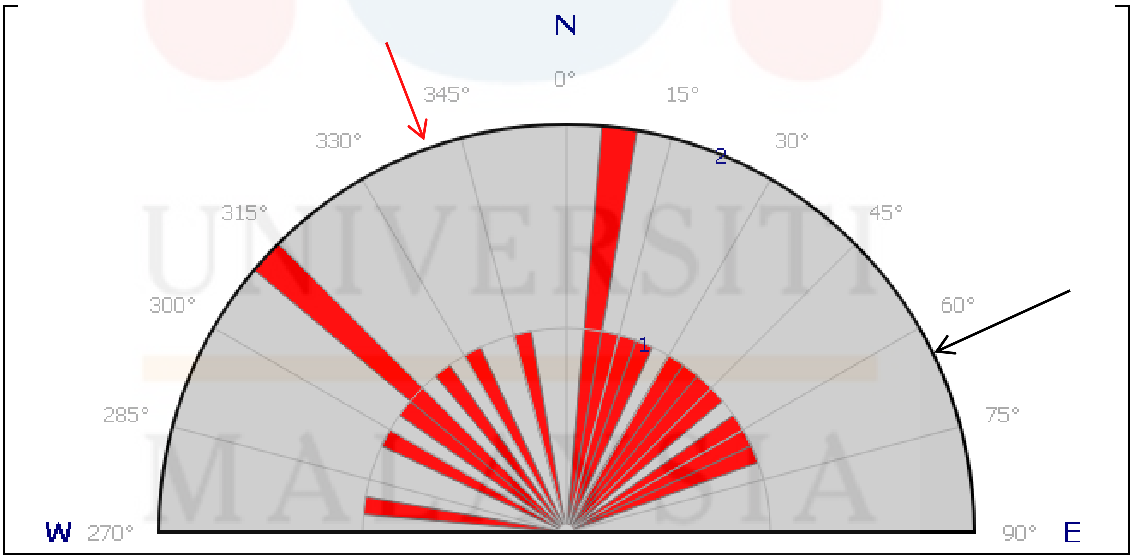


Figure 4.27: Rose diagram lineament analysis

Figure 4.27 shows the rose diagram of lineament analysis of study area. The biggest force acting on the study area that gives rise to lineament is from N 340° W and the force that acts perpendicular to the biggest force is from N 63° E. These forces is responsible for the structures in the study area.

4.5 Historical Geology

The principles and techniques of geology to reconstruct and to understand the geological history of the Earth is called historical geology. Historical geology focuses on geological processes that alter the Earth's subsurface and surface, which includes the Earth's stratigraphy, structural geology and paleontology that enables us to know the sequence of Earth's events. Other than that, by studying historical geology of the Earth we will also be able to know the evolution of Earth's flora and fauna according to the geological time scale (Levin and Harold, 2003).

Felda Aring 10 composed of a few formations which are Aring Formation, Telong Formation, Nilam Marble Formation and Koh Formation. Mainly there are four types of lithology found in the study area which are limestone, sandstone, sandstone interbedded with mudstones, and metasedimentary rocks. The limestones are believed to be in Koh Formation which is the youngest formation in Aring area. The sandstones interbedds with mudstone aged Jurassic. The weathering process onto these rocks resulting in deposition of clay in the study area.

The limestones encountered are from Nilam Marble Formation aged carboniferous. It is scattered all over the study area as Gua Musang is popular with its dominant limestones distribution. From the occurrence of limestone, the depositional environment of the study area can be determined which is shallow marine environment. Metasedimentary rocks are an indication of metamorphism of rock that was exposed to weathering and pressure. At some part of the study area, the sandstone shows quartzite characteristic. Overtime, the rocks in the study area metamorphose into another type of lithology.

CHAPTER 5

RESULTS AND DISCUSSION

5.1: Introduction

The geochemical analysis of stream sediments comprises of pH analysis and XRF analysis. The pH analysis determined the pH value of each samples. The identification of pH value of stream sediment will determine whether the stream sediments are acidic or basic. The geochemical analyses were done to determine the concentration of the five elements within the study area. The concentrations were obtained in ppm value and were used to produce an interpolation map where it shows the distribution of the elements within the range of sampling localities. All of the interpolation maps were combined to produce a geochemical map of the study area.

5.2: pH Analysis

Table 5.1: pH values for each of the samples.

Sample	pH Value	Temperature
1	6.15	24.2
2	6.35	24.7
3	6.36	24.3
4	5.93	24.1
5	5.20	24.4
6	6.14	24.3
7	5.29	24.1
8	5.96	24.1
9	5.65	24.1
10	5.39	24.5

Table 5.1 shows the pH values for each of the samples collected randomly within the study area. The pH values were tested using a pH meter and their results of pH values with their respective temperature were recorded. The pH scale measures how acidic or basic a substance is. The pH scale ranges from 0 to 14. A pH of 7 is

neutral. A pH less than 7 is acidic. A pH greater than 7 is basic. According to table 5.1 the range of pH value are from 5.20 to 6.36. The overall result shows that the stream water is slightly acidic.

The pH value of the stream sediments also indicates the concentration of heavy metals. Certain metals exist in certain pH values depending on its acidity and toxicity. Even though Aring 10 is a palm estate area, the rivers were not contaminated with high toxicity and therefore the pH value of the stream sediment does not show any strong acid occurrence.

5.3: XRF Analysis of Stream Sediment

Table 5.2 shows the concentration of 5 different heavy metals in 10 different localities within the study area. The 5 element showed on the table are ferum, zirconium, barium, manganese and aluminium. The transition medium is from solid to powder form which is from stream sediment to powder to be analyzed under XRF machine.

Table shows the highest concentration among all the elements is ferum at 42.9 ppm in location 2 and the lowest concentration for ferum is 4.68 ppm in location 1. The next major element deposition is aluminium with the highest concentration of 8.45 ppm in location whereas its lowest concentration is 4.60 ppm. Aluminium is followed by zirconium with the highest concentration of 1.33 ppm in location 1 and the lowest concentration of 0.291 ppm in location 2. Barium's highest concentration is 0.838 ppm after zirconium in location 4 whiles its lowest concentration of 0.293 ppm in location 5. The lowest concentration among all the elements is manganese having it highest concentration of 0.787 ppm in location 2 and lowest concentration at 0.109 ppm in location 1.

Figure 5.1 until Figure 5.5 shows the graph of concentration of Fe, Zr, Ba, Mn and Al respectively. The graphs show the changes of the elements concentration from location 1 until location 10.

The most significant deposition is iron element, which marked the highest value of 42.9 ppm with the mean value of 14.835ppm. Figure 5.6 shows the location of sampling and the ppm value of iron element. From the figure, the highest concentration of iron is located at location 2 and the second highest value of concentration is located at location 5 with value of 27.4ppm. Location 2 and location 5 are both located along Sungai Lebir. Besides that, the concentration of iron also scattered widely at all other locations in Sungai Lebir, Sungai Antia, and small streams with ppm value of not lower than 8 ppm which are higher than all the mean ppm value of other elements.

The study area is dominated by sedimentary rocks composed of sandstones and mudstones. Most of the sedimentary rocks are iron bearing rocks containing high concentration of iron. Iron oxides are the main iron bearing minerals (Hiroi et al., 1994). The intensive and continuously rate of weathering due to rainfall and pressure the exposed of iron ore deposits at the study area were transported throughout Sungai Lebir. The occurrence of iron also maybe originated from human activities that located within the study area. The occurrence of iron oxide minerals were used to produce the scattered interpolation map of the ppm value range of iron.

The distribution of aluminum is the second most significant with the highest value of 8.28 ppm and with a mean of 5.757 ppm. Figure 5.10 shows the locations of stream sediments with aluminum ppm values. From the figure the highest concentration of aluminum is at location 5 with a value of 8.45 ppm followed by 8.28

ppm at location 2. Location 2 and location 5 are both located along Sungai Lebir. The distribution of aluminum is scattered widely at all other locations with the value range of 4.00 ppm to 7.00 ppm.

Aluminum is the most abundant metal and the third most abundant element in the earth's crust. It is mostly found in rocks not free in nature (Lide 2005; Staley and Haupin 1992). Aluminum enters environmental media naturally through the weathering of rocks and minerals. Anthropogenic releases are in the form of waste water effluents and solid waste primarily associated with industrial processes, such as aluminum production. Sandstone is the most dominant rocks covering the study area. Sandstones within the study area are higly concentrated with feldspar mineral. Feldspars are unstable in the sedimentary environment, most feldspars in sandstones show the effects of alteration. This is usually evident as growths of microcrystalline clay minerals along cleavage planes and on the surfaces of the feldspars. Clay can be seen on the small roads inside the felda. Rocks with high amount of feldspar are aluminum bearing rocks. The weathering of sandstone is a major reason for the occurence of aluminum within the study area.

The Figure 5.7 shows the sample locations of stream sediments with zirconium concentration values. The highest concentration value of zirconium is 1.33 ppm with a mean value of 0.6837 ppm. The figure shows that the highest concentration of zirconium is at location 4 with value of 1.33 ppm followed by location 8 with 1.01 ppm value. Location 4 is located at Sungai Lebir while location 8 is located at Sungai Antia, a smaller river within the study area. The concentration of zirconium is distributed widely at all other locations with range value of 0.20 ppm to 0.80 ppm.

Zirconium is not usually noticed in rocks and sediments due to their very small particle size. Even so, zirconium is widely distributed across the rocks of Earth's surface. It's resistant towards chemical alteration and abrasion is high therefore they are not easily weathered. Weathered zirconium bearing rocks will result in numbers of tiny zirconium crystal and persist in sedimentary rocks for years. Along the river in study area, limestone was exposed. Some of largest crystals of zirconium are formed in limestone altered by hydrothermal metamorphism. The weathering of limestone might be the source of zirconium occurrence in stream sediments.

Sample locations of stream sediment with barium concentration values can be seen in Figure 5.8. The highest concentration value of barium is 0.838 ppm with mean value of 0.554 ppm. From the figure, it can be seen that the highest concentration of barium is at location 4 with 0.838 ppm followed by 0.832 ppm at location 6. Both of the location is located along Sungai Lebir and Sungai Antia. The concentrations of barium are distributed widely at all other locations with range value of 0.20 ppm to 0.70 ppm.

Barium is never found in nature as a free element due to its high chemical reactivity. Barium that was released from a weathered rock is not mobile because it is easily precipitated as carbonate. It can be easily absorbed by clays and concentrated in Mn concretions (Kabata-Pendias 2001). This explains the low concentration of barium in stream sediments. The concentrations of barium in stream sediments are strongly controlled by the abundance of barium element in bedrock. As the environment changes, the geochemical processes also shows variability. In the study area, besides dominated by sandstones, clay are also found in most of the area. Clay are one of barium bearing rocks and therefore the concentration of barium might come from the dissolution of barium minerals from clay thus transported throughout the water bodies.

Figure 5.9 shows the sample locations of stream sediment with manganese concentration values. The highest concentration of managnese is 0.787 ppm with a mean value of 0.2916 ppm. Manganese has the lowest distribution of concentration compared to the other four elements. The highest concentration of managnese is at location 2 with value of 0. 787 ppm followed by 0.407 ppm at location 5. Both of the locations are located along Sungai Lebir and Sungai Antia. The distribution of manganese was spreaded widely at all other locations with the ranging value of 0.20 ppm to 0.50 ppm.

The distribution of manganese can strongly affect the distribution and concentration of other metals, particularly the heavy metals. The occurrence of maganese might be solely due to human activities in the study area. Manganese concentrations in river from an urban lake receiving inputs from industrial and residential areas, as well as windborne dust from old palm oil factory.

Software Arc-GIS IDW method was applied to study the possible distribution of the five elements within the study area. The software determines the possible extension and distribution of each element based on the elements coverage from sampling method in the study area. Figure 5.11 until figure 5.15 shows the possible distribution of Fe, Zr, Ba, Mn, and Al respectively to the fullest extends of the study area at scale of 1:25000. Figure 5.16 shows the possible distribution of all five elements within the study area.

From Figure 5.11, it shows that the trend of possible concentration distribution of iron is increasing from south east to North West direction of the study area. Figure 5.12 shows the possible distribution of zirconium, according to the figure, the distribution of zirconium is random without any specific trend. There are some parts where the concentration of zirconium is high and some parts are very low. For Figure 5.13 the distribution of barium shows a higher concentration at the central of the study area and has lower concentration towards the south and north of study area. The Figure 5.14 shows the distribution of manganese where it shows a trend of increasing in concentration towards North West of the study area. Lastly, Figure 5.15 showing that aluminum is having the same trend of increasing in concentration towards North West of study area.

A geochemical map is produced my combining all the interpolation map of each element in one map. Geochemical map can be seen in figure 5.16. According to the map, the distribution of concentration of all the elements increases from south east towards North West. Most of the elements occurs in Sungai Lebir as it is the main river of Aring 10 and was used widely by the population in Aring 10. Other than all the geological events that contributes to contamination of the elements in stream sediements, human activities also contributes to the occurrence of the elements.

The agriculture activities in Felda Aring 10 are very active and they used three types of fertilizers for the plantation which are ammonium sulphate, borax, and muriate of potash. The uses of the fertilizers might be one of the sources of metals contamination in stream sediment. The fertilizers will usually dissolve in soil or water and deposited throughout the study area and along the water bodies. The Figure 5.17 shows the location of high concentration of heavy metals.

Table 5.2: Overall result of 5 element concentration (ppm) for 10 sampling localities.

Fe= ferum, Zr= zirconium, Ba= barium, Mn= manganese, Al= aluminium

Sample/Location	Ppm Fe	Ppm Zr	Ppm Ba	Ppm Mn	Ppm Al
1	4.68	1.33	0.525	0.109	4.6
2	42.9	0.291	0.593	0.787	8.28
3	5.53	0.897	0.508	0.27	4.75
4	12.8	0.516	0.838	0.237	6.01
5	27.4	0.375	0.293	0.407	8.45
6	14.1	0.64	0.382	0.263	5.71
7	10.9	0.506	0.807	0.204	5.30
8	9.33	1.01	0.383	0.227	4.61
9	11.1	0.662	0.50	0.175	4.78
10	9.61	0.61	0.714	0.237	5.08

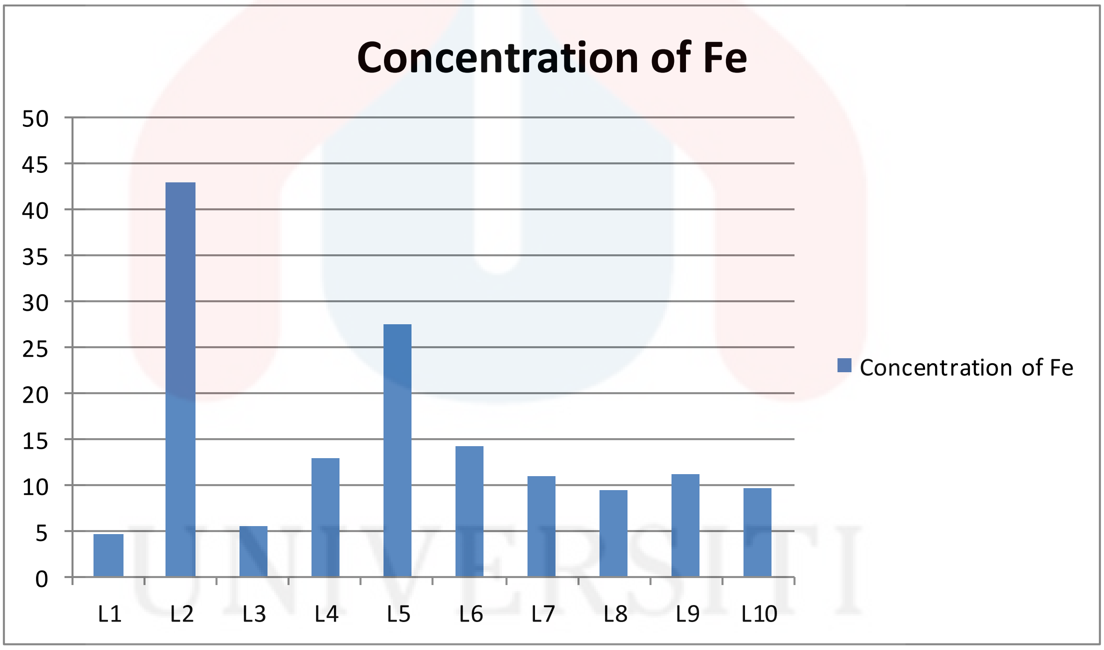


Figure 5.1: Graph of concentration of Fe.

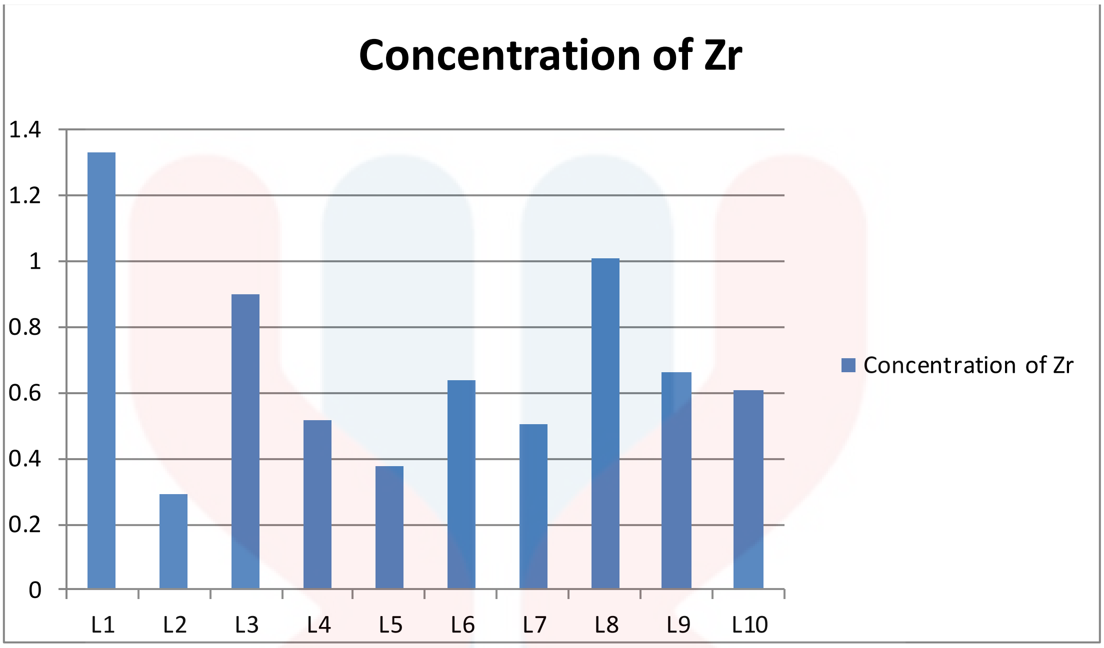


Figure 5.2: Graph of concentration of Zr.

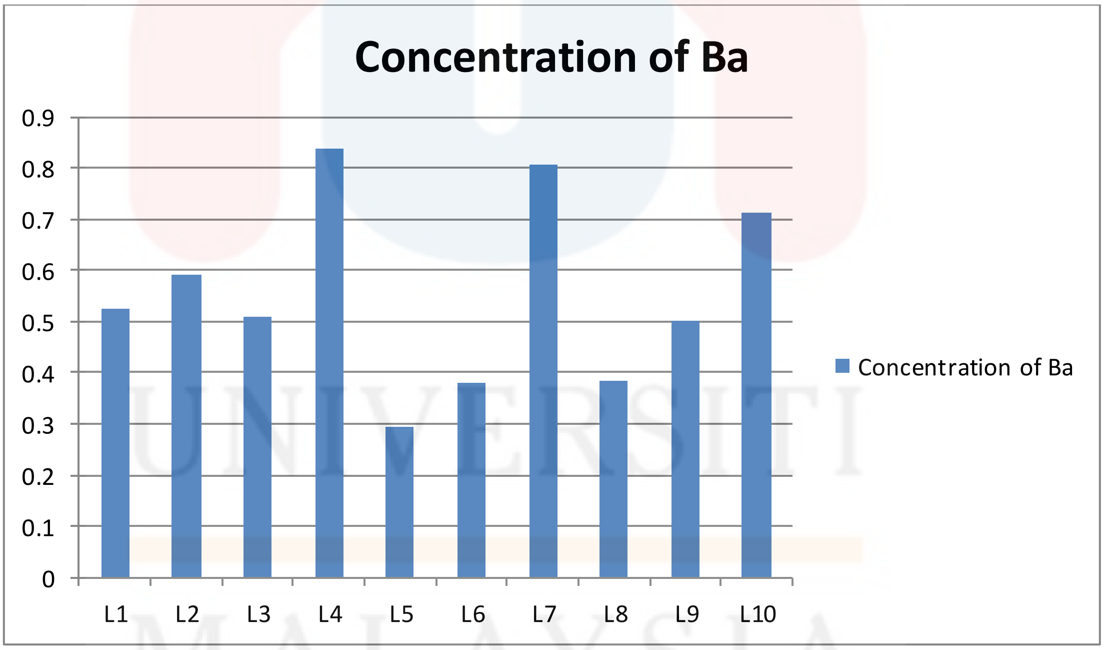


Figure 5.3: Graph of concentration of Ba.

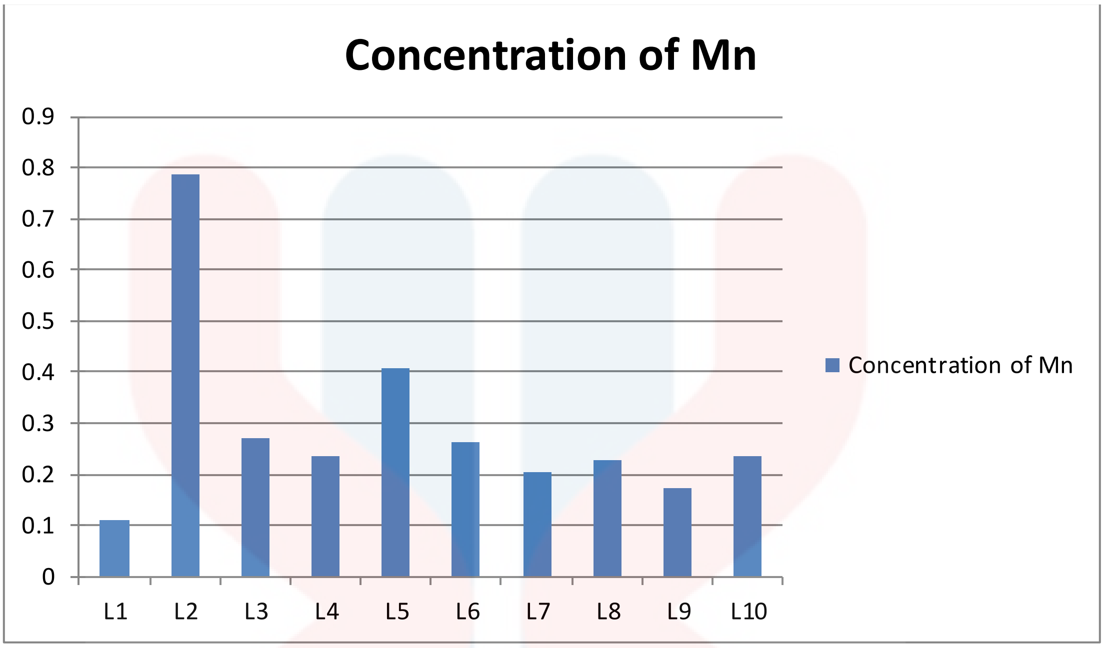


Figure 5.4: Graph of concentration of Mn.

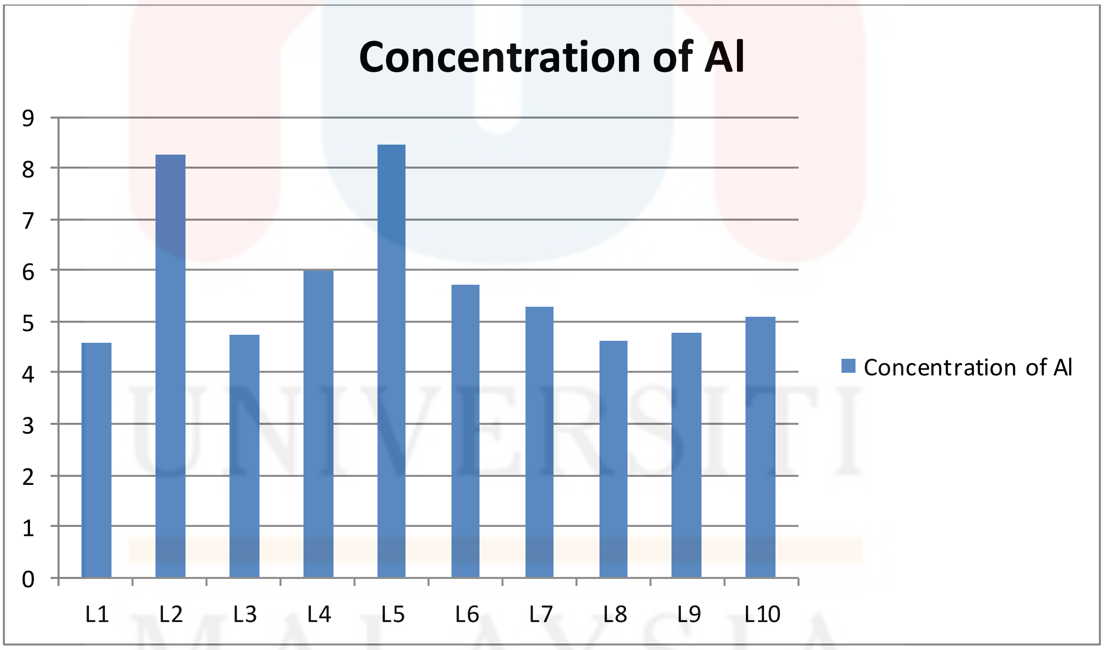


Figure 5.5: Graph of concentration of Al.

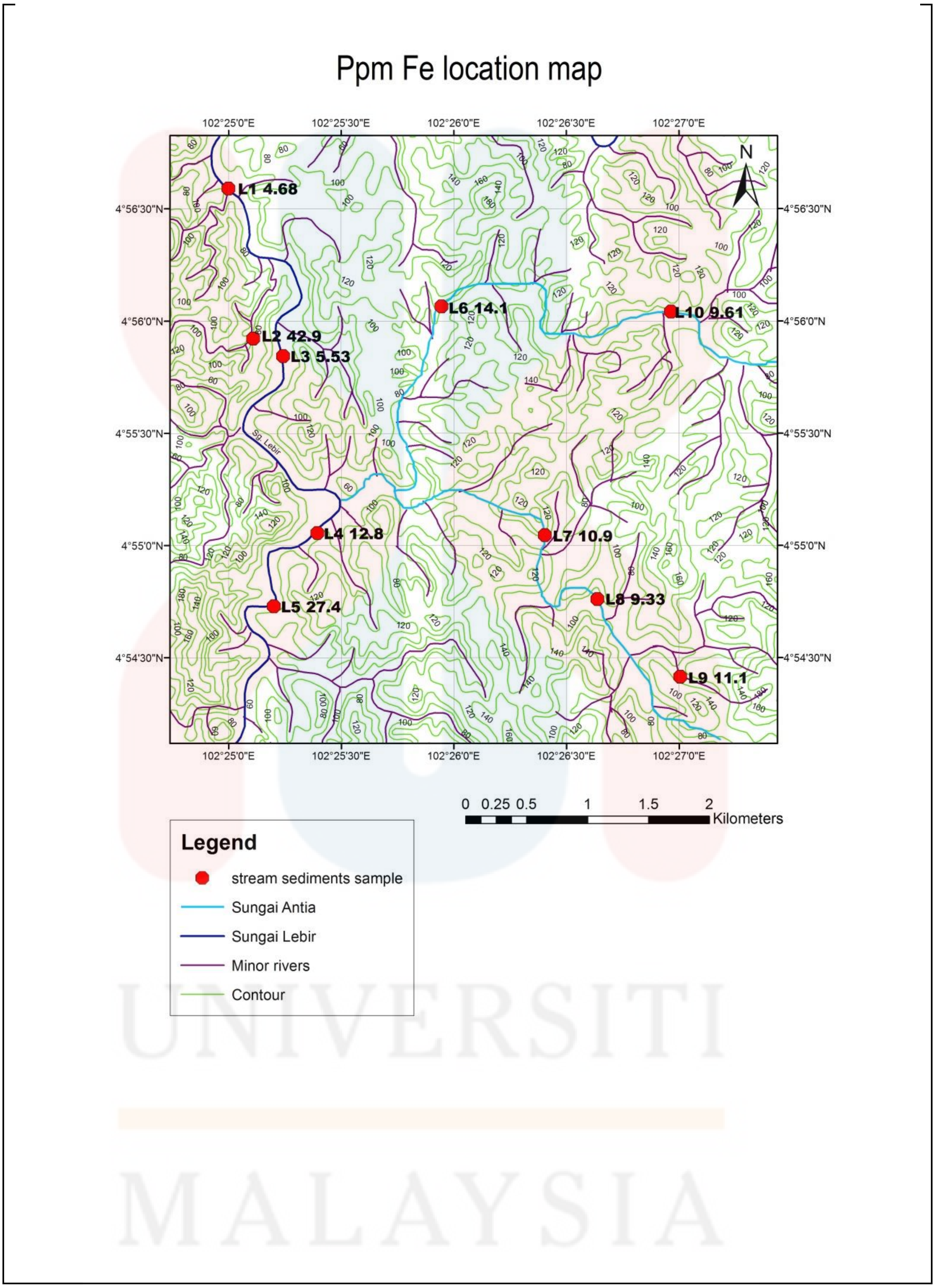


Figure 5.6: Sample location with Fe ppm.

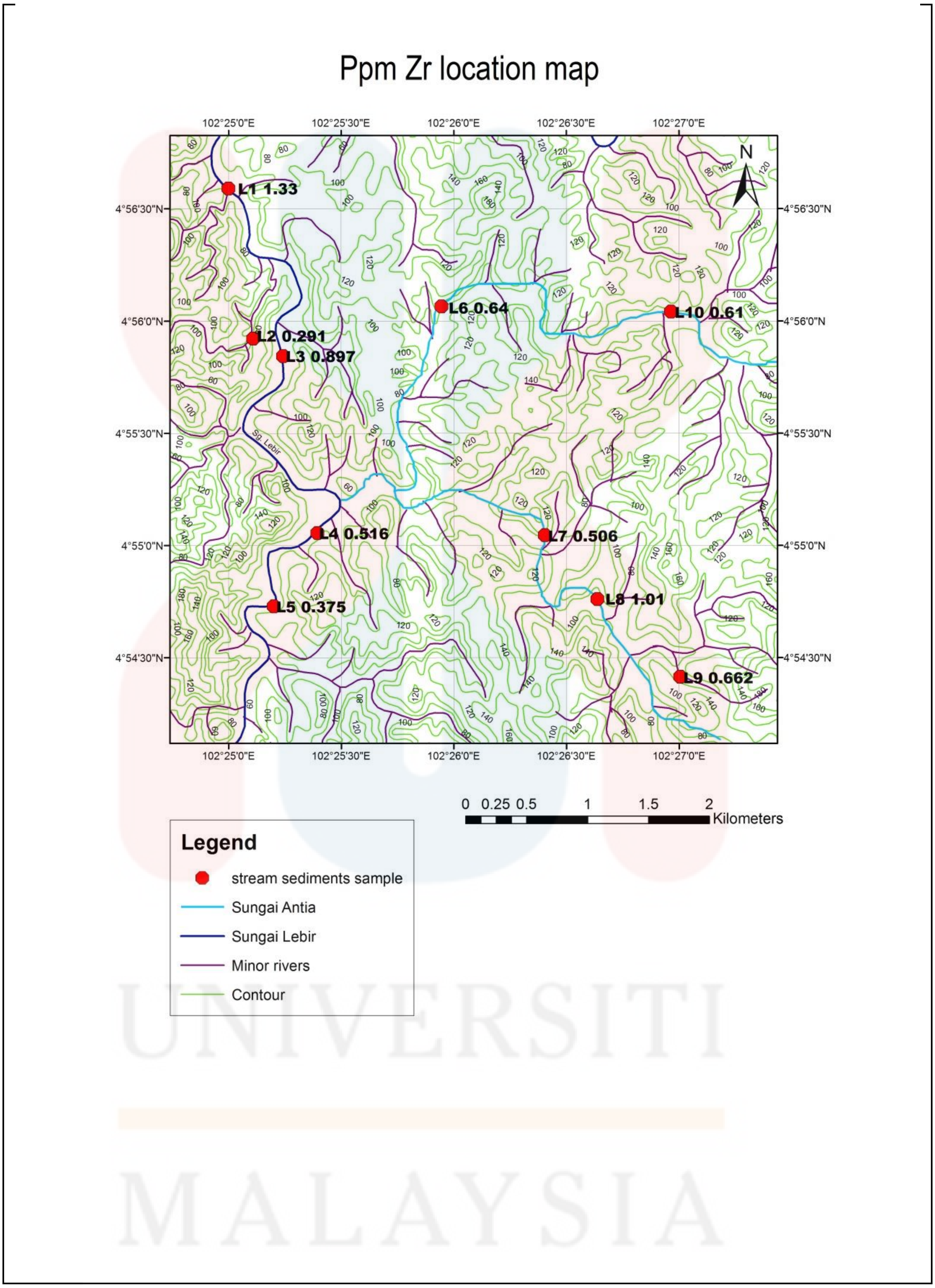


Figure 5.7: Sample location with Zr ppm.

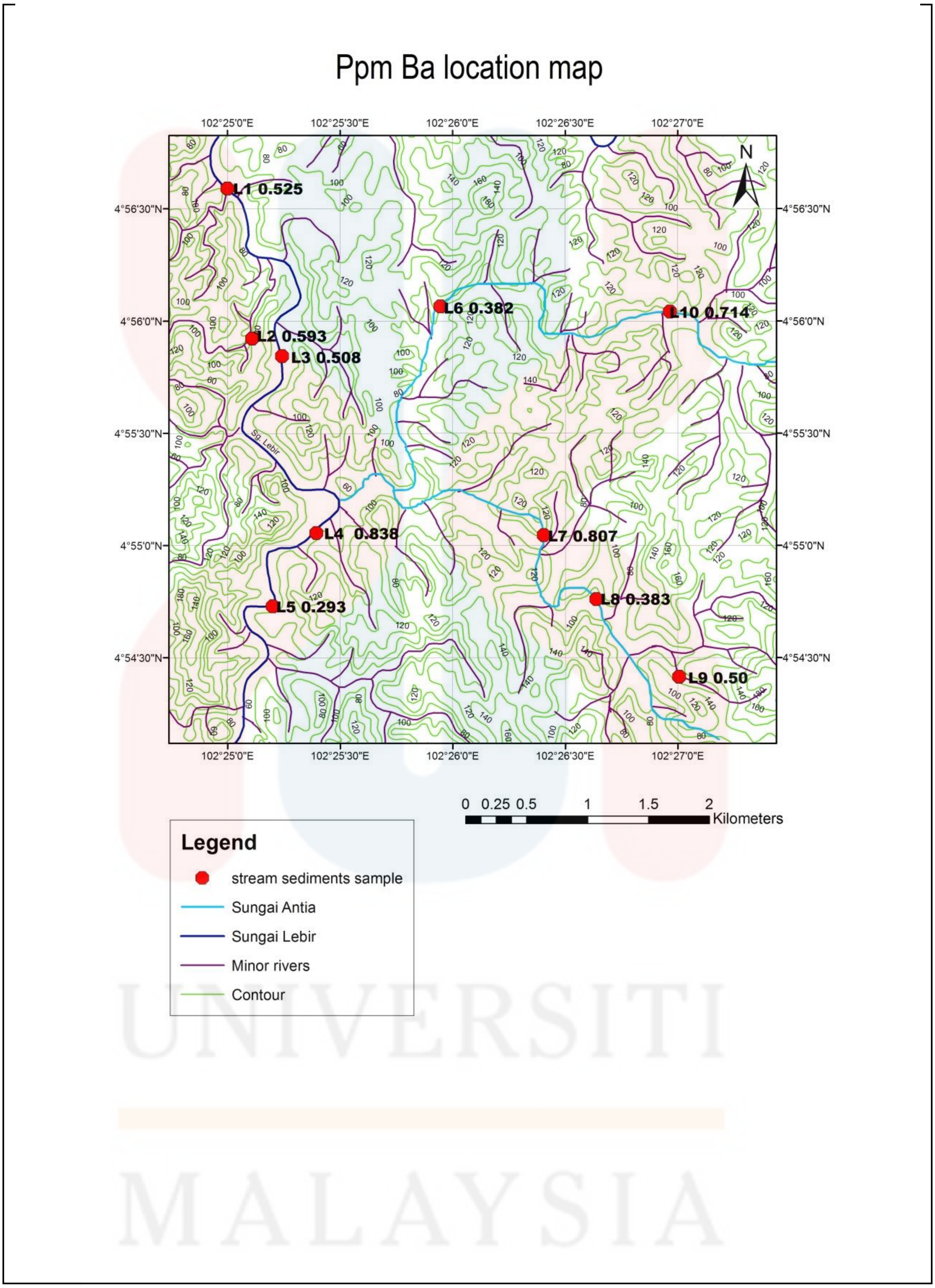


Figure 5.8: Sample location with Ba ppm.

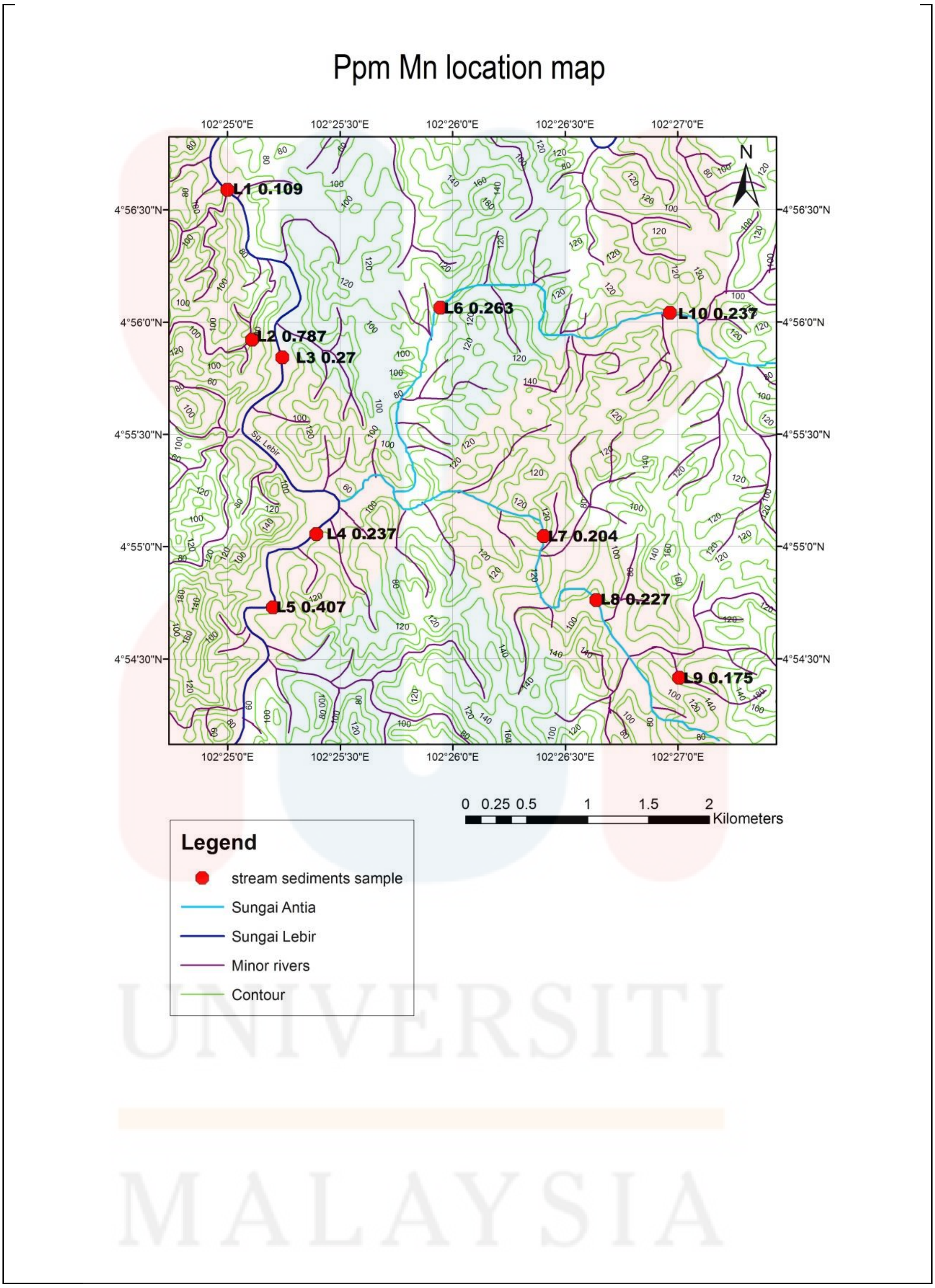


Figure 5.9: Sample location with Mn ppm

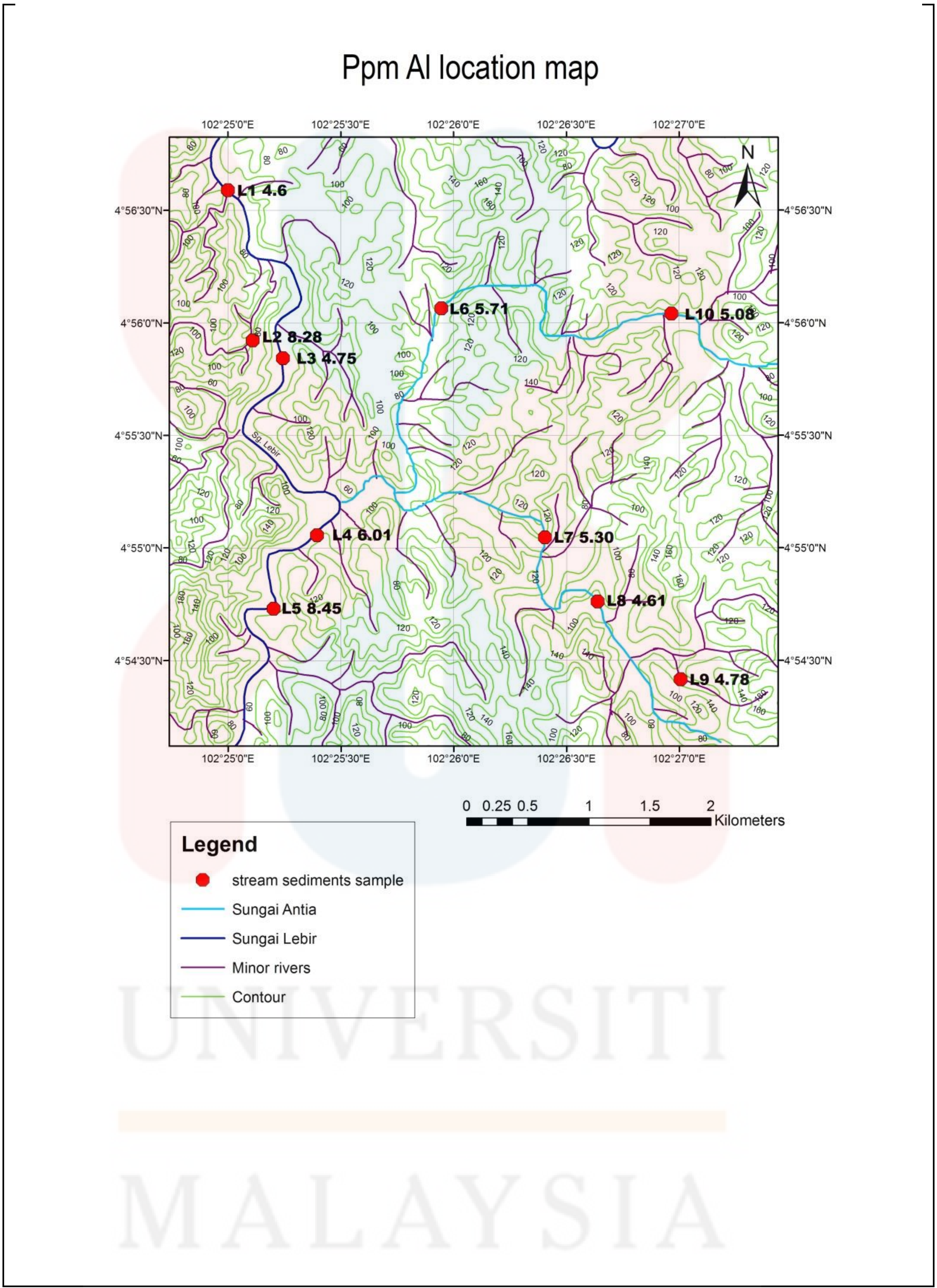


Figure 5.10: Sample location with Al ppm

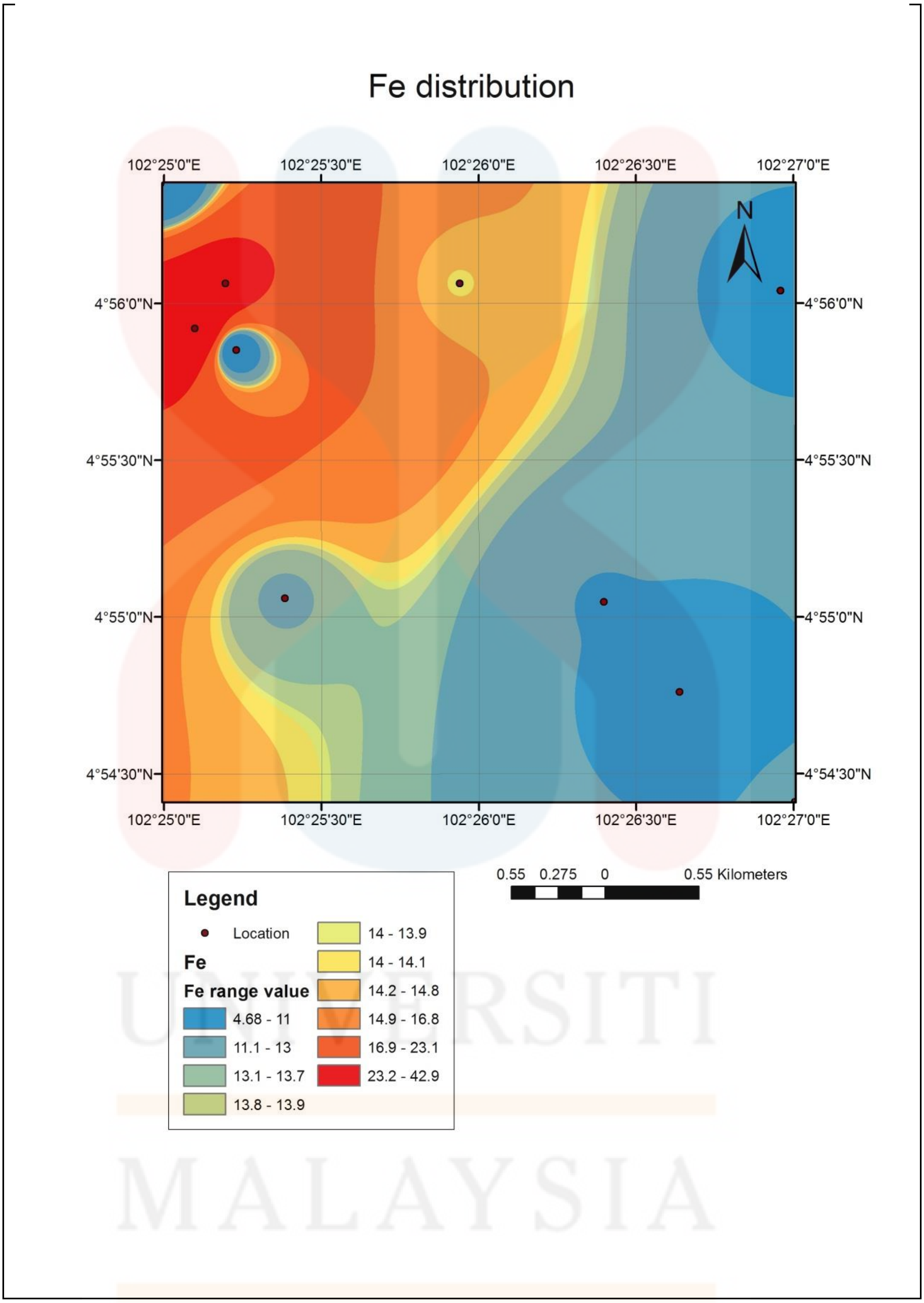


Figure 5.11: Range of Fe distribution within study area

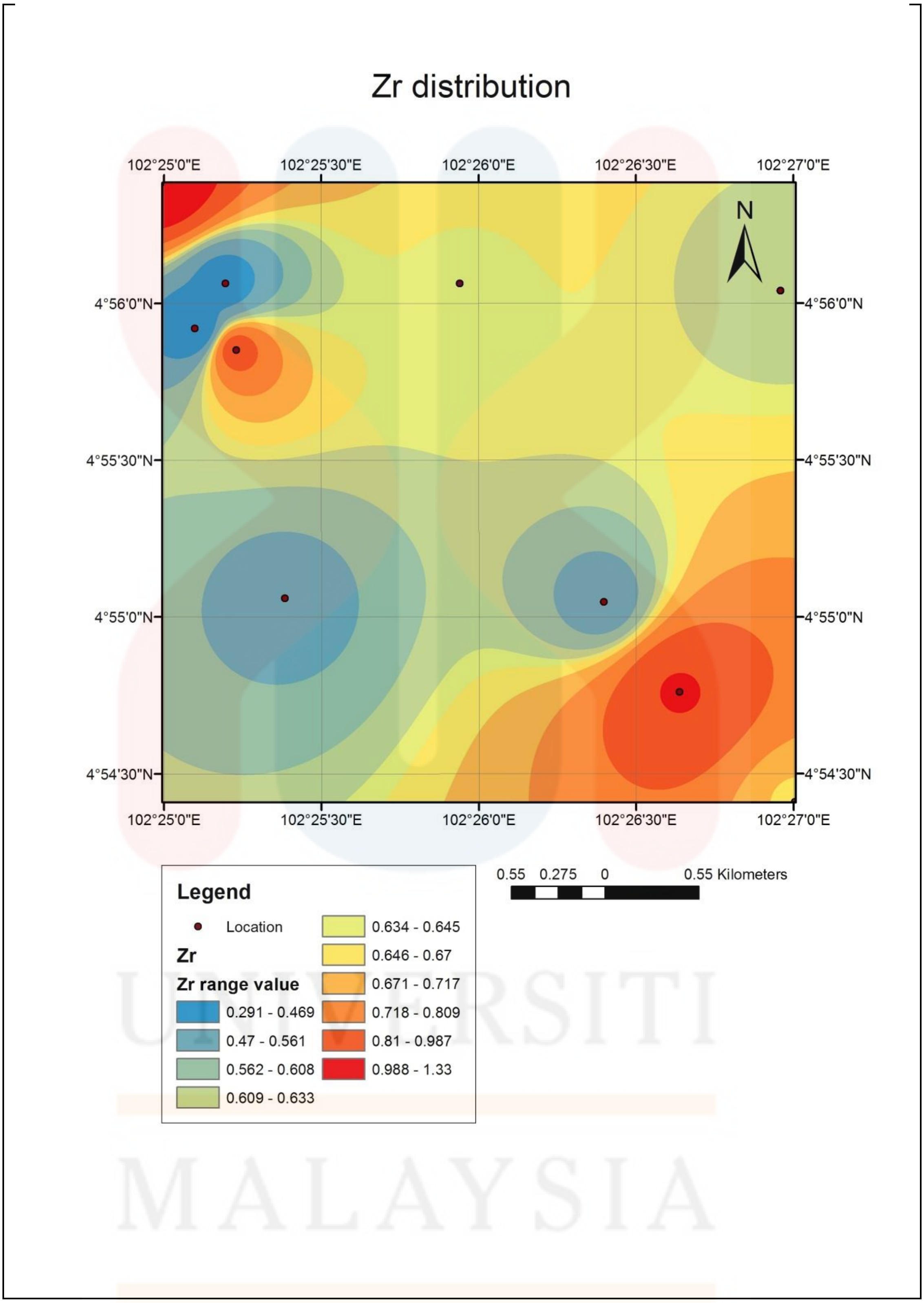


Figure 5.12: Range of Zr distribution within study area

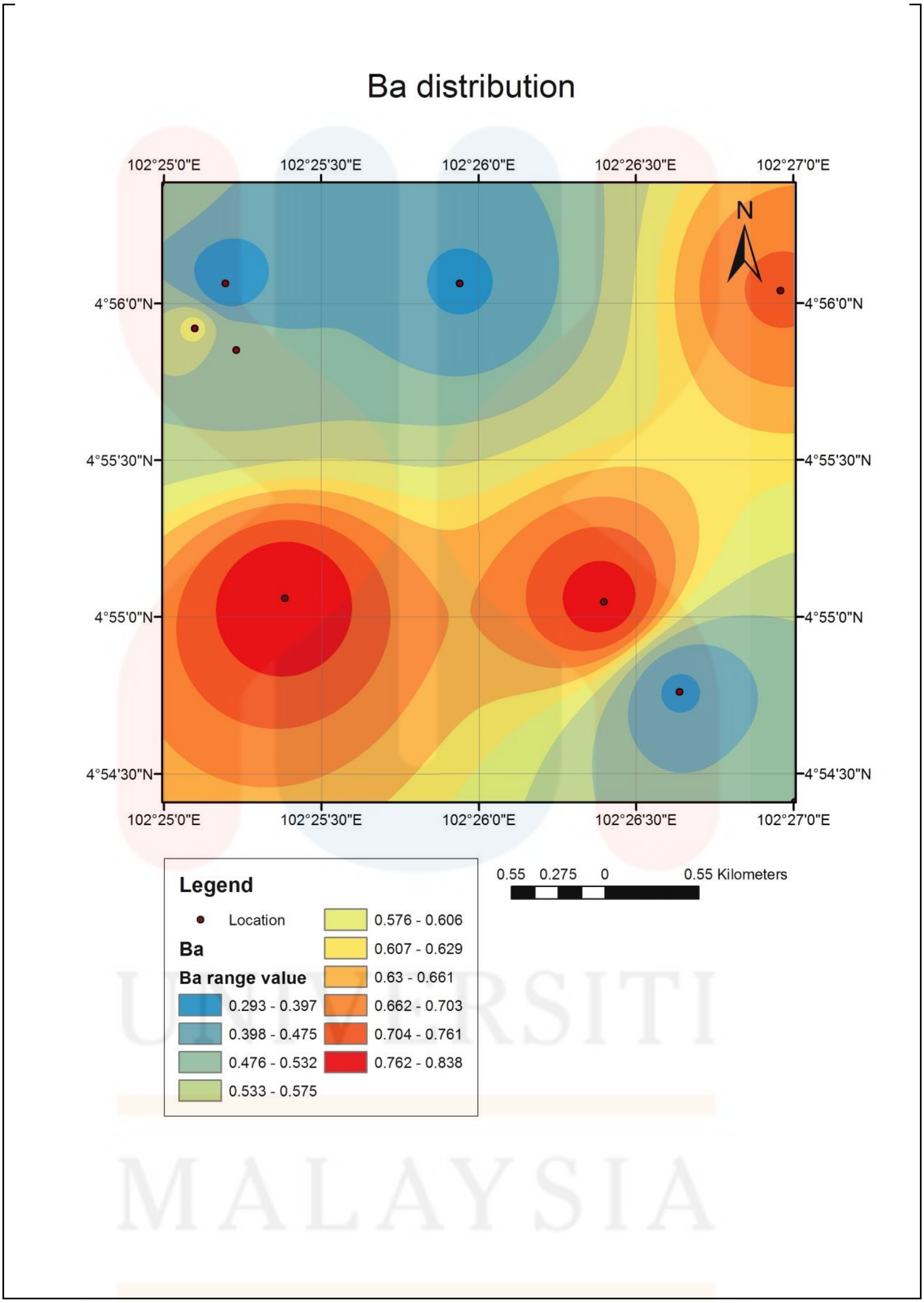


Figure 5.13: Range of Ba distribution within study area

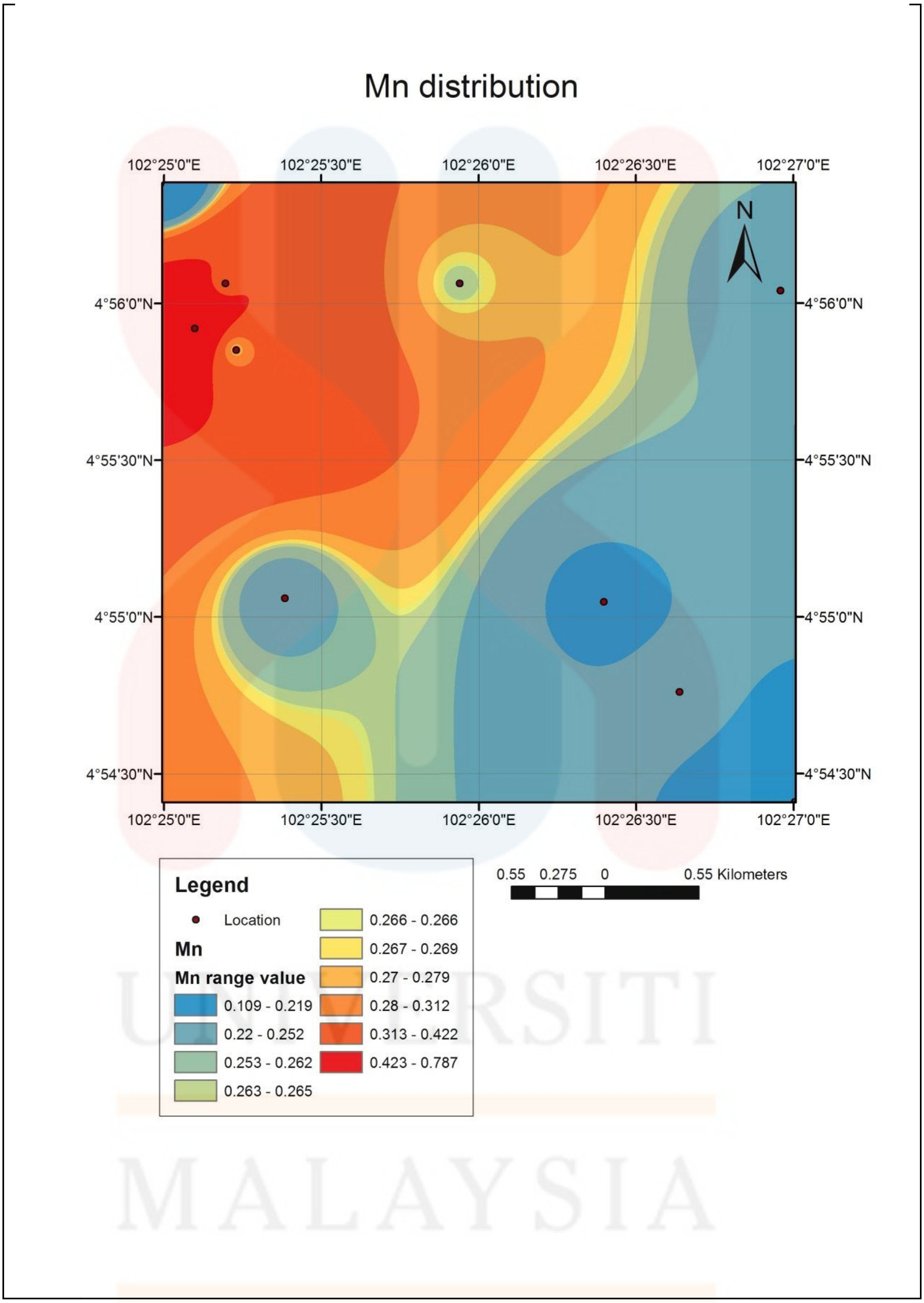


Figure 5.14: Range of Mn distribution within study area

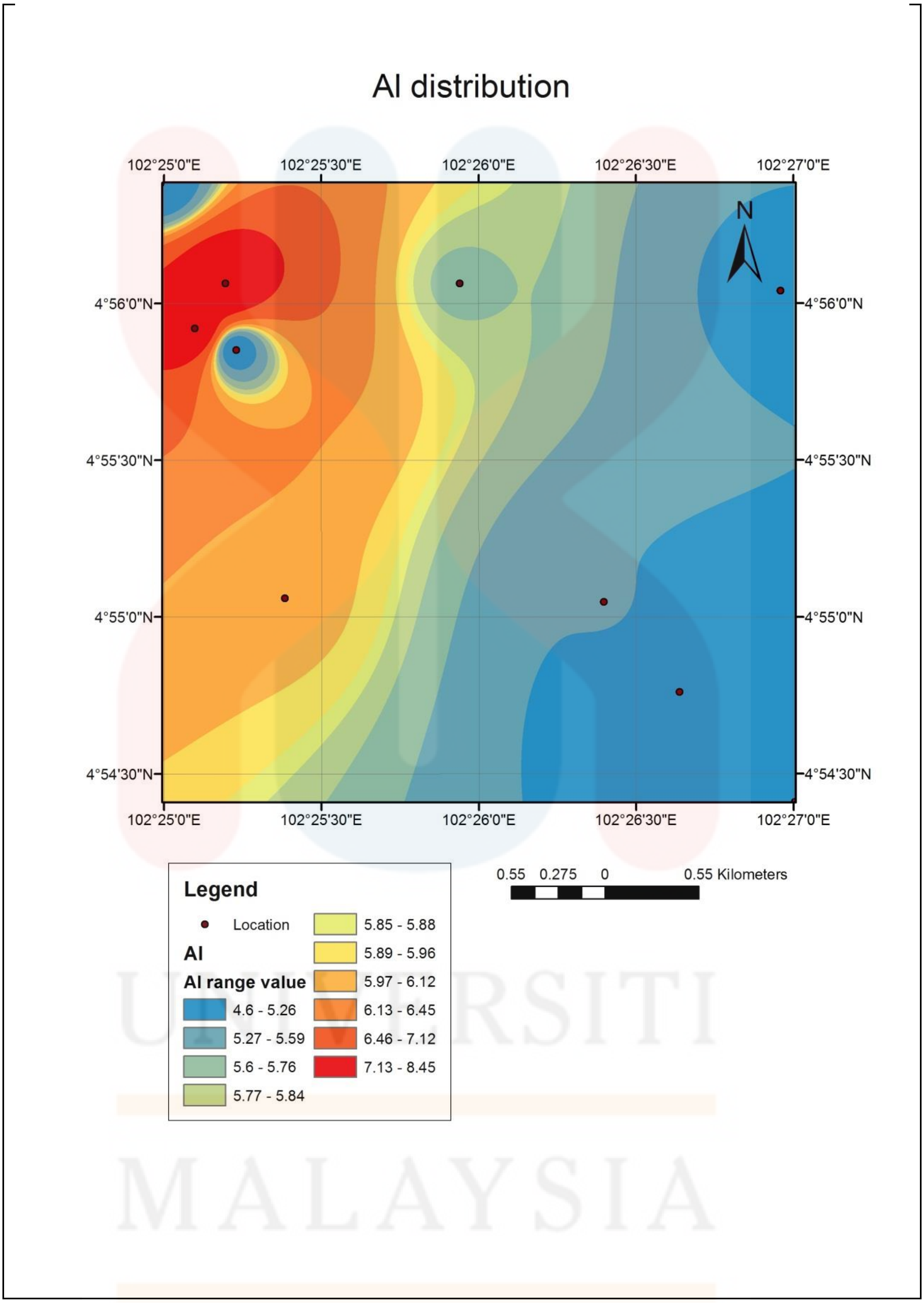


Figure 5.15: Range of Al distribution within study area

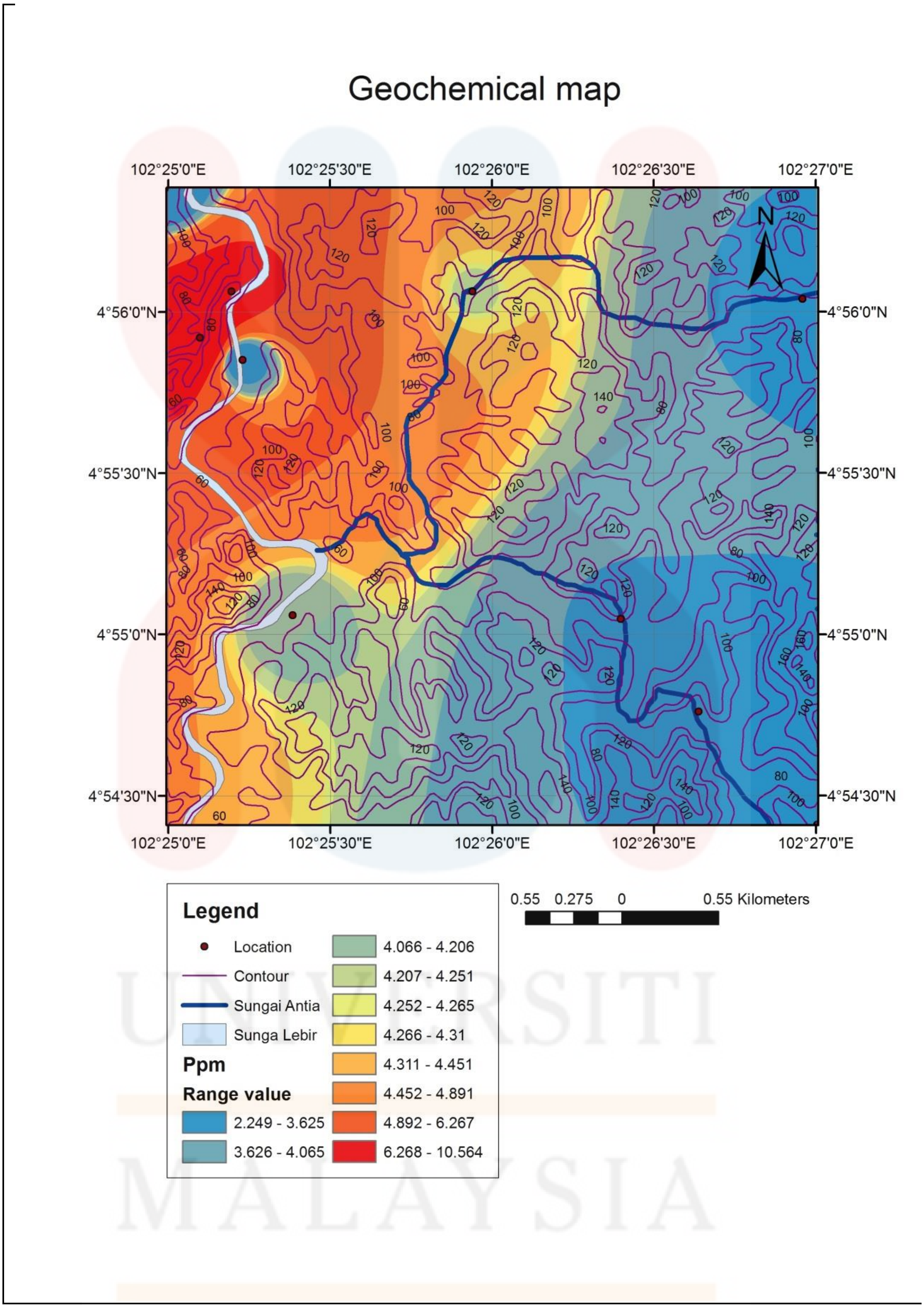


Figure 5.16: Geochemical map

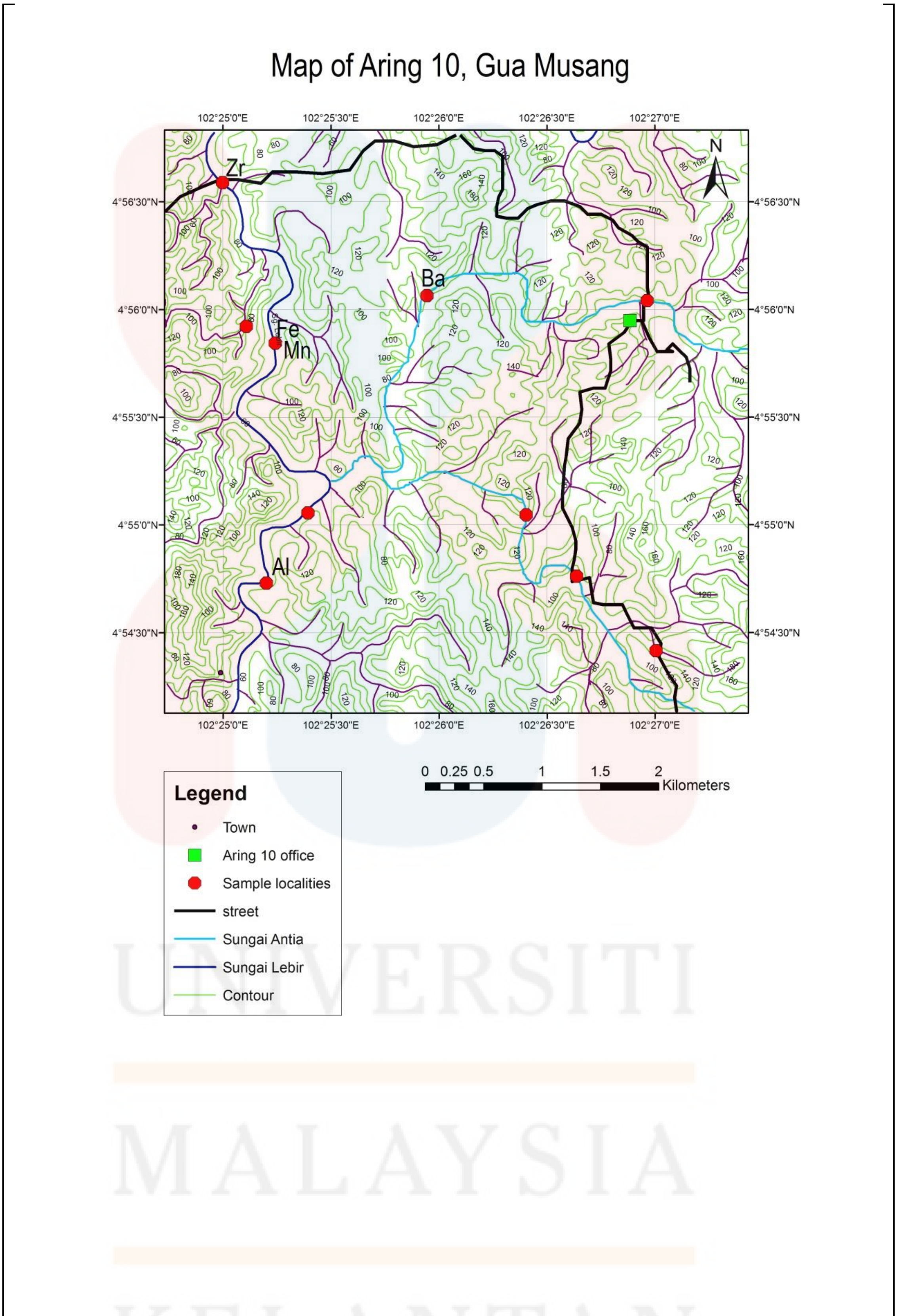


Figure 5.17: High of heavy metal distribution

CHAPTER 6

CONCLUSION AND SUGGESTION

6.1 Conclusion

Ground mapping is an essential method to update a geological map of a particular area. From mapping activities, four types of lithology were identified which are sandstone, sandstone interbedded with mudstone, limestone, and metasedimentary rock.

Geochemical analysis of stream sediment was carried out to determine the distributions of heavy metals within Aring 10, Gua Musang. Within the study area there are 2 rivers which are Sungai Lebir and Sungai Antia with small tributaries. The samples were taken from all the rivers within the study area. The 5 heavy metal elements are ferum, zirconium, barium, manganese and titanium.

The occurrence of metals in stream sediments can be controlled by several factors such as primary ore minerals that are resistant towards weathering and dense enough to occur within the heavy mineral fraction of stream sediment. The erosion of oxides and carbonates of heavy metals also contributes to the elements occurrence in stream sediments. Lastly, heavy metals can be absorbed by iron, manganese oxides, clay minerals, or organic matter. The weathering or iron bearing rocks or rocks that contains those particular elements might contribute to the occurrence of the elements in stream sediments.

The distributions of the heavy metals at different location are different in concentration. The different concentration determines the depositions of the elements whether it is near to urban areas or the opposite. Other than that, the agriculture activities in Aring 10 also contribute to the distributions of the elements along the rivers. The fertilizers used for the plantations may affect the sedimentation of sediments along the river. There is an old factory that flows out their waste to the small rivers in the area therefore increase the toxicity of the rivers.

In addition, the type of lithology within the study area are mostly sedimentary rocks such as black shale, mudstone and sandstone while some part of the area were covered with metasediment rocks. The lithology of the area also affects the sedimentation or stream sediments resulting in different distributions and concentrations of the heavy metals. Besides that, the ph value also one of the factors affecting the types of element present in the stream as certain metals only exist in certain ph value.

6.2 Recommendation

The data of geochemical baseline is becoming more relevant within environment research and mineral exploration. Therefore, more studies about geochemical analysis should be taken into account and further consideration. The other methods of exploration that can be use are Atomic Absorption Spectroscopy, Induced Coupling Plasma, and X-ray Diffraction. Furthermore, with different angle and field of expertise that differ from geochemical studies, more convincing and precise information can be obtain for future studies. Method such as geophysical investigation and remote sensing is applicable to produce more significant and informational data or results for future application.

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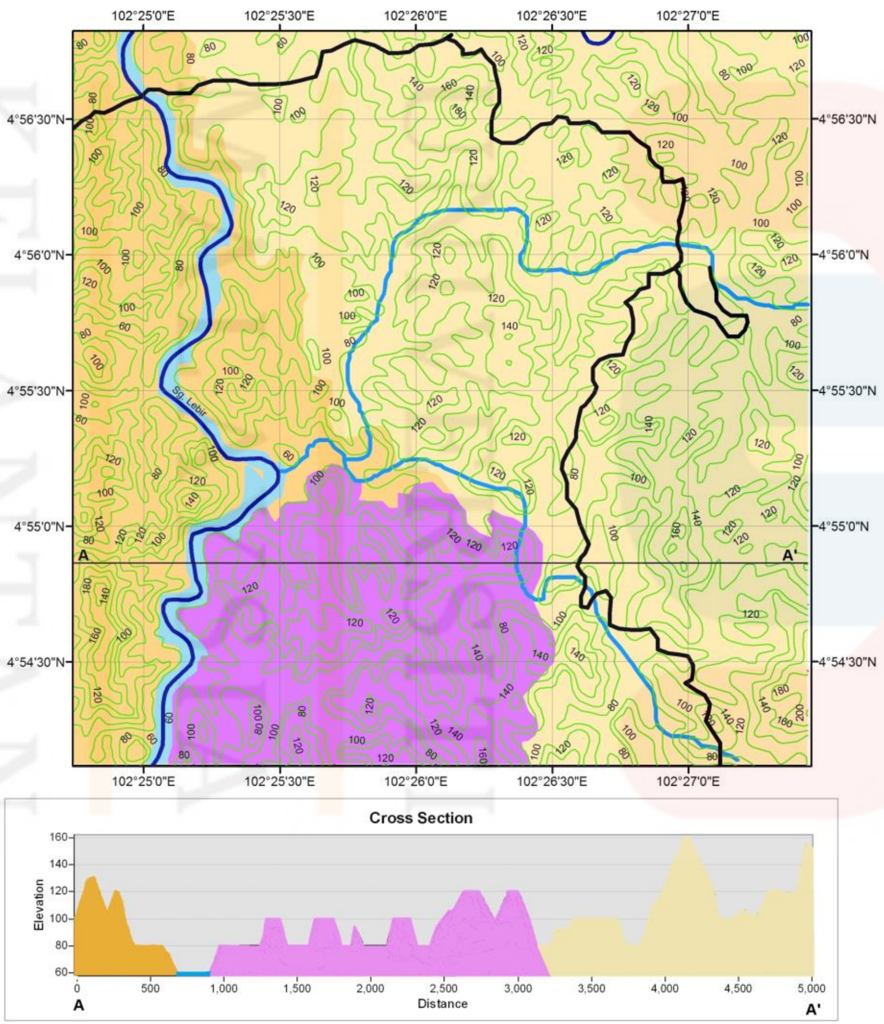
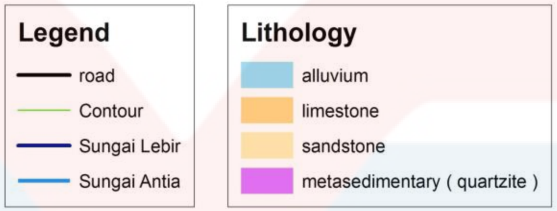
Geological Map of Study Area





PERIOD	LITHOLOGY	DESCRIPTION
Quaternary	Alluvium	- The alluvial materials which flow down from mountains, accumulates at foothills where the stream enter the plain. - The deposition of alluvium still continues until this day.
Permian-Triassic	Quartz dyke Sandstone Mudstone	- Aring Fomation - Intrusion of igneous rock into sandstone. Younger in age. - Sandstones and mudstone interbedds.
Carboniferous	Limestone	- Koh Formation - Occurrence of invertebrates fossils.

Summary of Geological Map
The study area consist of foue dofferent lithologies
which are alluvium, sandstone, limestone,
and metamorphic rocks of quartzite.
The sandstone are interbedded with mudstone.
Study area is mainly covered with hilly features with
some undulating features.
There are two big rivers which are Sungai Lebir and Sungai Antia.
The highest elevationis 200 m whereas
the lowest elevation is 20 m.