



Universiti Malaysia  
KELANTAN

**GEOLOGY AND CHARACTERIZATION OF  
FELDSPAR IN GUA MUSANG, KELANTAN**

by

**SITI SAFIAH BINTI HARIS FADZILAH**

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

**FACULTY OF EARTH SCIENCE  
UNIVERSITI MALAYSIA KELANTAN**

(2023)

## DECLARATION

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

Signature :

Name :

Date :

UNIVERSITI  
MALAYSIA  
KELANTAN

## APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient  
interms of scope and quality for the award of the degree of Bachelor of Applied  
Science (Geoscience) with Honours.

Signature :

Name of Supervisor :

Date :

UNIVERSITI  
MALAYSIA  
KELANTAN

## ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful, all praise to Allah that I have been giving strength and opportunities to finish writing my final year project. I would like to thank the people who has been supporting me whether directly or indirectly throughout this project.

First and foremost, I would like to sincerely thank to my supervisor Dr. Roniza Ismail for her guidance, understanding, patience and encouragement during completion of my final year project. It has been a great honour and pleasure to have her as my supervisor for this project.

My deepest gratitude goes to all my family member who have been support me mentally and financially. It would not be possible to write and finish the report without their support. Sincere thanks to all my friends especially Ain, Shafila, Zaidatul, Syahirah. Syuhadah, Najwa, Nurathirah and others for their kindness and moral support during my study.

UNIVERSITI  
MALAYSIA  
KELANTAN

## **Geology and Characterization of Feldspar in Gua Musang, Kelantan.**

### **ABSTRACT**

The study area located at Kampung Tanah Puteh, Gua Musang, Kelantan at coordinate of N 4°49'35.52" E 101°55'56.84" to N 4°46'49.93" E 101°55'56.84". Gua Musang located in the southern part of Kelantan which consists of argillaceous and interbedded of calcareous rock. The objective of the study is to update geological map with scale of 1:25,000 and to determine the characterization of feldspar in Kg Tanah Puteh, Gua Musang. In this study, six soil samples has been collected for elemental analyses using X-ray Diffraction (XRD) while three rock samples have been selected for elemental analyses using X-ray Fluorescence (XRF). The characteristic of feldspar was identified using petrography method supported by XRD and XRF analyses. As for geological study, the samples were collected randomly throughout the map. In general, the study area consists of limestone, meta-sediment, and tuff. Based on petrography, both plagioclase and alkali feldspar has been spotted in the thin section sample while XRD analysis show that feldspar in the sample has high albite compared to other feldspar as sodium ( $\text{Na}_2\text{O}$ ) was higher around 7.20% compare with others  $\text{K}_2\text{O}$  (4.40%) and Ca (2.7%). Hence, characteristic of the feldspar in the study area composed majorly from Na-end member with minor of K-end member follow by Ca-end member. As for crystalline pattern, twinning of Carlsbad, tartan and lamellar twinning has been spotted by petrography method.

**Keywords:** Geological map, feldspar, Kg, Tanah Puteh, petrography, XRD, XRF

UNIVERSITI  
MALAYSIA  
KELANTAN

## Geologi dan Karakteristik Feldspar di Gua Musang, Kelantan

### ABSTRAK

Kawasan kajian terletak di Kampung Pasir Puteh, Gua Musang, Kelantan pada koordinat N 4°49'35.52" E 101°55'56.84" hingga N 4°46'49.93" E 101°55'56.84". Gua Musang terletak di bahagian selatan Kelantan yang terdiri daripada argillaceous dan interbedded of calcareous rock. Objektif kajian adalah untuk mengemaskini peta geologi berskala 1:25,000 dan menentukan karakteristik feldspar di Kg Tanah Puteh, Gua Musang. Dalam kajian ini, enam sampel tanah telah dikumpulkan untuk menganalisis unsur elemen menggunakan *X-ray Diffraction (XRD)* (pembelauanmanakala tiga sampel batuan telah dipilih untuk analisis unsur elemen menggunakan *X-ray Fluorescence (XRF)*). Ciri-ciri feldspar dikenal pasti menggunakan kaedah petrografi yang disokong oleh analisis XRD dan XRF. Bagi kajian geologi pula, sampel dikumpul secara rawak di seluruh peta. Secara amnya, kawasan kajian terdiri daripada batu kapur, meta-sedimen, dan tuf. Berdasarkan petrografi, kedua-dua plagioklas dan feldspar alkali telah dikesan dalam sampel petrografi manakala analisis XRD menunjukkan bahawa feldspar dalam sampel mempunyai albite yang tinggi berbanding feldspar lain kerana natrium ( $\text{Na}_2\text{O}$ ) adalah lebih tinggi sekitar 7.20% berbanding dengan yang lain  $\text{K}_2\text{O}$  (4.40%) dan Ca (2.7%). Oleh itu, ciri feldspar di kawasan kajian terdiri terutamanya daripada anggota *Na-end* yang terdapat dalam sampel tanah dengan anggota *K-end* yang sedikit diikuti oleh anggota *Ca-end*. Bagi corak kristal, *Carlsbad*, *tartan* dan *lamellar twinning* telah dikesan melalui kaedah petrografi.

**Kata Kunci** : Peta Geologi, feldspar, Kg Tanah Puteh, petrografi, XRD, XRF

UNIVERSITI  
MALAYSIA  
KELANTAN

## TABLE OF CONTENT

	PAGE
<b>DECLARATION</b>	i
<b>APPROVAL</b>	ii
<b>ACKNOWLEDGEMENT</b>	iii
<b>ABSTRACT</b>	iv
<b>ABSTRAK</b>	v
<b>TABLE OF CONTENT</b>	vi
<b>LIST OF TABLES</b>	viii
<b>LIST OF FIGURES</b>	ix
<b>LIST OF ABBREVIATIONS</b>	xi
<b>LIST OF SYMBOLS</b>	xii
<b>CHAPTER 1 INTRODUCTION</b>	1
1.1 General Background	1
1.2 Study Area	2
1.3 Problem Statement	6
1.4 Objectives	6
1.5 Scope of Study	7
1.6 Significance of Study	7
<b>CHAPTER 2 LITERATURE REVIEW</b>	8
2.1. Introduction	8
2.2. Regional Geology and Tectonic Setting	8
2.3. Stratigraphy	9
2.4. Historical Geology	11
2.5. Research Specification	11
2.5.1 Feldspar Occurrence	12
2.5.2 Feldspar Properties	13
2.5.3 Petrography of Feldspar	15
2.5.4 Application of Feldspar	18
<b>CHAPTER 3 MATERIALS AND METHOD</b>	22
3.1 Introduction	22
3.2 Material	22
3.3 Methodology	24

3.2.1 Preliminary Study	24
3.2.2 Geological Mapping	24
3.2.3 Data Sampling	27
3.2.4 Preparation of Laboratory Analysis	27
3.2.5 Preparations of Thin Section	29
<b>CHAPTER 4 GENERAL GEOLOGY</b>	<b>32</b>
4.1 Introduction	32
4.1.1 Accessibility	33
4.1.2 Settlement	35
4.1.3 Forestry/Landuse	35
4.1.4 Traverse and Observation	37
4.2 Geomorphology	39
4.2.1 Drainage pattern	40
4.2.2 Geomorphological classification	42
4.2.3 Weathering	46
4.3 Lithostratigraphy	47
4.3.1 Stratigraphic position	47
4.3.2 Unit explanation	50
4.4 Structural Geology	57
4.4.1 Joint	57
4.4.2 Lineament Analysis	58
4.5 Historical Geology	60
4.5.1 Historical Geology	60
<b>CHAPTER 5 RESULTS AND DISCUSSIONS</b>	<b>61</b>
5.1 Introduction	61
5.2 Overall Sample Description	61
5.2.1 Petrography Analysis	63
5.2.2 XRD analysis	66
5.2.3 XRF analysis	67
5.3 Discussion	68
<b>CHAPTER 6 CONCLUSION AND RECOMMENDATIONS</b>	<b>69</b>
6.1 Conclusion	69
6.2 Suggestion	70
<b>REFERENCE</b>	<b>72</b>
<b>APPENDIX A</b>	<b>74</b>
<b>APPENDIX B</b>	<b>81</b>

**LIST OF TABLES**

<b>No.</b>	<b>TITLE</b>	<b>PAGE</b>
1.1	Demography district of Gua Musang	4
2.1	Chemical analysis of feldspar in ceramic industry	18
2.2	Chemical analysis of feldspar in glass industry	19
2.3	Element percentage in feldspar from previous study by XRF.	21
4.1	The classification of topography	42
4.2	Lithologies column	49
5.1	Element analysis from XRD analysis	66
5.2	Percentage element from XRF analysis	67

## LIST OF FIGURES

No.	TITLE	PAGE
1.1	Basemap of Kg. Tanah Puteh, Gua Musang, Kelantan.	3
1.2	Map to the study area from the main road.	4
2.1	Geological Map of Peninsular Malaysia.	10
2.2	Ternary diagram of feldspar group.	14
2.3	Twinning in feldspar minerals.	16
2.4	Example of perthite and antiperthite twinning.	17
2.5	Example of microcline feldspar with lamellar twinning.	17
3.1	Flow chart of the methodology	31
4.1	The unpaved road along the main road	33
4.2	Accessibility map of Kg Tanah Puteh, Gua Musang.	34
4.3	Vegetation map of Kg. Tanah Puteh, Gua Musang.	36
4.4	Traverse and Observation Map of Kg. Tanah Puteh, Gua Musang.	38
4.5	The drainage pattern	40
4.6	Drainage map of Kg. Tanah Puteh, Gua Musang.	41
4.7	Geomorphology of karst and mountain	43
4.8	The karst hill with biological weathering	44
4.9	Cave feature of karst limestone	44
4.10	Topography map of Kg. Tanah Puteh, Gua Musang.	45
4.11	Several weathering process occurrences.	46
4.12	Geological map of Kg. Tanah Puteh, Gua Musang.	48
4.13	Meta-sedimentary (phyllite) hand specimen and outcrop.	50
4.14	Meta-sedimentary (slate) hand specimen and outcrop.	51
4.15	Limestone hand specimen and outcrop.	52
4.16	Petrography of tuff (Sample 5)	53

4.17	Petrography of limestone (Sample 9)	54
4.18	Petrography of limestone (Sample 17)	55
4.19	Tuff hand specimen and outcrop.	56
4.20	Joint structure on the outcrop.	57
4.21	Rose diagram for joint analysis.	58
4.22	Rose diagram for lineament analysis.	58
4.23	Lineament map of Kg. Tanah Puteh, Gua Musang.	59
5.1	Observation and lithology map of Kg. Tanah Puteh, Gua Musang.	62
5.2	Plagioclase feldspar thin section	63
5.3	Sanidine thin section	63
5.4	Microcline thin section	64
5.5	Muscovite thin section	64
5.6	Muscovite thin section	65
5.7	Muscovite thin section	65
5.8	XRD analysis of soil sample	66

## LIST OF ABBREVIATIONS

Na	Sodium
K	Potassium
Ca	Calcium
Mt	Metric tons
km	Kilometres
XRF	X-Ray Fluorescence
XRD	X-Ray Diffractometer
Al	Aluminium
SiO <sub>2</sub>	Silica
Al <sub>2</sub> O <sub>3</sub>	Aluminium oxide
Fe <sub>2</sub> O <sub>3</sub>	Iron oxide
K <sub>2</sub> O	Potassium oxide
Na <sub>2</sub> O	Sodium oxide
Ti	Titanium
Fe	Iron
GPS	Global Positioning System
CaCO <sub>3</sub>	Calcium Carbonate
XPL	Cross-polarize light
PPL	Plane-polarized light
COD	Crystallography Open Database
HCl	Hydrochloric acid
kV	Kilovolt
mA	milliampere
μA	microampere
SQD	Semiquantitative gene dose

## LIST OF SYMBOLS

%	Percentage
$\mu$	Micro
$^{\circ}$	Degree
$^{\circ}\text{C}$	Degree Celsius
$\lambda$	Lambda
“	Minute
$\theta$	Theta

UNIVERSITI  
MALAYSIA  
KELANTAN

## CHAPTER 1

### INTRODUCTION

#### 1.1 General Background

The research was conducted to update geological map and data in the study area. Previous research on the subject only utilized data from the previous year. Subsequently, feldspar is abundant in the Earth's crust and commonly used in various industry. This research study was conducted to determine the characterization of feldspar in Kg. Tanah Puteh, Gua Musang. The purpose of the study is to update geological map and identify the characteristic of feldspar in Gua Musang.

Feldspar covered more than half of the earth's crust and all this feldspar was formed as aluminosilicate mineral with various amount of potassium, sodium or calcium that can easily be found in igneous rock. Feldspar is divided into three group and potash feldspar, or orthoclase are commonly found, it has straight fracture while orthoclase that has twinning are known as microcline. Other than that, there is soda feldspar also known as albite and the last group is lime feldspar or anorthite which commonly known as plagioclase (Alling, 1921). Feldspar groups are divided based on their major content of Na, K and Ca.

Important members of feldspar group in the commercial industry are potash feldspar and soda feldspar where the application of feldspar at 60% in ceramic industry, 25% in glass industry and 5% in others industry (Hassan, 2012). Application of feldspar have been growing tremendously over the years due to their excellent properties which suitable for the production in application fields such as ceramic,

building materials and electronic sector. Annual production of feldspar in the world estimate to be 26 million metric tons (Mt) in 2019, where Turkey being the main feldspar producing country estimate producing 7.5 Mt following, Italy (4Mt), India (4Mt) and China (2Mt) (Tanner,2016).

## 1.2 Study Area

The study area was located at Kg. Tanah Puteh where the village is surround by hills and located at the southern part of Kelantan. Kelantan located at the Central Belt of Peninsular Malaysia and the study area located at Gua Musang district. The study was located at the southwest of Gua Musang, Kelantan at coordinate of  $4.7905^{\circ}$  N,  $101.9489^{\circ}$  E. The study area is surround by mountain, karst hill and river. The main river in the study area is Sg, Galas, with the contour around 80 to 380 metres.

### a. Location

The study area covers about  $5 \text{ km} \times 5 \text{ km}$  in a box shape with the parameters of 20 km. Each corner of the coordinates is between of  $N 4^{\circ}49'35.52'' E 101^{\circ}55'56.84''$ ,  $N 4^{\circ}49'35.85'' E 101^{\circ}58'35.49''$ ,  $N 4^{\circ}46'49.95'' E 101^{\circ}58'38.49''$  and  $N 4^{\circ}46'49.93'' E 101^{\circ}55'56.84''$ . Specific location of the study area was located at Kg. Tanah Puteh and the geomorphology of the area is mainly consisting of karst limestone, hills, and mountain. The study area also including the northern part of Kg. Pulai.

b. Accessibility

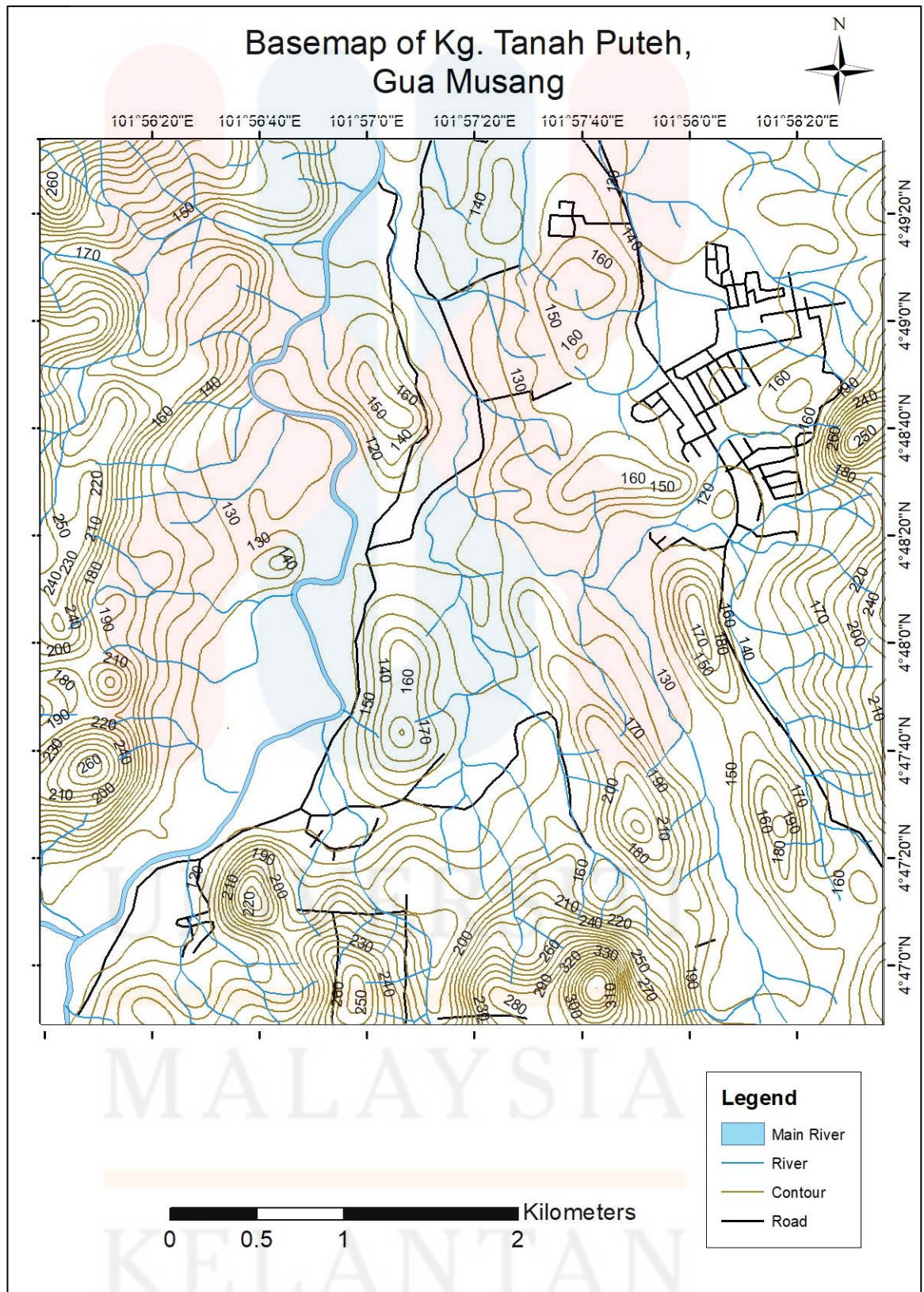
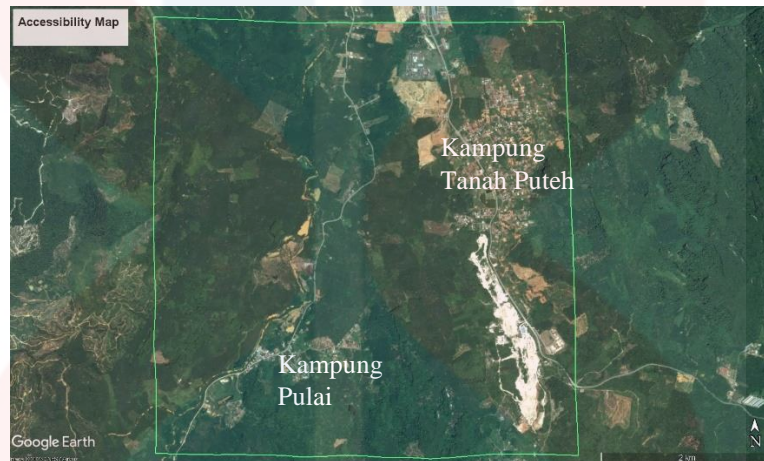


Figure 1.1: Basemap of Kg. Tanah Puteh, Gua Musang, Kelantan.

The location of the study area is near with the Gua Musang town which is an urban area (**Figure 1.1**). The location of the study area is southwest from Gua Musang town, thus the study area can be access from the main road which is Lebuhraya Kuala Lumpur – Gua Musang/ Route 8 (**Figure 1.2**). This area can be access from UMK Jeli through Dabong about 123 km or around 2 hours.



**Figure 1.2:** The map displays the road to the study area where it can be access by main road.

c. Demography

The population of Gua Musang district increase each year as show from **Table 1.1**. The table shows average annual population growth by state and administrative district in year 2000, population consist of 74,988 people while in 2010 is 86,189 people and increase to 113,900 in year 2020.

**Table 1.1:** Demography district of Gua Musang, Kelantan from year 2000, 2010 and 2020.

Name	Status	Population Year 2000-07-05	Population Year 2010-07-06	Population Year 2018-07-07
Gua Musang	District	74,988	86,189	113,900

(Source: Department of Statistic Malaysia, 2020)

a. Landuse

The land use in Kg Tanah Puteh area mostly covered in oil palm and rubber plantation and others agriculture. Most of the plantations is private and owned by local people to increase their living condition. However, large area of the study area was still covered with thick vegetation and hills along with abandoned vegetation in certain area. The rural community has been practicing agriculture in the form of ordinary farming as the source of their income as the result from British rule in Malaya between 1874 and 1955 (Hussin & Abdullah, 2012). The production of this vegetation were lower thus two agencies, FELDA and KESEDAR were formed to increase the production, thus increasing the land use of agriculture on the Gua Musang district.

b. Social Economic

Most of the population in Kg. Tanah Puteh is local people where social economic in the area consist of worker and owner for the oil palm and rubber plantation. This plantation help increasing the living standard in the area. There were also a mining quarry company in the study area which generate employment for the local people. As for the government that have been handling the social economic in Gua Musang were The South Kelantan Development Authority (KESEDAR) and Federal Land Development Authority (FELDA). These two agencies were assigned to develop land schemes in Gua Musang district and to counter the problem regarding poverty in rural area. FELDA objective was to develop land for agriculture purpose while KESEDAR aims for development for both north and south Kelantan (Hussin & Abdullah, 2012).

## 1.2 Problem Statement

Gua Musang is rich with feldspar and feldspar has been commonly exploit in the Gua Musang. Feldspar is an aluminosilicate mineral consists of vary amount of potassium, sodium, or calcium (Aliyu et at., 2015) and this research has been conducted to identify the characteristic of feldspar in the study area and compare it to the industry standard used of feldspar. This research also conducts due to the limited study on feldspar in the area and one of the past study that was conducts on feldspar deposit in Malaysia and one of the deposits was located at Tanah Puteh, Gua Musang, Kelantan (Alimon & Ahmad, 2011). Feldspar is known for their used in commercialize industry as it widely used in glass and ceramic industry for their properties. The demand for raw feldspar has continuously increased throughout the year because of the industrial application. Based on the previous research conduct by Alimon & Ahmad (2011), the feldspar deposit in Malaysia produced low quality feldspar due to the presence of iron oxide and low content of feldspar. Nevertheless, the result from the research state that Tanah Putih feldspar deposit contain relatively low iron oxide compare deposit from others place which are from Merapoh and Bukit Mor. The aim of this research is to determine the characteristic of feldspar in Gua Musang and determine their potential in industrial application as raw material.

## 1.3 Objectives

The objective of this following research study is:

1. To produce geological map Kampung Tanah Puteh, Gua Musang with 1:25,000 scale.
2. To determine characteristic of feldspar in Kampung Tanah Puteh, Gua Musang.

#### **1.4 Scope of Study**

This study was to produce and update the geological map for the selected study area in Gua Musang as well as to determine the characteristic of feldspar. The samples were collected at Kg, Tanah Puteh Gua Musang, and the characteristic properties was analysed by geochemical instruments such as X-Ray Fluorescence (XRF), and X-Ray Diffraction (XRD). The purpose of analyses was to determine element and mineral composition. The study was conduct on both soil and rock sample that collected on the earth's surface. The result from the analysis were compared with the standard composition for commercial feldspar in glass and ceramic industry to identify whether the sample were suitable to be used in the industry.

#### **1.5 Significance of Study**

This study important to produce up to date geological map of the study area. Feldspar is abundant on earth which can be easily found whether in igneous, sedimentary, or metamorphic rock. The study area which is Gua Musang are abundant which feldspar which can be produce commercially in the industry such as ceramic and glass industry. Thus, government or private agency can exploit feldspar which can be extract from rock and process it commercially to gain profit. It also important to provide data for scientific purpose in the future. The data from this study can be used for future research.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1. Introduction

This chapter discuss regarding past research and article that have been done by other researchers and their finding. The purpose of this chapter is to present evidence that can support the data that will be used in this study. Furthermore, literature review will assist in improving understanding in the topic. The information was gathered from past journals, books, article, and research paper.

#### 2.2. Regional Geology and Tectonic Setting

The regional geology of Kelantan as in located at the Central Belt of Peninsular Malaysia **Figure 2.1** where the bordered on the west consist of sediment and meta sediment while on the east consist of granite from the Main Range. As for lithology present in the Gua Musang formation, it consists of argillaceous and calcareous rock interbedded with volcanic along with minor arenaceous rocks. Previous study which conducted assessment on the lithology of Gua Musang group present that argillaceous of Gua Musang formation dominantly of consist of shale, siltstone, mudstone, slate, and phyllite. As for the carbonate facies, it can be found as extensive facies in Gua Musang formation while pyroclastic that can be found in Gua Musang more to the rhyolitic composition (Kamal et al., 2016).

North-western domain mainly consists of shallow-marine shelf sediment whereas it exhibits complete sequence of Palaeozoic sedimentary rock from Upper Cambrian to upper Permian while the rest distributed along the Main Range granite batholith. As for Central Belt, it mainly consists of Permian clastic along with Carboniferous limestone which occurred along Mesozoic sediment. Depositional setting of this belt is shallow-marine environment with intermittent submarine volcanism that range from upper Carboniferous to Triassic. Eastern Belt sediment distribute along the east part of Malaysia ranging from age Carboniferous to Permian. Sediment are shallow-marine argillo-arenaceous deposit with isolated reefal limestone lenses and volcanic.

### **2.3. Stratigraphy**

Based on Hutchison & Kiat, (2009) Peninsular Malaysia divided into three based on their Palaeozoic stratigraphy which is Western Belt whereas it included the north-western domain, Central Belt, and Eastern Belt. Although Upper Palaeozoic rock can be found among these three belts, lower Palaeozoic rock has only been discovered in Western Belt. As such Gua Musang, Kelantan located at the northern part of Central Belt in Peninsular Malaysia. Gua Musang formation were based on this location where this formation form during Middle Permian to Upper Triassic. Based on the study from Lee (2004), Gua Musang formation range from Middle Permian to Late Triassic which determined from their fossil findings and their depositional setting was shallow marine shelf deposit and it consist of active volcanic activity.

The Gua Musang group sedimentology can be divide into three different facies which is argillaceous, carbonate and volcanics (Mohamed et al., 2016). Dominant facies in Gua Musang group are argillaceous facies and it is the most extensive and

fossiliferous facies where the northern part is more fossiliferous than southern part. As the study area was located at southern part of Kelantan, it can be assumed that fossil is hard to find in the area. For carbonate facies, these facies can be identified by unique karst topography such as limestone hills. These facies can be found in Gua Musang formation and in the southern part the limestone still exhibit distinct micrite and allochem. The study area consist of carbonate platform was deposited during Permo-Triassic before it exposed to erosion and karstification. Aring Formation is dominant with volcanic facies presence in the form of agglomerates, tuffs, lapilli, and breccia. As for the volcanism located at the study area which is on the western side, it consists of more rhyolitic composition while more andesitic composition in the eastern side.

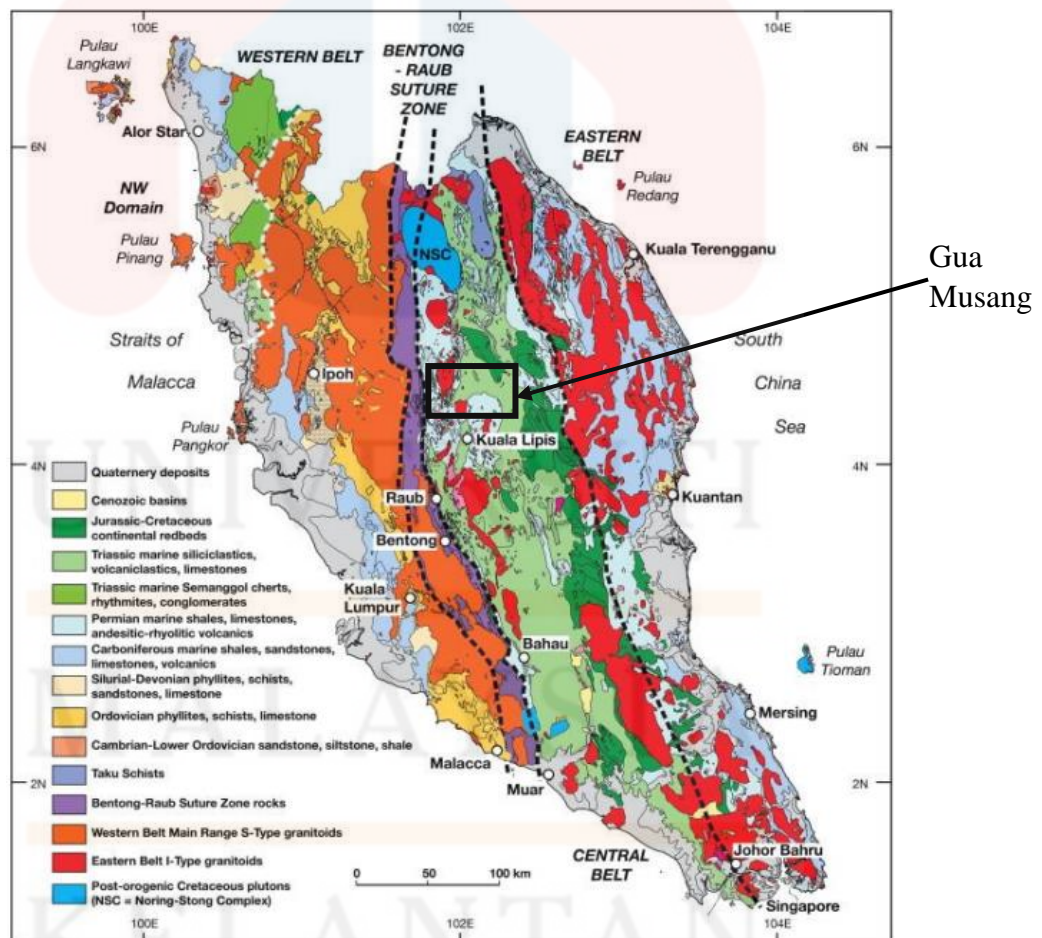


Figure 2.1: Geological Map of Peninsular Malaysia. (Source: Metcalfe, 2013)

## **2.4. Historical Geology**

Historical geology discussing the evolution of the earth and its life form that was present from past until the present. Historical geology of Gua Musang is that the formation in Gua Musang age from Middle Permian to Late Triassic and this was determined based on the fossil found in the formation. For example, fossil finding in Sungai Toh, Sungai Yu and Padang Tengku which is from Middle Permian fauna, Upper Permian fossil and Lower Triassic conodont and bivalves can be found in Merapoh. This location exhibit of warm tropical region during Permo-Triassic age due to the presence of Paleotethys (Mohamed et al., 2016)

## **2.5. Research Specification**

Feldspars are the most abundant mineral in the Earth's crust and can be found in majority of rock types. For igneous rock, feldspar can be found whether the rock is acidic, alkaline, intermediate, or basic and only absent on certain ultrabasic and rare alkaline rock. As for the metamorphosed rock, feldspar is a major constituent in most gneiss and schist. Even though feldspar is more likely to be exposed to alteration and weathering, they are the second most abundant mineral after quartz in the arenaceous sediment and occur as detrital grains or authigenic crystal. Only for the argillaceous sediment or highly carbonate rock that feldspar available in minor constituent.

Characterization of feldspar is identified based on the thin section where the structural state can be observed. This structural state depends on the temperature of crystallization along with subsequent thermal history. A high-temperature feldspar retains their structure adequate to their high-temperature formation in which this

feldspar can be found in volcanic rock. Low-temperature feldspar are feldspar with structure of crystallization at lower temperature or slow cooling from elevated elevation.

Feldspar minerals are aluminosilicates that include sodium, potassium, and calcium in multiple proportions. Feldspar is divided into two categories which are alkali feldspar and plagioclase and it belongs to the group of silicate. Feldspar can be identified by their appearance on thin section and composed of aluminium, sodium, potassium, iron, calcium, or barium in this combination. Feldspars are mined for their properties and their used in the industry. It has been used in many industries such as ceramic and glass industry where it acts as flux agent during processing. This flux agent act increases the durability and strength of the product. This section will explain regarding the characteristic of feldspar along their used in the commercialize industry.

### **2.5.1 Feldspar Occurrence**

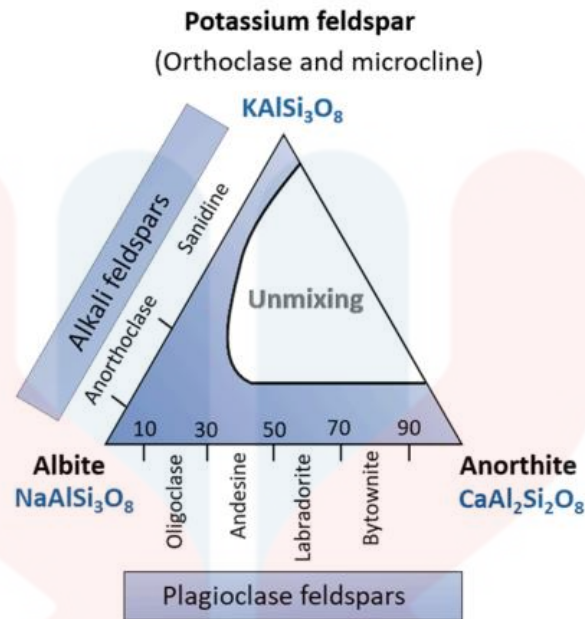
Feldspar is divided into two categories, which are alkali feldspar and plagioclase based on their occurrences. Each of this group has continuous solid solution series between end-member compositions. Albite ( $\text{NaAlSi}_3\text{O}_8$ ), microcline, and orthoclase are all types of alkali feldspar ( $\text{KAlSi}_3\text{O}_8$ ) while for plagioclase it can be in proportion of anorthite ( $\text{CaAl}_2\text{SiO}_8$ ) to albite ( $\text{NaAlSi}_3\text{O}_8$ ). Feldspar is the most abundant minerals in the Earth's crust where it composes of 60% of it and commonly found in various of rock type. Feldspar is available in the sedimentary rock and the most stable feldspar in the sedimentary environment is K-feldspar, either in clastic fragment or authigenic which is crystallization from the clastic fragment. The second most stable feldspar in sedimentary is albite exist as authigenic. As plagioclase, it unstable due to

the calcic content thus rapidly altered. For igneous rock, the feldspar has been used to identify and classify the igneous rock due to wide range composition in the igneous rock.

When feldspar form in hydrothermal rock, it usually exists in form of albite and adularia that can be found in hydrothermal veins. Albite presence in the hydrothermal veins formed from metasomatism of various rock and minerals, as for albite the form from K-feldspar, it exhibits chessboard albite. The oceanic hydrothermal metamorphism form albite at the expense of calcic plagioclase. In metamorphic rock, plagioclase commonly found as reverse zoning with a border more calcic than the core. Then, this calcic plagioclase became stable as its temperature increase. As for plagioclase that its origin is not igneous rock when undergo metamorphism, the plagioclase usually retains their structure without twinning. As for potassium feldspar in metamorphic rock, it usually available in form of microcline or formed by destruction of mica.

### **2.5.2 Feldspar Properties**

Feldspars are mineral that belong to the group of silicate with fundamental building unit of silicates is the silicon tetrahedron  $(\text{SiO}_4)^{4-}$ . Different subgroups are differentiated based on how the tetrahedra are joined and among the well-known one is group of tectosilicates, known as framework silicate, identify by having structure with rings of tetrahedra joined by four vertices forming a three-dimensional framework and group of quartz, zeolite, scapolite, feldspathoids and feldspar can be found within this tectosilicate.



**Figure 2.2:** A ternary diagram of feldspar group. (Source: Fuertes et al., 2022)

Generally, feldspars are described in ternary system formed whereas it divided into potassium, sodium, and calcium feldspar (**Fig. 2.2**). It commonly found in mixed, forming solid solution instead of pure phase and the composition are divide into two series which are alkali feldspar and plagioclase. Composition of alkali feldspar group defined in the system of; first end member, K-end member ( $\text{KAlSi}_3\text{O}_8$ ), and second end member, Na-end member ( $\text{NaAlSi}_3\text{O}_8$ ), while plagioclase group in third end member, Ca-end member ( $\text{CaAl}_2\text{Si}_2\text{O}_8$ ). Celsian is Ba-end member ( $\text{BaAl}_2\text{Si}_2\text{O}_8$ ) and hyalophane form a continuous series between this end member and potassium feldspar.

Feldspar formed based on the temperature appropriate with their structure, where at high temperature (above  $700^\circ\text{C}$ ), the feldspar presence were series from alkali feldspar and plagioclase with very limited of the third end member. As for the medium and low temperature, feldspar form as a complete solid solution series of plagioclase. But the mineral also able to exist in two or more phase between K-feldspar and albite, and this is more important as the temperature lower. Thus, when the alkali feldspar

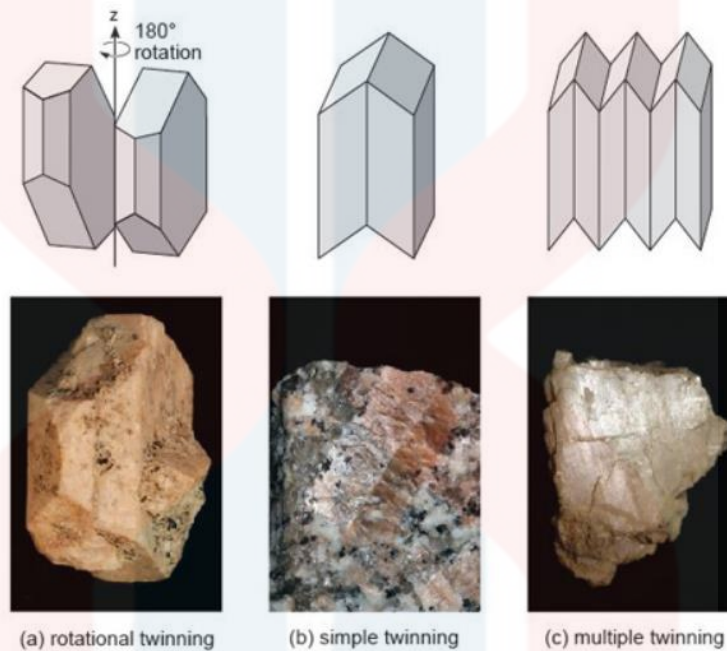
crystallizes at high temperature then cool slowly, an exsolution appear in the mineral. At low temperature which is below 550-600 °C, that form demixed plagioclase which form a very fine lamellar twinning called peristerite. The exsolution from this temperature cannot be observed through microscope. Other than that, the characteristic of feldspar structure can be observed from the petrography (Howie et al., 1992)

### **2.5.3 Petrography of Feldspar**

Petrography of feldspar are highly influence during their formation. The formation of feldspar is affected by the temperature of formation. This effect the structure state of feldspar as such feldspar that are crystallized at sufficient high temperature then it cools slowly will form an exsolution in the mineral. The exsolution that dominant in potassium feldspar with exsolution of albite is called perthite while plagioclase feldspar with potassium feldspar is called as antiperthite and when the feldspar is proportion of two end member are comparable it called as mesoperthite. Each of the series has their own high, medium, and low temperature form. For potassium feldspar, it has three polymorphs in which are a monoclinic sanidine with completely disordered polymorph of high temperature. Next, a monoclinic orthoclase a polymorph from intermediate temperature and lastly is microcline, a triclinic of low temperature polymorph (Demange, 2012).

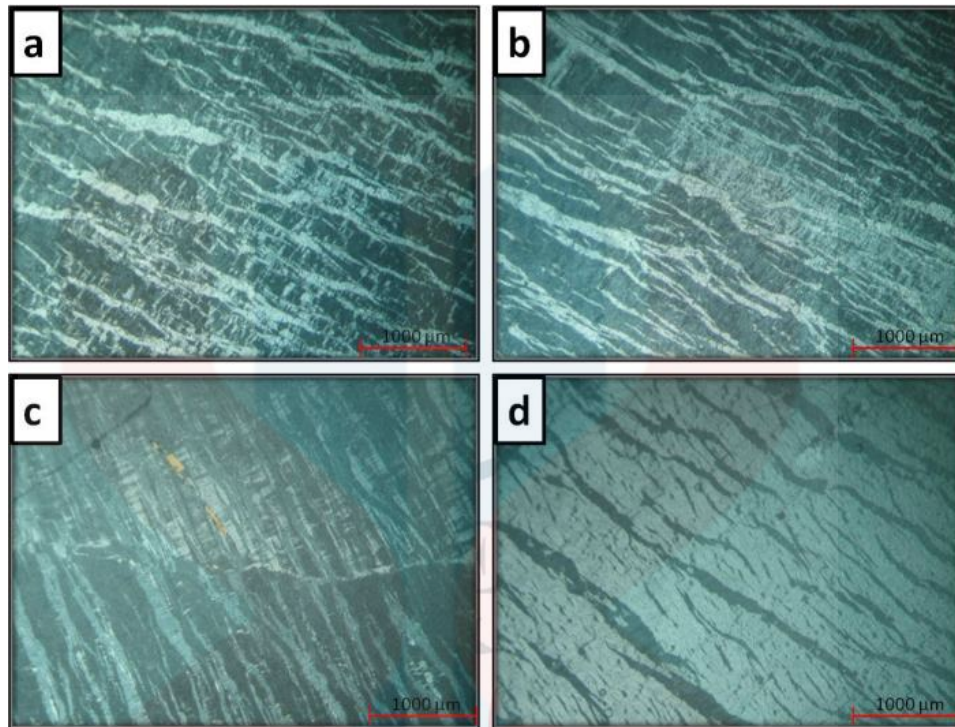
Feldspar can be identified under microscope based on their lack of colour, its low birefringence, and its twinning. Twinning that can be found in feldspar called Carlsbad twin commonly found in K-feldspar. Twinning may occur by reflection along twin plane producing either simple or multiple twinning (Lamellar twinning). In plane polarise light, feldspar has low relief and colourless. As feldspar contain micas and

clay mineral, it exhibits turbid appearance under thin section. As for microcline, the lamellar twins overlap each other giving a ‘tartan’ appearance known as cross-hatched twinning.



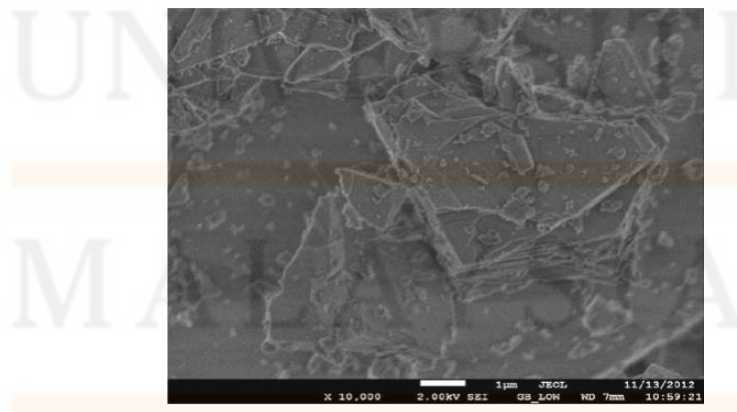
**Figure 2.3:** Twinning in feldspar (a) by rotation, Carlsbad twinning, (b) simple twinning, (c) repeated twin component. (Source: The Open University, n.d.).

For an example, feldspar petrography that has been found based on research from Mahesh & Prabhakar (2020). The feldspars were found consist of perthites and antiperthites with interstitial quartz. These perthites was formed because intergrowth of orthoclase and plagioclase feldspar which occurred high temperature phenomenon and function at lower temperature process in different condition.



**Figure 2.4:** Example of perthites and antiperthites with interstitial quartz form due to intergrowth of orthoclase and plagioclase feldspar (Source: Mahesh & Prabhakar, 2020).

Another study that examined microstructural of feldspar was conducted by Aliyu et al. (2015) using Scanning Electron Microscopy (SEM/EDX) technique. The result from this experiment, it shows that microcline feldspar as dominant phase with exhibit lamellar twin (**Fig 2.5**).



**Figure 2.5:** Example of microcline feldspar with lamellar twin (Source: Aliyu et al., 2015).

### 2.5.4 Application of Feldspar

Study on the potential of feldspar in ceramic industry Fuertes et al. (2022) state that feldspar can be used to produce wide range of ceramic product as fluxing agent during processing. Element of Na and K cation in feldspar enable to decrease melting temperature of glass batch and most likely to melt other mineral that were present in the formula while composition of  $Al^{3+}$  and  $Ca^{2+}$  cations increase both physical and chemical resistance of the product. Feldspar helps to improve ceramic product in terms of their durability, whiteness, strength, toughness, fade, chemical resistance and cement the crystalline phase Silva et al. (2019). Feldspar also used in household item such as dinnerware, sanitary ware, floor tile, wall tile, high tension electrical porcelains, dental porcelains, kitchen, and ovenware which the content of feldspar may vary based on their use.

There has been research on the chemical properties of feldspar. The result from the study has been compared with the chemical analysis for glass and ceramic commercial. From the comparison, the feldspars were determined whether it is suitable for commercial use for glass or ceramic. The constituent of feldspar that are focused on ceramic industry  $SiO_2$ ,  $Al_2O_3$ ,  $Fe_2O_3$ ,  $K_2O$ , and  $Na_2O$  as for glass industry  $CaO$  along with other element were included in the assessment. The percentage of each element were present by study from Loughbrough (1993) for ceramic while for glass study based on Harben (1995).

**Table 2.1:** Chemical analysis of feldspar in ceramic commercial industry.

Oxides	Weight percentage (%)
$SiO_2$	75
$Al_2O_3$	15
$Fe_2O_3$	0.3
$K_2O$	3.3
$Na_2O$	4.5

(Source: Loughbrough, 1993)

**Table 2.2:** Chemical analysis of feldspar in glass commercial industry.

Oxides (%)	Weight percentage (%)
CaO	1.85
SiO <sub>2</sub>	68.9
Al <sub>2</sub> O <sub>3</sub>	18.75
Fe <sub>2</sub> O <sub>3</sub>	0.07
K <sub>2</sub> O	3.85
Na <sub>2</sub> O	7.15

(Source: Harben, 1995)

Based on the research by Amaireh & Mohammad (2014), the result indicated that it contains high iron oxide compared to requirement for commercial feldspar due to mafic mineral in the original granitic rock and it has been proven that the feldspar from Wadi Al-Jayshiah was suitable for application as raw material in ceramic while it can be used for glass industry but necessary to include pre-treatment in the processing step as to increase the amount of Na<sub>2</sub>O.

Based on the Moharem & Saleh (2007), the study was conduct to analyse whether the feldspar from Wadi Zariab were suitable for ceramic commercial used based on five parameter which are total alkali (1) total alkali (Na<sub>2</sub>O + K<sub>2</sub>O%) at least 9%, (2) uranium content less than 4 ppm (3) grinding ability less than 240 min (4) suitability of physical parameter (water absorption less than 17% shrinkage less than 6.5% and bending strength over 17 N cm<sup>-2</sup>), and (5) resistance for thermal shock. The feldspar that was used for this study are collect from zoned pegmatite. The result from this study state that this feldspar was fit for wall and floor ceramic industry.

Result chemical analysis of feldspar at Matari from Aliyu et al. (2015) has shown high composition of potash in the feldspar and low of iron oxide which is ideal for glass industry. Potash act as fluxing agent during processing while iron oxide present indicate the impurity which added colour to the glass produce. As the feldspar from this area lack of iron oxide, it can be process into high class colourless glass.

Study on Kandukuru feldspar by Mahesh & Prabhakar, (2020) took 12 (twelve) different sample from the site. The samples that were taken exhibit variation on the oxide percentage due to heterogenous distribution of feldspar mineral. Alteration of mafic mineral in the deposit also cause variation to the iron oxide percentage in each sample. The samples were collected from pegmatite and felspathic vein from the area. Next study was based on the feldspar from Uganda by Olupot et al. (2006) The feldspar took from two deposits, Lunya and Mutaka. Based on the result, flux content in Lunya deposit were slightly higher than Mutaka deposit. Nevertheless, amount of iron oxide present in Lunya were higher than Mutaka thus Mutaka feldspar were suitable for white-based application.

From the study that has been explained, the amount of each composition was listed in the table. As for study that has many samples on certain area such as Kandukuru, average has been counted and used in table to present each data. **Table 2.3** present data and comparison of each feldspar in the study.

**Table 2.3:** Compound percentage of element in the feldspar based on the result from previous study.

Compound (%)	Wadi Al-Jayshiah (Amaireh & Mohammad, 2014)	Wadi Zareib (Moharem & Saleh, 2007)	Matari (Aliyu et al, 2015)	Lunya (Olupot et al., 2006)	Mutaka (Olupot et al 2006)	Kandukuru (Mahesh & Prabhakar, 2020)
CaO	4.75	0.17	0.12	0.1	0.09	0.86
SiO <sub>2</sub>	67.96	67.14	67.32	65.7	62.9	70.58
Al <sub>2</sub> O <sub>3</sub>	17.74	17.17	17.54	18.3	22.5	15.86
Fe <sub>2</sub> O <sub>3</sub>	2.33	0.27	0.1	1.65	0.065	0.46
MgO	-1.27	0.01	0.01	0.0436	0.02	0.17
K <sub>2</sub> O	4.33	11.8	11.33	12.3	11.8	9.39
Na <sub>2</sub> O	4.13	2.89	2.75	1.84	0.409	1.99
TiO <sub>2</sub>	-	0.01	-	0.0053	0.0036	-
P <sub>2</sub> O <sub>5</sub>	-	-	0.35	0.0366	0.0874	-
SO <sub>3</sub>	0.09	0.08	-	-	-	-
Total	100.06	99.83	99.69	100	97.88	99.71
LOI	0.085	0.47	0.14	0.1	3.1	0.41

(Source: Amaireh & Mohammad, 2014; Moharem & Saleh, 2007; Aliyu et al, 2015; Mahesh & Prabhakar, 2020; Olupot et al., 2006).

Feldspars are applied during production of glass and ceramic industry because of it is source of alkali and alumina which make the product more transparent. As for the preference of feldspar member that are used in the glassmaking is soda feldspar while ceramic commonly used potash feldspar (Gougazeh, 2022). In the glassmaking industry, content of iron oxide is important to determine the grade of feldspar that can be used in the industry.

MALAYSIA  
KELANTAN

## CHAPTER 3

### MATERIAL AND METHOD

#### 3.1 Introduction

This chapter discuss regarding the material, method and analysis that will be conducted to ensure the fulfilment of the objective. This chapter present preliminary study, data collection, data process, and data analysis.

#### 3.2 Material

Material is an equipment that are required to obtain the sample, create geological map, and collect the laboratory data. Equipment to obtain the sample are geology hammer, plastic sample, compass, GPS, geological map, camera, or phone. As to obtain geological map, ArcGIS software was used to create and label the map. For laboratory analysis equipment that has been used are Xray Fluorescence (XRF), Xray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Polarizing Light microscope. Below is the list of equipment that will be used on the field and during lab analysis.

Materials for geological mapping and data sampling:

##### a. Topography Map

Topography map was used to identify the location, study area, elevation, contour, and drainage in the area. It can be used to navigate and mark the sample location in the study area.

b. Geological Hammer

Tools was used to collect the sample and split the rock to create fresh surface where the mineral and grain are more visible.

c. Brunton compass

Brunton compass was used to determine orientation of geological plane and lineation and angle of dip of geological features. It also can be used to determine the direction or azimuth.

d. Measuring tape

Measuring tape was used to obtain an accurate measurement of bedding's thickness. It can be used to collect data for lithology log.

e. Plastic sample

Plastic sample was used to store the sample and avoid it from any contamination or damage during transportation to the lab.

f. Camera

Camera was used to take picture of the outcrop or sample. This photo was used to review the outcrop and ensure the analysis that was conducted from the field was accurate.

g. Hydrochloric acid (*HCL*)

It was used to identify the presence of calcite mineral by placing a drop of HCL on rock and observe the reaction. The bubble reaction shows that it consist of calcite

h. Global Positional System (GPS)

It used high-frequency wave signal from the satellites to locate the current location. GPS was used with topography map to conduct traverse mapping.

i. Field Notebook

Notebook is important to take note the data that are gathered in the field. All the data taken was analyse and interpret into the field study.

### **3.3 Methodology**

#### **3.2.1 Preliminary Study**

Preliminary study needs were conducted before conducting the fieldwork. The information was collected from journals, research paper, internet, and book to know the nature of the study area. As such, when visiting the fieldwork, the nature of the rock was assumed in certain location whether the location consist of igneous, sediment or metamorphic rock. Thus, it can be used to support analysis of the data based on the observation and sample collection from the field.

#### **3.2.2 Geological Mapping**

This study was to investigate the study area by producing geological mapping using GIS software. GIS software was used to visualize, manage, and analyze geological data in the surrounding area of the study which is around Gua Musang. Exploration was conduct on the study area and any geological change that can be

identify which is differ from old data was identify. Then, GIS software was used to update the data to produce up-to-date map with scale of 1:25,000.

a. Collecting data from the field.

Data was collected throughout the field work such as the day and date of the field, coordinate of the location, sketches, lithology, fossil, and structural information are gathered and collected. Observation of different rock body, composition and texture were taken. The data that has been collected were used for cross reference later where additional information was added from another document.

b. Data of Sedimentary Structure.

Sedimentary structure consists of variation and complex data thus it needs to be record and describe during geological mapping. Sedimentary structure provide data such as deposition process and depositional setting. Structure data was collected by observing the structure that look similar and interpret in a lithology log. The sample collected from sedimentary structure must show the main composition of rock in the structure. For example, if the structure mainly consists of sandstone while has minor muddy sandstone, sample that need to be collect was the main sandstone. Strike and dip of the bedding, fault and joint were collected from sedimentary structure.

c. Data of Igneous Rock

The data for igneous rock was recorded based on the knowledge that has been gathered whether the location consist igneous rock or not, and with the observation in the field can support the evidence that it is an igneous rock. Then, the igneous rocks are determined whether it is an intrusive or extrusive rock. If there is unconformity found in the outcrop, strike and dip need to be measured to identify the intrusion by

igneous rock. Igneous rock commonly found in the outcrop as intrusion as dyke or sill. The data of joint and veins was collected from the igneous rock.

d. Data of Metamorphic Rock

Metamorphic rock was gathered by observing the expose outcrop whether the rock is layered, massive or patchy. Contact between others type of rock or intrusion was observed. This information help to recognize the lithology of the rock. For metamorphic rock, the textures, banding, mineral, features, and grain texture was observed in the field. Most of the metamorphic rock preserved their protolith composition layering such as sedimentary rock. This banding can be identified based on the aligned or flattened mineral grain after exposing to pressure and temperature. As for the grain texture, the rock was observed whether it consist of orientated crystal or granular texture. Granular texture occurred when there is contact metamorphism that cause by igneous rock. As metamorphic rocks are formed due to pressure and temperature, it commonly found in a deformation state. This feature can be identified in common example such as pre-kinematic, syn-kinematic, and post kinematic exposure that can be observed in the field.

e. Producing Geological Map

The geological map is produced by using traversing mapping method. The information in the map consists of elevation, contour, major rock types, drainage, and land use. Major rock types of maps show the rock boundary that presence in the study area. The drainage map exhibits the water flow in the area while the land use consists of data of vegetation and soil use. This map will be created electronically by using Geographic Information System (GIS) in a scale of 1:25,000.

### 3.2.3 Data Sampling

Sample was collected during traverse in the study area. The sample were collected from both soil and rock sample. Feldspar occurred in various type of rock as such the data was gathered from igneous, sedimentary, and metamorphic rock. This study utilizes the rock from the surface to gather information regarding the feldspar composition. For the rock sample, the rock taken from fresh outcrop with size larger than average hand palm while soil sample collect weight about 200 grams. The sample was put into plastic sample with ziplock to avoid contamination during transport to the laboratory. The location of the sample that collected was marked on the map. The samples were label on the plastic sample where the sample were collected, sample number, sample is orientated or not and the condition of the weathering during data collection.

### 3.2.4 Preparation of Laboratory Analysis

After the sample was collected from the field, it was taken care to ensure the quality of the sample. Any presence of weathered material was removed before conducting the laboratory analysis. This process was conducted during field work to ensure that the sample in the laboratory is a fresh sample.

Laboratory analyses were conducted on certain sample that has been collected. For laboratory analysis, XRF, and XRD were used to discover chemical composition, crystalline pattern, and microstructural configuration respectively. The soil sample undergo drying in the oven for 100° C for 24 hours, and grind by using mortar and pestle to reduce it into fine powder, and same grain size. This sample were separated

for different test. The process must be carefully conduct during crushing the sample to avoid contamination.

i. X-ray Powder Diffraction (XRD) Analysis

X-ray powder diffraction (XRD) is a rapid analytical technique to identify crystalline material and provide information regarding unit cell dimension. The sample that will be used in this analysis are in determined average bulk composition, finely ground and homogenized. Crystalline substance serves as three-dimensional diffraction grating for X-ray wavelength similar with spacing of planes in crystal lattice thus it commonly used to analysed crystal structures and atomic spacing. The mechanism of this instrument is based on the Bragg's Law ( $n\lambda=2d \sin \theta$ ) where identification of mineral is based on the conversion of diffraction peaks to d-spacing as each mineral has their own set of unique d-spacing (Dutrow & Clark, 2022).

This instrument consists of X-ray tube, sample holder and X-ray detector. Intensity of the reflected X-rays recorded during the sample and detector are rotated, as it rotates the constructive interference occurs and a peak in intensity occurred when the geometry of the incident X-rays satisfies the Bragg Equation. The pre-set angle in the X-ray scan is at  $2\theta$  from  $\sim 5^\circ$  to  $70^\circ$  which commonly used in powder patterns.

XRD analysis was performed using Bruker D2 Phaser diffractometer with voltage and current source of 30 kV and 10 mA, respectively. The diffractometer was equipped with Cu-K $\alpha$  radiation ( $\lambda = 0.154$  nm), and scanning was conducted at step size of 0.020. The output from XRD analysis was a diffraction pattern graph with peak's intensity versus  $2\theta$  degree. Mineral phase identification was analysed by using DIFFRAC EVA 5.2 software by comparing experimental XRD pattern from sediment sample with theoretical XRD pattern from Crystallography Open Database (COD).

## ii. X-ray fluorescence (XRF) Analysis

This study has been used portable XRF spectrometer whereas the data is quite different from the powder XRF. XRF analysis was conducted by using Bruker S1 TITAN Handheld with calibration of oxide three phases on each sample. Voltage, and current source of 30 kV, 50 kV, 15 kV and 13.6  $\mu\text{A}$ , 18.4  $\mu\text{A}$ , 9.7  $\mu\text{A}$ , respectively. This analysis was conducted on the rock sample. X-ray fluorescence (XRF) spectrometer is an instrument used for non-destructive chemical analysis of rocks, minerals, sediments, and fluid works based on the wavelength-dispersive spectroscopic principle commonly used in bulk analysis of larger fraction of geological materials. It commonly used for analysis in major and trace element of rocks, minerals, and sediment due to the ease and low-cost preparation, stability, and ease use of X-ray spectrometer (Wirth & Barth, 2020).

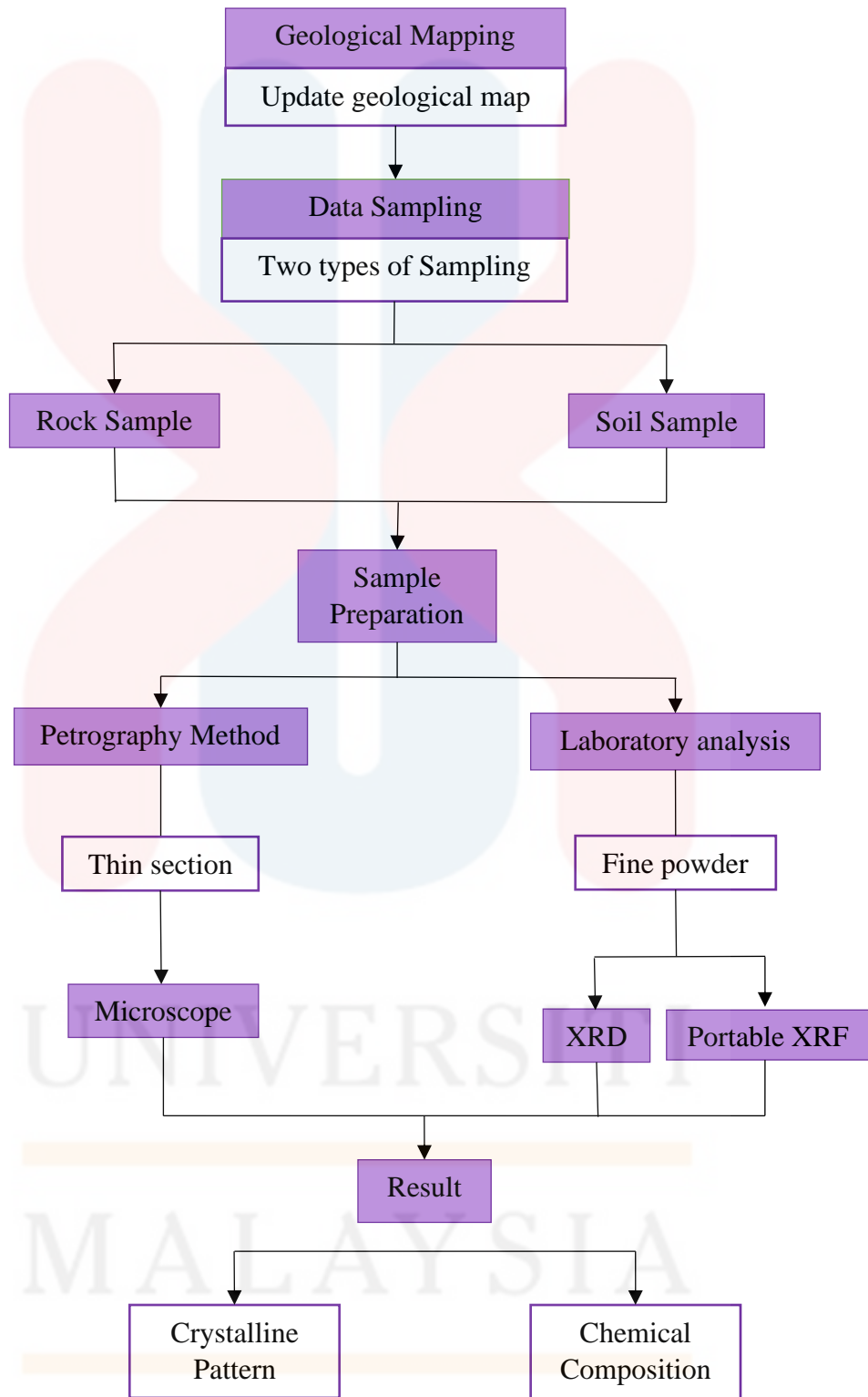
### 3.2.5 Preparations of Thin Section

For the thin section the sample collected was about 10 cm thick  $\times$  5 cm  $\times$  5 cm for each thin section sample. The sample taken need to be large enough for it to be clamped in rock saw and if the rock needs to be in different orientation. Larger sample need to be collected if the rock is deformed, as the thin section require to be cut into two or three thin sections for the right angle. Thin section is prepared for the rock sample to identify mineral composition, condition it formed and observe any structural pattern. The sample will be cut into an approximately 30 microns thick for mounting on a glass slide and view by polarizing light microscope. Feldspar is identified based in thin section by their lack of colour, its low birefringence, and its twinning.

i. Polarizing Light Microscope

Polarized light is a contrast enhancing technique that improve the quality image that obtained with birefringent material. It has high degree of sensitivity and can used for both quantitative and qualitative studies and offer a wide range of anisotropic specimen. For geologist, quantitative aspect used to determine the crystallography that is presence in the specimen.

**RESEARCH FLOW CHART**



**Figure 3.1:** Flow chart of the overall methodology.

## CHAPTER 4

### GENERAL GEOLOGY

#### 4.1 Introduction

The data and information gathered from the mapping activities in Kampung Tanah Puteh are discussed in this chapter. This information covers all aspects of the studied area's geology, including geomorphology, lithostratigraphy, geological structure, historical geology, and the structural mechanisms. This chapter includes the traverse and observation map, geomorphology map, and drainage map to help readers better comprehend the study area's landforms and their characteristics. Based on the information acquired, a geological map of Kampung Tanah Puteh was produced, as shown in the diagram. However, due to the restriction of varied scale when saving from ArcGIS into word or image, a geological map with an accurate scale of 1:25,000 cannot be exhibited on the paper. Therefore, the only place to find a geological map with this precise size is from a digitized geological map.

This chapter is important for the geologist to find out or identify the past event that had been occurred in the study area.

#### 4.1.1 Accessibility

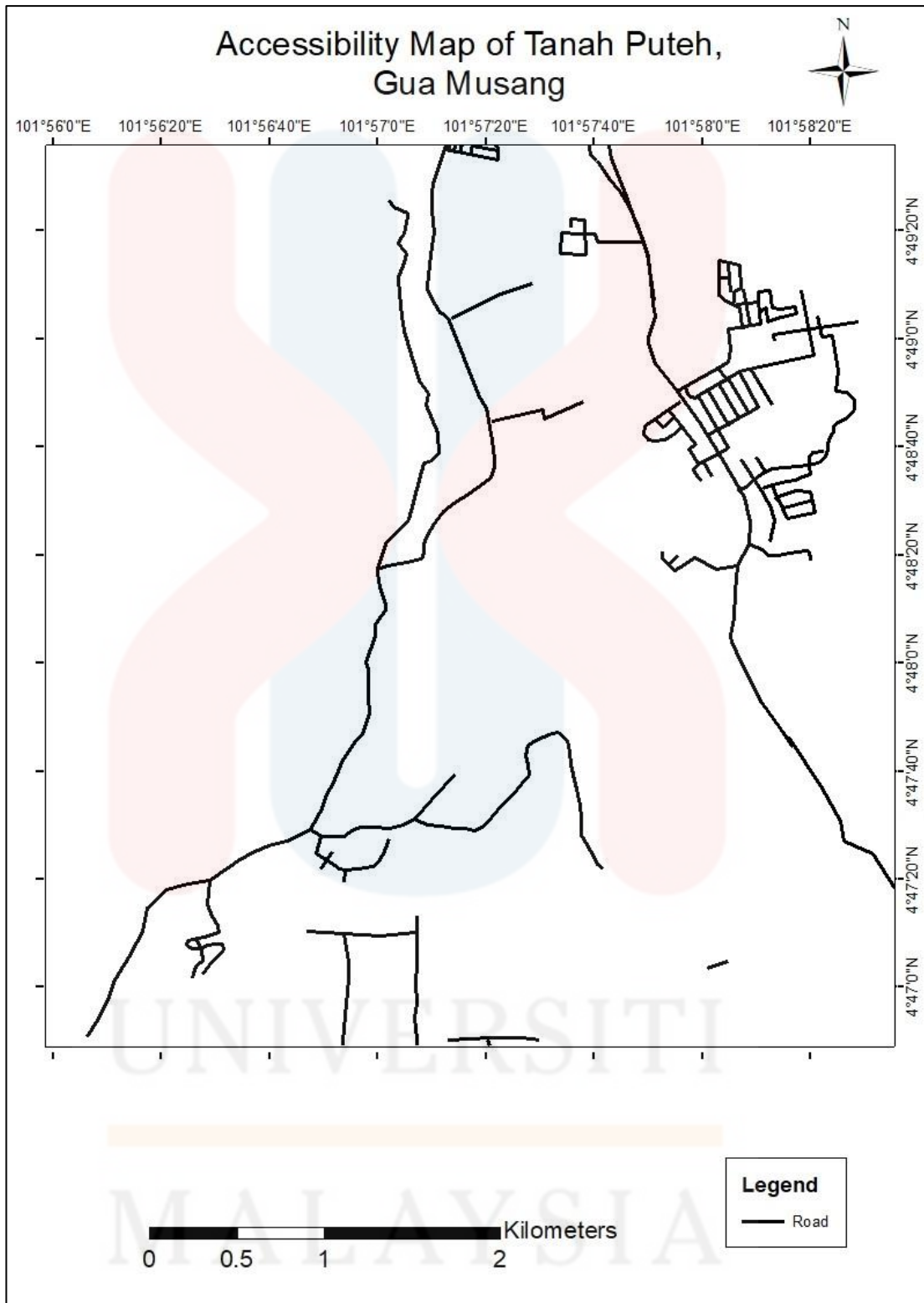
This section discussed on the capability of the study area to be able to reach from one location to others. to travel between different locations. The major roads and dirt roads are the primary means of access to the study area. With a few exceptions, such in the mountains or the forest, the local telecommunications network has rather decent coverage. Due to the study area's proximity to a city and a residential region and the area's extensive road network, access to the area's north and northeast sides is quite developed. However, west side is a rural area thus the road is either paved road or byroad while areas such as plantation is mostly covered in unpaved road. **Figure 4.1** shown the accessibility map of the study area.



**Figure 4.1:** The unpaved road along the main road. (Source: Google Map, 2022)

MALAYSIA

KELANTAN



**Figure 4.2:** Accessibility map of Kg. Tanah Puteh, Gua Musang.

#### 4.1.2 Settlement

Settlement is a place that involve a group of people that develop community with involving economic activity and social development in one place. Settlement that has been identified in the study area composed of urban and rural settlement. Gua Musang is the result of expansion area with several village including Kampung Star, Kampung Pulai, Pasir Tumbuh, Chegar Bogor, Kampung Kerinting, Limau Kasturi, Batu Papan, and Lapan Jaya. Village that was included in the study are Kampung Tanah Puteh and Kampung Pulai. Majority of the settler main occupation and income came from palm oil and rubber.

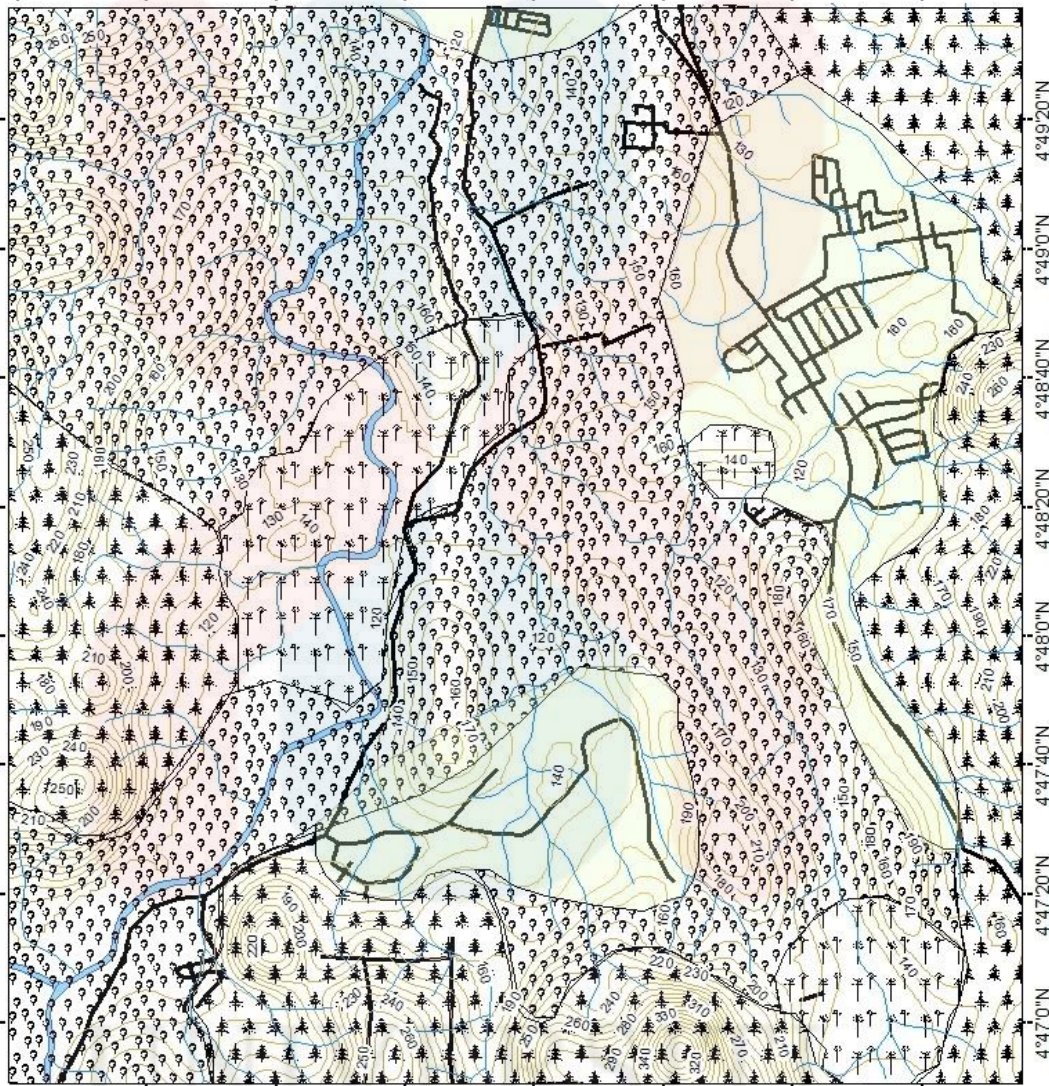
#### 4.1.3 Forestry/Landuse

Landuse refers to how people use land for economic and cultural purposes, including practices like agriculture, residence, industry, mining, and recreation in various locations. It involves modifying the built environment through managing the natural environment or wilderness. Plantations of rubber, palms, and trees, as well as some settlement, are the three main types of vegetation that may be found in the research region. A little more than 60% of the research area was made up of rubber plantations, 20% of it was covered in forests, 5% was made up of palm plantations, and the remaining 15% was populated. Plants like palm oil and rubber provided career opportunities for locals in Gua Musang to improve their financial situation. In this research region, rubber plantations, including those that have been abandoned, are the dominant vegetation. Rubber plantation benefits the local economy as a portion of the plantation is owned by a private corporation and others by individual private property.

# Vegetation Map of Tanah Puteh, Gua Musang



101°56'0"E 101°56'20"E 101°56'40"E 101°57'0"E 101°57'20"E 101°57'40"E 101°58'0"E 101°58'20"E



0 0.5 1 2 Kilometers

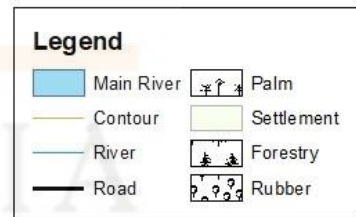


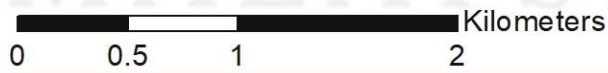
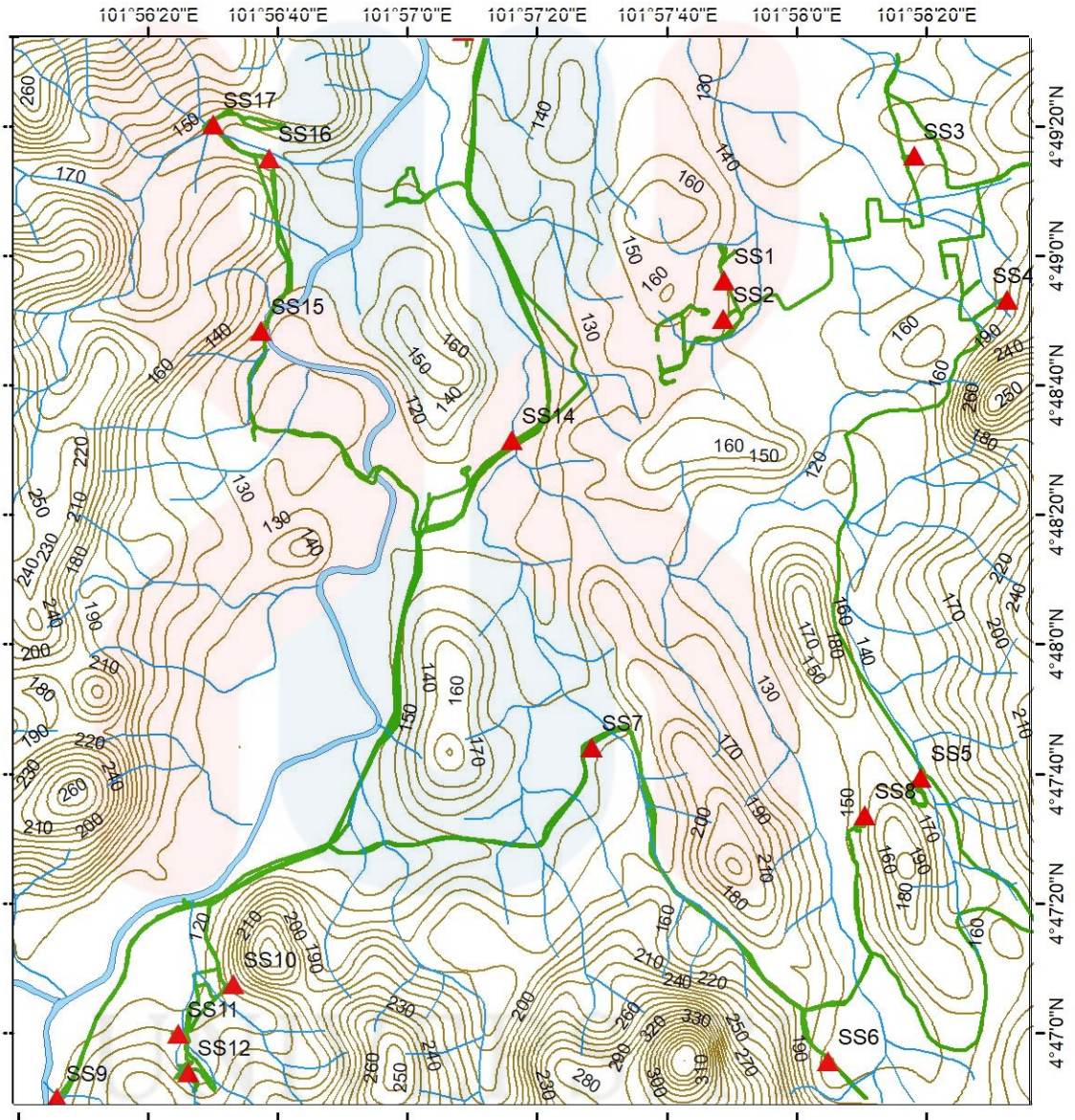
Figure 4.3: Vegetation map of Kg. Tanah Puteh, Gua Musang.

#### 4.1.4 Traverse and Observation

Mapping activity was done by using traversing and observation to collect data along with rock sampling. The traverse and observation conducted by accessing along the road and certain river. Before traversing, the route and location for the day is being planned and set. Then, based on topographic map, the contour line is being study to determine and assume lithology in the area. The traverse route and observation point is recorded in both GPS and note is taken for detailed explanation in each area. This description involves information such as coordinate, elevation, lithology, strike and dip, weathering level, rock's colour or vegetation type.

Based on the traverse map in **Figure 4.4**, the area that covered during traversing covered about 70% of the map. Certain part of the area in the map is not covered due to high slope near the karst formation which make it inaccessible.

# Traverse Map of Kg. Tanah Puteh, Gua Musang



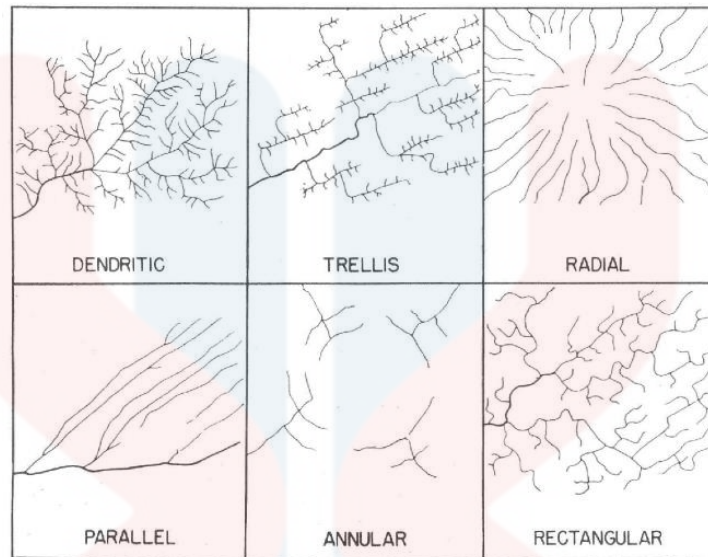
**Figure 4.4:** Traverse and observation map of Kg. Tanah Puteh, Gua Musang.

## 4.2 Geomorphology

The geomorphology section discussed the study area's topography classification, weathering process, and drainage pattern. By observing and analyzing a location's geomorphology, it is possible to identify a variety of landscape and landform features. This allows for the assessment of the physical change of the earth's landform and the identification of any potential natural or man-made hazard. Thus, geomorphology allows for the safe and effective socioeconomic planning and development for societies. Observations for geomorphology are conducted by moving to a higher elevation away from buildings, which enables clear, unobstructed views of the surrounding landscape.

Endogenic and exogenic processes are major contributors to landform change in the study area. Exogenic processes derive from external forces on or above the planet and can be accelerated by human activity, whereas endogenic processes are caused by forces from within the planet. In the study area, endogenic processes included diastrophism, volcanism, and metamorphism, while exogenic processes included mass movement, weathering, and erosion.

### 4.2.1 Drainage pattern

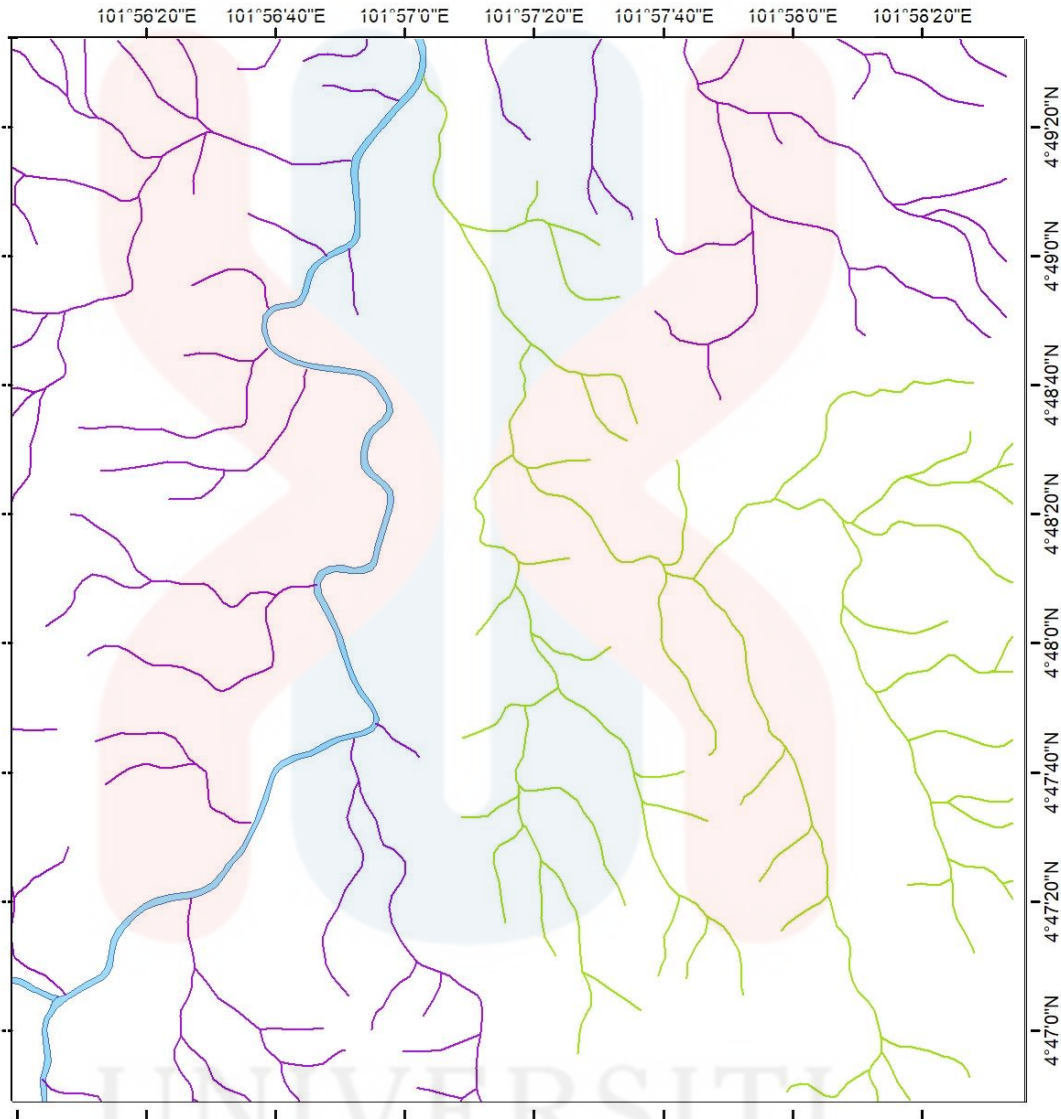





**Figure 4.5:** Common drainage pattern as suggested by Parvis (1950).

According to the drainage pattern map in **Figure 4.6**, the study area has two types of drainage patterns: dendritic pattern and parallel pattern branches off the main river, Sungai Galas. The pattern of dendritic drainage resembles the branching pattern of tree roots. It is found in a region underlain by homogeneous material with similar resistance to weathering, so it has no distinguishable impact on the flow of waterways. Then, the water that flows, join a larger stream at an acute angle less than  $90^\circ$ . The study area mostly covered with limestone thus it has similar resistance to weathering as the area was covered by dendritic while certain area is parallel where it transitions from dendritic pattern.

Parallel drainage pattern was common in areas with noticeable surface slope, or it can develop in areas with parallel, elongated landforms, such as outcropping resistant rock bands. Following the slope of the surface, the stream stretches out in a parallel fashion, and this pattern can sometimes indicate a major fault in steeply folded bedrock. This pattern is a transition between dendritic and trellis patterns.

# Drainage Map of Kg. Tanah Puteh, Gua Musang



Legend	
	Main River
<b>Drainage</b>	
	Dendritic
	Parallel

**Figure 4.6:** Drainage map of Kg. Tanah Puteh, Gua Musang.

#### 4.2.2 Geomorphological classification

The geomorphology Kampung Tanah Puteh was classified based on their topography and rock type landform. The topography of the study area is divided into three which is plain, hilly, and mountainous. The rock's type landform that can be identify is karst landform.

**Table 4.1:** The classification of topography suggested by Van Zuiddam, 1985.

Classification	Elevation (m)
Plain	50-100
Low hill	100 - 200
Hill	200-500

Topography of the study area consist of low land, low hill, and hill. The topography classification is based on Van Zuiddam where 50m to 100m consider as low land, 100m to 200 meter is a low hill and 200m to 500m is a hill. Most of the hill in study area is a karst limestone.

According to the topography map in **Figure 4.10**, the study area consists primarily of flat and hilly landforms with elevations ranging from 120m to 380m. The highest elevation is found in the western region of the study area, which is composed of karst limestone. Gua Musang's undulating and undulating topography is a result of the karst landform. It originates from carbonate bedrock, which gives rise to karstic features such as caves and steep cliffs.



**Figure 4.7:** Geomorphology of karst and mountain that can be observed from the study area.

a. Karst limestone

Karst limestone consist of calcium carbonate,  $\text{CaCO}_3$  and found abundance as isolated steep hill limestone. It characteristic of easily soluble when exposed to slightly acidic water make it easy for the material to dissolve and form others feature. Although, karst limestone in study area appears to be enormous when view from outside, yet mostly this limestone has cavities due to dissolution by water. In **Figure 4.9** show the cave feature of karst limestone. There is also various cave feature such as stalactite, stalagmite and columnar that form through weathering where dissolve calcium carbonate became solid again to create a new feature. Though, this structure of the karst limestone was hard to observe by traverse due to the biological weathering that cover the entire karst limestone.



**Figure 4.8:** The karst hill fully covered by root of plants.



**Figure 4.9:** Cave feature due to dissolution of water.

KELANTAN

# Topography Map of Kg. Tanah Puteh, Gua Musang

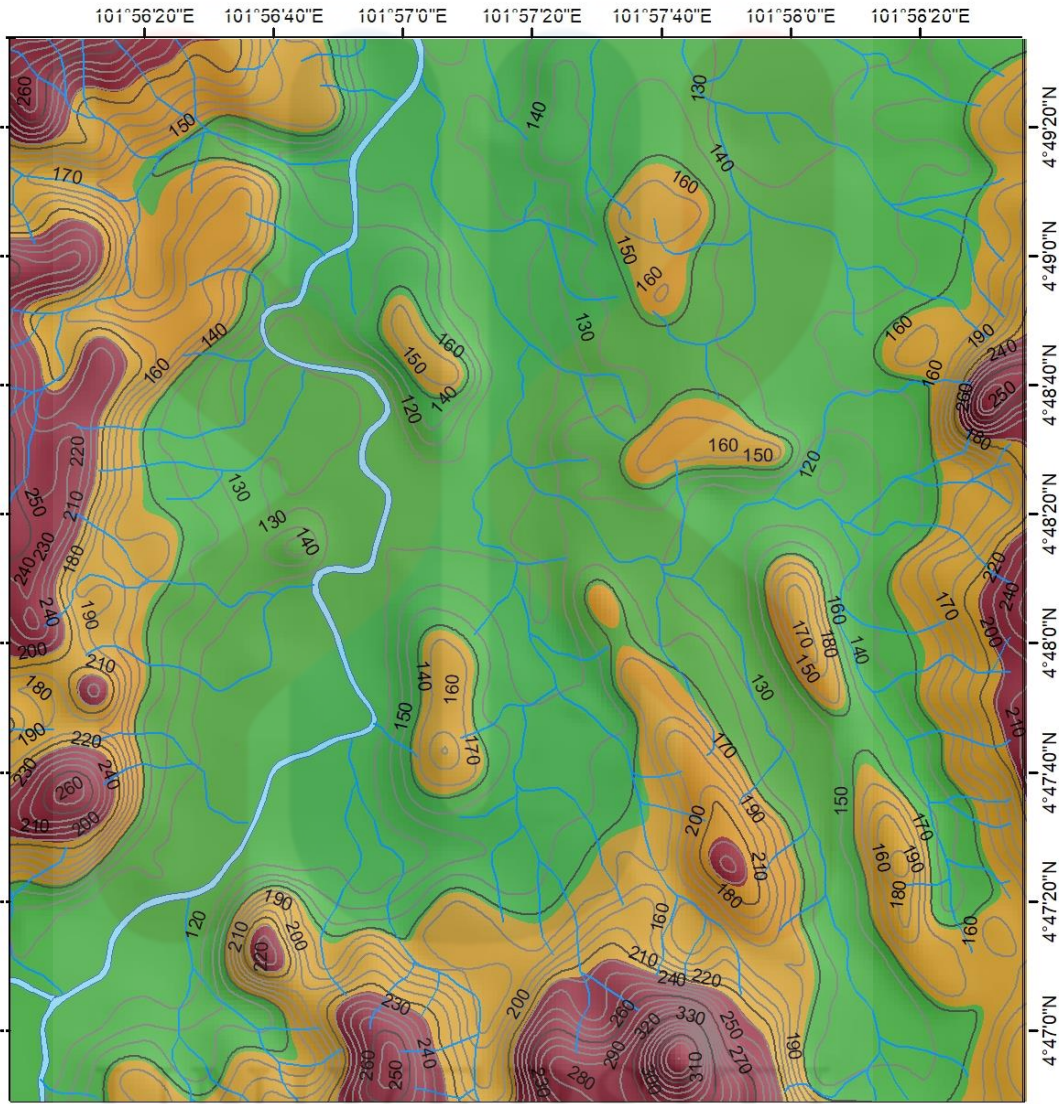


Figure 4.10: Topography map of Kg. Tanah Puteh, Gua Musang.

### 4.2.3 Weathering

The weathering process is the disintegration or dissolution of rocks and minerals on the earth's surface. Physical weathering, chemical weathering, and biological weathering are weathering processes that can be identified in the research area. The composition of regolith and soil relies on the composition of the parent rock, which is transformed by the weathering process when exposed to the weathering agents.

Physical weathering is the disintegration of a rock without altering its chemical content. The agents of weathering that trigger this process might be wind, water, or gravity. Chemical weathering is the process of a rock decomposing by chemical alteration, hence altering the rock's composition. This process is caused by a variety of agents, including dissolution, carbonation, and oxidation. Biological weathering is the disintegration of rocks by plants, animals, and microorganisms. Based on the observation, all type of weathering were presence in the study area as in **Figure 4.11**.



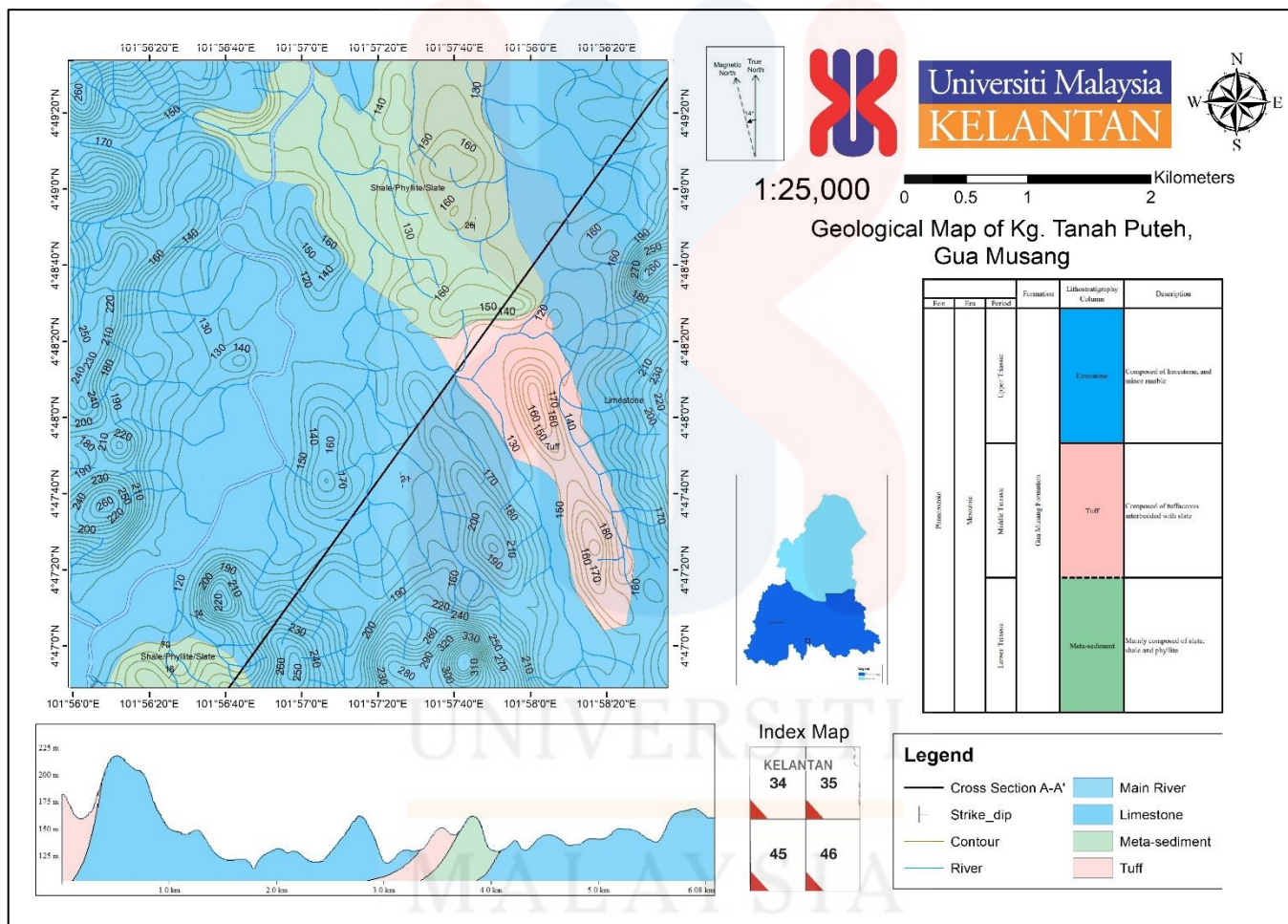
**Figure 4.11:** (A) Physical weathering by water flow which break the rock along the water flow, (B) Chemical weathering by dissolution of karst limestone, (C) biological weathering by root of plant penetrate the karst limestone and (D) physical weathering of rock by wind and gravity.

### 4.3 Lithostratigraphy

Lithostratigraphy section discuss on both combination of lithology and the stratigraphy that has been identified in the study area. Lithology describes the physical properties of rock such as colour, texture, composition and the grainsize of rock body unit. As for the stratigraphy, it defined as study of the arrangement of rock formation, distribution, chronological succession, or order. Lithostratigraphy is important to describe the geological event that occurred in the study area.

#### 4.3.1 Stratigraphic position

Lithologies in the study area composed of Gua Musang Formation aging from Middle to Late Triassic in Mesozoic era. The lithology that belongs in the study area are Limestone unit, meta-sediment unit and tuff unit. The youngest lithologies in the study area is limestone from middle to late Triassic while the oldest rock is meta sediment. **Table 4.2** show the arrangement of the lithologies, the age and detail description of the lithologies in the study area.



**Figure 4.12:** Geological Map of Kg. Tanah Puteh, Gua Musang

**Table 4.2:** Lithologies column of the study area.

Eon	Era	Period	Formation	Lithostratigraphy Column	Description
Phanerozoic	Mesozoic	Upper Triassic	Gua Musang Formation	Limestone	Composed of limestone, and minor marble
		Middle Triassic		Tuff	Composed of tuffaceous interbedded with slate
		Lower Triassic		Meta-sediment	Mainly composed of slate, shale and phyllite

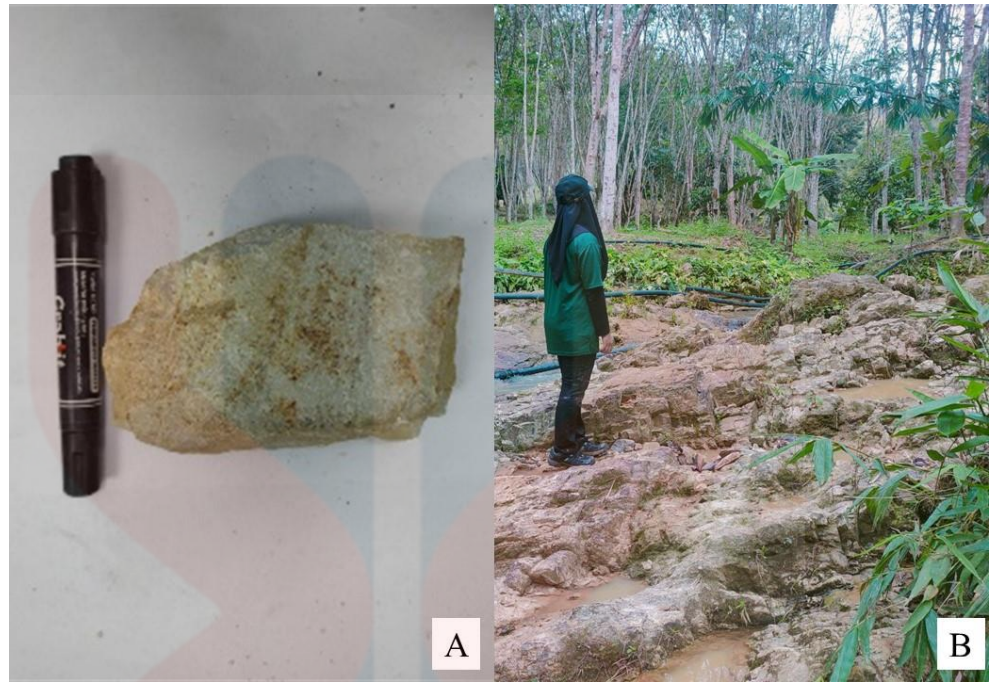
### 4.3.2 Unit explanation

#### a. Meta-sediment

Meta-sediment that presents in the study area is phyllite, shale and slate. Meta-sediment is the oldest rock in the sequence age in early Triassic. Phyllite that was found in the study area has blackish colour and fine-grained size. Phyllite outcrop that found in the study area break off in a blocky shape. As for the slate, it has fine-grained size with whitish colour. There is also slate that found in the study area has been weathered but still show it distinct cleavage. Shale in the study area was found in weathered condition with blackish colour.



**Figure 4.13:** (A) Hand specimen of phyllite and (B) The phyllite outcrop in the study area.



**Figure 4.14:** (A) Hand specimen of slate and (B) The slate outcrop in the study area.

#### b. Limestone

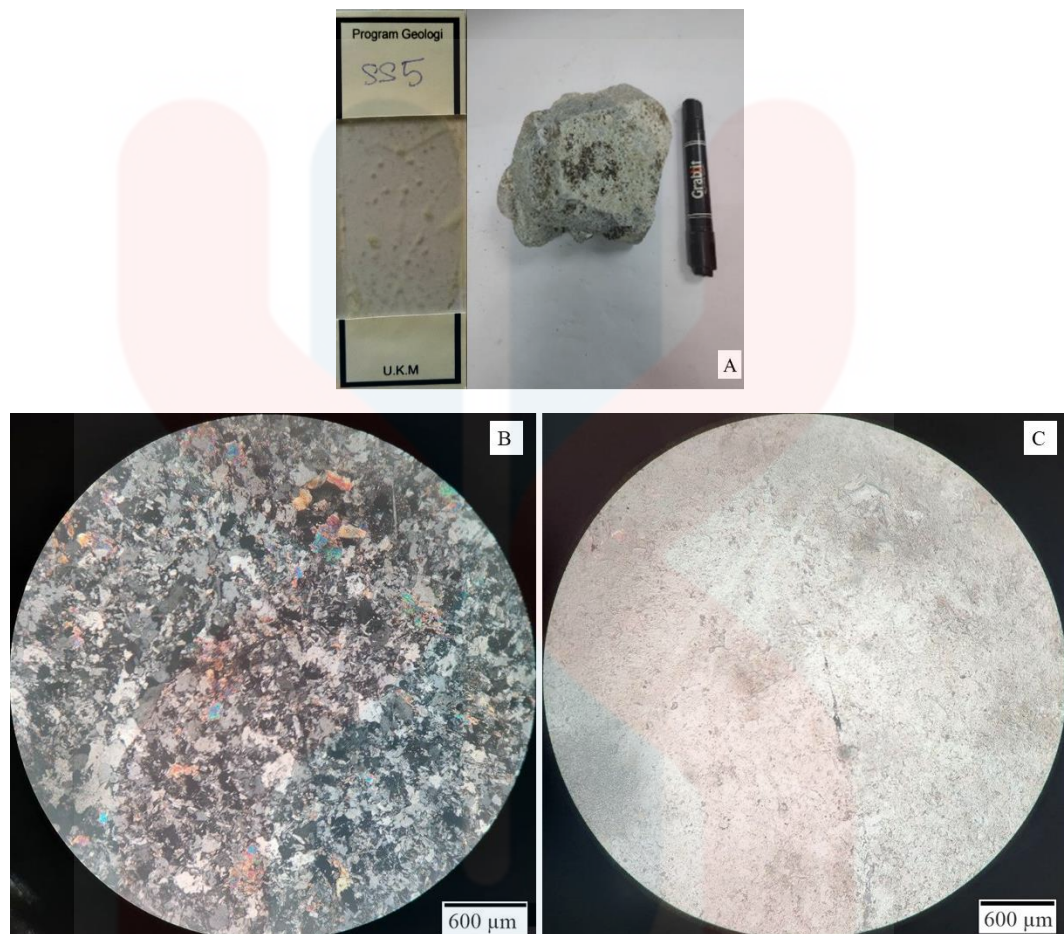
Limestone unit that found in the study area consist of fine-grained size and vary in colour ranging from blackish to whitish colour. Limestone can be found throughout the study area and majorly found as karst or hill.

Two types of limestone found in the study area are limestone in white and carbonaceous limestone which has black in colour. The white limestone commonly forms from chemical origin where the calcium carbonate precipitate from marine water and fresh water. As for the carbonaceous limestone, it forms from biological origin and the reason for dark colour came from its composition which the presence of magnesium and iron.



**Figure 4.15:** (A) Hand specimen of white limestone, (B) The white outcrop in the study area. (C) Hand specimen of carbonaceous limestone, and (D) The carbonaceous limestone outcrop in the study area.

Sample 5



**Figure 4.16:** (A) Hand specimen of tuff sample and the thin section. (B) Thin section of sample 5 in XPL. (C) Thin section of sample 5 in PPL.

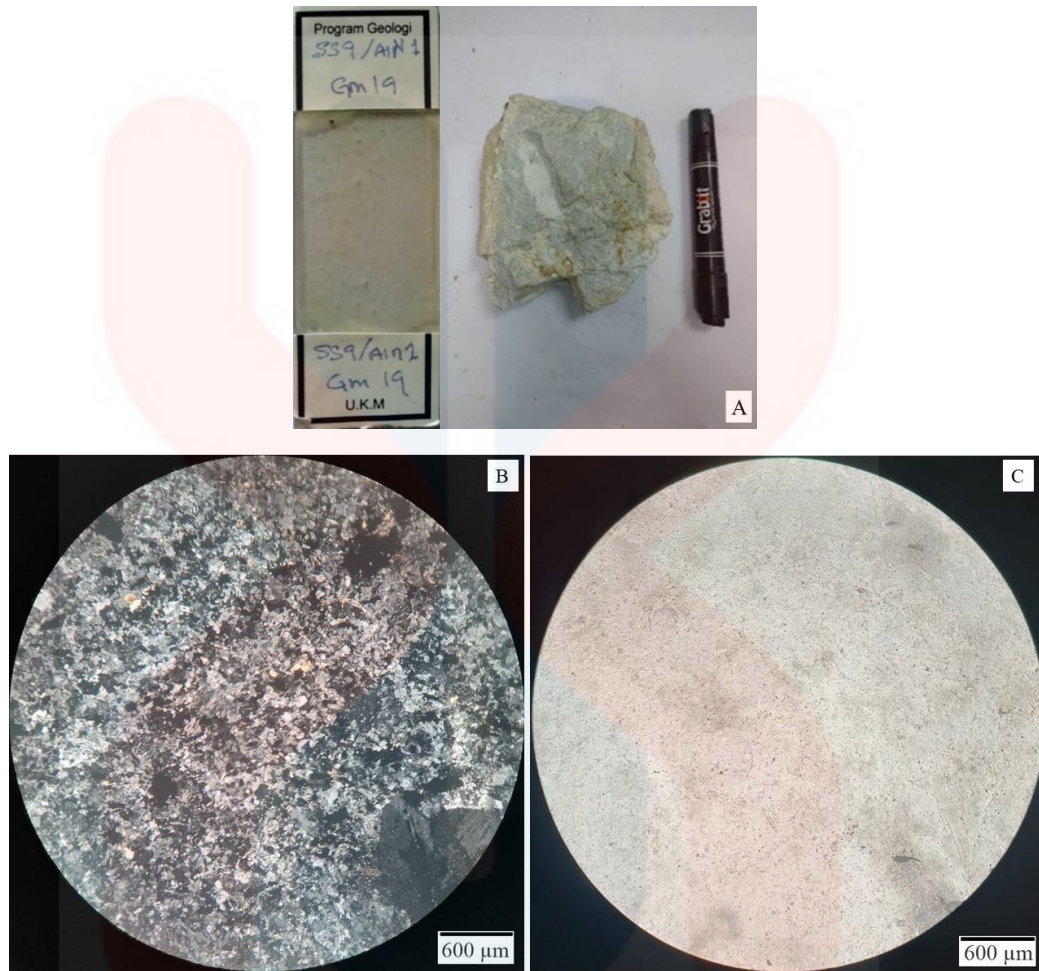
Rock : Tuff

Texture : Fine-grained, sub angular to angular shape, poorly sorted.

Description : The hand specimen is a fine grained with whitish colour and minor greyish to black colour. The specimen may consist opaque mineral of graphite based on the XRD analysis.

Minerals	%	Description
Quartz (Qtz)	14	Colourless and clear in PPL, clear white in XPL extinction at certain angle which cause it to appear from grayish or black, low relief, no twinning, fragmented quartz,
Calcite	73	Greyish colour, cement-like in XPL
Opaque mineral (Opq)	2	Black in both XPL and PPL as it does not allow light in thin section
Feldspar (Fs)	11	Feldspar have cleavage and appear dirty in PPL, low relief. Colour brownish to greyish in XPL

Sample 9



**Figure 4.17:** (A) Hand specimen of limestone sample and the thin section. (B) Thin section of sample 9 in XPL. (C) Thin section of sample 9 in PPL.

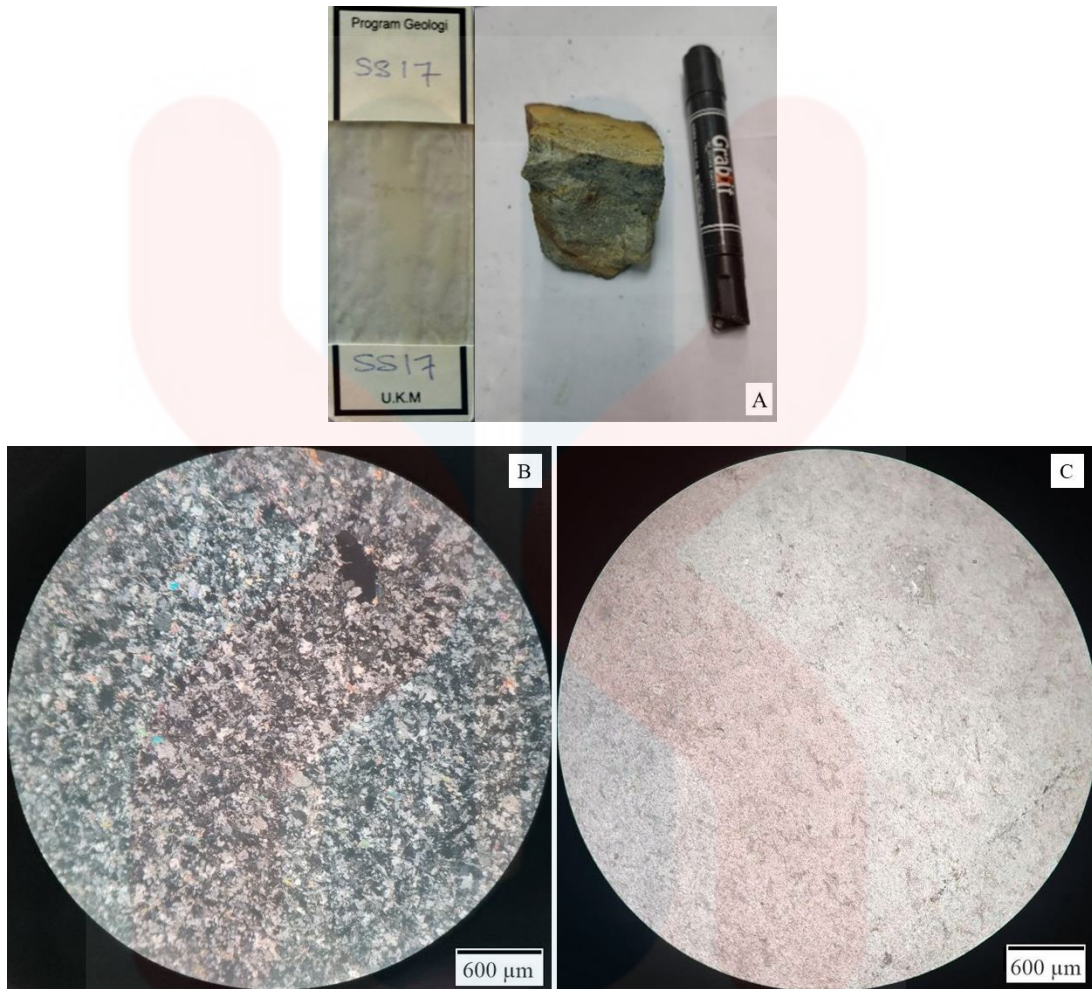
Rock : Limestone

Texture : Fine-grained , sub rounded to rounded grain shape, very poorly sorted

Description : The hand specimen is fine grained in size with milky white colour. Reacted with HCl thus has calcite in the composition.

Minerals	%	Description
Quartz (Qtz)	6	Colourless and clear in PPL, clear white in XPL extinction at certain angle which cause it to appear from grayish or black, low relief, no twinning, fragmented quartz,
Calcite	60	Greyish colour, cement-like in XPL
Feldspar (Fs)	32	Feldspar have cleavage and appear dirty in PPL, low relief. Colour brownish to greyish in XPL
Pyroxene (Px)	2	Fragmented pyroxene and has bright colour range from yellowish to greenish

Sample 17



**Figure 4.18:** (A) Hand specimen of limestone sample and the thin section. (B) Thin section of sample 17 in XPL. (C) Thin section of sample 17 in PPL.

Rock : Limestone

Texture : Fine-grained , sub rounded to rounded grain shape, poorly sorted

Description : The hand specimen is fine-grained in size with white to yellowish colour. Reacted with HCl thus has calcite in the composition. Certain part does not react with HCl may be due to the rock is weathered.

Minerals	%	Description
Quartz (Qtz)	6	Colourless and clear in PPL, clear white in XPL extinction at certain angle which cause it to appear from grayish or black, low relief, no twinning, fragmented quartz,
Calcite	65	Greyish colour, cement-like in XPL
Feldspar (Fs)	22	Feldspar have cleavage and appear dirty in PPL, low relief. Colour brownish to greyish in XPL
Pyroxene (Px)	1	Fragmented pyroxene and has bright colour range from yellowish to greenish

c. Tuff

Tuff found in the study area is more to rhyolitic composition where it has whitish colour and fine-grained size. The tuff form from chemical deposition of calcite or calcium carbonate. The tuff found in the study area consists of quartz, alkali feldspar and some of the biotite.



**Figure 4.19:** (A) Hand specimen of tuff. (B) The tuff outcrop in the study area.

## 4.4 Structural Geology

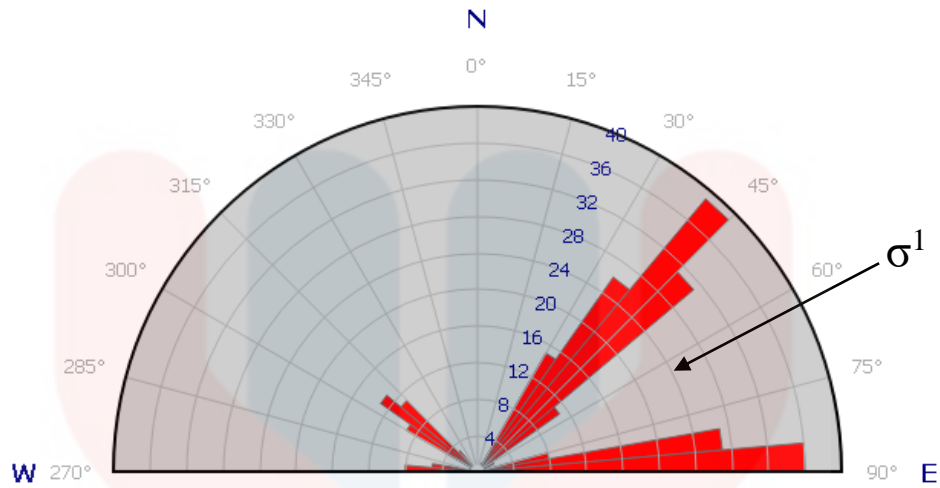
### 4.4.1 Joint

Joint is cracks or fracture present in the rock where there is no displacement has taken place. Joint present in all type of rock and it can be either vertical, incline or horizontal. Joint occurred because of regional tectonic, folding, faulting or internal force. It also forms when the rock is exposed to the compression or tension force during geological movement. Joint that has similar orientation and morphology consider as a set. If there are two or more set of joint presents in the rock, it called as joint system. This joint system commonly intersects at constant dihedral angle.

Joint analysis was collected in locality 12 with coordinate of N 04° 46' 54" E 101° 56' 26.2". Based on the rose diagram in **Figure 4.17** show that the set of joints with major principal stress,  $\sigma^1$  in the direction of NE-SW. The tensional force is on E-W. Type of joint observed was a nonsystematic joint.



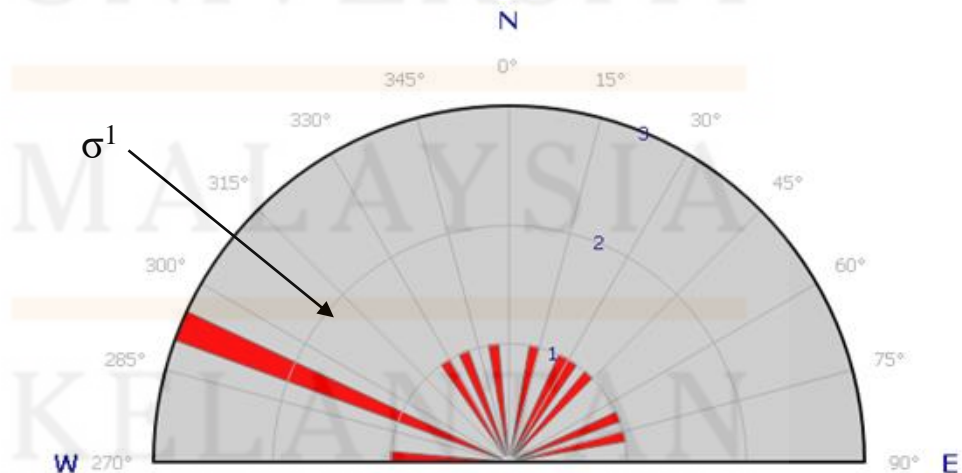
**Figure 4.20:** The joint structure on the outcrop with their direction.



**Figure 4.21:** The rose diagram for joint analysis.

#### 4.4.2 Lineament Analysis

Lineament is a linear feature in a landscape that can be used to identify underlying geological structure such as fault, fracture or joint. Lineament analysis was conducted by using remote sensing such as satellite imagery to identify the structure based on the data given. Lineament in the study area was analyzed based on the raster data from ArcGIS database. The principal stress of the lineament analysis is in the direction of NW.



**Figure 4.22:** The rose diagram for lineament analysis.

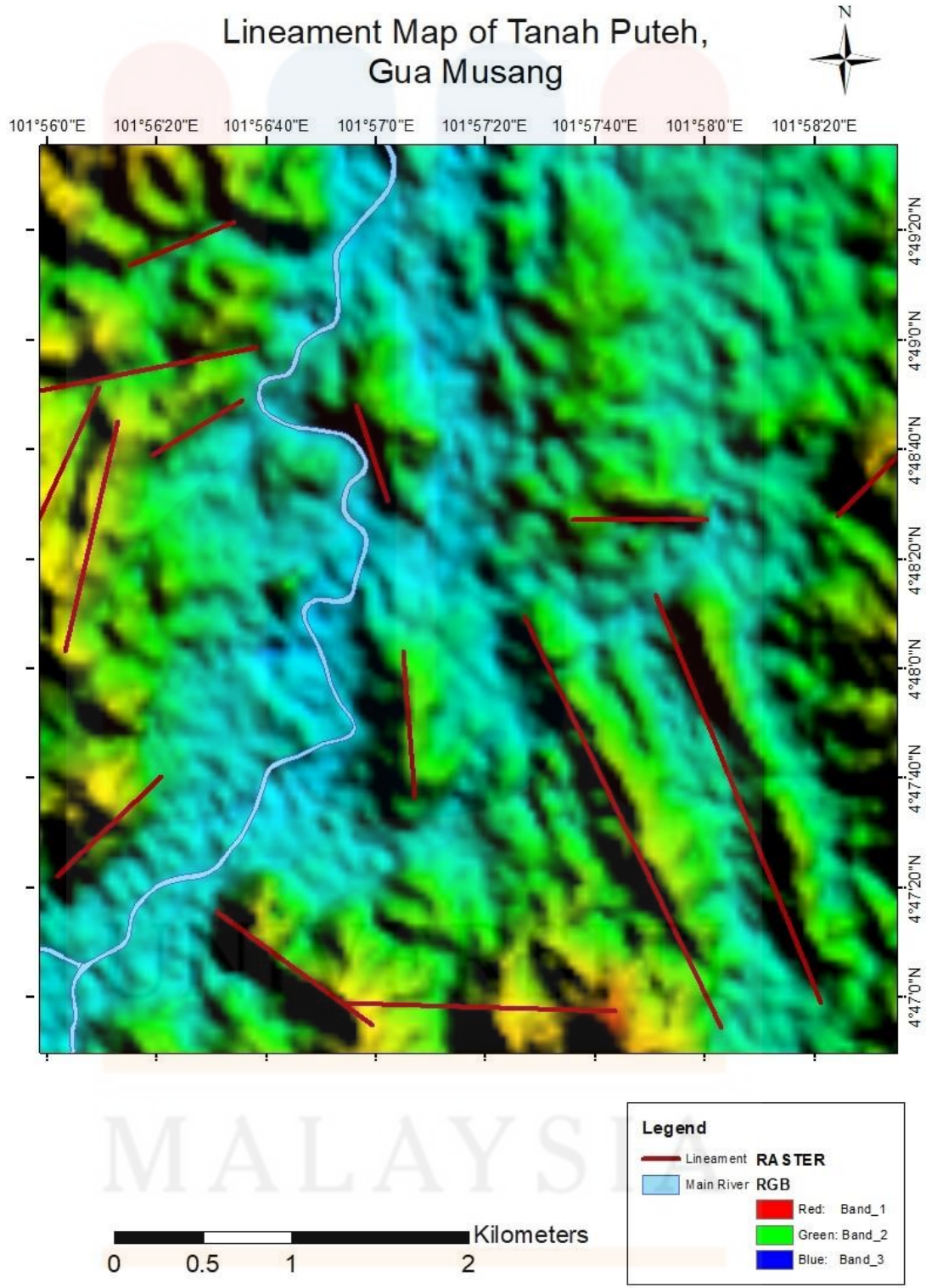


Figure 4.23: Lineament Map of Kg. Tanah Puteh, Gua Musang.

## 4.5 Historical Geology

### 4.5.1 Historical Geology

Kampung Tanah Puteh is part of Gua Musang formation along with the tributaries of Sungai Galas. The age of the study area is Mesozoic period in Middle Permian to Upper Triassic. The deposition form at the study area deposited at the bottom is the oldest whereas the upper part is youngest rock. The older rock deposited in the study area is meta-sediment rock which consist phyllite, shale and slate. Then, along with meta-sediment, tuff were deposited in the study area where this has been exposed to weathering and alteration that cause rhyolite to form tuff. This show that the volcanic rock was cause by volcanic eruption and the rock more to rhyolitic. Limestone is the youngest where it deposits from marine sediment deposit on the upper part of the study area. Thus, the rock that was found in the field consist of limestone unit, meta-sediment unit and volcanic tuff. Gua Musang formation consist of carbonate, argillaceous and pyroclastic/volcanic facies.

Meta-sediment unit is the oldest unit that found in the study area. This meta-sediment unit consist of phyllite, shale and slate. This unit is from argillaceous facies which is dominant facies in Gua Musang formation. The exposed outcrop of meta-sediment shows a various color from light to dark grey, brown, and black. Tuff unit is the second youngest unit that found in the study area. Tuff unit is volcanic facies and interlayered with carbonate and argillite from others formation in Gua Musang Group. In the Gua Musang area, the volcanism composition to rhyolitic in which associated with subduction-related rhyolitic composition. The tuff rock is from alteration of rhyolitic which cause the composition change kaolinite. The limestone unit of the Gua Musang is the youngest unit found in the study area. The limestone that can be found in the study area is mostly the isolated steep hill distributed throughout the study area. The limestone from continuous carbonate platform deposited within Gua Musang platform during Permo-Triassic before it exposed to the erosion and karstification and the depositional environment of limestone unit is from shallow marine.

## CHAPTER 5

### RESULT AND DISCUSSION

#### 5.1 Introduction

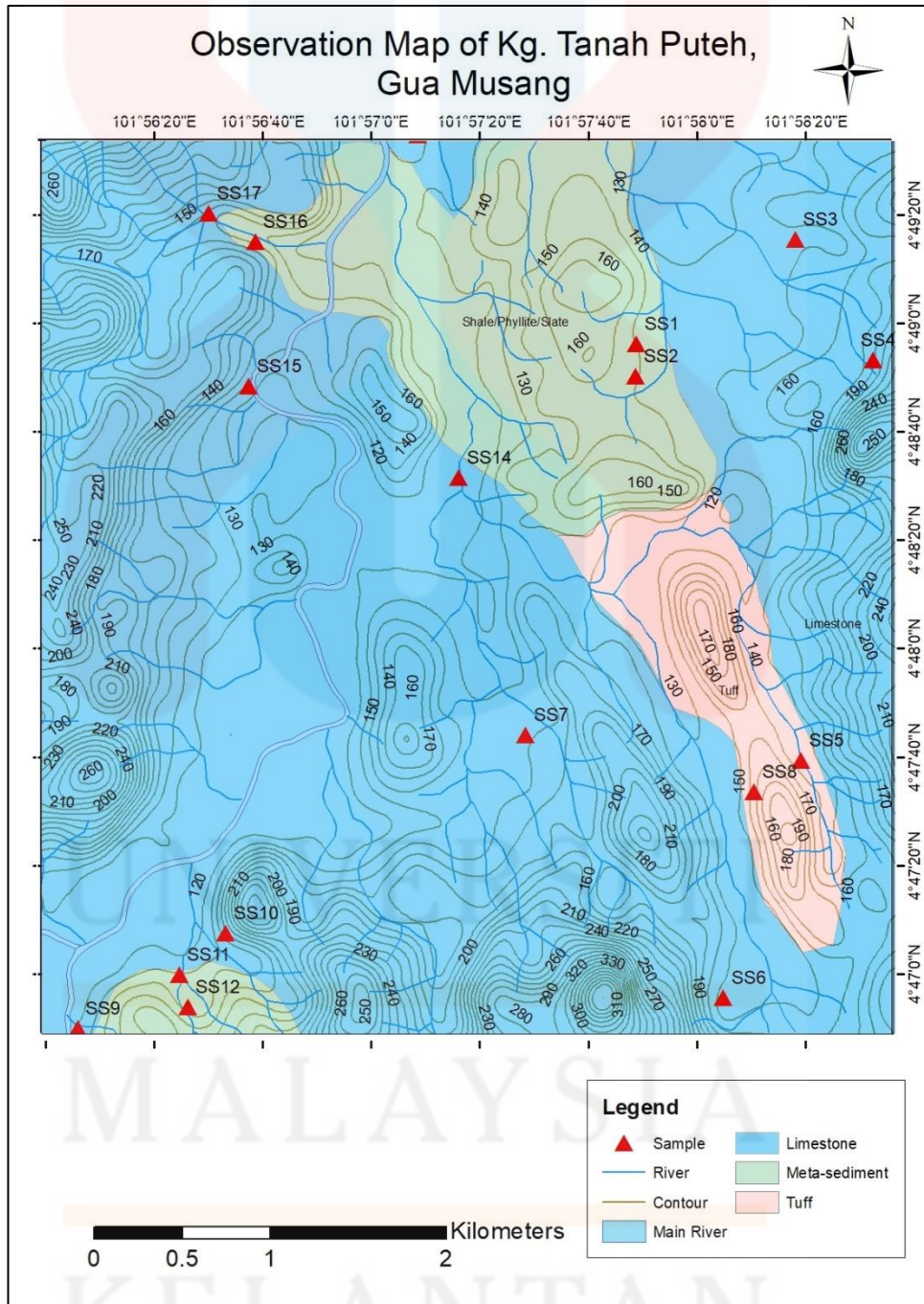
This chapter discuss about the percentage of element presence in the sample that has been found. The percentage of element in the sample is used to identify the presence of feldspar that ideal for commercialize used in ceramic and glass industry. The sample undergoes X-ray Fluorescence analysis and X-Ray Diffraction analysis. The result percentage of the element is discussed in this chapter. Based on the result, the data are compared with the standard for the commercial used for glass and ceramic industry.

#### 5.2 Overall Sample Description

The sample was collected randomly within study area and certain sample were chosen to conduct analysis. Criteria for the selected sample is to fulfil the objective of the study area and to represent the mineralogy equivalent to the lithology of the area. For example, limestone sample consist of mineral such as quartz and calcite. As for the specification analysis, petrography was conducted rock sample which is sample SS5, SS9, and SS17. The petrography analysis result was support by both XRF and XRD result to justify the presence of the mineral in the thin section.

**Figure 5.1** display the location of each sample that were collected randomly in the study area. Based on the data collect, the rock boundary was estimate roughly due to

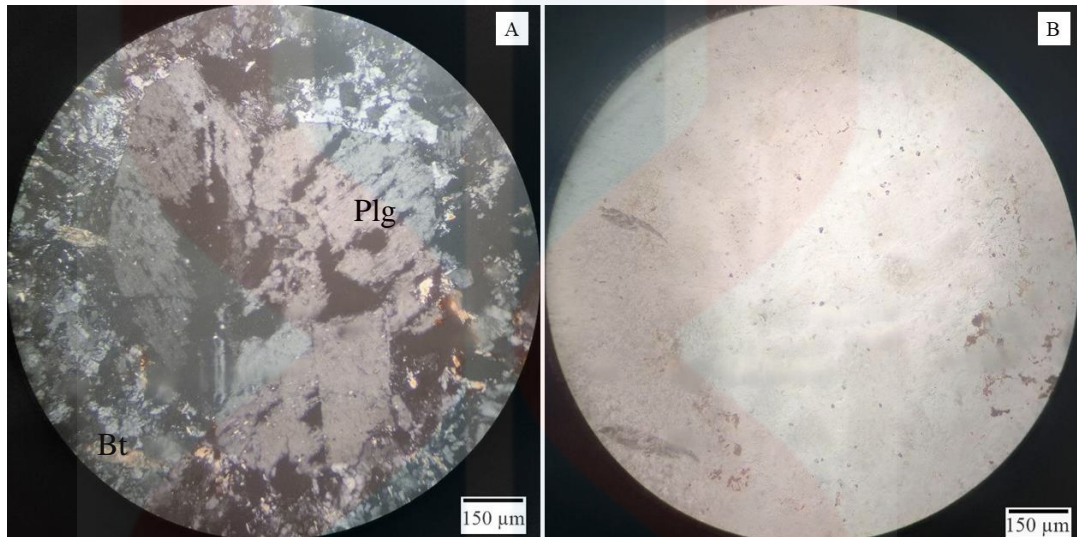
the contact boundary between each type of rock was not visible on the surface. The sample collected within study area is mostly limestone, followed by meta-sediment and tuff. Each sample were described accordingly in **Appendix A** and only certain samples was sent for analysis.



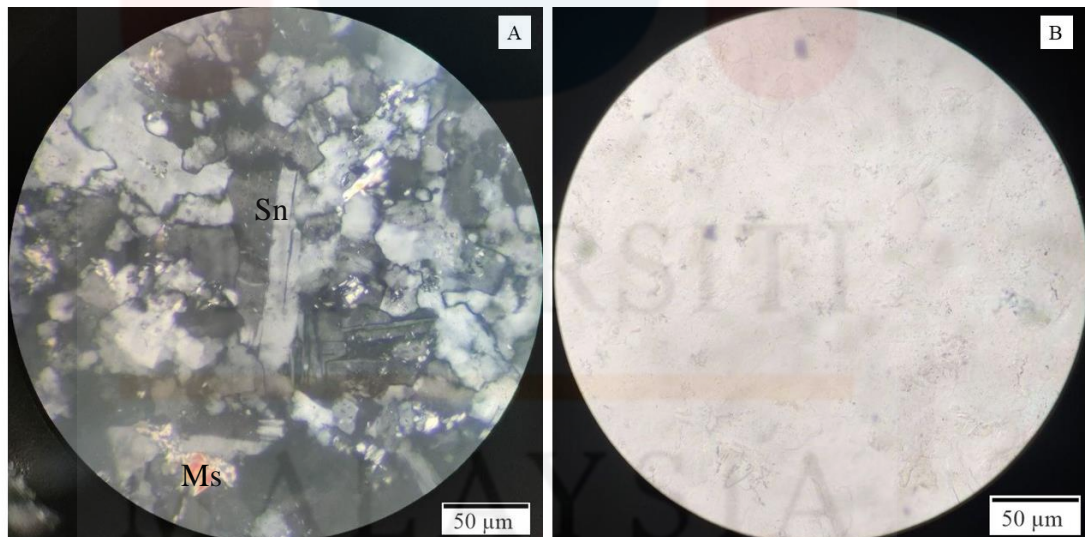
**Figure 5.1:** Observation Map of Kg. Tanah Puteh, Gua Musang.

## 5.2.1 Petrography Analysis

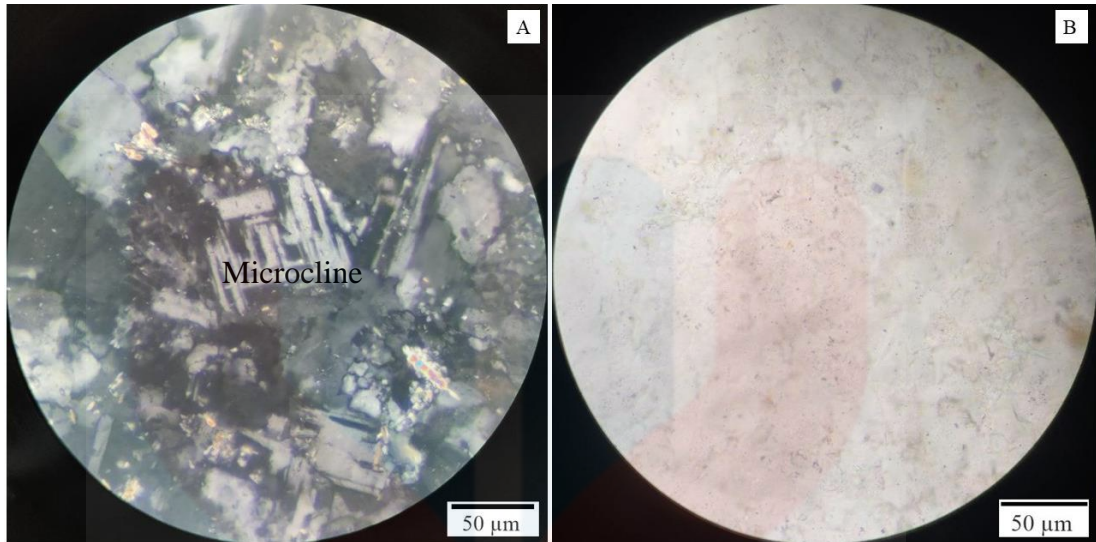
### a. Feldspar mineral



**Figure 5.2:** Sample SS9, a plagioclase surrounded by fine-grained calcite, quartz, and biotite. (A) In XP light, the plagioclase with first order colour of dark grey and show it extinction on certain angle while biotite has brownish colour. (B) In PP light, the plagioclase gave a grainy appearance and has low relief while biotite shows moderate relief.



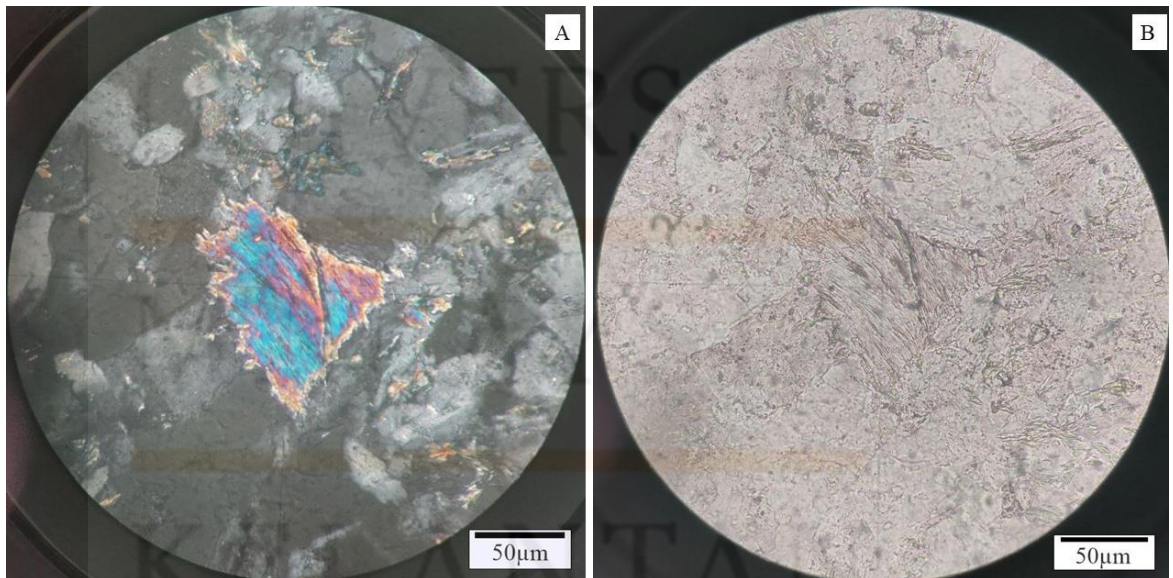
**Figure 5.3:** Sample SS9, Sanidine surrounded by an anhedral grain shape of calcite, muscovite, and feldspar. (A) In XP light, sanidine with first order colour of dark grey with presence of Carlsbad twinning while muscovite with third order interference colour of light red. (B) In PP light, the feldspar gave a grainy appearance and has low relief while muscovite show a perfect cleavage and moderately relief.



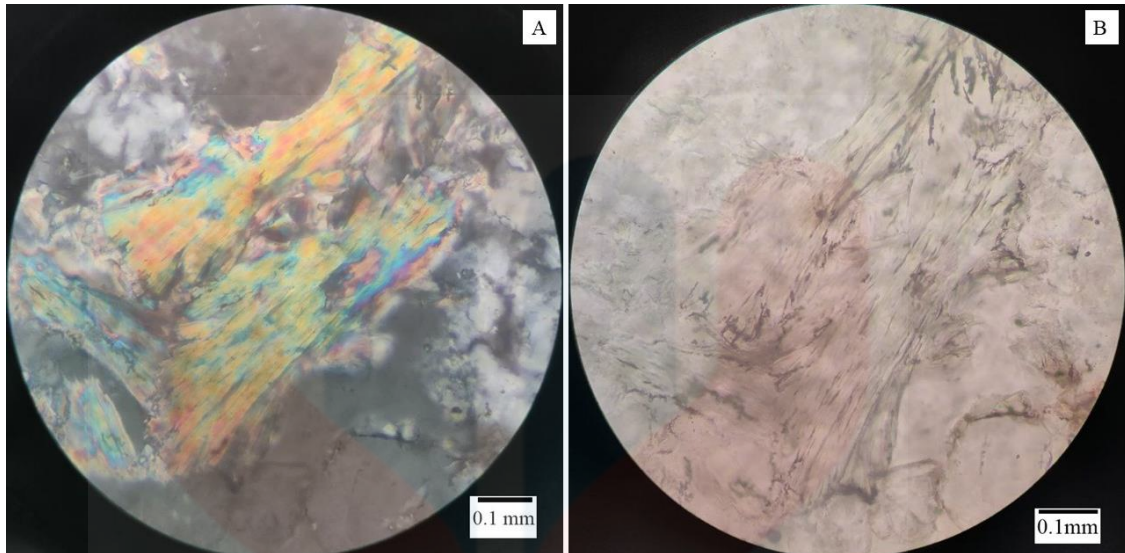
**Figure 5.4:** Sample SS9, Microcline surrounded by calcite, and muscovite. (A) In XP light, microcline with first order colour of dark grey with presence of tartan twinning while muscovite with third order interference colour of light yellow. (B) In PP light, microcline gave a grainy appearance.

Feldspar can be observed by their structure which commonly exhibit twinning under thin section. Based on the thin section, feldspar in the sample shows Carlsbad twinning in sanidine and tartan twinning in microcline. Feldspar under XPL show extinction. Commonly found in cloudy in PPL due to alteration. The cleavage of the feldspar was difficult to observe due to low relief.

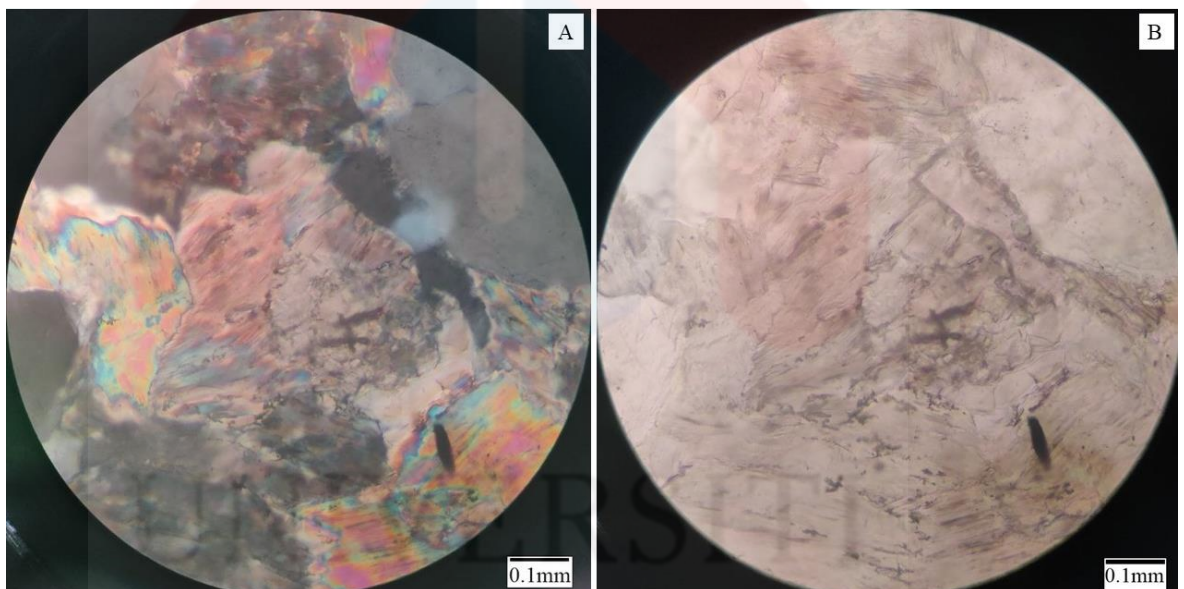
#### b. Muscovite mineral



**Figure 5.5:** Sample SS5, muscovite surrounded by calcite, and feldspar. (A) In XP light, muscovite with third order colour of blue to red. (B) In PP light, muscovite exhibit and flaky with well-formed tabular crystal while certain of it, in a form of flake with a cleavage in one direction.



**Figure 5.6:** Sample SS17, Muscovite with higher magnification surrounded by calcite, and feldspar. (A) In XP light, muscovite with third order colour of light yellow. (B) In PP light, muscovite exhibit and flaky with well-formed tabular crystal with a cleavage in one direction.

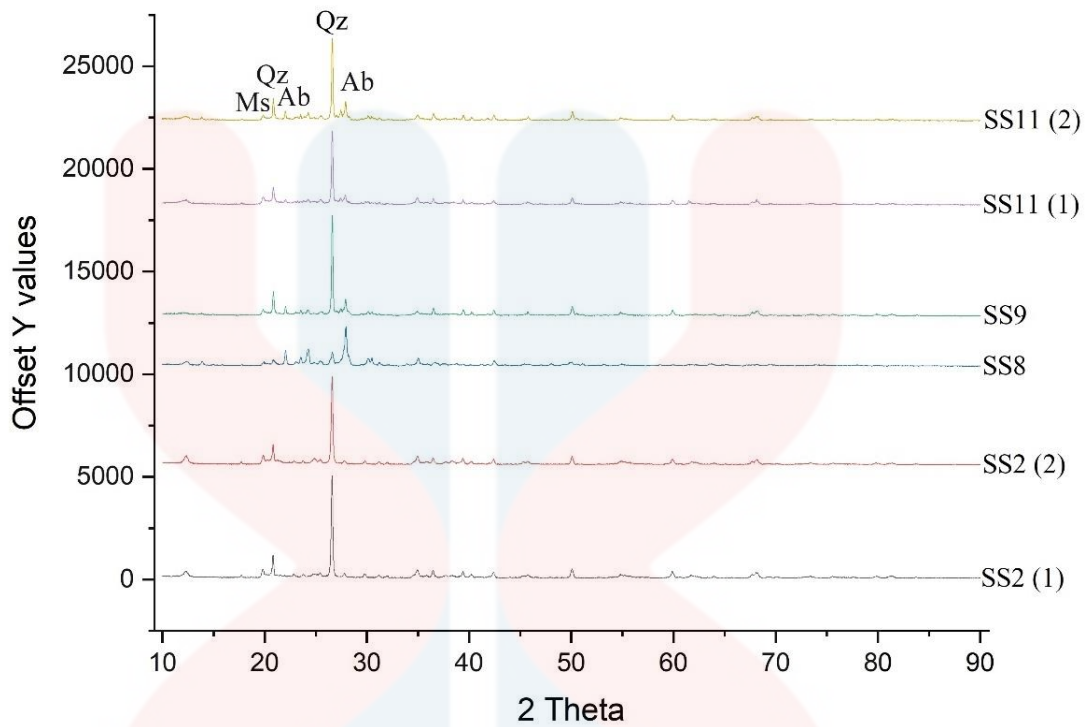


**Figure 5.7:** Sample SS5, Muscovite surrounded by feldspar. (A) In XP light, muscovite with third order colour of red. (B) In PP light, muscovite exhibit well-formed tabular crystal

Muscovite presence in every thin section and roughly can be seen from 4x magnification. It composed roughly about 10%-15% in the thin section. The muscovite show the third interference colour and has a moderate relief compare to the mineral.

**Figure 5.7** show muscovites in certain areas while a small dark spot at the edge of figure is suspected from scratch by marker pen .

### 5.2.2 XRD analysis



**Figure 5.8:** XRD analyse by matching phase from Crystallography Open Database (COD) in software DIFFRAC EVA 5.2

Based on the figure, all soil sample that has been collected mainly composed of quartz mineral ( $2\theta = 26^\circ$ ) except for sample SS8. Sample SS8 has high peak of albite ( $2\theta = 28^\circ$ ) than quartz. All samples consist of accessory mineral of muscovite ( $2\theta = 21^\circ$ ) as shown in the graph. **Table 5.1** show the element concentration of the mineral.

**Table 5.1:** Element analysis of samples by DIFFRAC EVA 5.2.

Element	Oxide	Concentration Semiquantitative gene dose SQD (%)					
		SS2(1)	SS2 (2)	SS8	SS9	SS11(1)	SS11(2)
Hydrogen	H <sub>2</sub> O	0.40	0.20	0.10	0.10	0.40	0.50
Oxygen	Oxygen	51.20	50.90	49.90	51.00	51.30	49.60
Aluminum	Al <sub>2</sub> O <sub>3</sub>	10.70	9.40	10.30	5.50	10.80	12.40
Silicon	SiO <sub>2</sub>	33.40	33.70	32.50	38.30	33.00	30.10
Potassium	K <sub>2</sub> O	4.40	3.90	-	1.60	3.60	2.60
Sodium	Na <sub>2</sub> O	-	0.10	7.20	2.50	0.50	2.00
Iron	Fe <sub>2</sub> O <sub>3</sub>	-	1.80	-	0.40	0.20	-
Magnesium	MgO	-	-	-	0.60	0.10	-
Calcium	CaO	-	-	-	-	0.10	2.70
Titanium	TiO <sub>2</sub>	-	-	-	-	0.10	-

### 5.2.3 XRF analysis

**Table 5.2:** Percentage of element in sample SS5, SS9, and SS8 by using XRF handheld.

Element	Percentage (%)				
	SS5	SS9	SS18	Industrial Ceramic (Loughbrough, 1993)	Industrial Glass (Harben, 1995)
SiO <sub>2</sub>	100.00	100.00	24.72	68.90	75.00
MgO	0.78	-	20.28	-	-
Al <sub>2</sub> O <sub>3</sub>	21.14	19.61	7.00	18.75	15.00
K <sub>2</sub> O	3.55	4.95	0.03	3.85	3.30
Ca	0.68	0.15	22.23	1.85	-
Ti	0.01	0.04	0.05	-	-
Fe	0.27	0.55	1.07	0.07	0.30
Na <sub>2</sub> O	-	-	-	7.15	4.50

The data shown in the table only include the necessary data related for the chapter, trace element that presence in the sample was not included in this table. Detailed of the XRF result can refer table in **Appendix B**.

### 5.3 Discussion

Based on the petrography analysis, both type of feldspar, plagioclase and alkali feldspar are presence in all samples. Under microscope, plagioclase presence with lamellar twinning while alkali feldspar can be found with Carlsbad twinning (Sanidine) and tartan twinning (Microcline) in XPL.

Based on the peak from the graph in XRD analyses, the peak was quite similar except for sample SS8. Overall, XRD analysis of soil sample in the study area mainly consist of quartz ( $2\theta = 26^\circ$ ) that can be observe from sample SS2, SS9, and SS11. As for the sample SS8, the XRD peak trend is quite different from others. The quartz ( $2\theta = 26^\circ$ ) peak is lower than others sample but show high peak of albite ( $2\theta = 28^\circ$ ). Based on the elemental analyses by DIFFRAC EVA, percentage of sodium was quite high compared to others end-member of feldspar. Sodium ( $\text{Na}_2\text{O}$ ) percentage at 7.20%, potassium ( $\text{K}_2\text{O}$ ) with percentage of 4.40% and the least is calcium ( $\text{CaO}$ ) with 2.70%.

XRF analysis has been conducted using portable XRF and the result has been shown in **Table 5.2**. However, the total element composition of the sample from XRF analysis didn't reach 100% and some of the samples have more than 100%. This due to the use of the portable XRF which the reading is based on the spot of mineral grain instead of using normal XRF that using powder sample. During analysis, the target area of the portable may reflect in the area with high silica (quartz) content as refer from **Table 5.2**.

## CHAPTER 6

### CONCLUSION AND DISCUSSION

#### 6.1 Conclusion

In conclusion, objective have been achieved where the geological map of Kg. Tanah Puteh, Gua Musang with scale 1:25, 000 can produce. The lithology that has been observed during research is limestone, meta-sediment, and tuff. Based on the joint analysis, the trend of the joint is northeast while the lineament of the study with northwest trend.

The characteristic of feldspar in Kg Tanah Puteh, Gua Musang has both plagioclase and alkali feldspar, range from albite, sanidine, and microcline. This feldspar characteristic can be observed as explain in **Chapter 5**. The twinning of the feldspar that can be observed is lamellar (Plagioclase), tartan twinning (Microcline) and Carlsbad twinning (Sanidine). The comparison of feldspar to the commercial grade feldspar is unavailable due to the result analyses from XRF is not appropriate for comparison. Based on the data from XRD analysis and petrography, it can be concluded that composition of albite (7.20%) was higher in the study area compared to others type of feldspar.

Based on the element composition in the soil sample, feldspar is less compared to others rock. This may be due to the sampling which mostly covered from limestone/carbonate sedimentary rock. Carbonate sedimentary rock majorly consist of calcite and feldspar presence as accessory mineral. Feldspar that has been mined in the area,

mostly were from tuff, where this rock is an alteration from rhyolite. The sample of SS8 has been collect from soil near with the tuff sample, this soil represents high sodium ( $\text{Na}_2\text{O}$ ) while others sample that were collect near limestone has potassium ( $\text{K}_2\text{O}$ ) in the sample composition. As for the sample SS18, the sample is black limestone and from the **Table 5.2**, it composes of high iron and magnesium at 1.07% and 20.28% respectively along with high calcium (22.23%). Hence, there is possibilities for the black limestone to have feldspar with Ca-end member such as anorthite. Therefore, based on the result from XRF and XRD, the white limestone in the study area consists of feldspar from K-end member, black limestone consists of feldspar from Ca-end member while tuff consist of feldspar from Na-end member. As the element composition for comparation for ceramic and glass industry, the percentage in magnesium at 0.78%, and iron 0.27% in sample SS5 while 0% of magnesium and 0.55% in iron. The feldspar of white limestone was acceptable thus it can be mined in the future while black limestone is not suitable for feldspar mining as it composes of high magnesium at 20.28%. Thus, the study area has potential to be exploited for feldspar in sample such as SS2, SS5, SS8, SS9, and SS11 and except for SS18 (Black limestone) as this sample has higher composition of magnesium (20.28%) and iron (1.07%).

## 6.2 Suggestion

In general geology study, geological mapping needs to be updated regularly due to development of the area. The study area is mostly composed of limestone and limestone can easily be affected by weathering by water, thus an up-to-date map will help to monitor and identify hazard for the safety of the local people. Other than that,

mapping should be conducted with the support of other modern technology such as drone to investigate areas with inaccessible roads.

Research regarding feldspar needs to be further investigated especially in mineralogy. Feldspar has been widely used in commercialized industry and will greatly help increase the economy of the area especially in the rural area. The method that can be used to improve the data is to use powder XRF instead of portable XRF. Powder XRF is more accurate in their data instead of portable XRF. Scanning Electron Microscope (SEM) with Energy Dispersive X-ray (EDX) also can be used to investigate the structure of the feldspar and the composition to support the data from the petrography method. Other than that, other researchers should investigate regarding feldspar in granitic rock or pegmatite as this type of rock has feldspar as its major constituent. The feldspar in the study area is mostly from limestone and limestone is highly carbonate thus the feldspar exists as an accessory mineral. As the feldspar in the study area is high in terms of their magnesium and iron, feldspar can be improved by floatation technique to increase the quality of the feldspar. Therefore, a good quality feldspar can be commercialized.

## REFERENCE



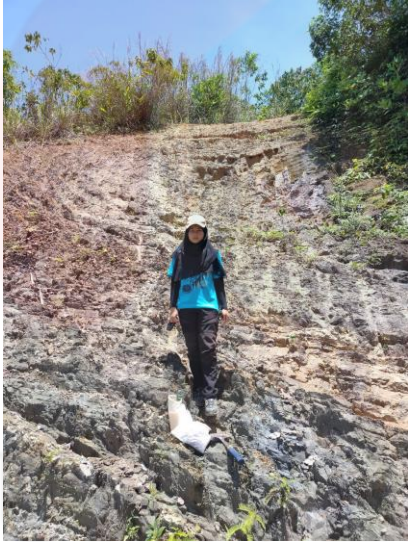



- Alimon, M. M., & Ahmad, N. (2011). Malaysian feldspar: Evaluation and processing of selected deposits. *Journal of Engineering Science*, 7, 27-35.
- Aliyu, Z. S., Garkida, A. D., Ali, E. A., & Dauda, M. (2015). Characterization of Feldspar by instrumental analytical techniques. In *Characterization of Minerals, Metals, and Materials 2015* (pp. 291-297).
- Alling, H. L. (1921). The mineralogy of the feldspars. Part I. *The Journal of Geology*, 29(3), 193-294.
- Amairah, M., & Aljaradin, M. (2014). Characterization of the Jordanian Feldspar Raw Materials for Application in the Ceramic and Glass Industries. *International Journal of Mining Engineering and Mineral Processing*. 3. 28-31
- Demange, M. A. (2012). *Mineralogy for Petrologists: optics, chemistry and occurrences of rock-forming minerals*. CRC Press.
- Department of Statistics Malaysia (2020). Kelantan (State, Malaysia). *Population Statistics and Charts*.
- Dutrow, B. L., & Clark, C. M. (2022). *X-ray Powder Diffraction (XRD)*. Montana State University.
- Fuertes, V., Reinoso, J. J., Fernandez, J. F., & Enríquez, E. (2022). Engineered feldspar-based ceramics: A review of their potential in ceramic industry. *Journal of the European Ceramic Society*, 42(2), 307-326.
- Harben, P. W. (1995). The industrial minerals handbook, *Metal Bulletin*, 62-65
- Hassan, H., Ilgin, K. and Mert, T., Beneficiation of Low-Grade Feldspar Ore using Cyclojet Flotation Cell, Conventional Cell and Magnetic Separator. *Journal of Physico chemical Problems of Mineral Processing* 48 (2) (2012), 381-392.
- Howie, R. A., Zussman, J., & Deer, W. (1992). *An introduction to the rock-forming minerals* (p. 696). London, UK: Longman.
- Hussin, F., & Abdullah, H. (2012). The role of FELDA and KESEDAR in the development of land in the district of Gua Musang: a comparison the socio-economic level of the settlers. *Sustainable Agriculture Research*, 1(526-2016-37827).
- Hutchison, C. S., & Tan, D. N. K. (Eds.). (2009). *Geology of peninsular Malaysia*. Published jointly by the University of Malaya [and] the Geological Society of Malaysia.
- Leman, M.S., 2004. Part 2: Mesozoic. In: Lee, C.P., Leman, M.S., Hassan, K., Md. Nasib, B. & Karim, R. (Eds.), *Stratigraphic Lexicon of Malaysia*. Geological Society of Malaysia, Kuala Lumpur, 37-64
- Loughbrough, R. (1993). Portugal's minerals. *Industrial minerals*, 308, 51-52.









- Mahesh, D. & Prabhakar, D. (2020). Characterisation of feldspar mineral deposits, Kandukuru and surrounding areas of Ranga Reddy District, Telangana State. *Journal of emerging technologies and innovative research*.
- Metcalf, I. (2013). Tectonic evolution of the Malay Peninsula. *Journal of Asian Earth Sciences*, 76, 195-213.
- Mohamed, K. R., Joe Harry, N. A. M., Leman, M. S., & Ali, C. A. (2016). The gua musang group: A newly proposed stratigraphic unit for the permo-triassic sequence of northern central belt, peninsular Malaysia.
- Moharem, A. F., & Saleh, A. E. (2007). Properties and suitability of Wadi Zariab Feldspars for ceramic industries in Egypt. *Journal of Applied Sciences*, 7(19), 2794–2799.
- Olupot, P. W., Jonsson, S., & Byaruhanga, J. K. (2006). Characterization of feldspar and quartz raw materials in Uganda for manufacture of electrical porcelains. *J. Aust. Ceram. Soc.*, 42(1), 29-35.
- Olupot, P. W., Jonsson, S., & Byaruhanga, J. K. (2006). Electroporcelains from raw materials in Uganda: a review. In *Proceedings from the International Conference on Advances in Engineering and Technology* (pp. 454-464). Elsevier Science Ltd.
- Parvis, M. (1950). Drainage Pattern Significance in Airphoto Identification of Soils and Bedrocks. *Highway Research Board bulletin*.
- Silva, A. C., Carolina, S. D., Sousa, D. N., & Silva, E. M. S. (2019). Feldspar production from dimension stone tailings for application in the ceramic industry. *Journal of Materials Research and Technology*, 8(1), 1-7.
- Tanner, A. O. (2016). Feldspar and Nepheline Syenite: Minerals Yearbook, *US Dept. of Interior*.
- The Open University. (n.d.). *An introduction to minerals and rocks under the microscope*. Royal Charter. Retrieved May 30, 2022, from <https://www.open.edu/openlearn/science-maths-technology/introduction-minerals-and-rocks-under-the-microscope/content-section-3.6.2>
- Wirth, K., & Barth, A. (2020). *X-Ray Fluorescence (XRF)*. Geochemical Instrumentation and Analysis.

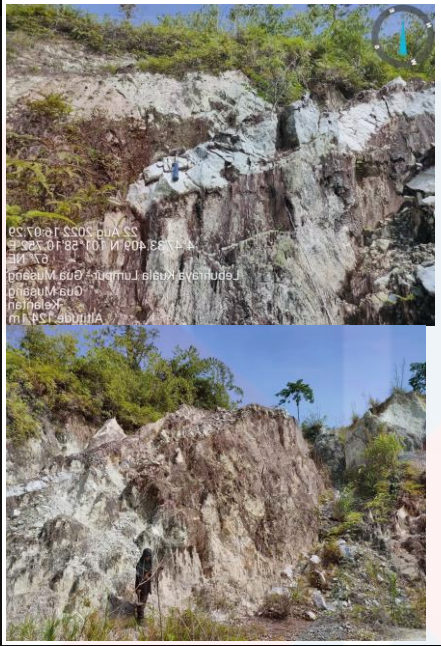


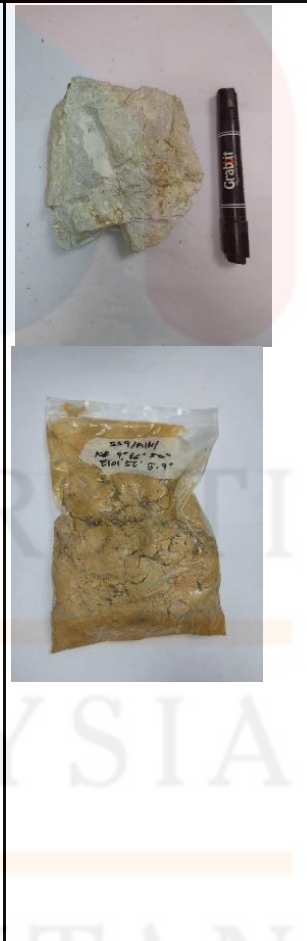
MALAYSIA





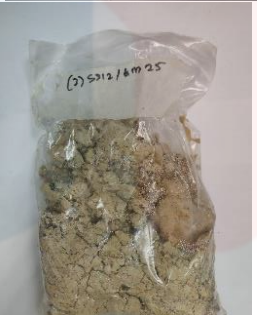
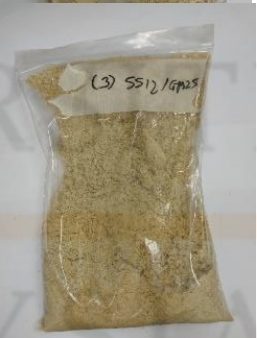


KELANTAN

**APPENDIX A**  
Description of all sample.





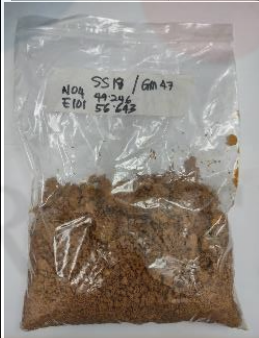


Sample	Coordinate	Sample Pic.	Description
SS1	N 04° 48' 56.1" E 101° 57' 48.9" 		Limestone, fine grained with greyish colour.
SS2/ GM17	N 04° 48' 50.1" E 101° 57' 48.7" 		Slate overlay with limestone. There are two different colours of soil in the area. 1. Brownish colour soil with grain size of a clay. 2. Blackish colour soil with grain size of clay.
SS3	N 04° 49' 15.3" E 101° 58' 18.0" 		Limestone, fine grained with greyish colour. The colour may be due to weathering.





<p>SS4</p>	<p>N 04° 48' 53.1" E 101° 58' 32.4"</p> 		<p>Limestone, fine grained with blackish colour.</p>
<p>SS5</p>	<p>N 04° 47' 39.4" E 101° 58' 19.14"</p> 		<p>Tuff rock, collected from quarry in Kg Tanah Puteh, Fine- grained with whitish colour along with brown spot.</p>
<p>SS6</p>	<p>N 04° 46' 55.5" E 101° 58' 04.8"</p> 		<p>Limestone, fine- grained with greyish to whitish colour</p>
<p>SS7</p>	<p>N 04° 47' 44.0" E 101° 57' 28.4"</p> 		<p>Limestone, fine- grained with blackish colour</p>

<p>SS8/ GM18</p>	<p>N 04° 47' 33.6" E 101° 58' 10.5"</p> 		<p>The sample has been collected behind the rock quarry area.</p> <p>Tuff, fine grain with whitish colour and a large quartz vein.</p> <p>Soil sample with grain size of clay and whitish colour.</p>
<p>SS9/ GM19</p>	<p>N 04° 46' 50.0" E 101° 56' 05.9"</p> 		<p>Limestone, fine-grained with whitish colour.</p> <p>Soil sample with clay grain size and yellow to orange colour.</p>

<p>SS10</p>	<p>N 04° 47' 07.5" E 101° 56' 33.2"</p> 		<p>Karst limestone, consist of bivalve fossil and trace fossil can be observe.</p> <p>Limestone, fine grained with blackish colour.</p>
<p>SS11/ GM25</p>	<p>N 04° 46' 59.8" E 101° 56' 24.6"</p> 	  	<p>Tuff rock, fine grain size with white to yellowish colour.</p> <p>Soil with grains size of clay and dark yellow colour.</p> <p>Soil sample with silt grain size and light-yellow colour.</p>
<p>SS12</p>	<p>N 04° 46' 54" E 101° 56' 26.2"</p> 		<p>Rock contact of slate and phyllite can be observed in the area.</p> <p>Slate, fine-grained with whitish colour.</p>

			<p>Phyllite, fine-grained with blackish colour.</p>
<p>SS13/ GM45</p>	<p>N 04° 51' 19.3" E 101° 57' 45.3"</p> 	 	<p>Granite, coarse grain with greyish colour.</p> <p>Soil with grain size of clay and whitish colour.</p>
<p>SS14</p>	<p>N 04° 48' 31.4" E 101° 57' 16.1"</p> 		<p>Limestone, fine-grained with greyish colour.</p>

<p>SS15/ GM46</p>	<p>N 04° 48' 48.3" E 101° 56' 37.4"</p> 		<p>Soil with grain size of clay and brownish colour.</p>
<p>SS16/ GM47</p>	<p>N 04° 49' 14.9" E 101° 56' 38.7"</p> 	 	<p>Slate, fine grained with brownish to orangish colour.</p> <p>Soil sample with grain size of clay and yellow to orange colour.</p>
<p>SS17</p>	<p>N 04° 49' 20.3" E 101° 56' 30.1"</p> 		<p>Weathered limestone, fine grained with greyish colour.</p>

<p>SS18/ GM48</p>	<p>N 04° 49' 34.7" E 101° 57' 08.6"</p> 	  	<p>Black limestone, fine grained with quartz veins.</p> <p>Reddish colour soil with grain size of clay, along with iron nodule.</p> <p>Orange to reddish soil, with grain size of clay.</p>
-----------------------	--	---	---

**APPENDIX B**  
XRF analysis result

Result Sample SS5

<b>Element/Compound</b>	<b>%</b>	<b>±2σ</b>
MgO	0.781	0.433
Al <sub>2</sub> O <sub>3</sub>	21.142	0.411
SiO <sub>2</sub>	100.000	0.900
S	0.015	0.011
K <sub>2</sub> O	3.553	0.033
Ca	0.676	0.012
Ti	0.011	0.003
Cr	0.007	0.003
Mn	0.069	0.004
Fe	0.274	0.007
Cu	0.001	0.000
Zn	0.003	0.000
Ga	0.002	0.000
Rb	0.046	0.001
Sr	0.004	0.000
Y	0.001	0.000
Zr	0.000	0.000
Nb	0.003	0.000
Rh	0.004	0.001
Sb	0.003	0.003
Pb	0.005	0.001
Bi	0.003	0.001
U	0.000	0.000

Result Sample SS9

Element/Compound	%	$\pm 2\sigma$
Al <sub>2</sub> O <sub>3</sub>	19.611	0.395
SiO <sub>2</sub>	100.000	0.817
K <sub>2</sub> O	4.953	0.038
Ca	0.152	0.008
Ti	0.039	0.004
Cr	0.007	0.003
Mn	0.003	0.002
Fe	0.549	0.009
Zn	0.003	0.000
Ga	0.002	0.000
As	0.001	0.000
Rb	0.033	0.001
Sr	0.005	0.000
Y	0.001	0.000
Zr	0.000	0.000
Nb	0.002	0.000
Ba	0.023	0.004
Hf	0.000	0.000
Pb	0.003	0.001
Bi	0.001	0.001
U	0.000	0.000

Result Sample SS18

Element/Compound	%	$\pm 2\sigma$
MgO	20.279	1.165
Al <sub>2</sub> O <sub>3</sub>	6.995	0.308
SiO <sub>2</sub>	24.721	0.333
P	0.035	0.026
S	0.452	0.019
K <sub>2</sub> O	0.033	0.006
Ca	22.227	0.058
Ti	0.050	0.005
Cr	0.007	0.004
Mn	0.014	0.003
Fe	1.068	0.017
Cu	0.001	0.001
Zn	0.006	0.001
As	0.001	0.001
Sr	0.065	0.001
Zr	0.002	0.001
Sn	0.004	0.003