GEOLOGY AND GEOCHEMISTRY OF WATER DISCHARGE FROM SAND MINING AT JELI, KELANTAN

by

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DECLARATION

I hereby declare that the work embodied in this Report is the result of the original research and has submitted for a higher degree to any universities or institutions.

.....

Student

Name: Mohd Suhaimi Bin Mat Rasat

Date:

I certify this report of this final year project entitled 'GEOLOGY AND GEOCHEMISTRY OF WATER DISCHARGE FROM SAND MINING AT JELI, KELANTAN' by MOHD SUHAIMI BIN MAT RASAT, matrix number E13B359 has been examined and all the correction recommended by examiners have done for the degree of Bachelor of Applied Science (Geoscience), Faculty Of Earth Science, University Malaysia Kelantan.

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Approved by:

Supervisor

Name:

Date:

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Thank you.

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

°	Degree
%	Percent
cm	Centimeter
mm	Milimeter
Kg	Kampung (village)
Sg	Sungai (river)
Bi	Biotite
Fld	Feldspar
Hb	Hornblend
Plg	Plagioclase
Fe	Iron
PPL	Plane polarize
XPL	Cross plane polarize
JMG	Jabatan Mineral dan Geosains
Mn	Manganese
Al	Aluminium
Zn	Zinc
TDS	Total dissolved solid
TSS	Total suspended solid
Ec	Electric conductivity
NWQS	National water quality standard
DOE	Department of environment

Abstract

Jeli is a district located in the state of Kelantan is rich in flora and fauna. Jeli in a number of villages that form a district. Pergau River is the main river that is contained in this district, which is one of the economic resources of the local population through activities, mining of sand and fisherman. Geological mapping has been done to view the geological structures and geomorphological features of the area. Overall, the area is covered by rocks of granite that many look at the river Pergau. Sand mining activity in the river Pergau has made this river water contaminated with dissolved substances that can harm the surrounding population if the quantity exceeds the set parameters. If this activity is not control properly, the possibilities for the population to be infected by diseases will be higher. The responsible parties must play a role in controlling sand mining to prevent water pollution as mining activities is also very important to the public for future development.

Keywords: Sungai Rual, Jeli, granite, sand mining, heavy metals

Abstrak

Jeli merupakan sebuah jajahan yang terdapat dalam negeri Kelantan yang kaya dengan flora dan fauna. Di dalam jajahan Jeli terdapat beberapa kampung yang membentuk sebuah jajahan. Sungai Pergau merupakan sungai utama yang terdapat dalam jajahan ini yang merupakan salah satu sumber ekonomi penduduk tempatan melalui aktiviti tanaman, perlombongan pasir dan nelayan sungai. Pemetaan geologi telah dilakukan dikawansan ini untuk melihat struktur geologi serta ciri-ciri geomorfologi kawasan ini. Secara keseluruhnya, kawasan ini diliputi oleh batuan jenis granit yang banyak kelihatan di kawasan sungai Pergau. Aktiviti perlombongan pasir di sekitar kawasan sungai Pergau telah menjadikan air sungai ini sedikit tercemar dengan bahan-bahan terlarut yang boleh membahayakan penduduk disekitar jika kuantitinya melebihi parameter yang ditetapkan. Jika aktiviti ini tidak dikawal selia dengan baik, kemungkinan untuk penduduk sekitar mendapat penyakit akan menjadi lebih tinggi. Pihak bertanggungjawab haruslah memainkan peranan dalam mengawal aktiviti perlombongan pasir ini agar pencemaran air tidak berlaku kerana aktiviti perlombongan ini juga amat penting kepada umum untuk pembangunan pada masa hadapan.

Kata kunci: Sungai Rual, Jeli, batuan granit, perlombongan pasir, logam berat

CHAPTER 1

INTRODUCTION

1.1 General background

Geology and geochemistry of water discharge from sand mining at Jeli, Kelantan is research about the general geology and the study of heavy metal contain in Jeli river from the mining activity. The primary river at Jeli are Renyuk River, Suda River, Pergau River and Balah River. For general geology, this research will focus about the regional geology and tectonic setting, historical geology, geomorphology, regional stratigraphy and structural geology of study area. General geology has include by doing mapping of study area was given 5 km x 5 km to identify the outcrop and the sand mining operation in the study area. This research also identify about the mineral composition of the rock of this area. By using thin section analysis, mineral composition can be identified. This research also study about the geography of Jeli, for example people distribution, rain distribution, social economic of the people at Jeli and the accessof this area. This general geology is very important to identify the type of rock, to know what is the formation of this area and to determine stratigraphy of this area.

This study will focus on heavy metal that contain in the primary river at Jeli from the water discharge from the sand mining activity. This study has been particulary given coordinate which is situated in three area that run sand mining activity around river at Jeli. By the past researcherhas stated that, from Kuala Krai to Tumpat has 128 sand mining operation along the Kelantan River (Peck Yen and Rohasliney, 2013). This mining is very important to nearby people for construction and industry. River is a main element for

community especially in the source of the water supply for nearby as a drinking, agriculture and plantation irrigation and fishing.

Some heavy metal are important as a micronutrients but if the concentration present is higher than minimum requiments, it will be toxic and can effect for the human body and ecology of the river. Heavy metal can accumulate in the soil at toxic level as result of long term application of untreated wastewater. Soil irrigated by wastewater accumulate heavy metal such as Cr, Zn, Pb,Cd, Ni, etc in surface soil. When the capacity of the soil to retain, heavy metal is redused due to repeated application of wastewater, heavy metal leach into ground water or soil solution available for plant uptake.

Factory outlet, mining operation, rainfall precipitation and land surface runoff is the normally factor of the heavy metal introduced in river at Malaysia. The water quality also was measured together in this study by using physical and chemical parameter. The physical parameters included water temperature, water conductivity, disintegrated oxygen (DO), pH, total dissolved solids (TDS), total suspended solids (TSS) and turbidity, while the chemical parameters incorporated the convergence of nitrogen supplements, for example, ammonia, nitrate and nitrite.

1.2 Problem statement

Jeli is bordered by state of Perak and Thailand, Tanah Merah locale toward the north east and Kuala Krai area toward the south east. This stream associated with Kelantan River at Tanah Merah. This territory has development action and sand mining movement where is releasing water to the Kelantan stream. The studies around there are concentrating on its water quality level utilizing physical and chemical parameters. This research also focusing on the heavy metal contain in Jeli River from the sand mining activity.

1.3 Objective

I. To produce a geological map of Jeli, Kelantan at scale 1:25000.

II. To identify the heavy metal contain in river of Jeli.

III. To determine of water quality.

1.4 Study area

1.4.1 Geography

a) People Distribution

(Jeli Land and district Office, 2016) stated 2016 has a population 42872 people. Jeli is administered by the Jeli District Council. Population people at Jeli can be devide by 3 district, Jeli 21120, Kuala Balah 12062, Batu Melintang 9690. Jeli which is located on the East-West Highway,has area of the colony is 128,020.56 hectares or 1,280.21 km2, which is the third largest colony in the State. Table 1.1 show the population of people at Jeli.

District	Male	Female	Total
Batu Melintang	4826	4864	9690
Jeli	10820	10300	21120
Kuala Balah	6118	5944	12062
			42872

Table 1.1

b) Rain Distribution

From Malaysian Meteorologi Department Batu 13 Jeli is the wettest place in Malaysia with more than 6,000 mm (240 in) of mean rainfall annually. In 2011 8,596 mm (338.4 in) of rainfall was recorded in Batu 13 Jeli, the highest annual rainfall recorded in Malaysia. (Ministry Of Science, Technology and Innovation, 2015)

c) Sosial Economic

Most people in Jeli work as rubber tappers. The rubber plantations which belong to the local people also attract people from outside to come and work. Commonly families own a small plantation of 6 acres (24,000 m^2) up to 50 acres (200,000 m^2) in size. The history of Jeli began when the government encouraged the people around Kelantan to start a great area of agriculture. This process began with a period of land clearing, or logging. Figure 1.1 show the Kelantan area and Figure 1.2 show the base map of study area.

Figure 1.1

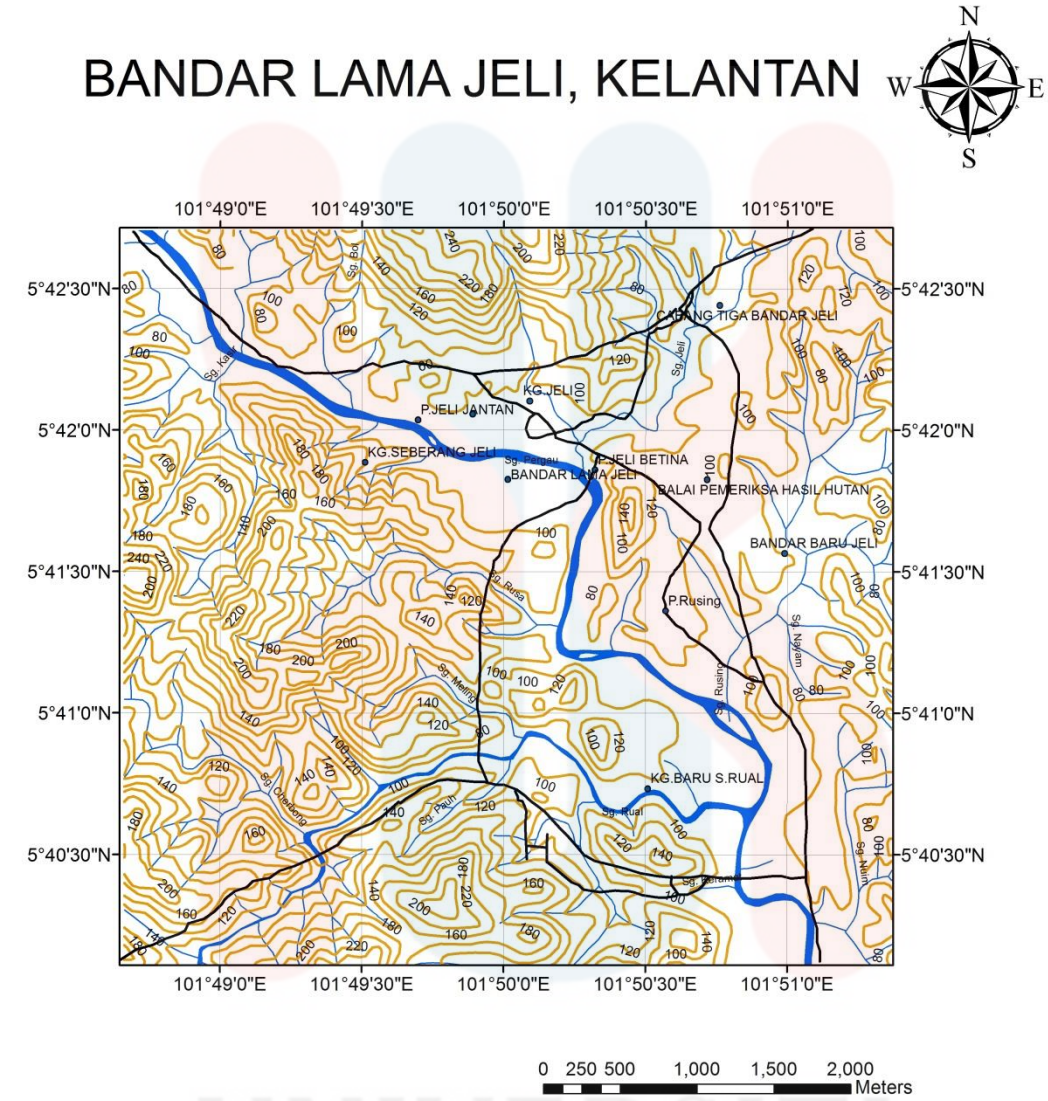

BANDAR LAMA JELI, KELANTAN
N
W
E
S
101°49'0"E
101°49'30"E
101°50'0"E
101°50'30"E
101°51'0"E
5°42'30"N
5°42'0"N
5°41'30"N
5°41'0"N
5°40'30"N
CABANG TIGA BANDAR JELI
KG.JELI
P.JELI JANTAN
KG.SEBERANG JELI
BANDAR LAMA JELI
JELI BETINA
BALAI PEMERIKSA HASIL HUTAN
BANDAR BARU JELI
P.Rusing
KG.BARU S.RUAL
Sg.Jeli
Sg.Rusing
0 250 500 1,000 1,500 2,000
Meters
Legend
Town
street
<all other values>
SMALL RIVER
MAIN RIVER

Figure 1.2

d) Road Connection

Jeli is connected to the main transportation grid by road. The study area are being connected by Tanah Merah-Grik main road,Dabong-Tanah Merah main road. There are three entrances to Jeli, from the west via the Grik, from the east via Tanah Merah and from south via Jelawang in Kuala Krai. Its has good facalities for transportion user to came this study area. Figure 1.3 show the main road at Kelantan.

Figure 1.3

CHAPTER 2

LITERATURE RIVIEW

2.1 Introduction

The previous study for this research is more focusing on the general geology and geochemical prospecting. In order to make the literature review in this thesis several articles, journals published and unpublished papers and previous thesis has been referred.

2.2 Geological Review

a) Regional Geology and Tectonic Setting

Kelantan is located in the north-eastern piece of Peninsular Malaysia. The Kelantan Stream (otherwise called Sungai Kelantan in the Malay dialect) is the biggest river in the Kelantan State. It is fed by more than 180 streams and depletes a catchment region of around 11900 km2 (Ahmad , 2009). (The Malaysian and Thai group, 2006) have expressed that Jeli territory is underlain by metasedimnents rocks, which are near the stone interruption. The metasediments comprises of interbedded metargilllites and metarenites of the Mangga development. Tiang schist and hornfelsic rocks of the Telong arrangement. Minor interruption eapecially quartz veins/stringers and microdiorites veins can be see in the study range. Some of substantial metals are required as micronutrients, it can be harmful when present higher than the base necessities. (Ahmad, 2009) Jeli river has been utilize intensely by the general population close to the stream for day by day movement, for example, for drinking, agribusiness and sand mining.

(Goh Swee Hengl, 2006) had done the focal zone of Kelantan is comprised of a various collection of rock sort which incorporate sedimentary rocks, metasediments and molten rock of the age Mesozoic. Sedimentary rocks happens broadly all through the territory and speak to by a wide assortment of sorts going from shale to aggregate, and including quartzite, limestone, greywacke,arkose, mudstone and siltstone.

(Goh Swee Hengl, 2006) likewise expressed that the transformative nature of the dregs rocks by the stone interruption is variable, extending through induration to the arrangement of andalusite shale and phylites, and in some locatilies schists and hornfels.

That are two sorts of sources that sand is mined from, physical and marine stores. The most widely recognized physical sources are waterway channel stores, floodplain alluvial stores and remaining soil stores, the marine sources are the shore and seaward stores. In any case, the implementation by the Branch of Watering system and Waste of the stream sand mining rules observing still should be fortified. As of late, the sand mining activities in Malaysian rivers have made a few ecological issues, for example, the weakening of stream water quality, bank disintegration, stream bed degradation and buffer zone encroachment.

b) Historical Geology

The Central Belt stretches from Kelantan to Johor between the eastern foothills of the Main Range, forming its western boundary, to its eastern boundary marked by the Lebir Fault in the north down to the western boundary of the Dohol Formation in the south. The Palaeozoic rocks consist largely of Permian clastics with sporadic outcrops of

Carboniferous limestone that occur as linear belts flanking Mesozoic sediments on both edges of the belts.

In the western part of the Central Belt are Upper Palaezoic rocks of the Gua Musang and Aring Formations in south Kelantan and Taku Schist in east Kelantan, and further south are the Raub Groupin west Pahang and Kepis Beds in Negeri Sembilan. These Upper Palaeozoic rocks are predominantly of argillaceous strata and volcanic rocks, with subordinate arenaceous and calcareous sediments deposited in a shallow-marine environment, with intermittent submarine volcanism, starting from the Upper Carboniferous and peaking in the Permian to Triassic. Lower Triassic lava unconformably overlies Permian phyllite in south Pahang and Johor, marking a change from submarine to subaerial volcanism in the south.

c) Regional Stratigraphy

The oldest rocks in the state are of Lower Paleozoic age, outcropping as a northerly-trending belt bordering the foothills of the Main Range and extending eastward up to Sungai Nenggiri. They are mainly metapelites with lesser volcanic fragmentals and minor arenaceous and calcareous intercalations. Rare occurrences of amphibolite and serpentinite have been recorded (MacDonald, 1967). Predominantly Permian volcanic-sedimentary rocks occur extensively on the eastern side of, and overlying uncomformbly, the Lower Paleozoic sequence in southwest Kelantan. The Taku Schist, the age of which is still doubtful but defmitely pre-Triassic, dominates central north Kelantan. Triassic rocks are confined mainly to central and south Kelantan. These rocks are mainly argillo-arenaceous sediments with intercalated volcanics and limestone. Several inliers of Permian rocks crop out through this veneer of Triassic sediments (MacDonald, 1967).

The youngest rocks are the Jurassic-Cretaceous continental rocks which overlie the Boundary Range Granite and Triassic sediments in the Gunung Gagau area at the common state boundary between Kelantan, Terengganu and Pahang and to the west in the Gunung Perlis and Gunung Pemumpu areas. This sequence consists of conglomerate overlain by sandstone with sporad ic volcanic intercalations (Hutchison, 2009). The geological map for the state of Kelantan is as shown in Figure 2.1.

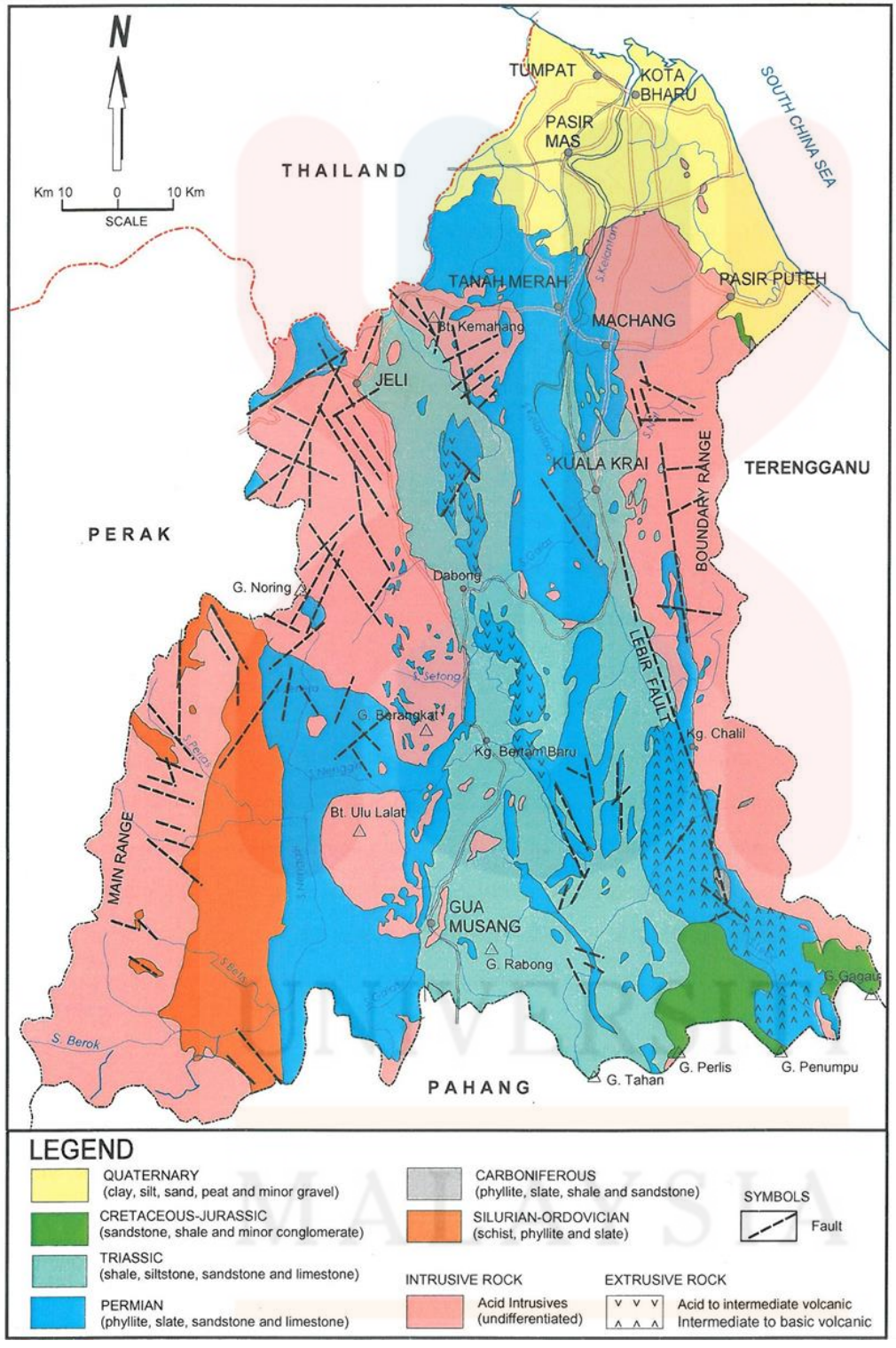

N
Km 10 0 10 Km
SCALE
THAILAND
TUMPAT
KOTA BHARU
PASIR MAS
SOUTH CHINA SEA
TANAH MERAH
PASIR PUTEH
Bt. Kemahang
MACHANG
JELI
KUALA KRAI
BOUNDARY RANGE
TERENGGANU
PERAK
G. Noring
Daboong
LEBIR FAULT
Kg. Chalil
G. Berangkat
Kg. Bertam Baru
Bt. Ulu Lalat
MAIN RANGE
GUA MUSANG
G. Rabong
G. Gagau
S. Berok
G. Tahan
G. Perlis
G. Penumpu
PAHANG
LEGEND
QUATERNARY
(clay, silt, sand, peat and minor gravel)
CRETACEOUS-JURASSIC
(sandstone, shale and minor conglomerate)
TRIASSIC
(shale, siltstone, sandstone and limestone)
PERMIAN
(phyllite, slate, sandstone and limestone)
CARBONIFEROUS
(phyllite, slate, shale and sandstone)
SILURIAN-ORDOVICIAN
(schist, phyllite and slate)
INTRUSIVE ROCK
Acid Intrusives
(undifferentiated)
EXTRUSIVE ROCK
Acid to intermediate volcanic
Intermediate to basic volcanic
SYMBOLS
Fault

Figure 2.1

d)Structural Geology

Structural geology is the study of the three-dimensional distribution of rock units. It also shows their deformational histories including determining the lineament of both positive and negative. A linear feature in a landscape which is an expression of an underlying geologicalstructure such as fault is a lineament. There are few factors that can rise the lineaments such as fracture zones, shear zones and igneous intrusion such as dykes.

2.3 Heavy Metal

From the two location selected, sand mining activity still run their operation every day. This because it has higher demand for industry and development. Based on (Ayres *et al,* 1994) heavy metal means, when in significant concentrations in water, that may pose detrimental health effects. Heavy metals include lead, manganese,aluminium, iron, chromium, zinc, cadmium and tin that must be removed to certain levels to meet discharge requirements.

The chemistry of drinking water commonly has been cited as an important factor in many diseases. A strong relationship between contaminated drinking water with heavy metals from some of the Great Cairo Cities, Egypt and chronic diseases such as renal failure, liver cirrhosis, hair loss, and chronic anemia has been identified in this study. These diseases are apparently related to contaminant drinking water with heavy metals. (Salem *et al*., 2000). Heavy metals may accumulate in aquatic species, enter the food chain and cause serious harm to human health when the contamination content and exposure are significant . The accumulation of heavy metals in fish is an important issue because many

fish species are consumed as a source of protein by a large section of the population, especially those who live near rivers. The low saturated fat and sufficient omega fatty acids in fish are also important in supporting good human health. Minomata disease is the onegood example for case health hazards that treaten fish consumer by the comsumtion of metal accumulated fish (Ahmad *et al*, 2009).

2.4 Water Quality

Water is a natural resources that very important to the life in the earth whether for human, animal or plant. This study will focus on physical and chemical parameter investigation. . The Water Quality Index (WQI) was used by the Department of the Environment for a baseline assessment of the watercourse in relation to pollution load categorisation and the designation of classes of beneficial use, as stipulated in the Malaysian Interim National Water Quality Standards (INWQS). For this research the WQI was derived by using only temperature,electric conductivity, total dissolved solid, total suspended solid, turbidity, and pH. Table 2.1 show the water class of users of river based on Water Index Quality (WQI) and Table 2.2 show the national water quality standards for Malaysia. The Department of the Environment (DOE) [Kelantan] was responsible for monitoring the water quality for the Kelantan River. The Department of the Environment detected changes of the Kelantan River's water quality and identified the pollution sources of the river. This research uses multisensory probe ysi model 556 MPS for investigate the dissolved oxygen, pH, electric conductivity, temperature, turbidity, salinity and TDS concentration and for chemical parameter, Van Dorn water sample is using and preserved in polyethylene bottle for analysis of fluoride, nitrate, nitrate, ammoniacal-nitrogen and

phosphorus. Spectrometer also use for this method (Ahmad, 2009). Figure 2.2 show the area of sampling water quality in study area.

Class	Uses
Class I	Conservation of natural environment. Water Supply I - Practically no treatment necessary. Fishery I - Very sensitive aquatic species.
Class IIA	Water Supply II - Conventional treatment. Fishery II - Sensitive aquatic species.
Class IIB	Recreational use body contact.
Class III	Water Supply III - Extensive treatment required. Fishery III - Common,of economic value and tolerant species,livestock drinking.
Class IV	Irrigation
Class V	None of the above.

Table 2.1 The water class of users of river by Department of Environment

Parameter	Unit	Class					
		I	IIA	IIB	III	IV	V
Temperature	c	-	Normal +2	-	Normal +2	-	-
pH	-	6.5-8.5	6-9	6-9	5-9	5-9	-
Electric Conductivity	µS/cm	1000	1000	-	-	6000	-
Total Dissolve Solid (TDS)	mg/1	500	1000	-	-	4000	-
Turbidity	NTU	5	50	50	-	-	-
Total Suspended Solid (TSS)	mg/1	25	50	50	150	300	300

Table 2.2

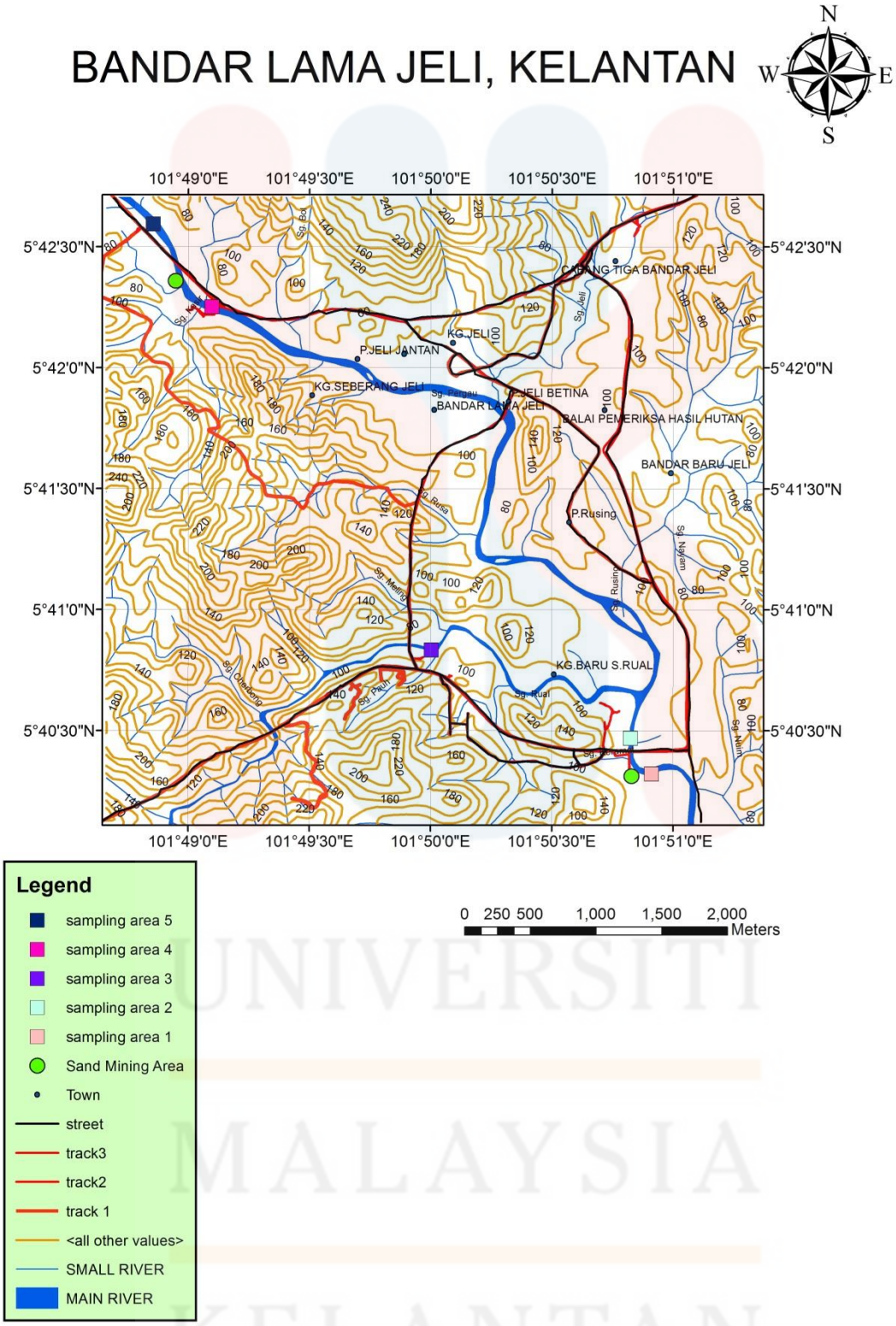

BANDAR LAMA JELI, KELANTAN
N
W
E
S
101°49'0"E
101°49'30"E
101°50'0"E
101°50'30"E
101°51'0"E
5°42'30"N
5°42'0"N
5°41'30"N
5°41'0"N
5°40'30"N
CABANG TIGA BANDAR JELI
KG.JELI
P.JELI JANTAN
KG.SEBERANG JELI
BANDAR LAMA JELI
P.JELI BETINA
BALAI PEMERIKSA HASIL HUTAN
BANDAR BARU JELI
P.Rusing
KG.BARU S.RUAL
Sg.Jeli
Sg.Rusing
Sg.Rual
Legend
sampling area 5
sampling area 4
sampling area 3
sampling area 2
sampling area 1
Sand Mining Area
Town
street
track3
track2
track 1
<all other values>
SMALL RIVER
MAIN RIVER
0 250 500 1,000 1,500 2,000
Meters

Figure 2.2

2.5 Sand Mining

Based on Federal Territories Director,the legal operation of sand mining have at Kelantan are 84 along the Kelantan River from Kuala Krai to Tumpat however at Jeli has 3 legal company sand mining and simply take just 3 stations for sampling. Table 2.3 show the company have run operation at Jeli. The volume of sand mining movement along stream at Jeli builds every year in light of the appeal of sand for industry and development. There are two sorts of sources that sand is mined from, terrestrial and marine deposits. The most widely recognized physical sources are waterway channel stores, floodplain alluvial stores and remaining soil stores. Figure 2.3 show the area of sand mining in study area.

Large scale mining of sand and gravel several folds higher than the natural replenishments, has led to irreparable damages to the land, water, biotic and social /human environments related to many of the world's river systems. The river channels are naturally modified into different bed forms depending on the changes in flow energy and sediment discharge. But the river systems of the study area especially in the midlands and lowlands, have notably changed due to anthropogenic activities rather than natural processes. The most destructive anthropogenic activity in the past 3-4 decades is the indiscriminate extraction of construction grade sand from the river channels and adjoining areas. A better understanding of the general distribution, sources and fates of sediments is necessary to discriminate the effects of sand mining from the other anthropogenic and natural processes.(Saviour, 2012) .

Sand mining had been in operation along the Kelantan River for years. The major cause for sand demand is responsible for unsustainable extraction of sand from dried river

paths. The layers of sand deposits are exploited almost up to the bottom. This in turn, has increased initial and premature failure of irrigation wells in riparian areas. This activity also release oil and heavy metal through the fuel and lubricant oil from heavy machine that uses to operate sand mining. The probality of leaking of the oil lubricant of the sand suction pump machine is higher, this can spill of fuel into the river.

No	Name of Company and Adress	Place of Operation
1	Baharom Bin Sarip Kg Bukit Berangan,17600,Jeli	Kg Relak, Bunga Tanjung,Jeli
2	Teguh Kekal Trading Kg Berdang,17600,Jeli	Kg Berdang,Jeli
3	Mek Bin Draman Kg Seberang Jeli,17600,Jeli	Air Bol,Jeli

Table 2.3

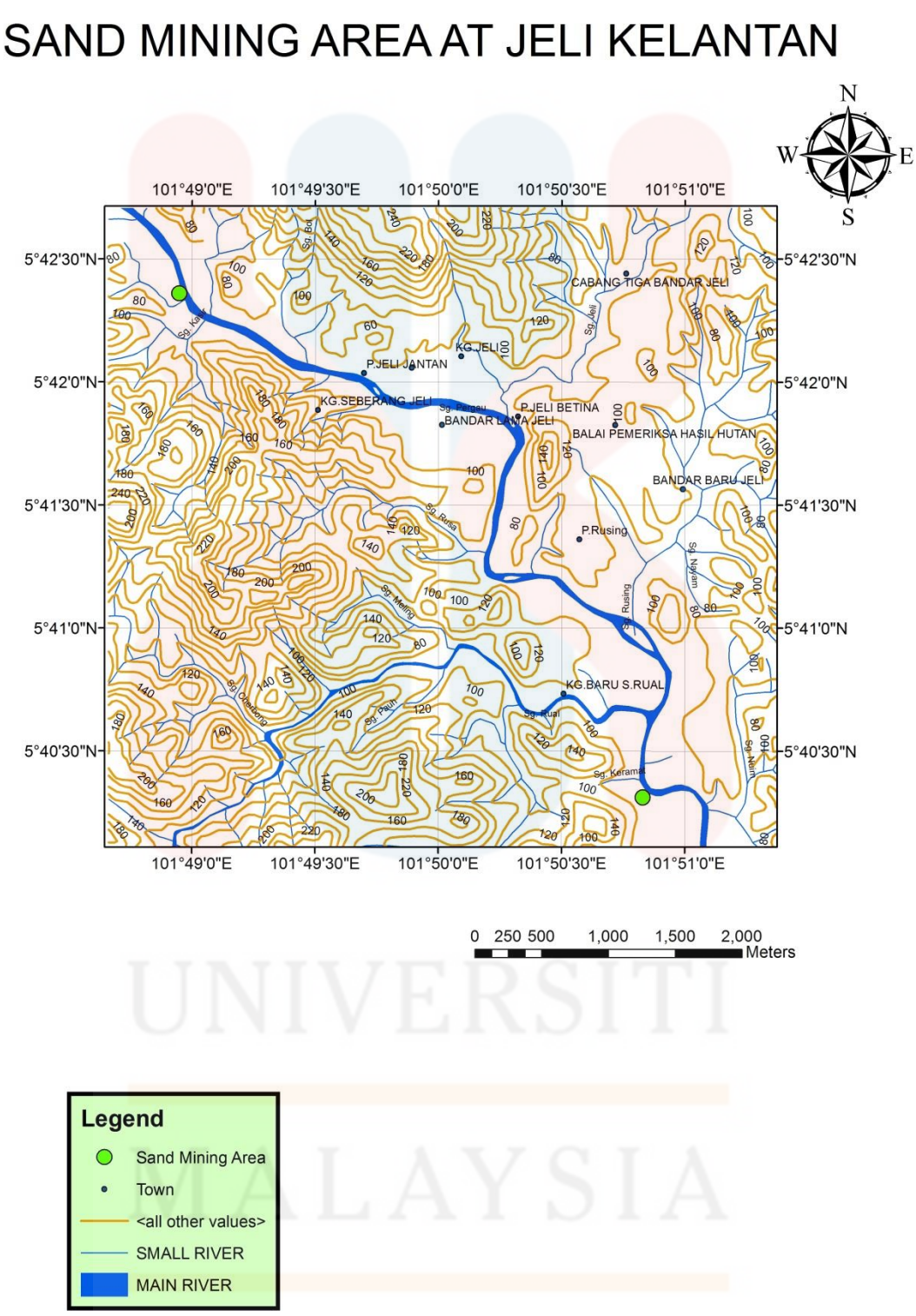


Figure 2.3 Sand mining area

CHAPTER 3

MATERIAL AND METHODOLOGY

3.1 Introduction

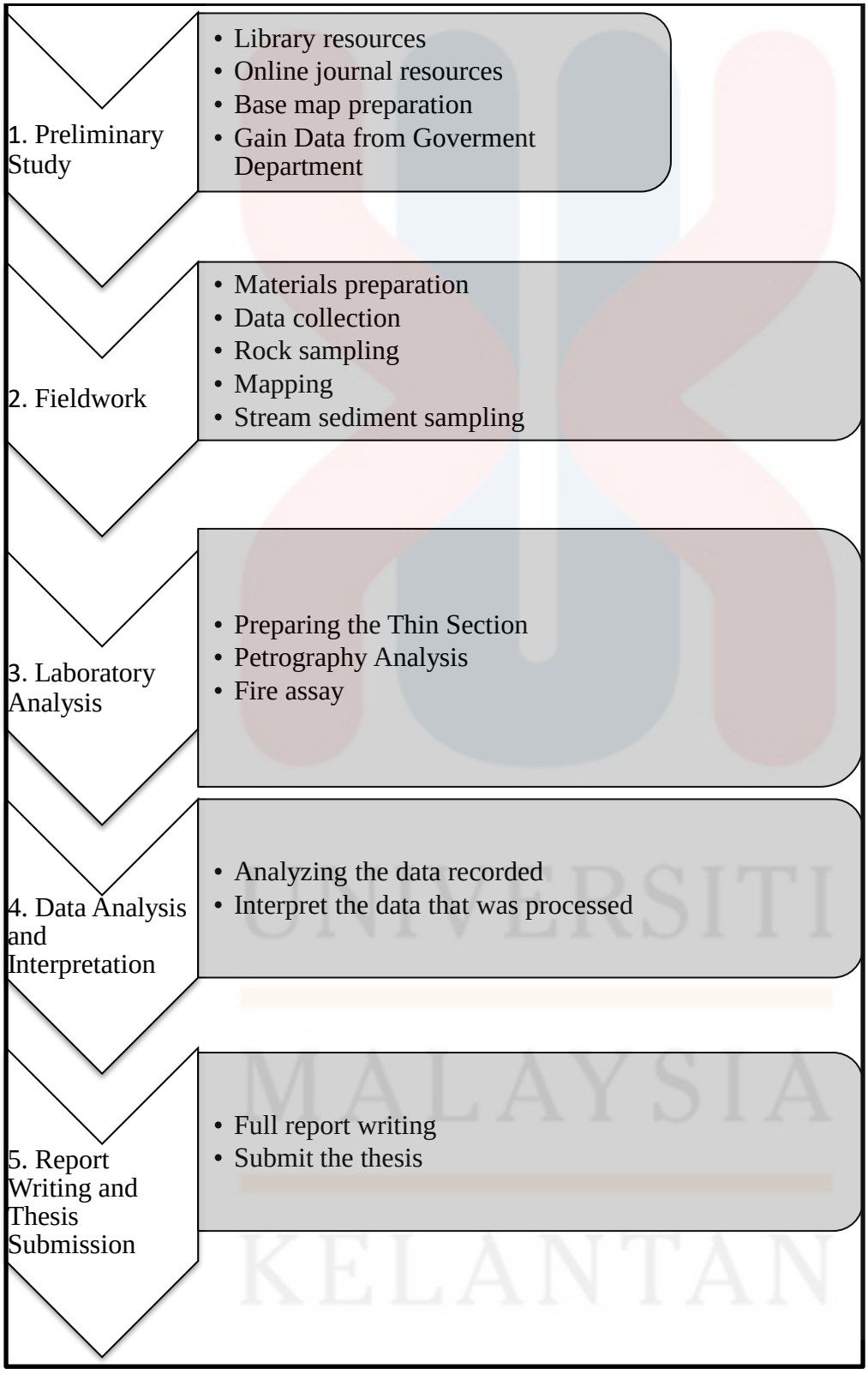
In this chapter,the methodologies of the study area described. It included identifying problem,desk study, data collection, data preparation, data analysis, result and conclusion.

3.2 Preliminary Researches

The research started with identifying the problems. The source of information are from by referring to previous work. Next step is desk study. This is the preliminary step in which the sources of the information are gathered from published and unpublished material such as articles, bulletins, journals, maps and photo.

The next step is data collection which included fieldwork and geochemical sampling. Then, data preparation involded in this project is by using Geographic Information System (GIS). The next step is data analysis. The analysis involved geochemical analysis by using DR 900 multiparameter and YSI multiparameter.

RESEARCH FLOW CHART



3.3 Materials and Method

Material and tools

- Hammers and Chisels
- Compass and Clinometers,
- Hand lenses,
- A field notebook,
- Masking tape,
- Marker pens,
- Acid in bottle (hydrochloric acid),
- Global positioning system (GPS)
- ArcGIS software
- The sample bag,
- Base map

3.4 Field Studies

In situ Analysis

In situ analysis is an analysis that can be done at the station or where we take the sample. It doesn't need any treatment and complex apparatus to be analysed. The in situ parameter are discuss below:

YSI Multiparameter (YSI 556 MPS)

Some of the parameter can be taken in situ without any laboratory analysis or adding chemical like:

- Temperature of water
- pH of water
- Total Dissolve Solid(TDS) of water
- Dissolved Oxygen (DO) of water
- Electrical Conductivity (EC) of water
- Turbidity of water
- Salinity

All this parameters can be measured by using YSI 556 MPS. This instrument consist of the body and sensor (probe) that place at the tip of long cable. This long cable will help in deploy the sensor into the middle of the rivers from embankment in case the river cannot be entered. When the probe had contact with water, it will immediately measure the above parameter. As the measurement is stable the reading will be taken.

Limitation for this multi-probe is it must be clean with distill water before and after to avoid miss reading. Due to him,multi-probe is very handy not just because it is mobility also because it accurancy in detected the parameters.

Geological Field Mapping

Planning

Before going to field work there need to have a plan or preparing to make the work progress smooth and done perfectly. The preparation includes the tool and equipment, time management, transportation, money, base map of the study area, and knowledge about the study area. Before starting the mapping activity there is need to know and do some study about the research study area. The most important thing when doing mapping is GPS. It can give the coordinate and can track the movement. This data from GPS need to transfer to the Argis to plot at the base map.

Observation/mapping/collecting

This part is collecting data that needed for the research in the study area. The data were collected by doing the mapping. With this method we collect the data about the geological process that happen in the study area, the lithology and geomorphology can be obtained. With mapping method also can find the strike and dip and the rock sampling of the study area.

After that, from doing observation of the data include physical observation by comparing with the base map. The basic physical observation, such as the existence of new roads or building that's not specified in the base map. With this, the comparison with the base map can be improved.

3.5 Laboratory Investigation

Thin section analysis

Thin section is important to identify the mineral that contains in the rock sample. The thin section process include slab cutting, slab lapping, slap sectioning, polishing and inspection. The thin section of rock about the thickness of 30 micron will be studied under polarized-light microscope.

For the procedure to making thin section from the rock sample is begin by cutting (using grinder) the rock into required size, normally smaller than size of glass slide (3x1 inch). The cutted rock than grind on 120 micron polisher to make sure one side of the rock surface is perpendicular to any planar surface and smooth enough until there are no air trap in process of sticking the rock on the glass slide.

After washed the rock, the rock than must be dry on hot plate for a while until it all dried up by place the grinded surface opposite of hot plate surface. When the rock is dried put Canada Balsam on grinded surface to glue the minerals and remove the air trap inside the rock by occupying the pores inside the rock.

As the Canada Balsam is completely is completely dried up, the rock once again be grind using 120 micron polisher to make sure the grinded surface is really smooth, therefore it is no bubble will produce during sticking the rock glass slide.

After polishing thin section, it will be proceed to observed under microscope. When placed thin section under microscope, result will shows between two polarizing filters set at right angles to each other, optical properties of the mineral in the thin section

alter the colour and intensity of the light as seen by viewer. As different minerals have different optical properties, most rock minerals can be easily identified.

Sampling

Sampling is the process that collecting the sample in the study area. The sample that needs to collect is based on the research that we conducted. The sample of this research is water sample who needs to collect five different places near the sand mining activity in the study area. Samples however have to be handled in such a way that no significant change in composition occurs before the test are made.

The water samples to be collected and stored in clean polyethylene bottles, before collection the bottle to be washed with distlled water to avoid any contaminantion to the sample. When the sample is collected the plastic bottle need to be wrap with aluminium foil to avoid light from reaching it, the sample bottle than must be store in dark cold place.

For trace element analysis, the samples need to be treated by adding concentrated nitric acid (HNO_3) with pH less than 2.0 to preserve the trace element from reacted with time and surrounding and absorbed by the container, than the samples to be carried out. To minimize the error each sample is taken in daily light at sunny day, the weather and time had to be recorded for further references.

DR 900 multiparameter

For this research are using Dr 900 multiparameter to identify the heavy metal that collect at the research study area.

- Iron
- Manganese
- Zinc
- Aluminium

All this can be measured by using Dr 900. This instrument consist of the body and sensor that place to put the water sample. This method must have reagent based on what parameter want to measured. The body sensor must set in the stored program and select the parameter. After fill the sample in the bottle, reagent will mix with the sample and sample must rest in 5 minutes for iron, 2 minutes for manganese, 3 minutes for zinc and 15 minutes for aluminium. Before run the sample in the instrument, wipe the blank and insert sample into the cell holder with the fill line facing and then press zero and the screen will show the unit of the parameter. After that, wipe the prepared sample and insert into the holder cell and the press read. The screen will show the result that parameter. Table 3.1 show the reagent that use for water sample to identify the heavy metal.

Parameter	Reagent
Iron	• Ferrozine iron reagent

Manganese	• Manganese reagent
Zinc	• Cyclohexanone • Zincover 5 reagant
Aluminium	• Absorbic acid pillow • Aluver 3 reagant • Bleaching reagant

Table 3.1

CHAPTER 4

STUDY AREA

4.1 Introduction

The area of research is lies between latitude from 5°40’00” N to 5°42’30” N and longitude 101°49’00” E to 101°51’00” E which cover approximately 25 km². The study area lies to the south of Jeli town with have two main rivers that is Sungai Rual and Sungai Pergau. Sungai Rual were flowing from west and join to the Sungai Pergau and move towards to south study area.

The study area is well connected by concrete road and unpaved road. Figure 4.1 show the road connection from other village to the study area and easy to accessibility and show the condition of road condition of connection for Kg. Sungai Rual Baru that is connecting from Kg. Berdang. The study area was traverse by walking, transportation and some area cannot allow by normal access except by using 4 x 4 transport. The research area as shown in Figure 4.2.

Figure 4.1 Road connection

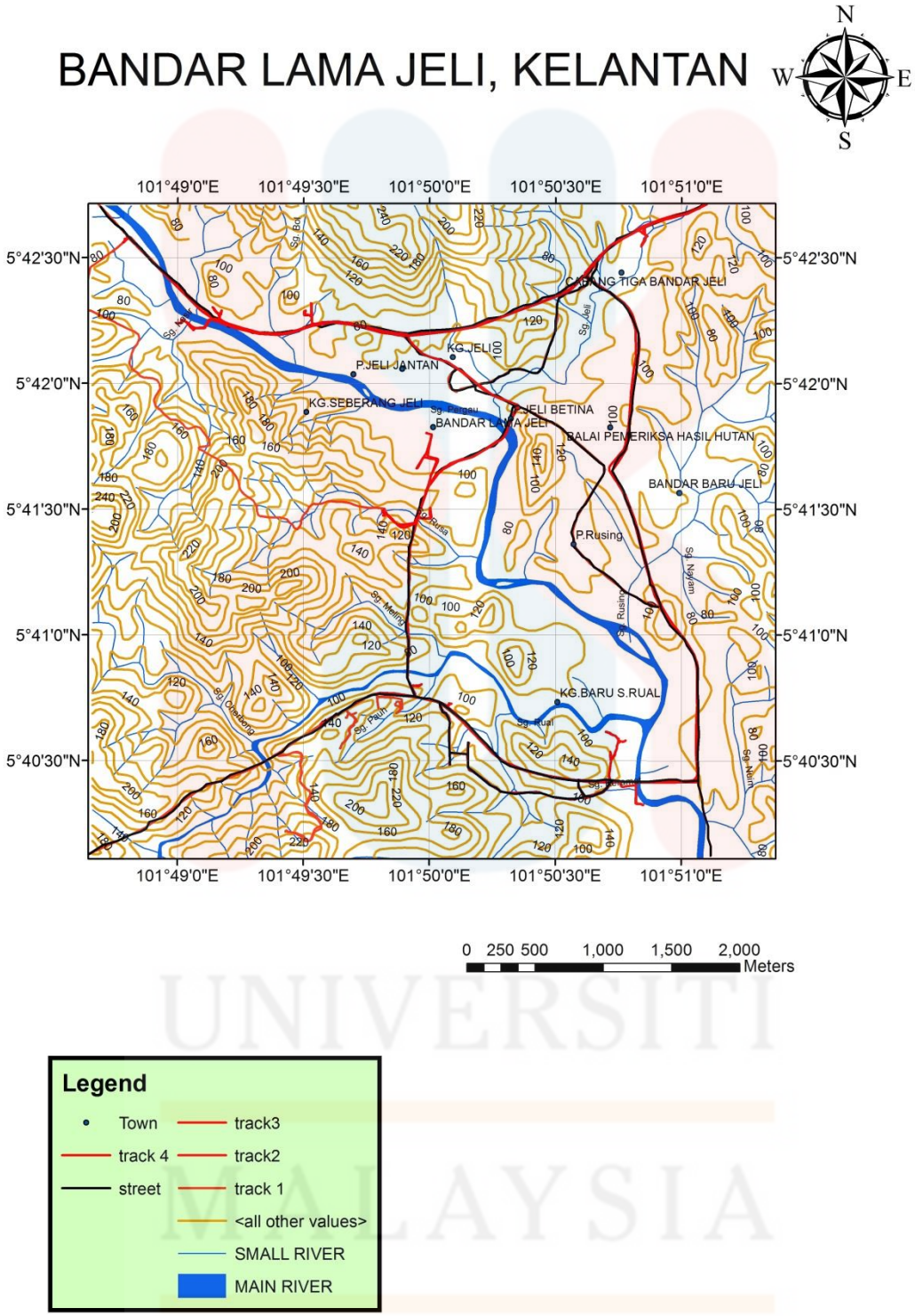


Figure 4.2 Traverse Map

4.2 Geomorphology

Geomorphology is the study of landforms, their processes, form and sediments at the surface of the Earth. Study includes looking at landscapes to work out how the earth surface processes, such as air, water and ice, can mould the landscape. Landforms are produced by erosion or deposition, as rock and sediment is worn away by these earth-surface processes and transported and deposited to different localities. The different climatic environments produce different suites of landforms.

4.2.1 Drainage System

The peninsula is characteristized by a dense network of streams and rivers that can be attributed to its sub-aerial exposure as well present day humid tropical climate (Raj, 2009). In kelantan, Sungai Kelantan whose drainage basin is of 11,922 km² comprises the entire state of Kelantan (Raj, 2009).

According to Raj (2009), common features of the rivers that have their headwaters in hilly to mountainous terrain are waterfalls and rapids where the waterfalls are caused by the river encountering some highly resistant rocks while deepening their valleys. Waterfalls and rapids also develop where the streams cut their valleys through rocks of very unequal hardness, as contact between granites and sedimentary rocks (raj, 2009).

In the study area, based on Figure 4.3 it consist two main rivers that is Sungai Pergau and Sungai Rual. It also shows the flow of water movement that move towards to south of the study area. Rivers can flow down mountains, through valleys (depressions) or along plain. A current, in a river or stream, is the flow of water influenced by gravity as the water moves downhill to reduce its potential energy. The current varies spatially as

well as temporally within the stream, dependent upon the flow volume of water, stream gradient, and channel geometry. Usually river water will flow to weak water current flow that called a weak zone. The water in a river is usually confined to a channel, made up of a stream bed between banks. In the study area, from the observation, it may be a dendritic drainage pattern where many contributing streams which are then joined together into the tributaries of the main river.

Other patterns can be observed in the study area is a parallel drainage system. It can see by the pattern of rivers caused by steep slope with some relief. The streams are swift and straight with very few tributaries and all in the same direction because of the steep slopes. The rectangular drainage system also can be found in the study area. It was develop on rocks that are of approximately uniform resistance to erosion but it must have two direction of joint at approximately right angles.

The dominant pattern of drainage this study area is dendritic pattern. The water flow (Figure 4.4) of river in study area is laminar and turbulent flow both. Laminar flow is occur when a fluid flows in parallel layers, with no disruption between the layers. It has a low velocity of fluids tend without mixing the particle in the river. Turbulent flow is occur when a fluid flow in random direction. It has a rapid velocity of fluids tend with mixing all particles in the river.

DRAINAGE PATTERN OF STUDY AREA

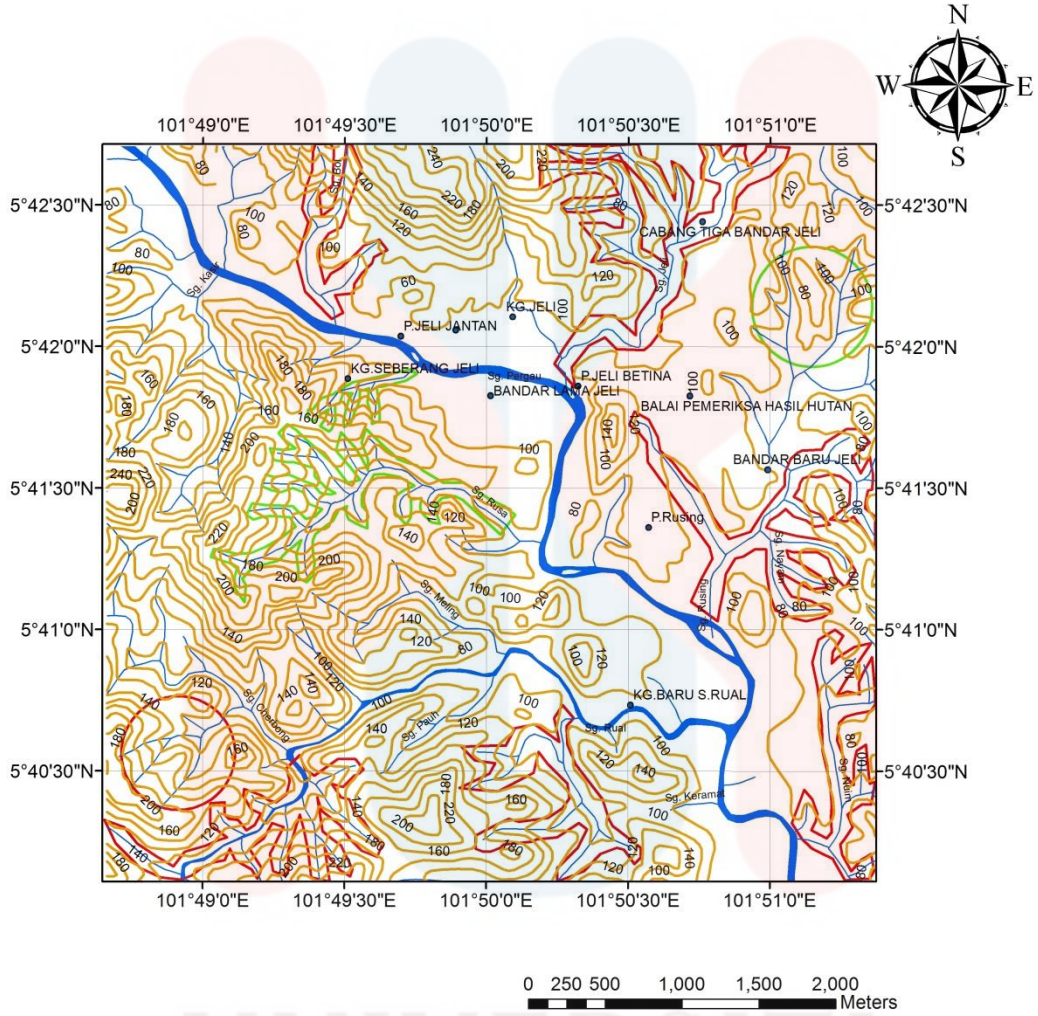


Figure 4.3 Drainage pattern

a)Turbulent flow

b)Laminar flow

Figure 4.4 Showing the flow of water in study area

4.2.2 Weathering and Erosion

In this study area, the weathering process was devided into three parts that is biological weathering (Figure 4.5), chemical weathering (Figure 4.6) and physical weathering (Figure 4.7). Chemical weathering is the decay of rock forming minerals caused by water, temperature, oxygen, hydrogen and mild acids. Physical weathering processes that break a rock or mineral into smallerpieces without altering its composition. Biological weathering is processes that are caused by,or assisted by, the presence of vegetation, or to a lesser extent animal, including root wedging and the production of organics acids. Where weathering will produce a new mineral or change the characteristics of rock from the origin. There are six grade of weathering that are describe by the percentage of the rock that was composes from rock material. Based on observation on the field and refer to Table 4.1 the grades of weathering of study area are from grade I until grade VI.

Weathering Grade	General Description
VI-Residual soil	The rock is completely changed to soil in which the original rock texture has been completely destroyed.
V-Completely decomposed	The rock is changed to soil in which the original rock texture is (mainly) preserved.
IV-Highly decomposed	50-100 percent soil from decomposition of the rock mass.

III-Moderately decomposed	Up to 50 percent soil from decomposition of the rock mass.
II-Slightly decomposed	100 percent rock, discontinuity surfaces or rock material may be discoloured.
I-Fresh	100 percent rock, no discolouration, decomposition, or other change.

Table 4.1 Weathering grades of different rock (Paul M. Santi, 2006)

a) Biological weathering

Figure 4.5 Biological weathering by vegetation

In study area, vegetation of biological weathering happens when the plant roots can exert stress or pressure on rock. Plants can grow withing the cracks in a rock formation and the root grow bigger they push open cracks in the rocks making them wider and deeper. Following time, the growing tree eventually prizes the rock apart.

b) Chemical weathering

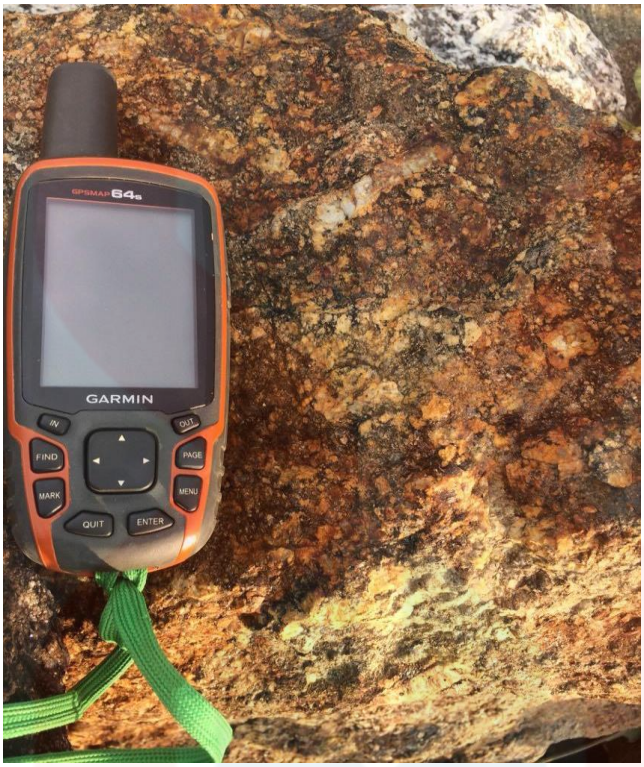


Figure 4.6 Chemical weathering by oxidation

Chemical weathering process is the internal structure of a mineral is altered by the addition or removal of elements. Change in phase and composition are due to the action of chemical agents. Chemical weathering is dependent on available surface for reaction temperature and presence of chemically active fluids. Smaller particle sizes weather by chemical means more rapidly than large particles due to an increase of surface area. The factors that influence chemical weathering are climate, living organisms, time and mineral composition. Where living organisms is divide to two that is bioturbation and acid production or mineral decomposition. The product that can produce from chemical weathering is clays, metal ores and rounding of boulders. Figure 4.6 show the chemical weathering by oxidation at the study area

c) Physical weathering

Figure 4.7 Physical weathering by thermal expansion

Physical processes in this area are happen due the temperature change as called as thermal expansion where it describes the effect of heating and cooling on a rock. Consider o rock outcrop in a moderate climate. During the day, this rock is exposed to sunlight, gradually heating the rock and causing it to expand. As the temperature drops overnight, the rock begins to cool and contract. Moreover , the rock may not be uniformly heated or cooled depending on its orientation and variety of other factors. The repeated heating and cooling places stress on the rock which can cause it to fracture and break. It cracks form eventually causing pieces of the rock to fall away.

4.2.3 Topography

Topography specifically involves the recording of relief or terrain, the three-dimensional 3D quality of the surface such in Figure 4.8 and the identification of specific landforms. Topography map do deal with third dimension by using contour line (Figure 4.9) to show elevation of change on the surface of the earth or below the surface on the ocean (sea level) and Figure 4.10 show the distribution of elevation of study area.. The elevation of hill was refers to the summit. In topography,a summit is a point on a surface that is higher in elevation than all points immediately adjacent to it. Table 4.2 shows the topography units to mean elevation above sea level.

No	Mean elevation above sea level (m)	Topography
1	<15	Low lying
2	16-30	Rolling
3	31-75	Undulating
4	76-300	Hilly
5	301>	Mountains

Table 4.2 Topography units of study area

From topography map the highest peak or contour is 280m elevation from sea level and the lowest area is 60m elevation from the sea level at study area. The geomorphology of study area can be classified as hilly and undulating. At study area the high elevation (280m) is situated on southwest that known as hilly. Other places in the study area are

mostly from 80m elevation to 200m elevation. The high elevation from southwest because low elevation towards to northeast of the study area.

Terrain is the upright and horizontal dimension of earth surface. The terrain is used as a universal term in physical geography, referring to the lay of the ground. This usually expressed in term of the elevation, gradient, and orientation of terrain features. Terrain can affect surface water flow and distribution. Over a large region, it can affect weather and climate pattern. In conditions of environmental quality, agriculture and hydrology, understanding the terrain of an area enable the understanding of watershed boundaries, drainage characteristic, water movement and impacts on water quality.

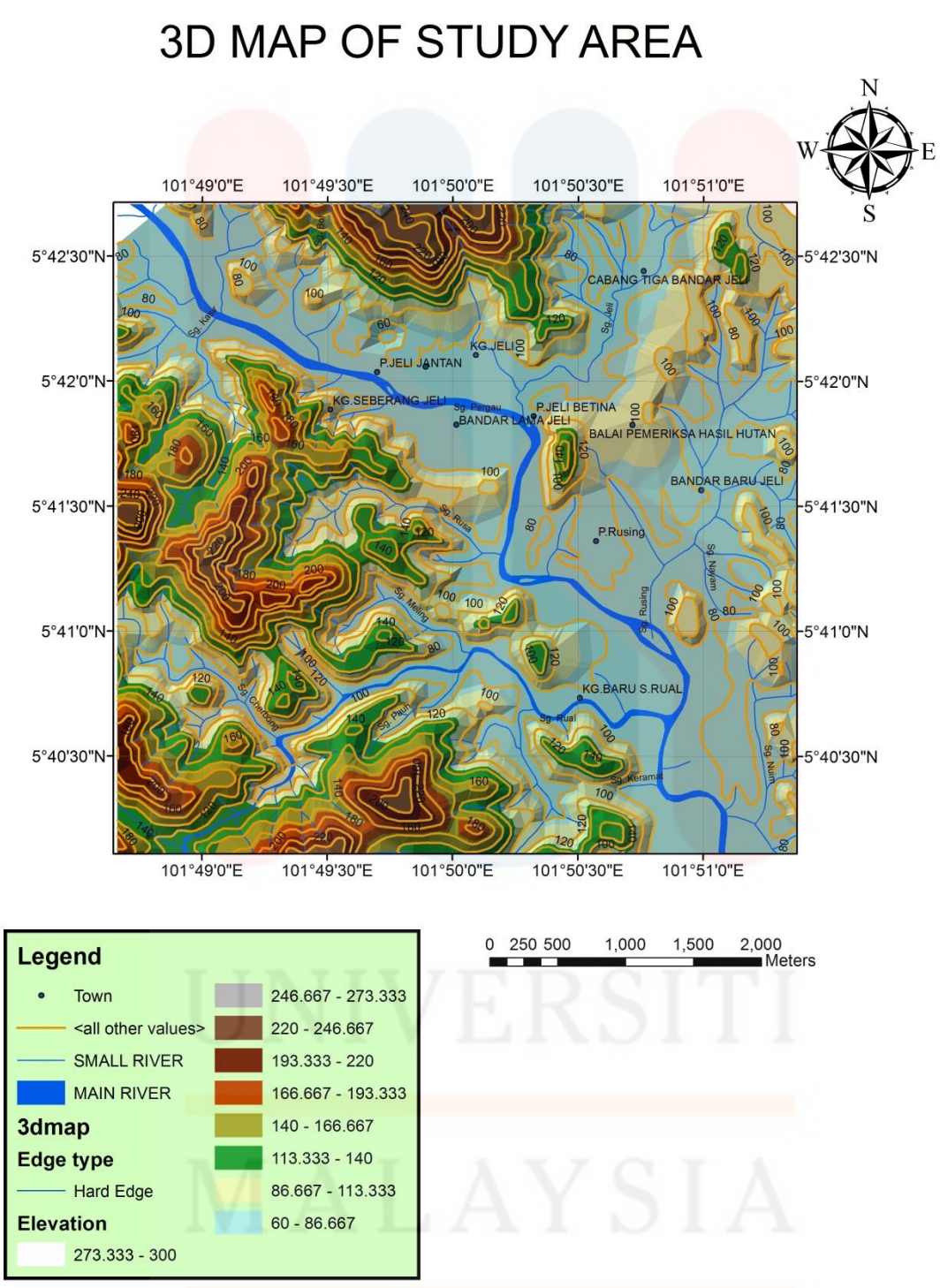


Figure 4.8 3D map of study area

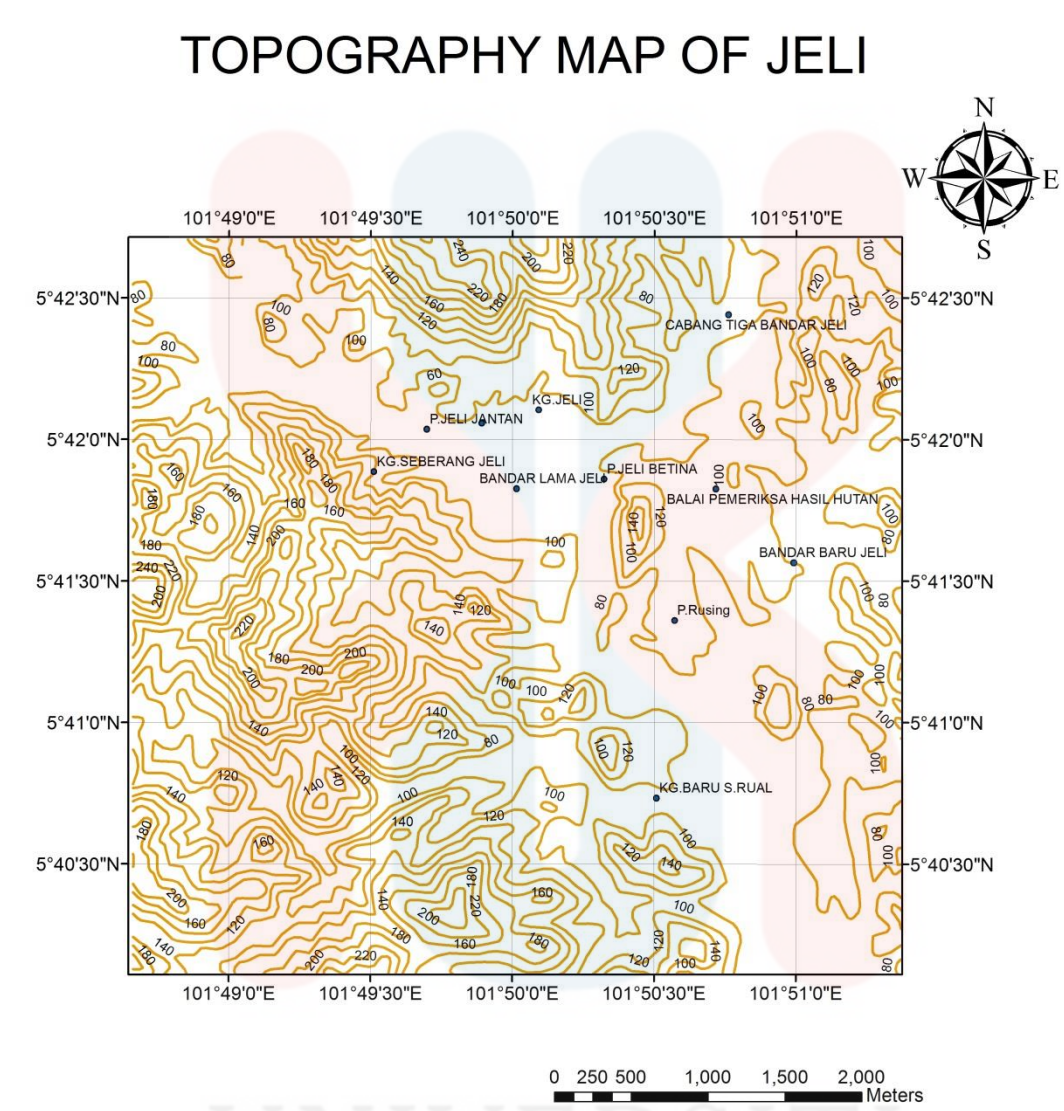


Figure 4.9 Topography Map (2D) of study area

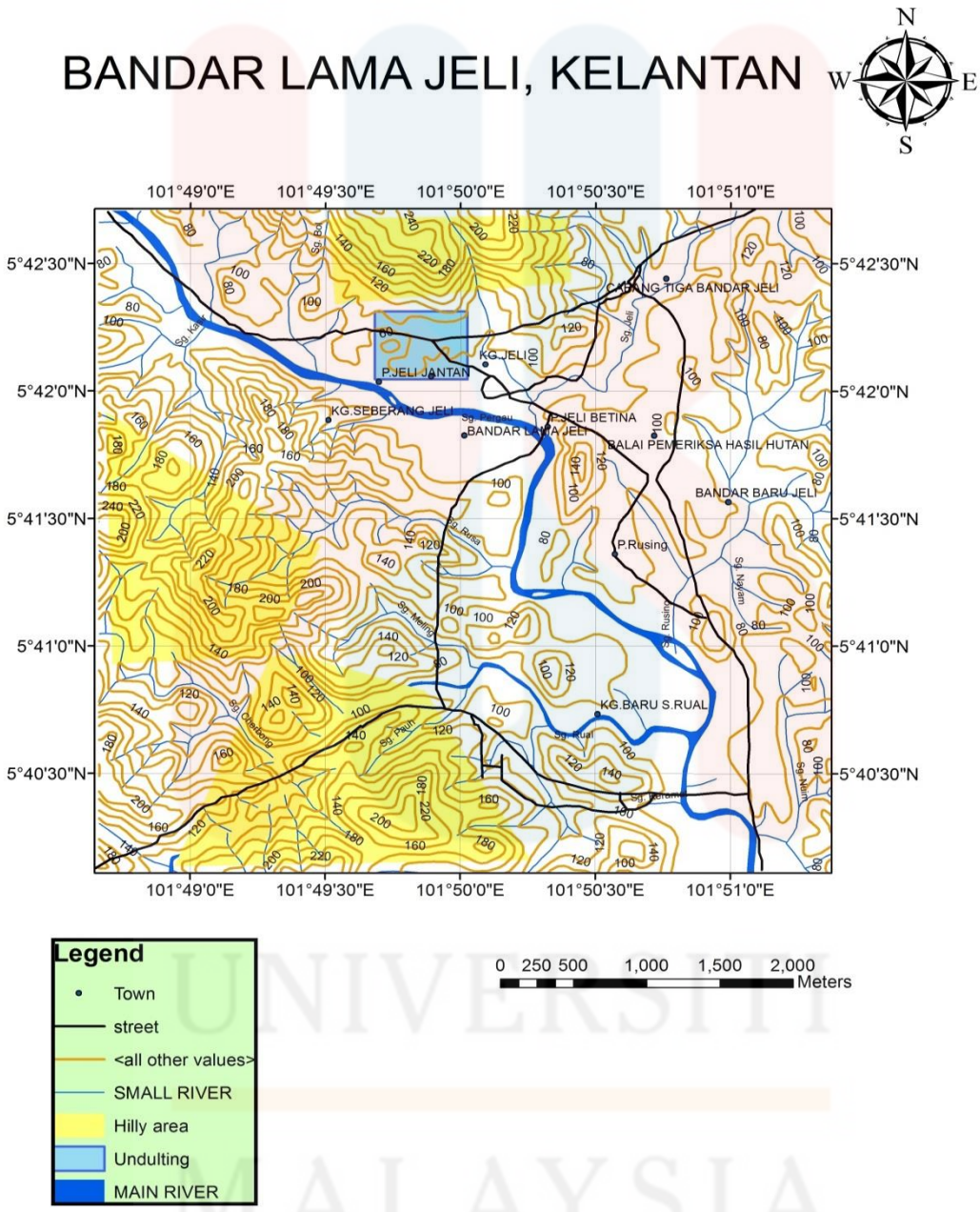


Figure 4.10 Distribution of elavation

4.3 Stratigraphy

Field work for geological mapping conducted throughout the study area. Figure 4.11 is an updated the geological mapping. This update map shows the development of urbanization in the study area. The percentage of built-up land also increases from the top-up placement and increasing infrastructure that gets expanded. For connection road, the main road is developing in Kampung Sungai Rual Baru and it still in construction.

The majority of rock exposed in the study area is an igneous rock with different grain size and mineral composition. The dominant accessory mineral in the igneous rock is biotite mica. Igneous rock was covered from the north, southeast and northwest. Because of road construction, the metamorphic rock is exposed to the earth's surface by the cut slope of the hill. Metamorphic rock was covered on southwest of study area only. The dominant accessory mineral composition in the metamorphic rock also biotite mica. The igneous rock that is present in the work area are granite and the metamorphic rock is gneiss. The sample location will be see in Figure 4.14.

4.3.1 Rock Distribution

The lithology of study area shows 2 types of rock formation. The major lithology at the study area is igneous rocks. 70% of the study area is covered by igneous rock and the igneous formation exposed to the earth at the hilly cut slope at Kampung Sungai Rual and metamorphic rock exposed in the Bandar Jeli area.

a) Gneiss

Gneiss is a high-grade regional metamorphic process from pre-existing formation that were originally either igneous or sedimentary rocks. This unit rock is exposed at the southeast of the mapping area and the coordinate this sample is N 05° 40’ 27.5”, E 101° 50’ 36”. It enclosed the main road connection of the southeast map. Along the road, there are slope hill comprise of gneiss unit. The colour of gneiss is dark colour (Figure 4.12). Gneiss can be recognized by the foliation on the rock body. This gneiss was show the highly biotite contain in the rock. Gneiss are banding with the quartz.

Gneiss has been buried very deep and squeezed very hard. In many case the darker part of rock, consisting mica and hornblend, has been intrude by lighter rock consisting quartz and feldspar. It can be seen through the curling light and dark veins. Partial melting has occurred and generated leucosomes of quartz, alkali and biotite.

Figure 4.12 Gneiss outcrop and hand specimen

b) Granite

Granite was founded in the study area. 70% of the study area cover by igneous rock which mean granite. This unit on rocks occupies the northwest, north, west, and southwest of the study area. Granite is one type of igneous rock. The igneous rock found at two main rivers and at the stream channel but with different grain size. The granite in the study area has a different rate of cooling in one of outcrop. The size of the outcrop of granite is 10 m^2 x 10 m^2. The position of this outcrop near to the village field. It is easy to take a sample the coordinate of this outcrop is N 05° 42' 18.4", E 101° 49' 35.7". Figure 4.13 show the outdrop of study area.

From the interpretation on hand specimen, its colour is greyish black and white. It is known as mesocratic based on colour index because its include rocks of an intermediate status. The texture is medium to coarse textures. The rock grain size is medium. From the observation of the hand specimen, the minerals found in the rock are quartz, alkali feldspar, biotite and plagioclase. Quartz and biotite has a size range approximate from 0.1-2.0 cm. Biotite exist as main mafic minerals in the rock sample. Quartz seen fill spaces between the mineral and the colour of quartz is colourless. Meanwhile for plagioclase it showed white grey in colour respectively.

Figure 4.13 Outcrop of granite and hand speciment

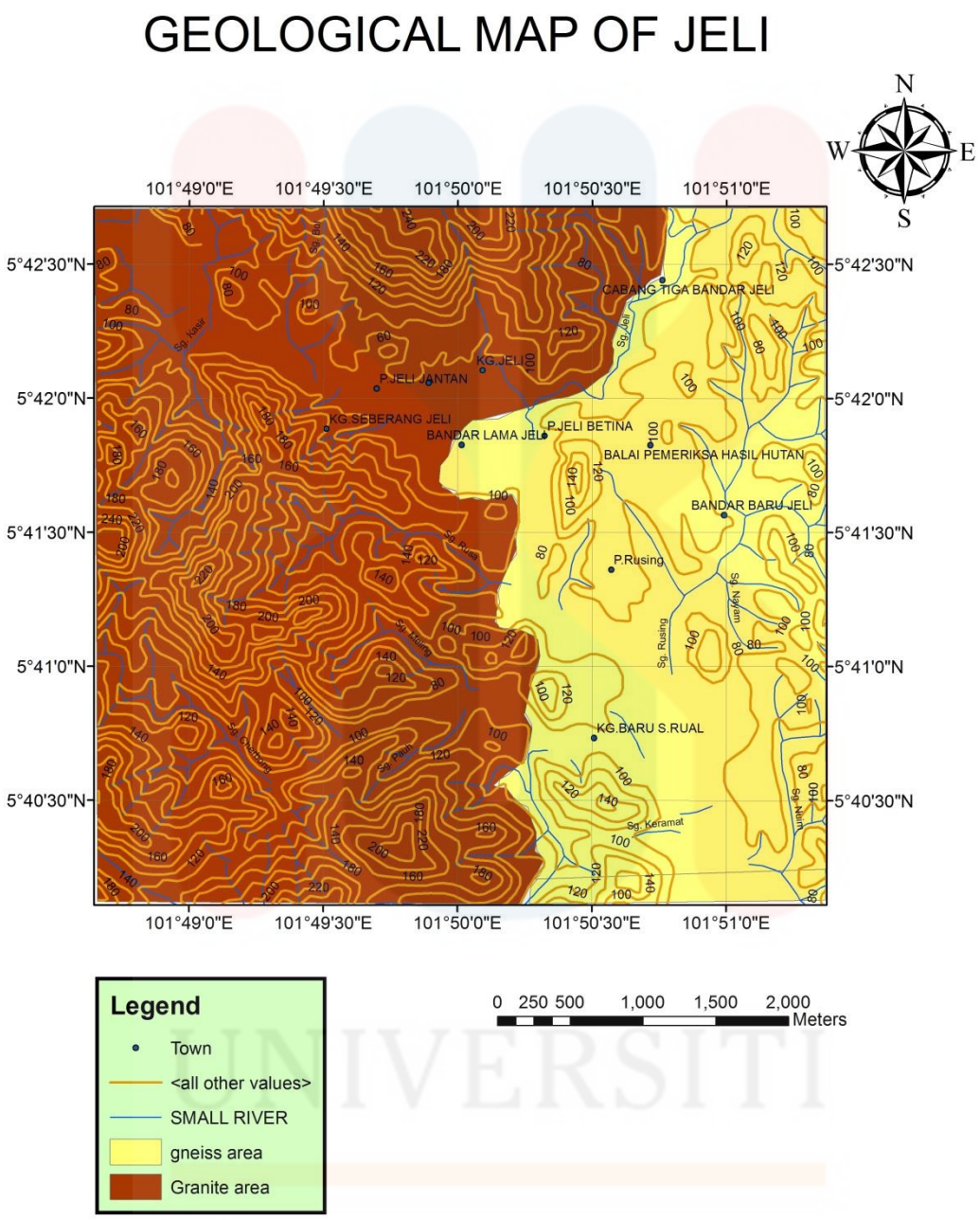


Figure 4.11 Geological map of study area

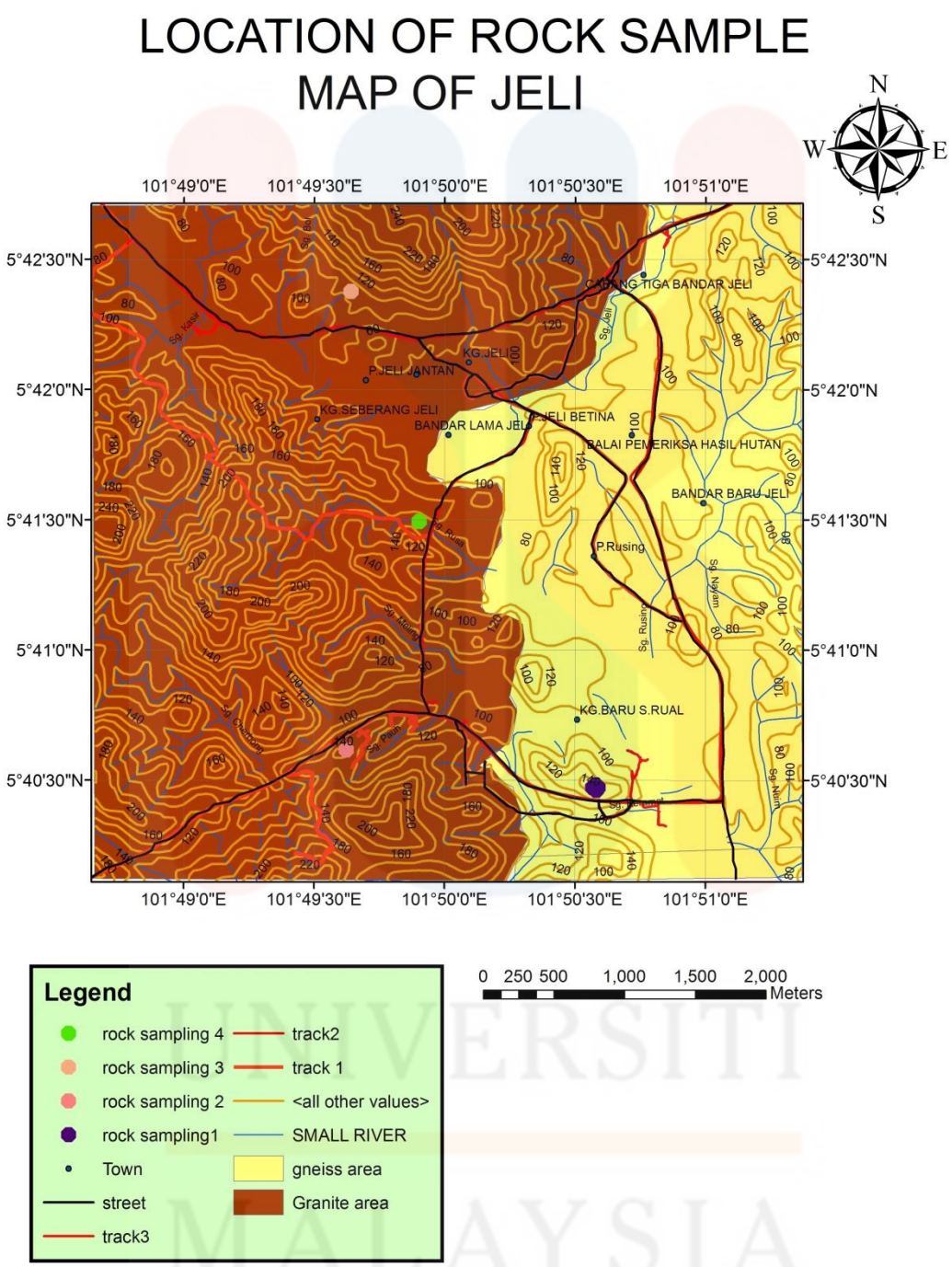


Figure 4.14 Location of sample rock of study area

4.3.2 Lithostratigraphy

The stratigraphy column shows the age of rock in study area. Based on the literature review, gneiss is a basement of Taku schist formation (Hutchison, 2009). Granite is parent of gneiss because it metamorphosed by granite and also having same mineral contant particulary rich in biotite. Table 4.3 shows the column of statigraphy of study area by comparing with the previous research that has been done around Jeli.. Based on the literarure riview studied, granite is the oldest rock in my study area (Triassic- Jurassic), while gneiss is youngest rock (Creataceous).

Granite covers almost 80% of study area. The age of the rock in the study area is Triassic and can be classified as Kemahang Granite. The Triassic Kemahang Granite forms a N-S trending mountainous area near the Jeli town which is located in the central of the Transect area. In Malaysia, The Kemahang Granite consist of predominantly grey, medium to coarse grained biotite hornblend granite to granodiorite in composition. The feldspar phenocryst has average of 2 cm and also may reach about 10 cm and show definite orientation. It also contain abuntdant of biotite with marked lineation of feldspar phenocryst (MT-JGSC, 2006).

Hutchison (2009) said that high grade metamorphism complexes are confined to the northern part of Peninsula, giving rise to the belief that the Peninsula has been uplifted and more deeply eroded in the north and tilted down towards the south.

Era	Period	Lithology
Mesozoic	Cretaceous	Granite
	Jurassic	Gneiss
	Triassic	

Table 4.3 Stratigraphy column of study area

4.3.3 Petrography

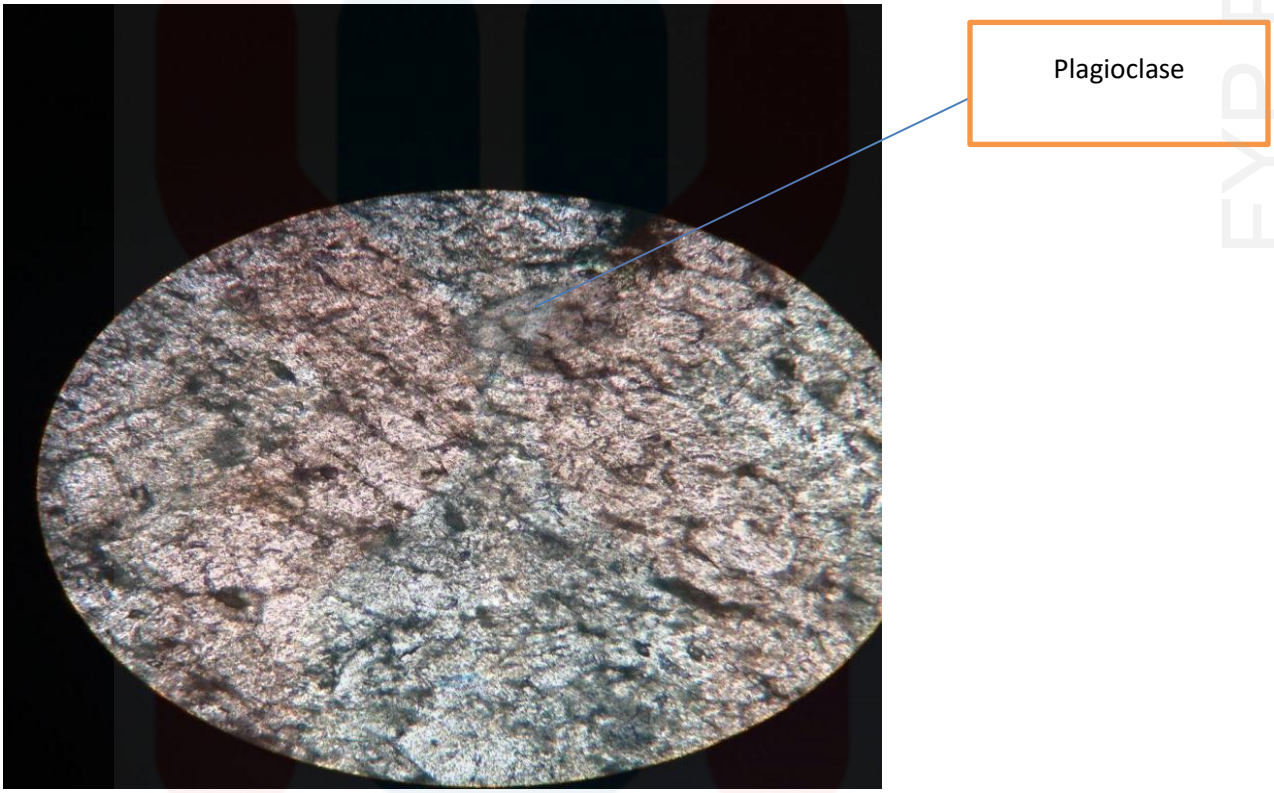
There are one thin section of gneiss have been analyzed under polarizing microscope. It can be observed that the minerals have undergone aligment have alternating light and dark minerals.

Quartz is colourless in plane polarized light (PPL) conditionwhile in cross polarized light condition (XPL), the colour is interference colours of grey and yellow. Quartz have the shape of anhedral and the size of 0.01 to 0.02. Plagioclase feldspar is colourless under plane polarizing light (PPL) condition while under cross polarized light (XPL) plagioclase have the colour of grey and sometimes dark. Plagioclase have simple twinnng. It has the shape of euhedral to subhedral. The size of the plagioclase in thin section is approximately the same of the size of quartz which are 0.01 to 0.02.

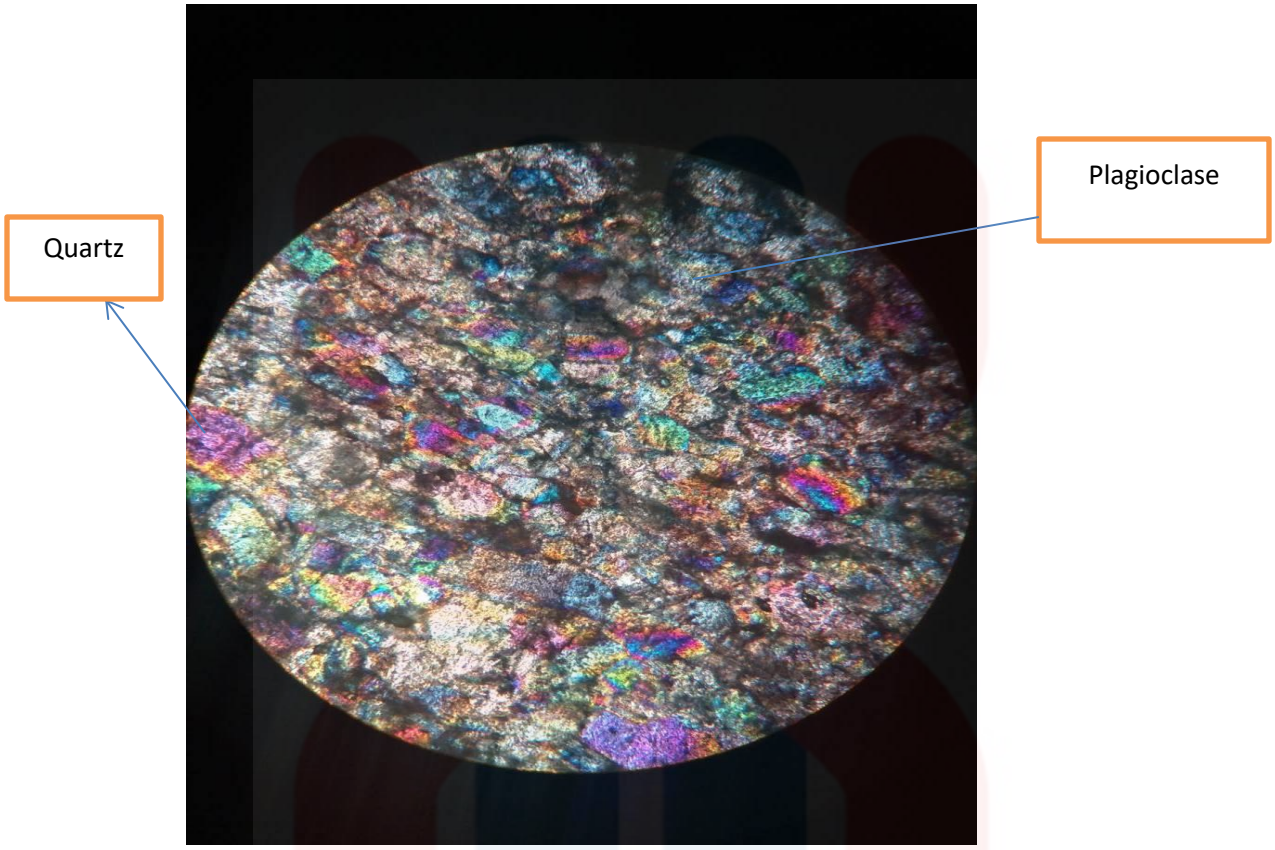
Under the microscope, gneiss shows variable grains of minerals closely packed preferred orientation. It display an even texture through individual grain are irregularly shaped. The major mineral observed is quartz, biotite, hornblend and plagioclase. The feldspar observed is plagioclase and occur as colourless mineral, which is subhedral to euhedral in shape. Quartz occurs as colourless mineral, anhedral in shape. For biotite, it has form colour of brown and has strong paleochroism from brown to dark. It has

undergone parallel alligment with the light colour mineral such as quartz and plagioclase.

Figure 4.15 show the plane polarized light (PPL) and under cross polarized light (XPL).



a) Cross polarised light of thin section



b) Plane polarized light of thin section

Figure 4.15 Analysis of thin section

4.4 Structural Geology

4.4.1 Lineament analysis

Lineament are defined as mappable linear surface features, which differ clearly from the pattern of adjacent and probably reflect subsurface phenomena. The subsurface effect is controlled by geological structures such as stream channels or human effect (roads, field boundaries) can also exist in the region (Gulcan Sarp, 2005). From data collected in Figure 4.16, a rose diagram is present as Figure 4.17. the rose diagram show the maximum force N 60° E and the minimum force is N 30° W.

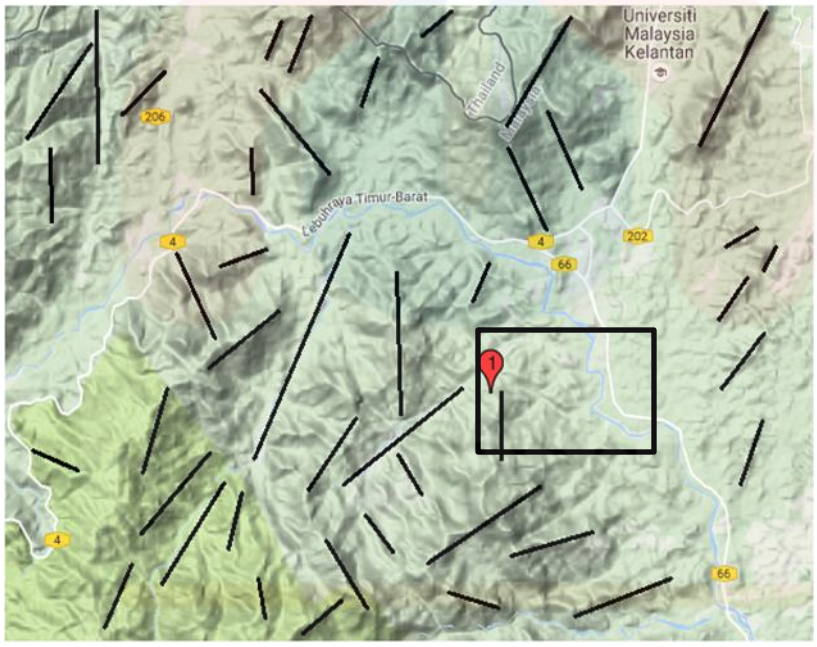


Figure 4.16 Lineament map

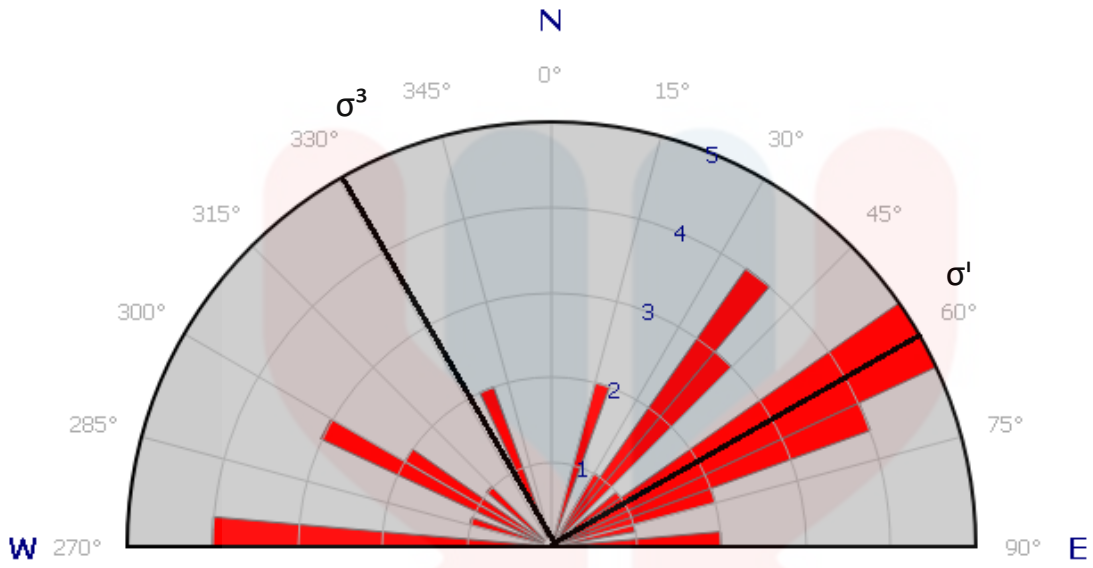


Figure 4.17

4.4.2 Joint analysis

Joint is the same geological fracture as fault. The only different between faults and joints is a short, straight and typically there in little to ni lateral movement across joint, whereas faults do, joints are the most common geologic structure that can form in many variety ways.

Joints ususally recorded to see trends for interpretation later. Joint system can be used to describe the final direction of the force acting on the study area. There also joints that filled by the other material such as filled by quartz, vein and etc. Joints exist in various types of rocks but most obviously in igneous rock. The strike data from each unit of rock

joints was plotted in the form of rose diagram for the analysis of force direction (Zainol *et al*, 2010). At the study area, one point of strike data of rocks along Sg, Rual was taken to do the joint analysis of study area. The coordinate of the point is N 05° 40’ 52.2”, E 101° 50’ 10.7”. Then all the data were inserted into software Georose in order to plot rose diagram and from the diagram, direction of deformation can be identify as shown in Figure 4.18. The maximum force for this diagram is N 55° W and the minimum force is N 35° E.

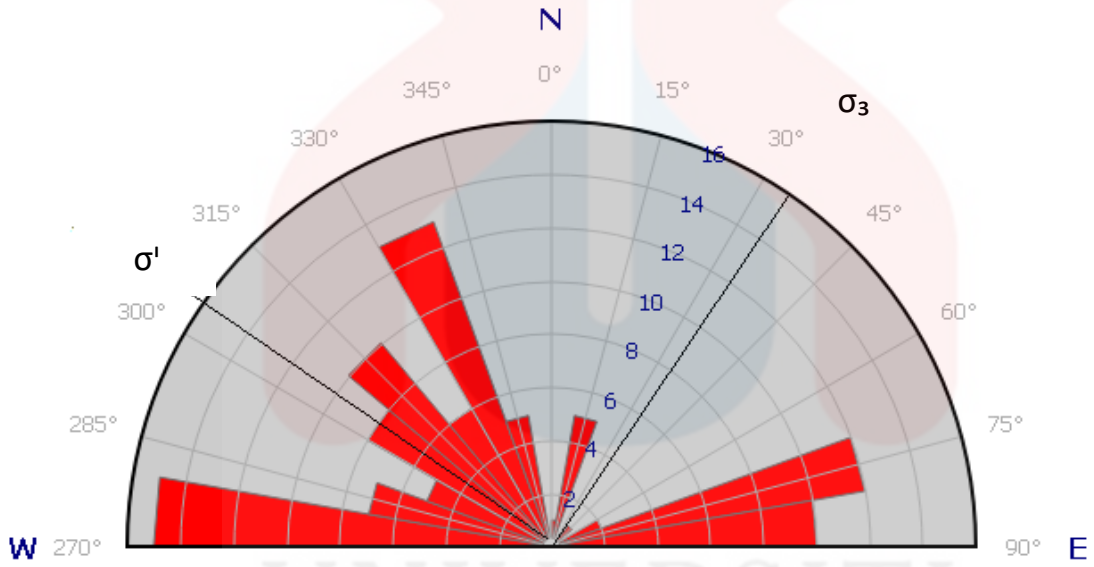


Figure 4.18 Rose diagram of joint analysis

CHAPTER 5

5.1 Introduction

This study was carried out to determine the Pergau River water quality. Water samples were collected from 5bstations along the river and analyzed using standard methods. The results showed that temperature, pH, conductivity, TDS, turbidity, electric conductivity, total dissolve solid and total suspended solid by NWQS, Malaysia. Statistical analysis of data was fulfilled using SPSS version 20. Analysis of variance (ANOVA) was carried out to determine the significant differences between sampling stations.

5.1 Result and discussion

a) water quality

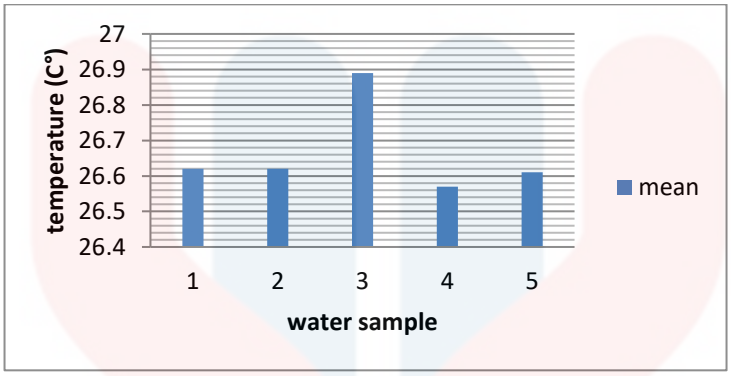
Based on the result, the highest temperature of the sample on the location 3 and the lowest temperature on the location 4. Generally, many factors such as the weather condition, sampling time, and location impact on the increase or decrease of temperature by which its role effect on the percentage of dissolved oxygen, biological activities, and other parameters .

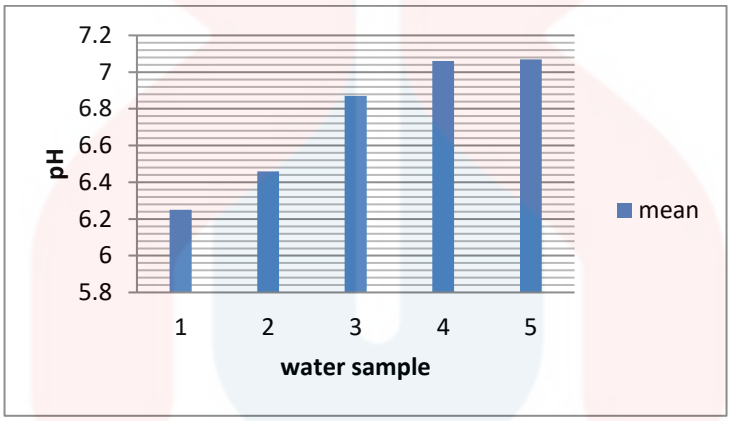
For total dissolve solid (TDS) result all location have a nearest result. The result for electric condutivity, sample 3 has a highest reading 59 µs and the lowest is sample 1, 53.30 µs. The electrical conductivity of the water depends on the water temperature, the higher the temperature, the higher the electrical conductivity would be. The electrical conductivity of water increases by 2-3% for an increase of 1 degree Celsius of water

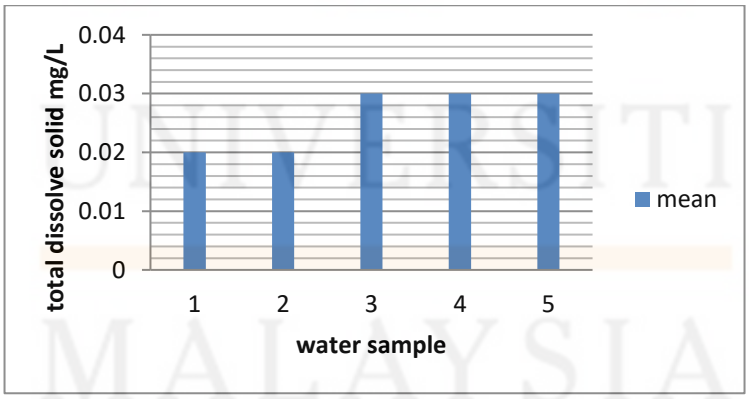
temperature. Normally, conductivity in the water was affected by the inorganic dissolved solids such as calcium, chloride, aluminum cations, nitrate, sulfate, iron magnesium, and sodium. On the other hand, organic compounds such as oil, alcohol, phenol, and sugar that can influence the water conductivity as well as the temperature also have an effect on the conductivity (Ahmad *et al.*,2009)

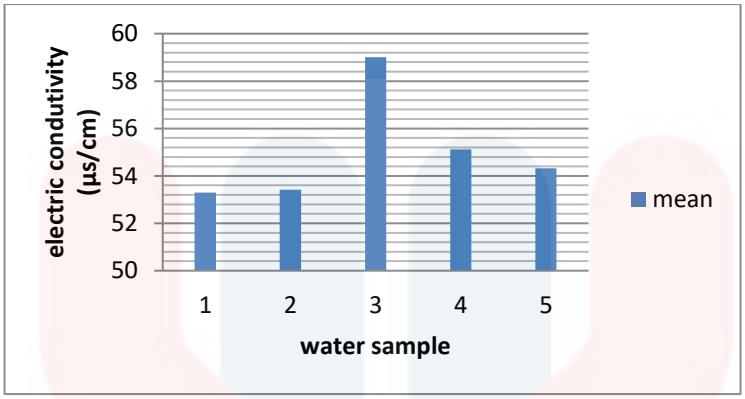
Turbidity for water sample 1 has a highest reading and the water sample 3 has a lower reading. The water sample 3 are taken after a active sand mining area hence has highest reading of turbidity. Turbidity is resulted from the presence of suspended particles such as silt, plankton, clay, organic matter, and other microscopic or decomposers organisms. The murkier water in general was ascribed to the higher amount of sediments. This can also be the indicator of a high measured turbidity, and stream flow, surface runoff, and overland flow in natural waters also increase the turbidity levels in the water.

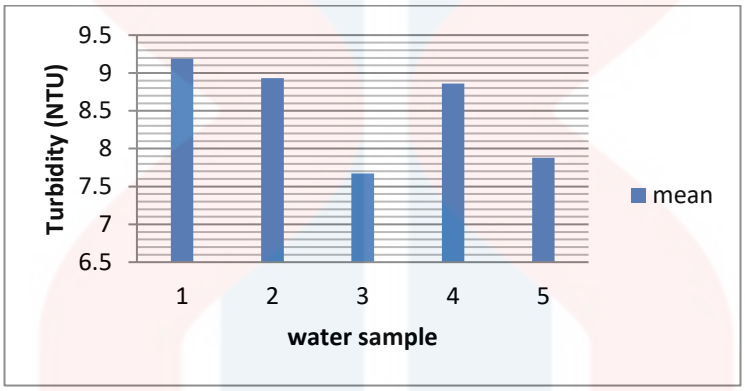
The total suspended solids (TSS) values of water sample ranged between minimum 4.04 mg/L of water sample 1 and maximum 5.22 mg/L of water sample 4. Normally, soil erosion considers the source for suspended solids that comes from the surrounding area caused by human activities Table 5.1 show the result by using SPSS version 20 for mean water quality based on all parameter. Figure 5.1 show the result by graph.











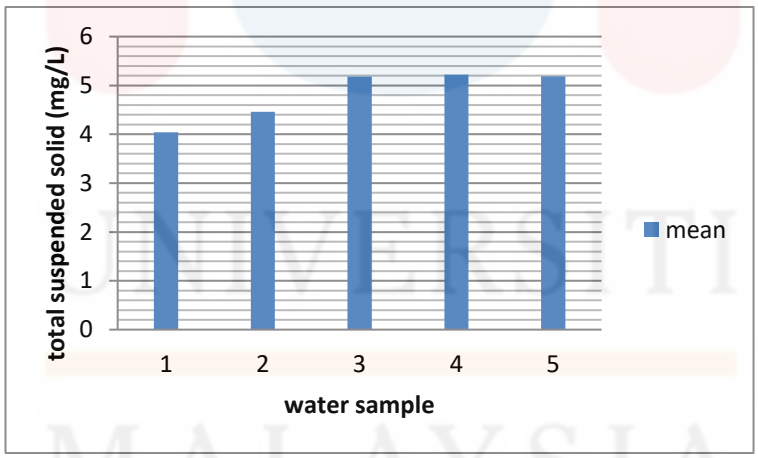


Figure 5.1 Bar diagram of the result

	No. Sample	N	Mean	Std deviation
Temperature	1.0	3	26.62	0.02
	2.0	3	26.62	0
	3.0	3	26.89	0.01
	4.0	3	26.57	0.02
	5.0	3	26.61	0.01
	Total	15	26.67	0.12
pH	1.0	3	6.25	0.005
	2.0	3	6.46	0.05
	3.0	3	6.87	0.08
	4.0	3	7.06	0.04
	5.0	3	7.07	0.02
	Total	15	6.74	0.34
TDS	1.0	3	0.02	0.002
	2.0	3	0.02	0.002
	3.0	3	0.03	0
	4.0	3	0.03	0
	5.0	3	0.03	0
	Total	15	0.02	0.001
EC	1.0	3	53.30	0.55
	2.0	3	53.42	0.1
	3.0	3	59.00	0.79
	4.0	3	55.12	0.19
	5.0	3	54.32	0.17
	Total	15	55.03	2.19
Turbidity	1.0	3	9.19	0.17
	2.0	3	8.93	0.17
	3.0	3	7.67	0.13
	4.0	3	8.86	0.14
	5.0	3	7.88	0.13
	Total	15	8.5	0.64
TSS	1.0	3	4.04	0.05
	2.0	3	4.46	0.18
	3.0	3	5.18	0.21
	4.0	3	5.22	0.1
	5.0	3	5.19	0.01
	Total	15	4.82	0.51

Table 5.1

b) Heavy metal

Mean metal concentrations in water (dissolved metal) from the 5 sampling stations in Sungai Pergau are summarized in Table 5.2. Based on table results show that mean dissolved in water sample 1, for Fe (mg/L), the concentration are 0.01, Zn 0.2, Al 0.004. For the sample 2, the mean concentration for Fe 0.01, Zn 0.96, Al 0. The mean conncentration for sample 4 are Fe 0.01, Zn 0.21, Al 0.003 and the mean concentration for water sample 5 are Fe 0.001, Zn 0.07,Al 0.001. For the water sample 3, all parameter not contain in the sample and parameter for manganese also not contain in all the water sample. All the result is using mg/l as a unit.

Metal concentrations in the water and sediment are good indicators of the degree of river contamination. n. Metal concentrations in the water were compared with the Malaysian Water Quality Standard (NWQS) (DOE 2010) . Results show that for Fe, Mn, Al and Zn, concentrations in the water were low and within the range of natural concentrations.

	No. Sample	N	Mean	Std deviation
Iron	1.0	3	0.01	0.01
	2.0	3	0.01	0.001
	3.0	3	0	0
	4.0	3	0.01	0.01
	5.0	3	0.001	0.001
	Total	15	0.004	0.007
Manganese	1.0	3	0	0
	2.0	3	0	0
	3.0	3	0	0
	4.0	3	0	0
	5.0	3	0	0
	Total	15	0	0
Zinc	1.0	3	0.2	0.03
	2.0	3	0.96	0.01
	3.0	3	0	0
	4.0	3	0.21	0.02
	5.0	3	0.07	0.005
	Total	15	0.11	0.08
Aluminium	1.0	3	0.004	0.003
	2.0	3	0	0
	3.0	3	0	0
	4.0	3	0.003	0.001
	5.0	3	0.001	0.001
	Total	15	0001	0.002

Table 5.2

CHAPTER 6

6.1 Conclusion

The present research is part of the basic degree with title 'Geology and geochemistry of water discharge from sand minint at Jeli, Kelantan'. This study focuses mainly geological mapping, to identiy the heavy metal contain and water quality in river of Jeli. For this study the three objective were selected to achieve this research.

An update geological map of study area is produced, which show two type of rock, gneiss and granite. Granite rock cover almost 70 % of study area and 30 5 was covered by gneiss. This objective give the additional knowledge about the geological history of Kelantan state.

The physical properties for water of river at Jeli especially Pergau river is totally clean and it depend on the pH value and TDS contain in water of river. The pH is high frequency of rainfall in this study area. The soil type is one of the factors that make the TDS become high. Based on the table by National Water Quality Standard of Malaysia (NWQS), water of Sungai Pergau in class I which means it suaitable for user and practically no treatment need when user want to used it. The result show that the method used in this research is suitable to achieve the objective state. For the laboratory result can be 85 % accurate because it has some error during run the experiment.

6.2 Recommendation

The recommendation for the further study can be useful with the help of exploration of aerial support such as by drones to easily observe and save the time to

interpreted geological structural data. This method can make student apply the new techonolgy in practically. Besides that, for the accurate results, the method can be change by using another method such as atomic absorption spectroscopy (AAS). By using this method, the parallax error can be reduced.

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