GENERAL GEOLOGY AND DISTRIBUTION OF METAL DEPOSIT IN STREAM SEDIMENT JELI, KELANTAN

by

MUAMMAR QARDHAWI BIN ABDUL RASHID

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DECLARATION

I declare that this thesis entitled "General Geology and Distribution of Metal Deposit in Stream Sediment Jeli, 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 : _____

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General Geology and Distribution of Metal Deposit in Stream Sediment Kampung

Telok Bayu, Jeli, Kelantan

ABSTRACT

The study of general geology and distribution of metal deposit in stream was covered 25km per square at Kanpung Telok Bayu, Jeli, Kelantan. General geology covered stratigraphy, geomorphology, structural, and historical and produced geological map scale 1:25 000. The geochemistry method are apllied in this research to find the distribution of element Zinc (Zn), Silver(Ag), Lead(Pb), Copper(Cu) and Gold (Au). The sampling are taken at eight different up stream. The Inductive Couple Plasma (OES) machine are used to analysed the sample.The result of the analysis are present in form of anomalies map by used Arc-GIS 10.3.

Geologi Am dan Taburan endapan besi dalam aliran sedimen di Kampung Telok Bayu, Jeli, Kelantan

ABSTRAK

Kajian geologi umum dan taburan endapan besi dalam aliran sedimen seluas 25km s persegi di Kanpung Teluk Bayu, Jeli, Kelantan. Geologi umum membincangkan stratigrafi, geomorfologi, struktur, dan sejarah dan dihasilkan skala peta geologi 1:25 000. Kaedah geokimia digunakan dalam kajian ini untuk mencari taburan unsur Zink (Zn), Perak (Ag), Plumbum (Pb), Tembaga (Cu) dan Emas (Au). Persampelan diambil di lapan aliran yang berbeza. Mesin Inductive Couple Plasma (OES) digunakan untuk menganalisis aliran sedimen. Hasil analisis dibuat dalam bentuk peta anomali menggunakan Arc-GIS 10.3.

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GIS	Geographic Information System
OES	Optical Emmission Spectrocopy
Au	Gold
Ag	Silver
Cu	Copper
Pb	Lead
Zn	Zinc

CHAPTER 1

INTRODUCTION

1.1 General Background

Peninsular Malaysia has already known by foreign country as "Golden Peninsular" and Malaysian already got the attention worldwide before other main country that produce gold and precious metal fields such as South Africa, Australian and USSR .The rich of economic mineral in Malaysia also help development of economic Malaysia. In 2009 only, Malaysia has produce 2.79million gram of raw gold. This included Pahang state, Kelantan and Terengganu (Tse, 2009). In additional, Malaysia's gold reserves was estimated 106.000 ton and listed as one of the country that has highest reserved. Malaysian land also rich in precious metal.

Gold can be found mostly in the central belt of Malaysia start from Northern Jeli downward to south of Gunung Ledang, Johor (Mahat et.al, 2013). Meanwhile the west belt is known as tin belt and to east belt is commonly known as tin and gold belt. Gold

has been mined mainly in the central part of Malaysia, for example Penjom and Selinsing located in Pahang state and Ulu Sokor in Kelantan.

Geochemical analysis will be applied in this research. This study will focus on specific economic mineral which is gold (Au), lead (Pb), Zinc (Zn), Silver(Ag), and Copper (Cu). The outcome of data analysis will give distribution of anomaly in study area. The idea of this study is to gain more understanding of gold and metal deposit in stream sediment specifically in Kelantan state region.

Through a time, the gold mining industry are well develop with new modern and bigger scale such as open pit gold mined. In Raub, Selinsing, Kerchau-Tui, Pulai, Rubber hill, Buffalo Reef, and Tersang are example of new goldfield (Fig.1). These all goldfield located at the old alluvial deposit. The central gold belt is a 20km wide and major N-S trend of gold mining area. This is because the area have a large type of hydrothermal fluids deposit in development and occurrence of gold in Central Belt. (Ariffin, 2012). The Penjom gold deposit and Selinsing gold mine are located 20km from central belt. It is also a zone a parallel steeply dipping N-S with several periods of reactivation.

Eventhough, the history of gold mining start to be exploited by other foreign people since Portugese era. There are thousand tonne of gold reserved still not been found. Mining company start to invest in Malaysia for example China company which manage gold mine at Ulu Sukor, Tanah Merah and Australia company manage the Penjom Goldfield, Kuala Lipis. The research hope the mining industry can contribute in Malaysia economy.

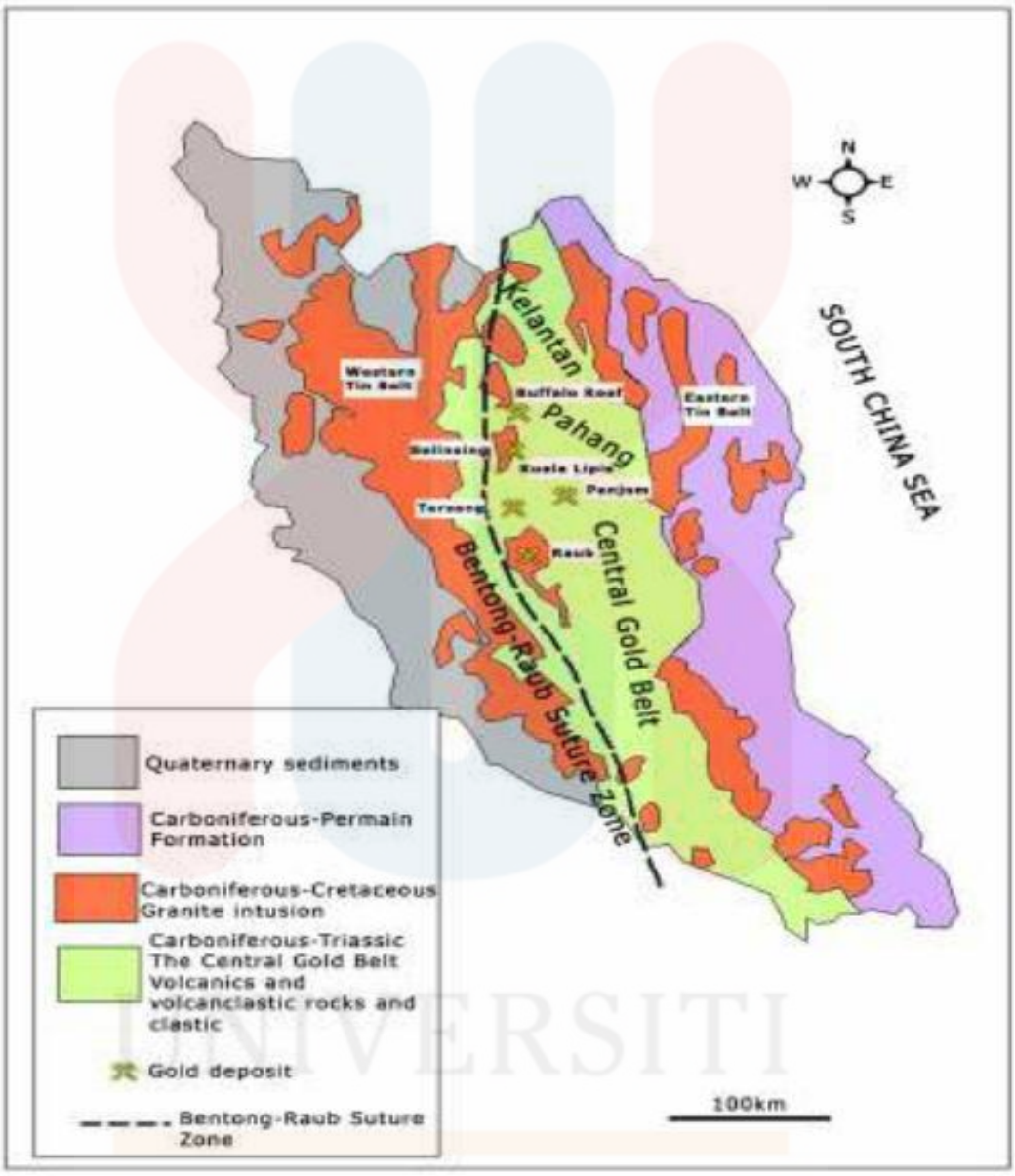


Figure 1.1:Central mineral gold belt of Peninsular Malaysia with major gold bearing deposits, Makoundi (2012)

1.2 Problems statements

The purpose of this research is to provide geochemical data analysis for metal deposits mineral. Based on previous research, the geochemical analysis has been done but does not have specific mineral. Alternatively, the study to explore, update and enhance geological data information from previous research such as structural analysis, sedimentology, hydrology and stratigraphy.

1.3 Research Objectives

Before a research can be conducted a researcher must have clear objective and understanding the problem from previous research. This will guide a researcher to keep in track before and after during the research in progress.

1 To produce a geological map of study area.

2. To analyse the distribution of metal deposit in stream sediment of study area.

1.4 Study area

This research will be conduct in Kg. Baru Telok Bayu, Jeli Kelantan.The research covered 5km×5km per square. From the previous research,The study area are located at west of Gua Setir Yeap (1993) it is known for primary gold prospects The location of study area are near to Kampung Baru Jalan Malaysia and Kampung Telok Bayu.The highest elevetion is 220m and lowest is 80m. In the study area has 4 main rivers which is Sungai Setir, Sungai Belahat, Sungai Maka and Sungai Chalang. The distance from Jeli town to study area approximately 2km.

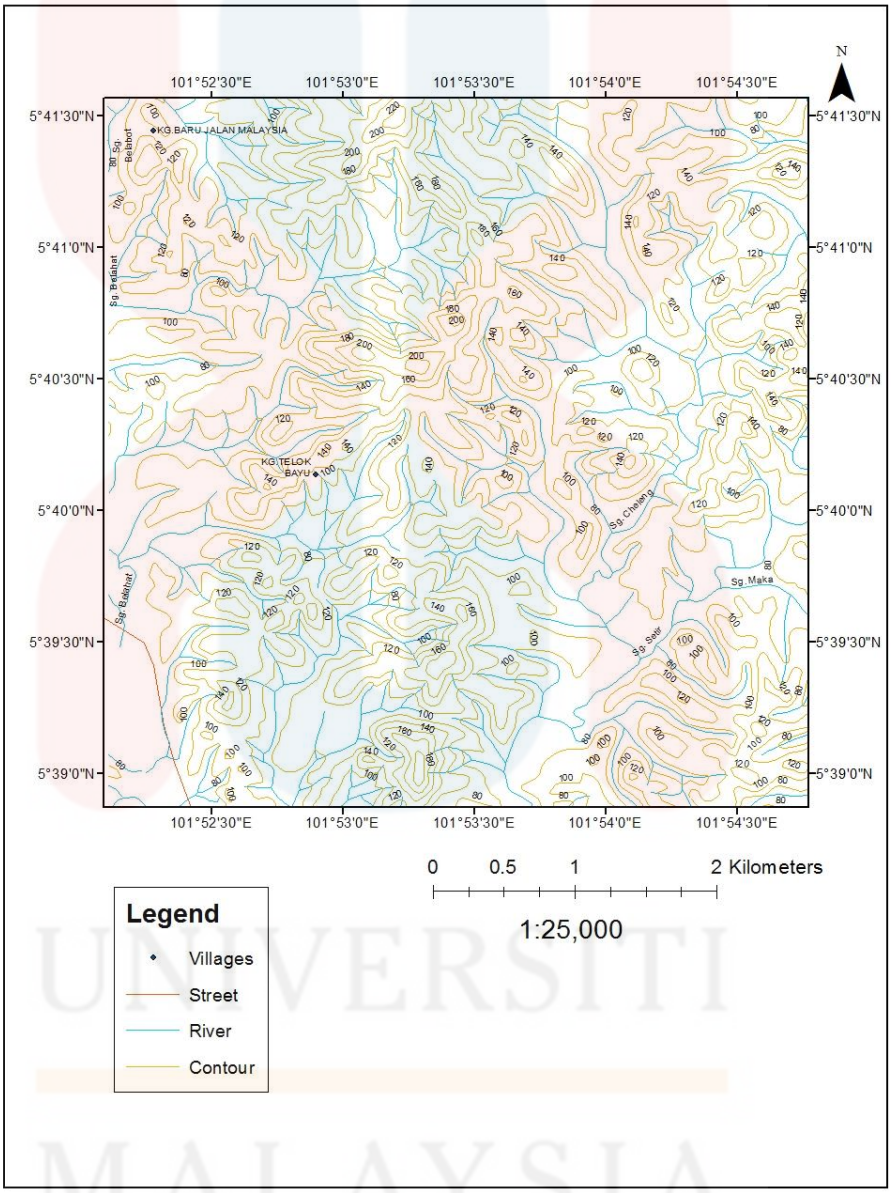


Figure 1.2: The base map of Kg Telok Bayu, Jeli , Kelantan

1.4.1 Geography

The geography part basically will cover basic information such as human activities, road, economic of people, building and climate. The researcher will observed the surrounding area of study area.

1.4.2 Demography

In the study area, the population distribution are included Malay, Chinese, India, other Bumiputera, none Malaysian citizen and others. All these made up total 33,186 peoples only. The Jeli district only have 10 small town or village which is Air Lanas, Batu Melintang, Berdang, Bukit Lakota, Gemang, Jeli, Kalai, Kuala Balah, Tunku Abdul Rahman. The total Malay and Bumiputera is 32,126 peoples only. Chinese are 91 peoples. Indians are 58 people. Others are 21 and none citizen890 people

Table 1.1: Total population by ethnic group, Local authority area and state

Jajahan/ Kawasan Pihak Berkuasa Tempatan *Jajahan/ Local Authority Area*	Jumlah *Total*	Warganegara Malaysia *Malaysian citizens*							Bukan Warganegara Malaysia *Non-Malaysian citizens*
		Jumlah *Total*	Bumiputera			Cina *Chinese*	India *Indians*	Lain-lain *Others*	
			Jumlah *Total*	Melayu *Malay*	Bumiputera lain *Other Bumiputera*				
M.D. Kuala Krai	**63,575**	**61,069**	**56,164**	**56,113**	**51**	**3,952**	**847**	**106**	**2,506**
Kuala Krai & Guchil	15,503	15,147	12,077	12,063	14	2,784	232	54	356
Kuala Pahi	377	376	366	366	-	10	-	-	1
Kawasan selebih M.D. *Remainder of M.D.*	47,695	45,546	43,721	43,684	37	1,158	615	52	2,149
JELI									
M.D. Jeli	**33,186**	**32,296**	**32,126**	**31,606**	**520**	**91**	**58**	**21**	**890**
Air Lanas	3,271	3,203	3,190	3,189	1	1	8	4	68
Batu Melintang	2,383	2,374	2,362	2,270	92	10	-	2	9
Berdang	1,284	1,202	1,200	1,199	1	-	-	2	82
Bukit Lakota	608	606	606	606	-	-	-	-	2
Gemang	1,047	1,038	1,038	1,038	-	-	-	-	9
Jeli	3,810	3,735	3,687	3,685	2	38	9	1	75
Kalai	1,033	1,006	1,005	1,005	-	1	-	-	27
Kuala Balah	-	-	-	-	-	-	-	-	-
Tunku Abdul Rahman	2,939	2,908	2,903	2,899	4	5	-	-	31
Kawasan selebih M.D. *Remainder of M.D.*	16,811	16,224	16,135	15,715	420	36	41	12	587

1.4.3 Land Use

Land used is define as the human activities or building in order for better life. In study area, almost 80% are used for agriculture activity. Example agricultures is rubber tree plantation, bananas tree plantation and palm plantation.

Figure 1.3 rubber plantation

1.4.4 Road Connection / Accessibility

The study area are located in rural area of Jeli. It's located approximately 7km from main highway of East-West highway .The type of road connection are paved and unpaved road. This the only road that can access to study area.

Figure 1.4: The paved and unpaved road in the study area

1.4.5 Social

Based on observation ,the social in study area is most of villager are farmer. This is because the surrounding area are cover with argriculture activities. The cafe and mini grocery shop are also had in study area.

Figure 1.6 : The small café shop and house in study area

1.4.6 Rainfall

Kelantan has a tropical climate, with temperatures from 21 to 32 °C and intermittent rain throughout the year. The wet season is the east-coast monsoon season from November to March which develops in conjunction with cold air outbreaks from Siberia produce heavy rains which often cause severe floods along the east coast states 8 of Kelantan, Terengganu, Pahang and East Johor in Peninsular Malaysia, and in the state of Sarawak in East Malaysia. During this season, most states experience monthly rainfall minimum (typically 100 - 150 mm). The highest rainfall stated on January 2015 which is last year.

Table 1:2 The rainfall distribution from Jan 2015-March 2016

day (year 2015)	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Day (year 2016)	Jan	feb	Mar
1	0	0	0	0	0	0	0	0	1.5	14.5	0	1.7	1	5.6	0	0
2	0.5	2	0	0	0	3.5	0	0	0	1	0	2.3	2	2.3	7.2	0
3	0.5	2.3	0	0	0	0	0	0	0	0	25.9	26.5	3	0.5	13.8	0
4	0.5	1.7	0	0	0	0	0	0	0	0	0	2	4	1.5	24.8	0
5	0.4	0	0	0	0	0	0	0	16.5	0	0.5	0.4	5	0	16.9	1
6	0.1	0	0	0	0	0	0	0	27	8.5	13	7	6	0	10.7	0
7	46.6	0.2	0	0	0	0	0	0	0.5	0	0.5	6.2	7	0	1.5	0
8	61.7	0.3	0	0	0	0	0	0	0.5	0	5.3	36	8	0	0.5	0
9	15.9	2.5	0	0	0	0	0	0	27	19	0.2	1.8	9	0	0	0
10	5.2	0	0	0	0	10	0	0	0	0	0.4	0	10	0	0.4	0
11	0.1	0	0	0	0	4	0	0	33	0	11.9	0	11	0	1.1	0
12	0	0	0	0	0	12.5	0	0	7.5	0	0.7	10.6	12	0	0	0
13	0	0	0	0	0	0.5	0	0	2.5	13	0	2.4	13	0	1	0
14	1	0	0	0	0	0	0	0	0.5	0	0	0.5	14	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0.5	2.5	15	16	0	0
16	0	0	0	0	0	0	0	0	2.1	0	0.5	0	16	1.5	0	0
17	0	0	0	0	0	0	0	0	1.4	20.5	7.5	36.3	17	0	0.5	0
18	0.5	0	0	0	0	0	0	0	0	0.4	0.5	36.7	18	0	5	0
19	4	0	0	0	0	0	0	0	0	0.1	3.1	0	19	0	24.5	0
20	0	0	0	0	0	0	0	0	0	0	29.3	0	20	0.5	0	0
21	0	0	0	0	0	0	0	0	0	0	23.4	0	21	88.5	0	0
22	0	0	0	0	0	0	0	0	3.5	0	8.8	0	22	0	0	0
23	0	0	0	0	0	0	0	0	0.5	0	0.5	0	23	0	0	0
24	0	0	0	0	0	0	0	0	17.5	5.5	2.5	0	24	11.4	0	0
25	0	0	6.5	0	0	0	0	3.4	64	0	0.5	1	25	25.1	1	0
26	0	0	1	0	0	0	0	0.1	37.4	0.5	15.2	0.5	26	263.3	2.6	1
27	0	0	0	0	0	0	0	0.4	25.1	7.4	116.8	26.8	27	45.2	6.3	0.5
28	0.4	0	4.7	0	0	0	0	4.6	9.5	19.8	45	24.1	28	2.6	7.6	5
29	4.6	0	0	0	0	0	0	2.6	26	34.4	13.6	1.1	29	0.4	0.5	0
30	0	0	0	0	0	0	0	0.5	0.5	19.9	28.9	0	30	2.6	0	0
31	0	0	0	0	0	0	0	0	45	11.5	0	8.1	31	0	0	0
total rainfall	142	9	12.2	0	0	30.5	0	0	44	24	39.4	39.9	21	9.9	73.4	1

1.5 Scope of the study

The scope of the study is about Geochemsitry analysis on stream sediment. The study will be used the Atomic Absorption Spectrometry (AAS) and Colorimetry method to analyze the stream sediment.This study also covered other sub-discipline geology such as sedimentology, stratigraphy, structural geology and petrology. The study also concern about gold distribution in the study area.

1.6 Research Importance

The purpose of the study is to provide geochemical data analysis (qualitative) of percentage or anomaly concentration sediment in study area. The data will act as references for other researcher, state government and related party. It is improvidence if we do not exploite our precious economic mineral for sake of our country economic.

1.7 Chapter's Summary

Generally, this study will applied Geochemistry discipline as exploration method. The unique of mineralization in central belt and tropical wheater lead to high whethering process. Thus, the Geochemsitry method is recommended method for exploration precious mineral (Flectcher, 1999).Otherwise ,this study also update the change of geographical study area.

CHAPTER 2

LITERATURE REVIEW

2.1 Regional Geological and Tectonic Setting

Malaysia Peninsular was formed during collision between two plate tectonic. The result of collision had lift up the mountain range in central of Peninsular Malaysia which namely as Titiwangsa range. The east part of Malaysia as Indochina while the west part as Sibumasu. Bentong Raub suture zone is known as the major fault .It divide the peninsular into three belt. The has 15 to 20 km wide zone.It is strike North-South from the Thai border south to Raub, Pahang. According to (Almashoor, 1996) stated that at least 7 tectonic units .It comprise of schist and phyllite sequence , olistostrome and bedded chert with elastic intercalation and a serpentinite lens within the schist.

2.1.1 Structural Geology

The major fault in Peninsular Malaysia is Raub-Bentong suture zone and Lebir fault. These are fault that divide the peninsular into three longitudinal belts or terrane. The Raub-Bentong suture zone is strike N-S from the Thai border south to Raub and SSE into the straits of Malacca off Muar. It has 20km wide zone of deformed rocks. . The formation suture zone is the result of northwards subduction of the Palaeo-Tethys ocean

beneath Indochina in the Late Palaeozoic and the Triassic collision of the Sibumasu terrane with and the underthrusting of Indochina (Metcalfe, 2000).

The Lebir fault is strike NNW-SSE along Lebir river near to Manek Urai in Kelantan. This fault also occur near to granite batholiths east of Lebir river, western part boundary with Gagau formation and eastern part of Koh formation. (Tan, 2009). The fault zone is 10 km wide.Resulted of this fault turn rock into brecciated metasediment, falsered granites and mylonites.There are also formed slickensides on the fault surfaces. (Tan, 2009).

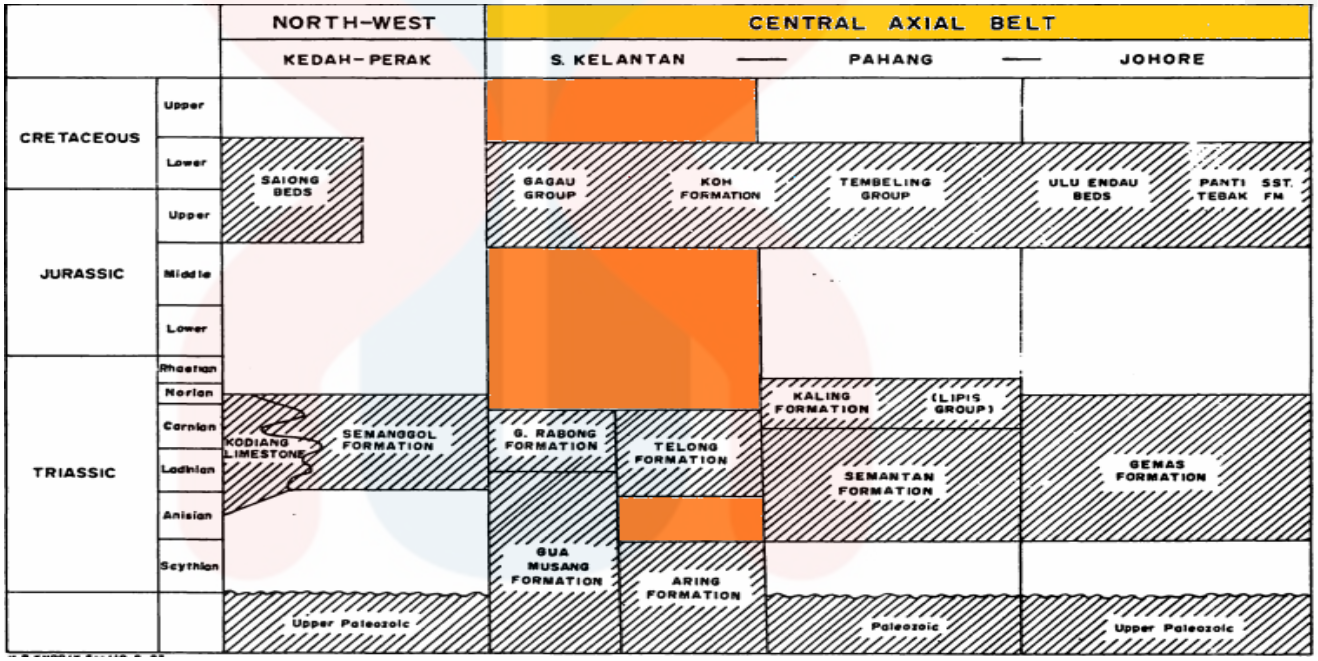
2.1.2 Hydrogeology

Malaysia is a country with humid tropical climate. Therefore, none of drainage system in Peninsular Malaysia has ever dried out. The frequent rainfall season keeps any water basin watered up. In Kelantan, the Sungai Kelantan, is the second longest river in Peninsular Malaysia after Sungai Pahang ,which comprises the entire state of Kelatan .It is flows from eastern flank of the Main Range, to the South China Sea at north. Geologically ,Sungai Kelantan is about 280 km long with the drainage basin of 11,922 km square. It become main river for tributaries in entire Kelantan (Tan, 2009)

2.1.3 Stratigraphy

Stratigraphy is a branch of geology which studies rock layers (strata) and layering. Based on previous research, there are one type of formation in my study area which is Telong formation.

Table 2.1 : Geological time scale for formation in Kelantan



Source (Peng, 1983)

2.1.3.1 Telong formation

The Telong formation consist of predominantly of argillite associated with tuffs in the Sg. Aring area in south Kelantan. It begin from west of Kelantan extend to south of Gua Musang. The age from Middle to Late Triassic (Peng, 1983). It is unconformable over the Aring Formation to the east and also probably overlain by the Koh Formation to the southeast and southwest. It is interpreted to be more than 1,000 metres thick. The type locality is along Sg. Telong after which the unit is named.

2.2 Gold and Metal Mineralization in Kelantan

Kelantan state is known as one of the state that rich in precious mineral resources such as iron ore, gold , barite, marble, feldspar granite and petroleum in bottom of ocean .It attracted investor around the world to exploited the value of economic mineral. Kelantan state contribute 10% of the annual gold production of Malaysia Gold mineralization in Kelantan mainly distributed in the central part of state, it is bounded by Stong Igneous Complex and Seting Granite on the west, Kemahang Granite in the north and Boundary Range Granite in the east(Fig2.3) (Goh Swee Heng, 2006).The gold mineralized at the rock age Permian-Triassic. Gold mineralization mainly occur in sedimentary-metasedimentary rock.. In Malaysia most of the gold are found on placer deposits.

Central Gold Belt is located in the north of Jeli downward to south at Mersing .In history of Mining industry stated that many mining located at the centre of central belt example Penjom, Selingsing, Raub and Buffalo reef all in Pahang state and Ulu Sokor in Tanah Merah. The unique of geological feature and process has mineralized many iron ore and gold. In central belt, geologist believe it dominated by gold mineralization (Ariffin, 2012). Thera are three type of gold mineralization in Kelantan which is hydrothermal quartz vein system, skarn and volcanogenic massive sulphide. The main factor of these mineralization is because the principle source rocks. The Permian-Triassic volcanic rocks that associated with sedimentary rock. The heating chamber that induced the hydrothermal fluid is the granitoid bodies that intruded under the volcanic – sedimentary rock Thus. the structure allowing the infiltration and deposition of gold. (Ariffin, 2012)

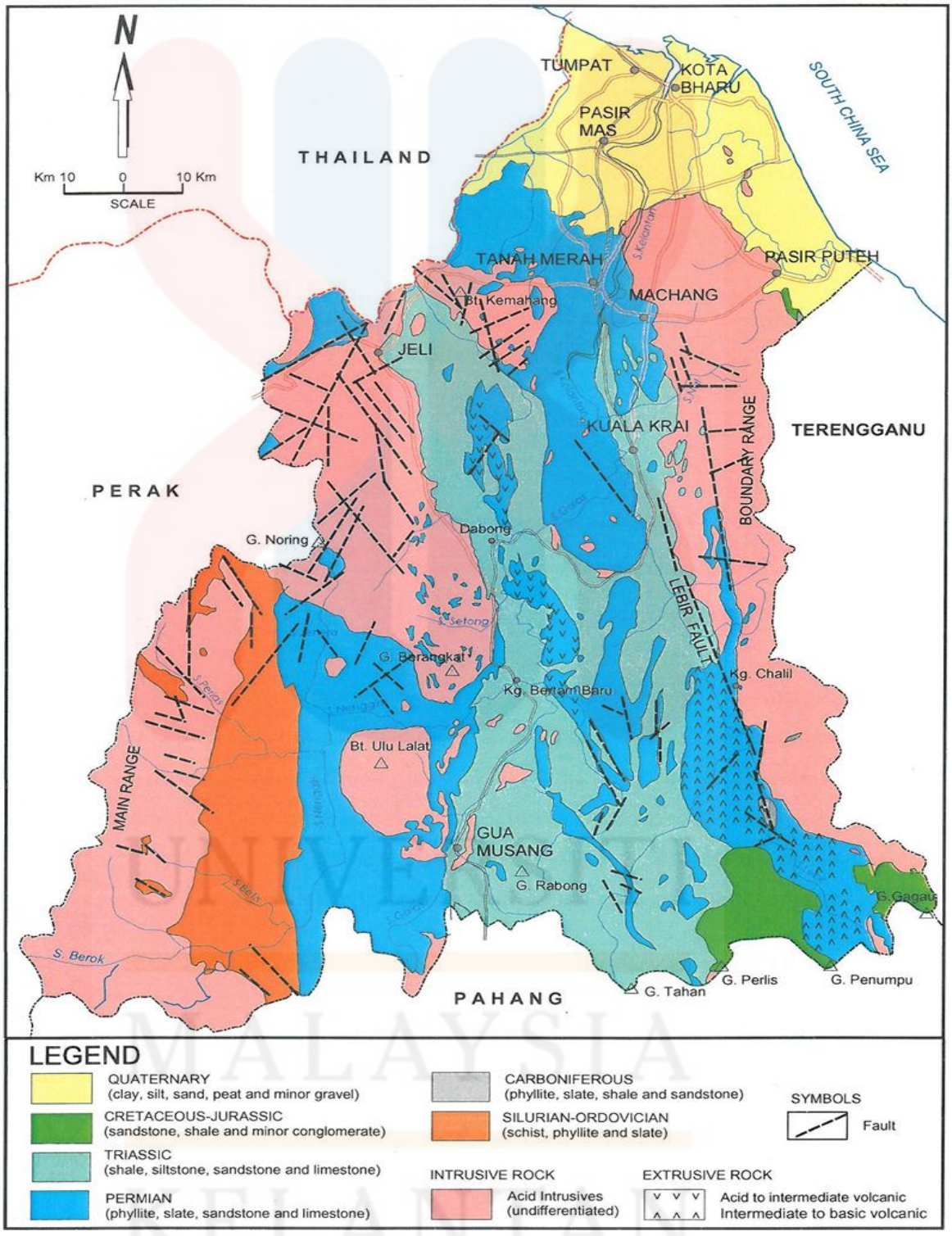


Figure 2.1 : The Geological map of Kelantan State from Department of Minerals and Geoscience Malaysia (2003)

2.3 Stream sediment

Stream sediment is one of exploration technique that are widely used method of mineral exploration in tropical rainforest. The stream sediment is known as the products of weathering and erosion upstream of the sample site and can thus detect anomalous concentrations of metals released from a mineral deposit within the drainage basin. (Flecther, 1999). Stream sediment also represent eroded bedrock that underlies the drainage basin whence the sediment came (Diggles, 1999)

The crucial understanding of stream sediment play important role in choose where to locate and take a sediment sample. There are many potential or strategic location has been recommended by other researcher. The range of sediment are active silt and fine to medium sand that has been transported and in active stream (Flecther, 1999).The factor need to consider before sampling is the catchment scale, bar scale and field sample. At the catchment scale, the enrichment of heavy mineral in stream sediments compared to soils .This is where clay-size particles from newly weathered regolith are rapidly flushed from the streambed by high frequent discharge condition. For bar scale , the heavy mineral element concentration are high on the streambed. The coarser fraction and heavy mineral element will deposit at low density. For the field sample, The heavy mineral element are finer than about 100 µm and it is less influenced by local hydraulic effects. Thus, it will best represent the catchment and consistent anomalous dispersion trains. The sample can be collected from high or low energy sites.

The potential or possible sediment to take is bar head, pools, riffles, below the boulder, between two river and river bed about 5 feet depth Otherwise, the samples are need to take at different stream order. All these factor need to consider because the gold will deposit at the bottom of riverbed.It has highest density which is 19.3 grams per cm3 and is so high relative to that of common minerals such as 2.6 grams per cm3 for quarts and feldspar. The running water will constantly flushed out the lighter mineral and leave behind concentration of gold and other heavier minerals.

CHAPTER 3

MATERIAL AND METHODOLOGIES

3.1 Introduction

This chapter discuss about a material and methodology that will carried out through this study. The list of material and equipment are obtained from laboratory. The methodology consist of preliminary research, data collection, data processing, data analysis and report writing. This chapter will be my guide during this research. The research flow has been planned in order to guide this study.

Research Flow Chart

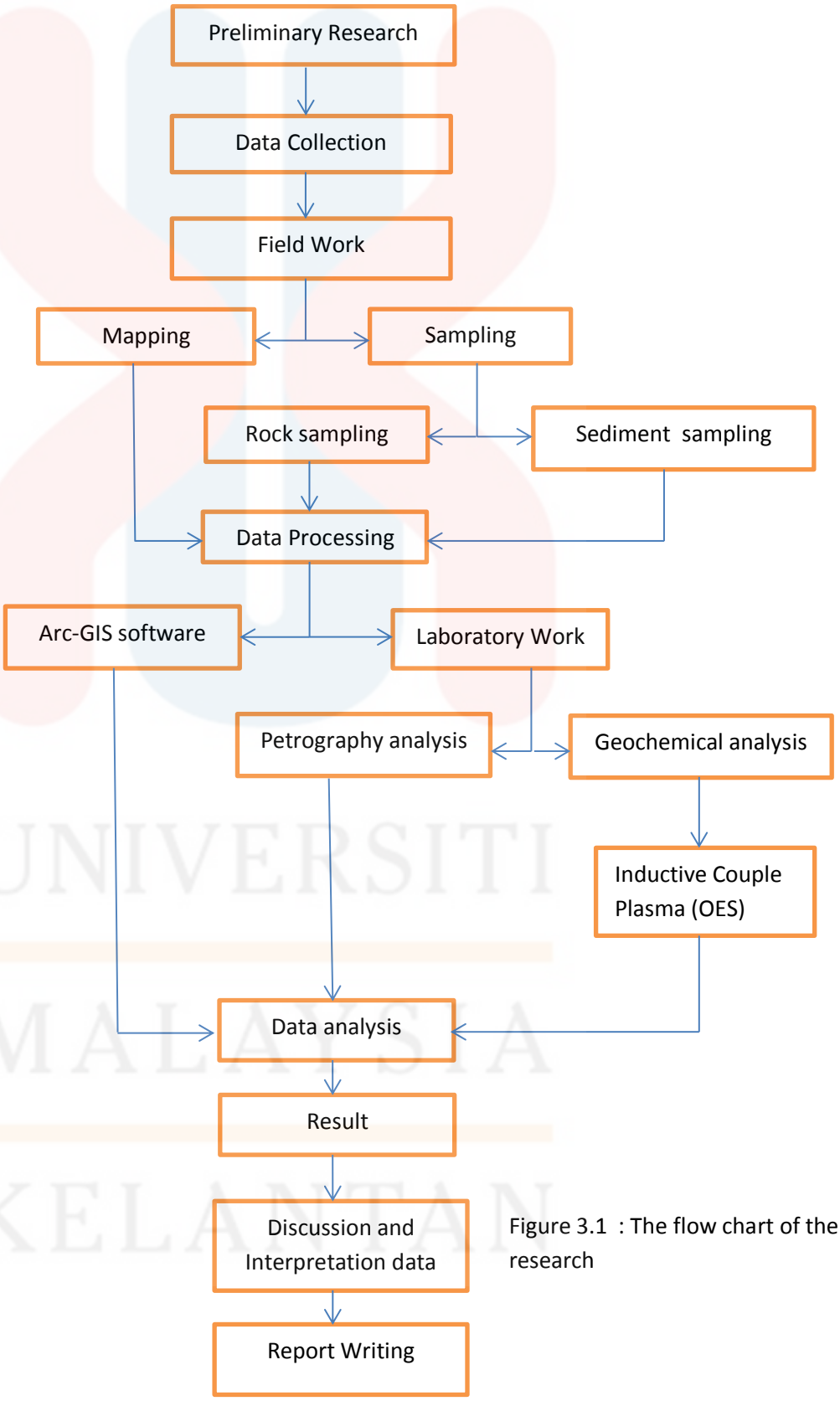


Figure 3.1 : The flow chart of the research

3.2 Preliminary Researches

The preliminary research stage is an important connection between pre-writing and formulating a thesis for researcher. This stage is characterized by many of the components of the pre-writing stage, such as gathering information from a variety of sources.

3.3 Material and Methods

This chapter discuss about a material and methodology that will carried out through this study. The list of material and equipment are obtained from laboratory .The methodology consist of preliminary research, data collection ,data processing, data analysis and report writing. This chapter will be my guide during this research.

3.3.1 Base Map

Base map is a map that provide Geologist about the geological data information such as main road, stream ,contour and landform.

3.3.2 Brunton Compas

Brunton Compass is used to help geologist read a base map. It will give direction towards our interest of locality. It also useful in structural analysis for example strike and dip reading.

3.3.3 Geological Hammer

Geological hammer can divide into two type. The pick-end hammer and chisel-end hammer. The pick-end hammer has a flat face on one side of the hammer head and a pick-end on the other. It usually very help in cracking rock in half especially for toughest rock like igneous and metamorphic rock. The chisel-end hammer provide striking surface than the pick-end and is suitable for opening up layers of sedimentary rocks.

3.3.4 Sample Bag

Sample bag is used for packaging the sample. It also easy to carry our sample to anywhere without loss original condition of sample.

3.3.5 Hand Lens

Geologists working in the field, lab or office often need to closely examine rocks, sediments, soils, sand, minerals and other materials with tiny features. A hand lens provides a quick and easy way to perform that work. It magnify a small mineral or rock that cannot be seen with naked eyes

3.3.6 Portable Geography Position System (GPS)

Geography Position System (GPS) is used to trek and mark our sampling or geological feature on a map.

3.3.7 Digital Camera

Camera is used to capture the outcrop or geological feature in order to document and write a report.

3.3.8 Measuring tape

Measuring tape is used to measure the size of outcrop or geological feature.

3.3.9 Paper Mark

Paper mark is used to label the sample. It helps geologist do their work well organized.

3.3.10 Gold Panning

Gold panning is a form of placer mining and traditional mining that extracts gold from a placer deposit using a pan. It is a cheapest find gold.

3.3.11 Polarising microscopy

A thin section is made by grinding down a slice of rock which has been glued to a glass slide until it reaches a thickness of about 0.03mm (30 microns). At this thickness most minerals become more or less transparent and can therefore be studied by a microscope using transmitted light.

3.3.12 Geological Mapping

The Geological mapping is the basic practical or outdoor work for geologist. A geologist will used all their knowledge in theory will turn in practical way. During geological mapping, a geologist will do collecting data, observed, determine the distribution type of rock and predict the tectonic setting in she study area.

3.3.13 Sediment Sampling

In this study, we focus on stream sediment as our sample. Therefore, before sampling process start the researcher need to plan and locate first on the map where a sample need to take. This technique is recommended by (Ab Halim bin Hamzah, 2003).

Step 1- The sample location need to mark on the map first. Each sample located in between 1.5km2 to 2km2.

Step 2- The sample will take only in 1 to 3 river order. The 4 order river no need to take because high erosion.

Step 3 - Silt sample are taken at the active and high energy river only. Sediment can take by hand or tools that made up of iron. The distance from each sample are 10 m to 30 m along sampling location. Polluted sediment such as wasted from river cliff, road, and factory try to avoided.

Step 4- One sample are collect for each location. The sample weight around 300-400g to get 60g after being filter.

Step 5- The sample are label and bring to laboratory for next procedure.

3.3.14 Rock Sampling

Rock sampling is used for petrographic analysis. The petrographic analysis where Geologist cut the rock into thin section. After that. the thin section will observed and analyse under polarising microscopy .A Geologist can determine precisely by the mineral that made variety of rock.

3.4 Field Studies

The field of this study is Geochemistry. Goldschmidt had stated that the geochemistry is the study of the distribution and amounts of the chemical elements in minerals, rocks, soils, water, and the atmosphere, and the study of the circulation of the elements in nature, on the basis of the properties of their atoms and ions. The professional applied this application of geochemistry to geological, economic, and environmental problems because it is very powerful tool, when properly applied by those trained in the interpretation of analytical results. The geochemical study is one of a method that used for exploration based on chemical properties of a naturally occurring material. The main purpose of geochemical study is to locate of geochemical anomalies or chemical pattern that can trace an occurrence of ore in the vicinity. The anomalies can divide into two. The primary anomalies and secondary anomalies. The primary anomalies due to apparent local variation in the original composition of the earth crust, impregnation of rock by mineralizing fluid and transported volatile element in gases form. While for secondary anomalies formed due to weathering of rock by gravity, moving water and glacial ice (Hawkes, 1957).

3.5 Laboratory Investigations

Data processing is the part where the sample will be undergo processing stage. The process included Arc-GIS software and geochemical analysis which is Colorimetry and Atomic Absorption Spectroscopy (AAS).All the analysis will be doing at University's Malaysia Kelantan laboratory.

3.5.1 Arc-GIS Software

The Arc-GIS software are used for making a base map, geological map ,topography map and 3D topography map and with drainage map a researcher can identify type of drainage pattern. It's help Geologist to construct a new geological map after site investigations and analysis .From the map , a researcher will present the result of the study by produce the map. For geochemistry study, at the end of study the percentage anomalies will present in form of map.

3.5.2 Petrographic analysis

The Petrographic analysis will cover analysis on thin section of rock by using Polarising microscopy. A Geologist can determine and examined the mineral inside of rock.

3.5.3 Geochemical analysis

This research will be using method Inductive Couple Plasma-Emission Optical Spectrocopy. It is one of the most powerful and popular analytical tools for the determination of trace elements in a myriad of sample types such sediment, soil and water (Jones, 2000)

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

The general geology provided general information of the study area. In this part, it will cover geological information such as topographic, drainage pattern and weathering process .These part are important for a Geologist before start the main study or do specification. It helps Geologist predict and expect what type of rock, type of landform, type of drainage pattern and tectonic setting of the study area. The topographic, geological information such as contour. What is the highest and lowest elevation on study area Geologist can predict. Other than that, a Geologist can plan where path can walk and help prevent from danger. The drainage pattern, from this data it can tell the weak zone of the area. Generally, stream will formed when there is a weak zone, But sometimes others factor also influenced the formation of stream such as structural geology and different type of rock. Otherwise, the weathering process. There are three type of weathering process which is physical, chemical and biological weathering. The rock that exposed directly by a sunlight or weather has highly weathering occurrence. The physical weathering on rock we can see such as joint and fracture. This happen due to regional deformation. Meanwhile, for chemical basically

the surface of rock has changed from original colour to others colour and biological is where the above or on rock a plant or tree has growth within the fracture or joint of rock.

4.2 Geomorphogy

4.2.1 Topographic

The topographic of study area are almost 70% hilly area and 30% flat area. The highest elevation is 220m from sea level and lowest is 80m from sea level. The study area also has steep hill and moderate hill.

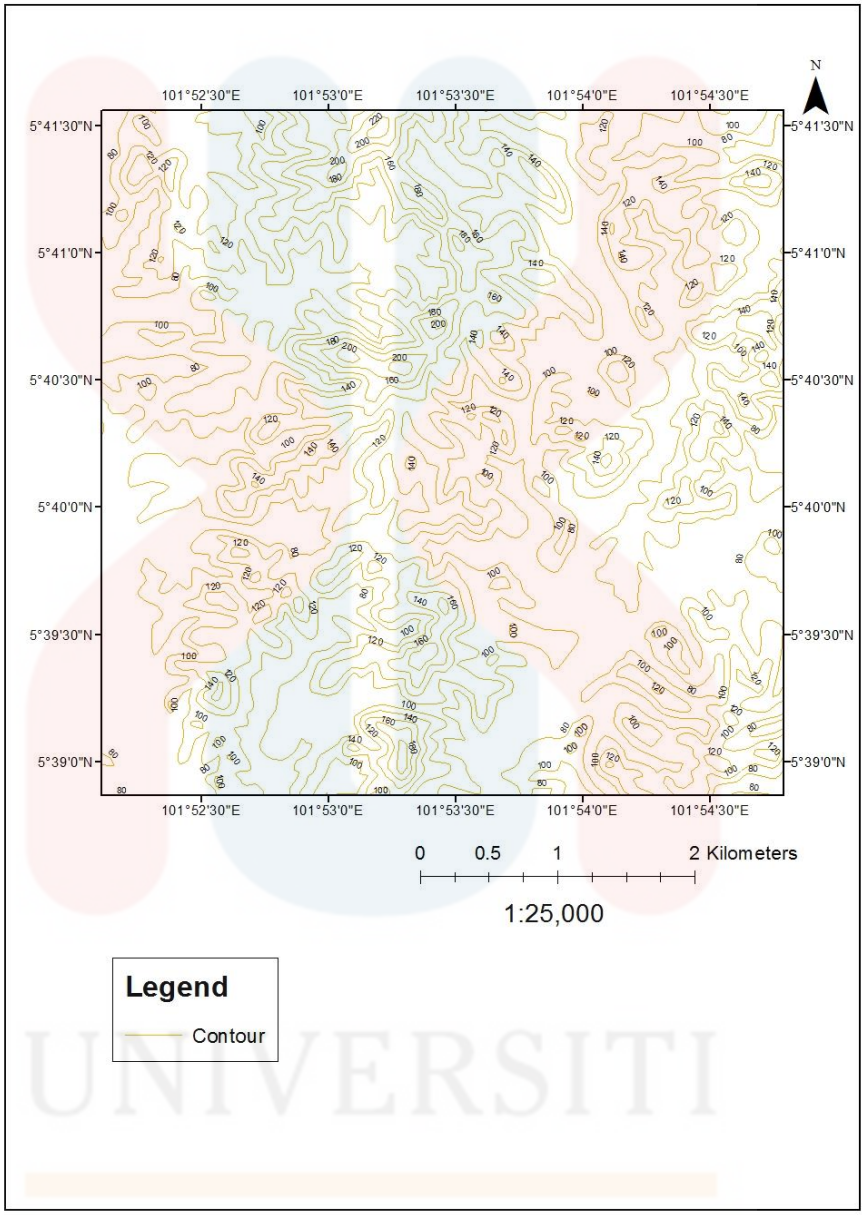


Figure 4.1 : Topography of study area

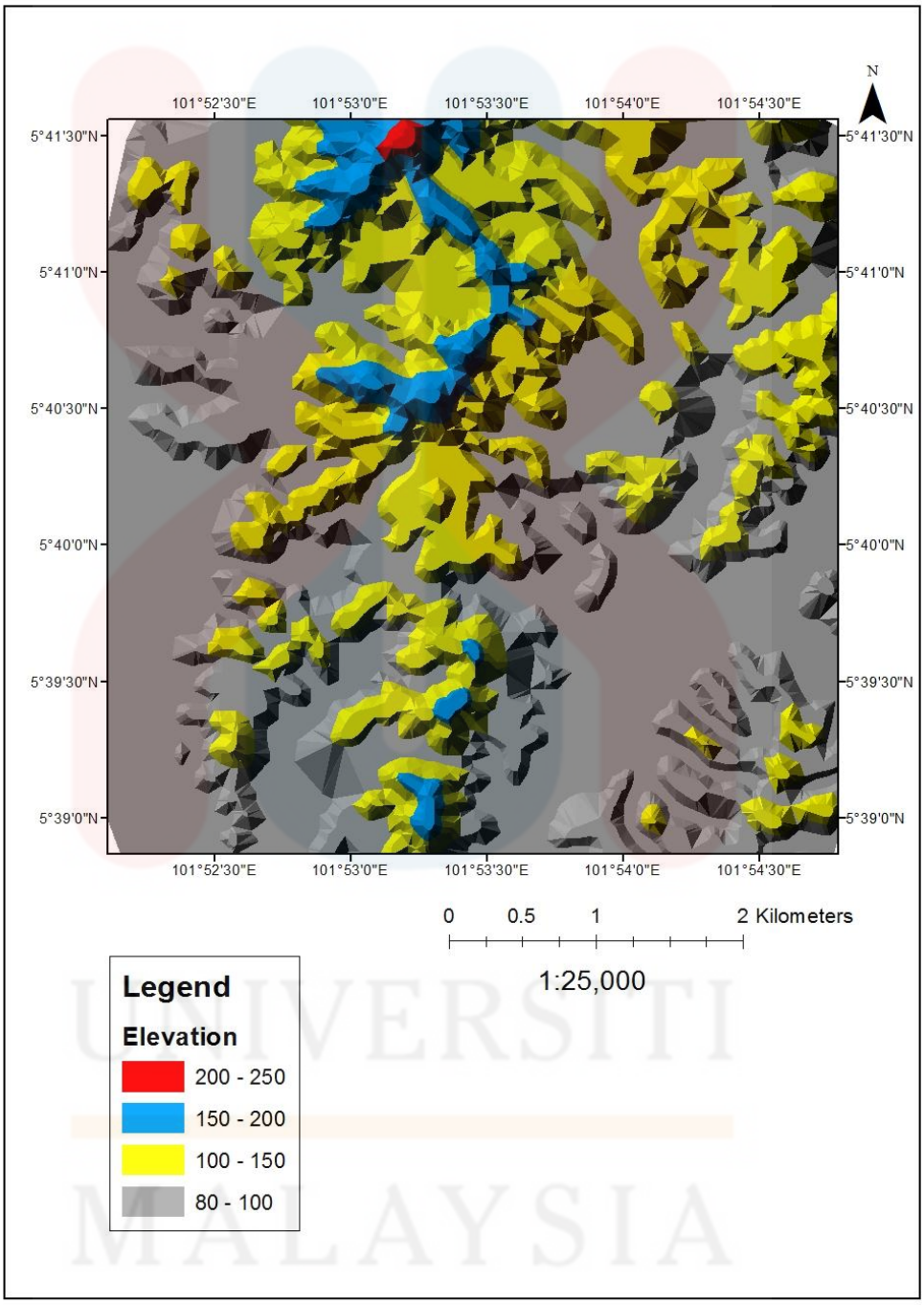


Figure 4.2: The 3D topography of study area.

4.2.2 Drainage System

The drainage pattern is a plan of a river system. The river that has been formed through particular geological process for example erosion, transportation and sedimentation within a period of time. The drainage pattern has varies pattern and it is very complex to determined which one a major river. There are directly or indirectly influenced by several factors such as the initial slopes over which the river flows, the difference in rock hardness ,lithological variation, structure of the area such folds, faults, joint lineation and bedding, the recent history of earth movement in the drainage area, the geological and geomorphological history of the area and lastly the climate and rainfall regime of the area. Some of the typical pattern existed is dendritic, parallel, rectangular, trellised, radial and annular pattern. All these pattern was formed by difference geological characteristic. A dendritic pattern, it is most common. This pattern are formed in basin drainage composed of homogeneous rock without control by the underlying geologic structure. A parallel pattern, it was formed in an area where the strata of sedimentary rock decline in the same direction and it channel area formed in the steepest direction. A rectangular pattern, it is formed if structural geology such fault or large joint are developed. A trellised pattern, is formed if the drainage basin composed of alternation of tilted hard and soft strata and it can also be paralled folding. A radial pattern, it appear on newly born volcano or an area composed of domed structure. A annular pattern, it was formed in an area with a dome structure. (Matsuda, 2004)

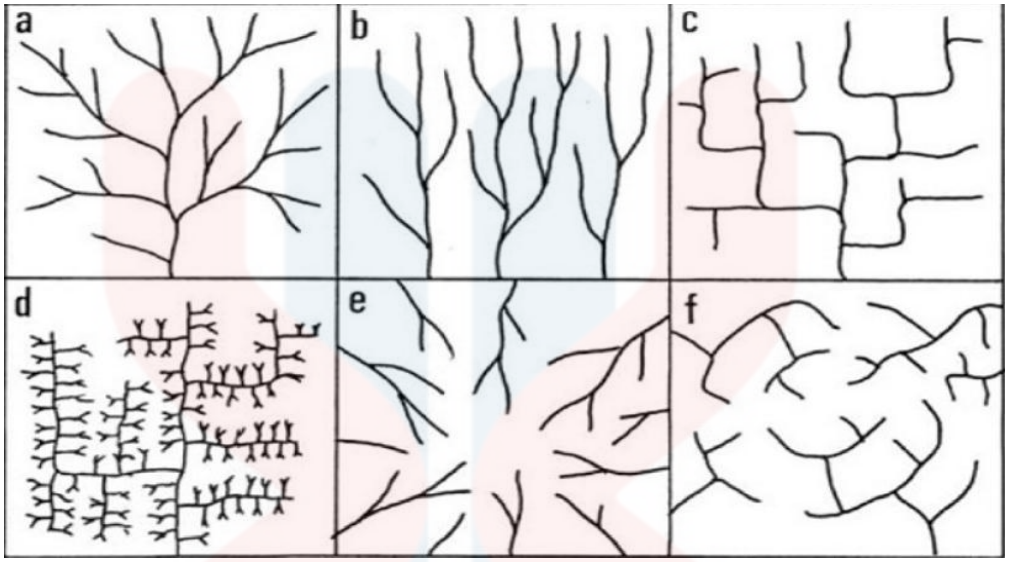


Figure 4.3: The figures show type of Drainage pattern a: dendritic; b: parallel; c:rectangular; d:trellised; e:radial; f:annular

After analysis and observation on drainage map, there are 4 type of drainage pattern can be identified in study area, it is parallel, dendritic, annular and radial drainage pattern. The figure 1.10 show the location of drainage pattern.

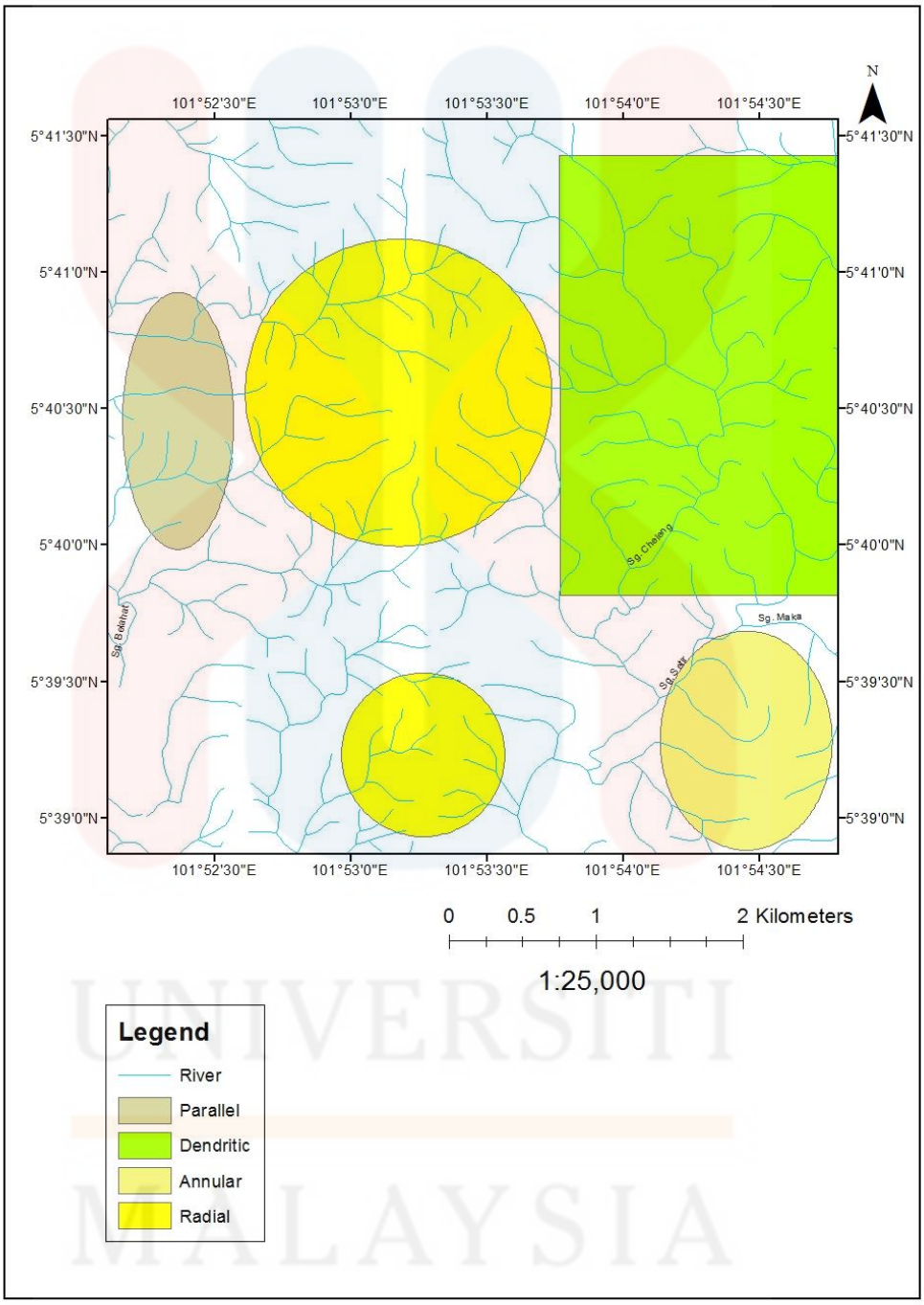


Figure 4.4 : The drainage pattern map of Kg Telok Bayu

4.2.3 Weathering

In the study area, we have find out that fresh outcrop are complicated to search or been found. Most of the outcrop we have found such as marble, granite, quartzite and mudstone are highly weathered. As we aspect from the climate data, it show these area among the highest rainfall in Kelantan particularly. The figure showed a Granite outcrop that has been 90 % fully cover by soil and the tree can well growth at top of the Granite outcrop. It called Biological weathering.

Figured 4.5: The outcrop of Granite are fully covered with vegetation.

For chemical weathering, we have found a outcrop of quartzite that has been highly weathered by iron oxide. The colour of iron in red and orange. Figure 4.6 showed the condition of quartzite and resulted of chemical weathered. For mechanical weathering in study area. The outcrop we have found is Marble and the set of joint. The uniform force has been released on this outcrop.

Figure 4.6 : Iron oxide at quartzite outcrop

Figure 4.7 : set of joint at marble outcrop

4.3 Stratigraphy

4.3.1 Lithostratigraphy

Rocks are often deposited in layers or strata, and the sequence of these strata can be correlated from place to place. These sequences of different rocks are used to establish the changing geological conditions or geological history of the area through time. The description, definition and naming of the rock units is termed lithostratigraphy (rock stratigraphy). The strata can also be described in other ways depending on the types of information availabl, Lithostratigraphy is fundamental to most geological studies. Rock units are described using their gross lithological characteristics and named according to their perceived rank in a formal hierarchy.

In the study area there are 4 type of lithostratigraphy unit(Fig.4.8) that are mappable. These are mudstone unit, reddish mudstone unit, granite unit and alluvium. The mudstone unit are the oldest while alluvium was the youngest unit. Otherwise, for structural there are fault line that has been identified based on topography but the research failed to indentify what type of fault.

Table 4.1 : The stratigraphic column of study area

Period	Formation	Rock Unit	Rock Description
Quaternary	Alluvium	Alluvium	Sand, gravel, and clay
Cretaceous	Kemahang granite	Granite	Granite phaneritic
Triassic	Telong formation	Reddish mudstone	Reddish mudstone are the major rock unit. Claystone and marble found as pebble and float
Permian		Mudstone	Mudstone are major rock unit. The outcrop quartzite are found at certain area and shale outcrop are covered small region.
Carboniferous	Taku schist	Schist	Biotite schist are not mapable.

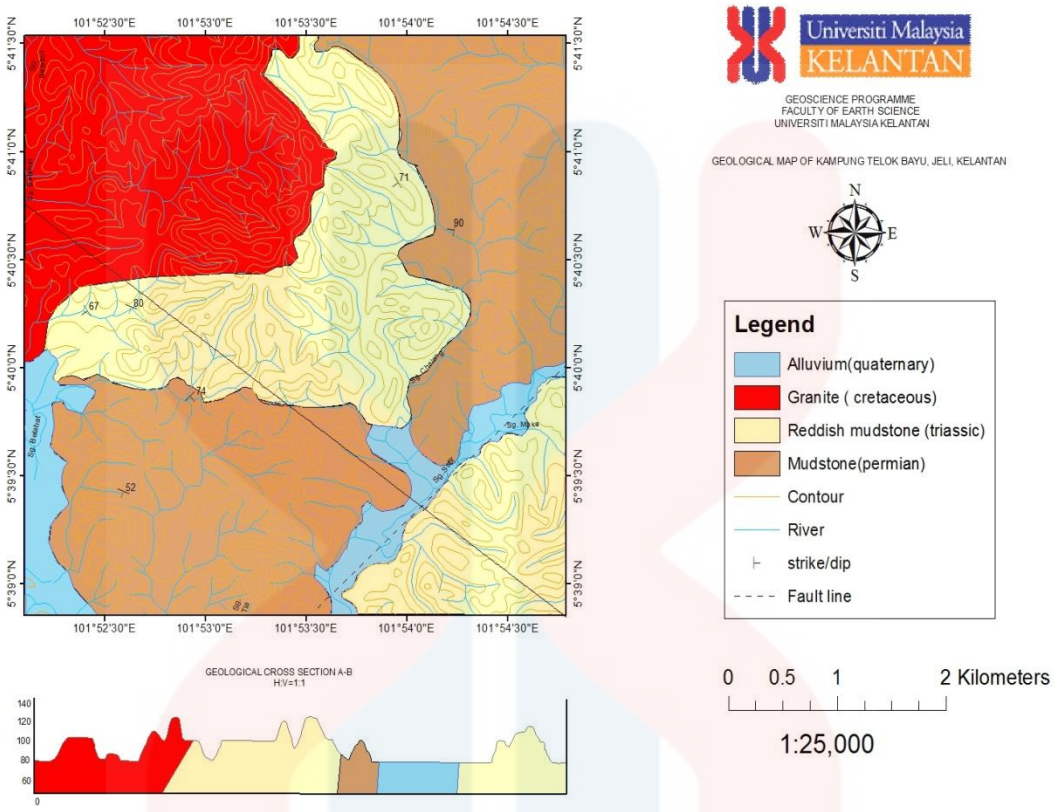


Figure 4.8 : The geological map of study area

4.3.2 Petrography

Petrography is the study of petrology that observing with the description and systematic classification of rocks (Winter, 2014). This part cover crucial part in determination of rock in terms of stage of crystalline by using cross and polarized plane. From this part, we will gain information that cannot been seen with our naked eyes like true colour, interference colour, shape of grain, pleochroism, cleavage, fracture, twinning and relief. Each of mineral has their owns identification.

a. Taku Schist

Sample 1 Biotite Schist

Figure 4.9 : The outcrop of biotite schist.

The sample was collected at coordinate 101’52’25.8 E, 5’40’13.4 N elevation 24m.This metamorphic rock consist of Biotite, Mica and Quartz. The Biotite mineral are dominant in this sample. Thus it called Biotite schist. The rock was formed due to regional metamorphism. It occurs over an area of wide extent, affect the rock volume. The large scale tectonic processes such as ocean floor spreading or crustal thickening related to plate collision are example of the regional metamorphism.

Figure 4.10 : The foliation of Biotite Schist

Based on figure4.10 we can see clearly the Biotite and Quartz grains had been metamorph and grain shape had turn form rounder to angular shape.

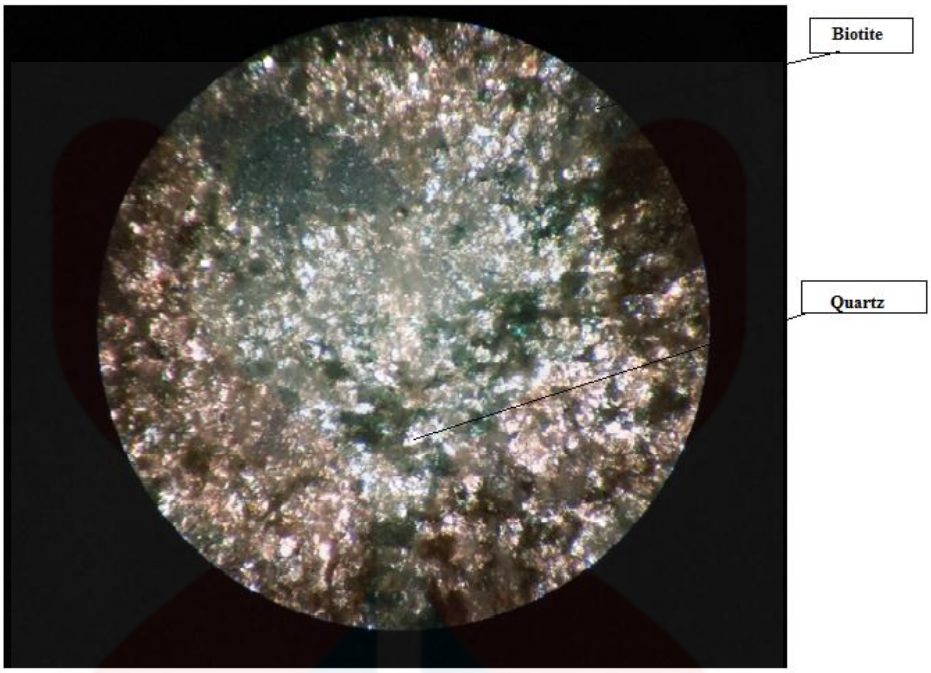


Figure 4.11 : biotite schist under crossed polarized view

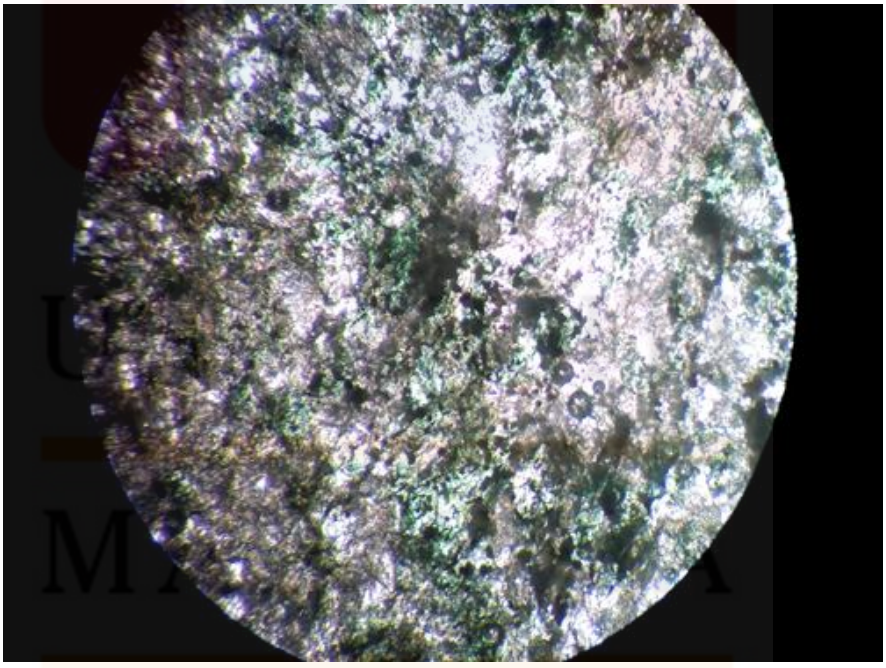


Figure 4.12 : biotite schist under plane polarized light view

b. Telong Formation

Sample 2 Marble

Figure 4.13 : The hand sample of marble

The sample was collected at coordinate N 5’40’15.8 E 101’52’32.5 elevation 26m. This marble are colour in milky white with clear crystalline. This type of metamorphic rock was formed due to contact metamorphism. The limestone was intruded by magma and change to marble.

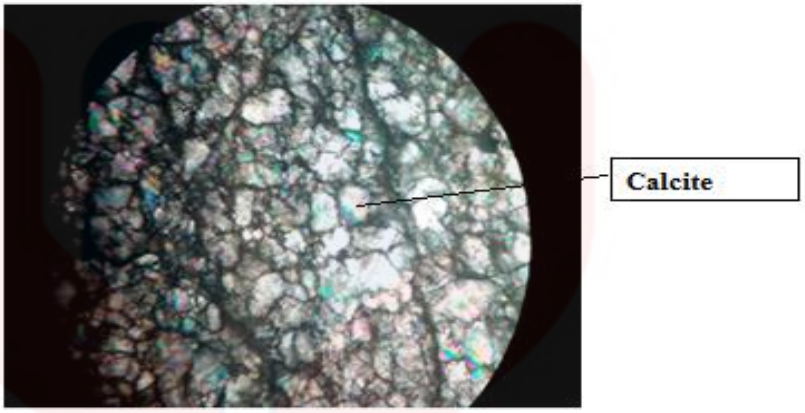


Figure 4.14: Marble under crossed polarised view

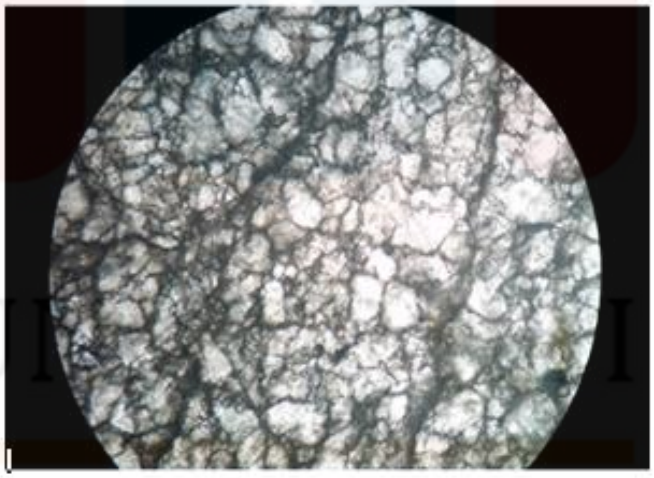


Figure 4.15: Marble under plane polarised view

Based on figure 4.14 showed the mineral calcite under cross polarized view while figure 4.3.4 under plane polarized view can seen the texture of marble which are interlocking anhedral.

Sample 3 Reddish Mudstone

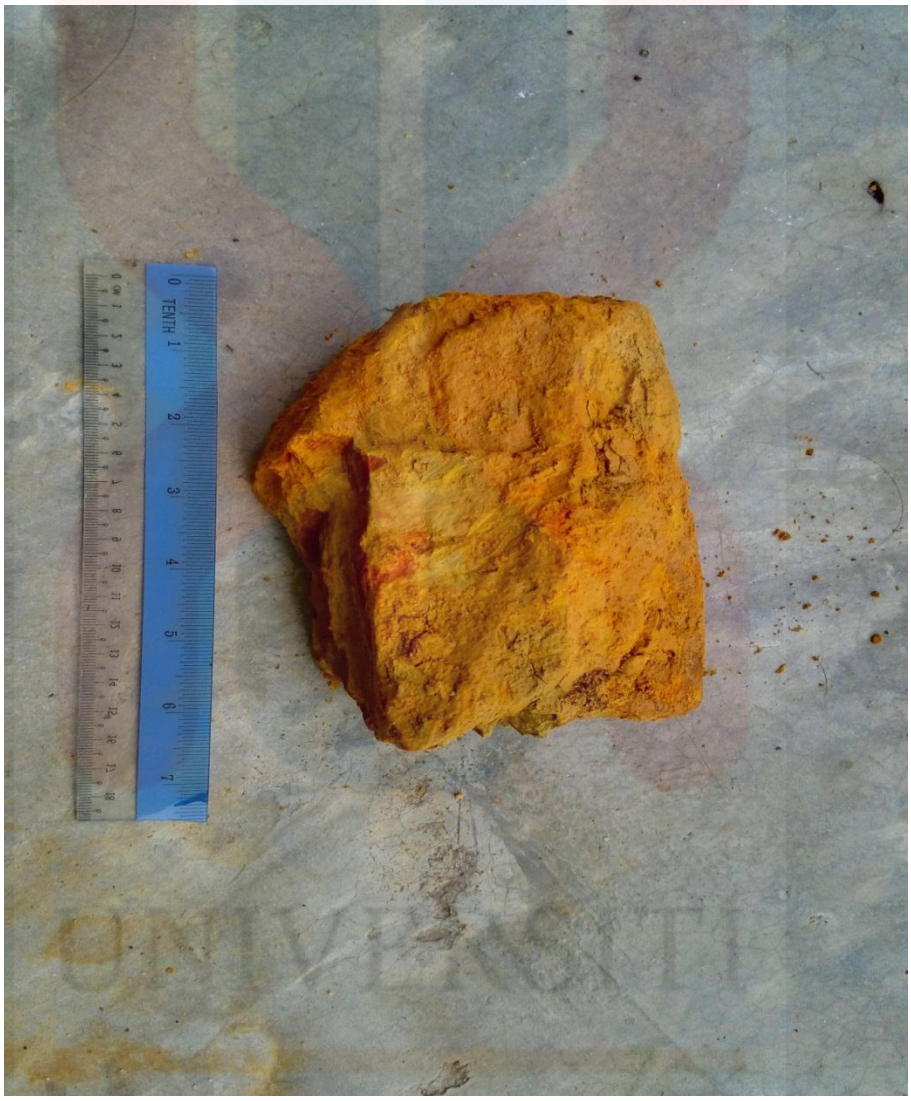


Figure 4.16: Hand sample of reddish mudstone

The sample was found at locality N 5’40’21.7 E 101’52’36.7 elevation 26m.The colour of mudstone are reddish. The size of grain are fine. The chemical weathering that make mudstone colour in red.The formation of mudstone happen in marine sedimentary basin.In early stage,its deposited as soft mud sediment. During lithification process,this soft mud was being force by compaction and de-watering beneath sucession of sedimentary rock (R J Merriman, 2013)

Sample 5 Quartzite

Figure 4.22 Quartzite outcrop

Figure 4.23 Hand sample of quartzite

The sample was collected at coordinates 101’53’38.3 E, 5’40’51.1 N. This type of metamorphic rock are called Quartzite. The colour texture are white with crystal. Quartzite are non-foliated metamorphic rock.

Figure 4.24 iron oxide on quartzite

Some of outcrop has been weathered by iron oxide. Based on figure 4.3. dark spot and reddish colour with shiny crystal.

c. Kemahang Granite

Sample 4 Granite

Figure 4.17 Hand sample of Granite

Figure 4.18 : The outcrop of Granite

The Granite outcrop was found at coordinate N 05’40’12.9 E 101’52’24.9 and elevation 25m. The basic information about sample. It has texture phaneritic which is coarse grained. The mineral can see clearly with naked eye. It colour in white generally. The minerals consists of quartz,alkali feldspar and biotite only.Based on texture, the sample was categorized as intrusive plutonic and crystallized slowly below the earth surface. The result analysis of Granite thin section by using ternary diagram of plutonic rock showed that the sample was classified as Quartz rich granitoids.

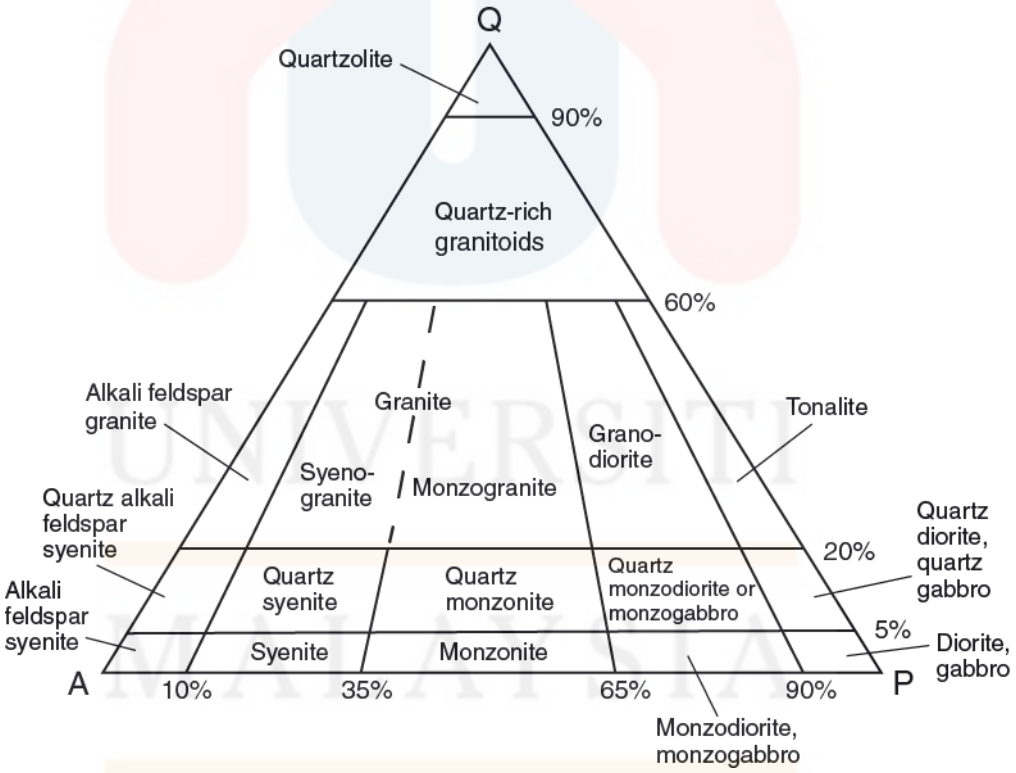


Figure 4.19 Ternary diagram of plutonic rock

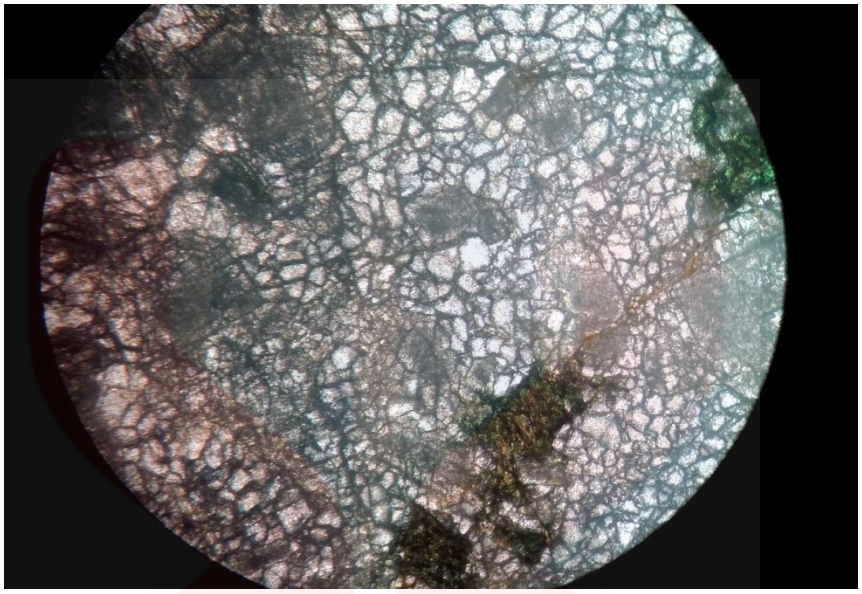


Figure 4.20 Granite under plane polarized light view

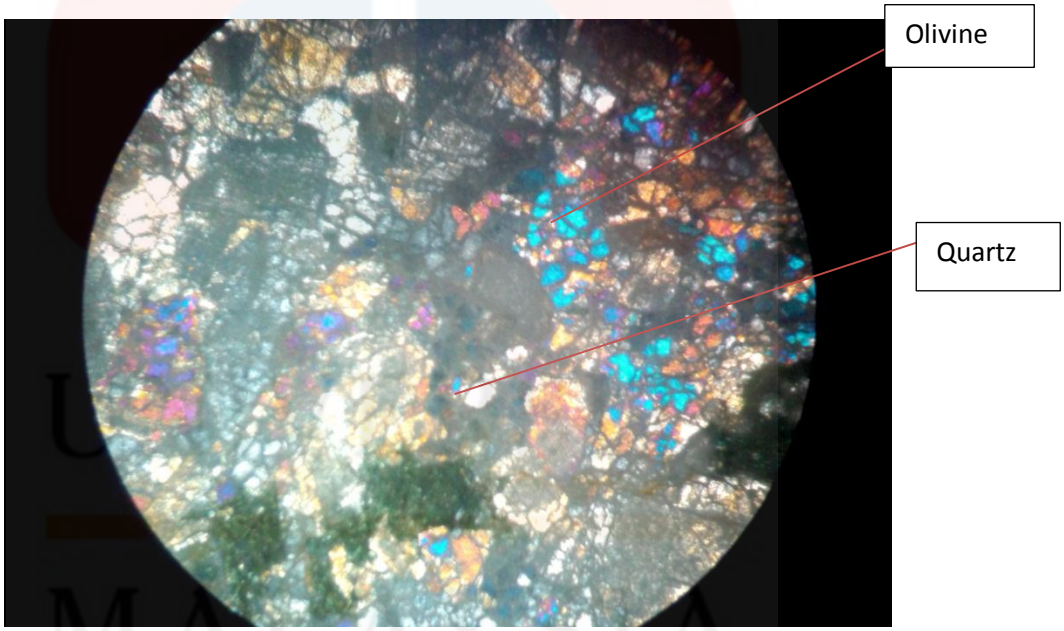


Figure 4.21 : Granite under crossed polarized view

4.4 Structural Geology

4.4.1 Lineament Analysis

A lineament is a linear feature in a landscape which is an expression of an underlying geological structure such as a fault. Typically a lineament will comprise a fault-aligned valley, a series of fault or fold-aligned hills, a straight coastline or indeed a combination of these features. Fracture zones, shear zones and igneous intrusions such as dykes can also give rise to lineaments.

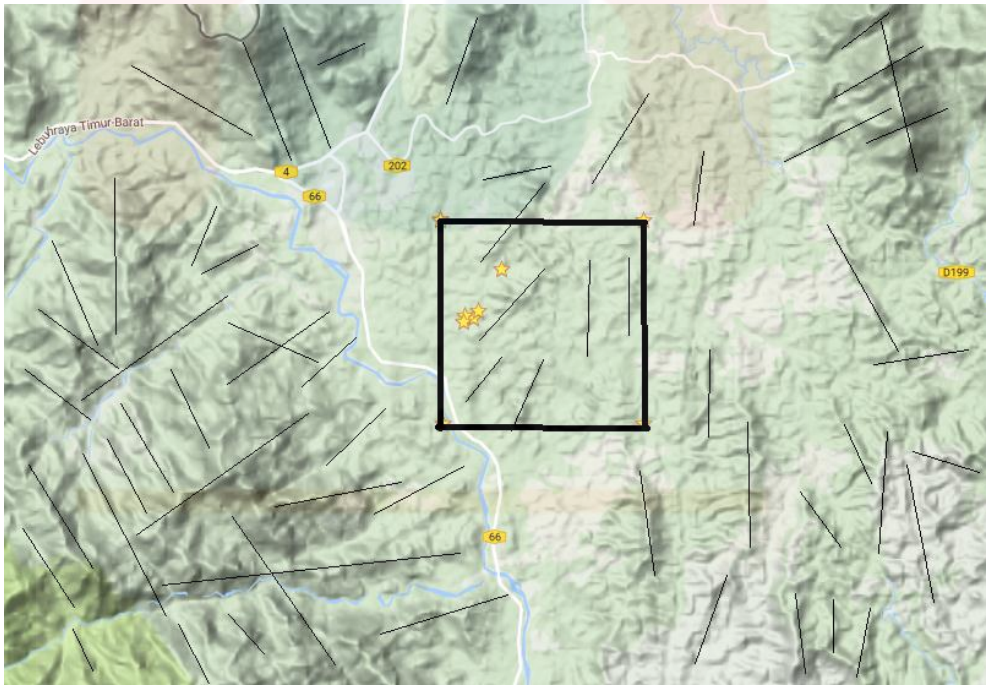


Figure 4.25 Regional lineament of study area

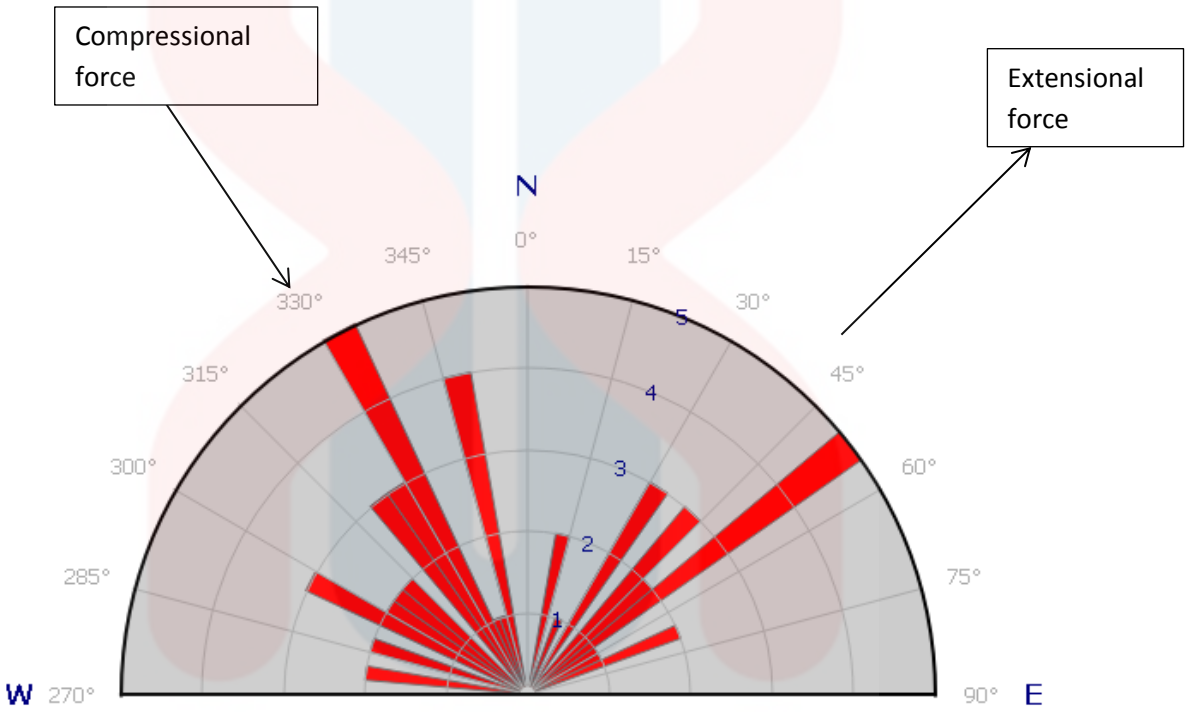


Figure 4.26: Rose diagram of regional lineament

Based on figure 4.25 we can allocated the compressional force are coming from North and West. The lineament we measured by taking regional map. The 50 azimuth reading was measured their direction.

4.4.2 Joint Analysis

The objective of joint analysis are to find or allocate where the regional forces comes from. The analysis can be done by take a strike reading on joint.A joint is a fracture without significant relative displacement of the walls, which is a member of a group of fractures spatially extensive in three dimensions generally (Mitcham, 1963)

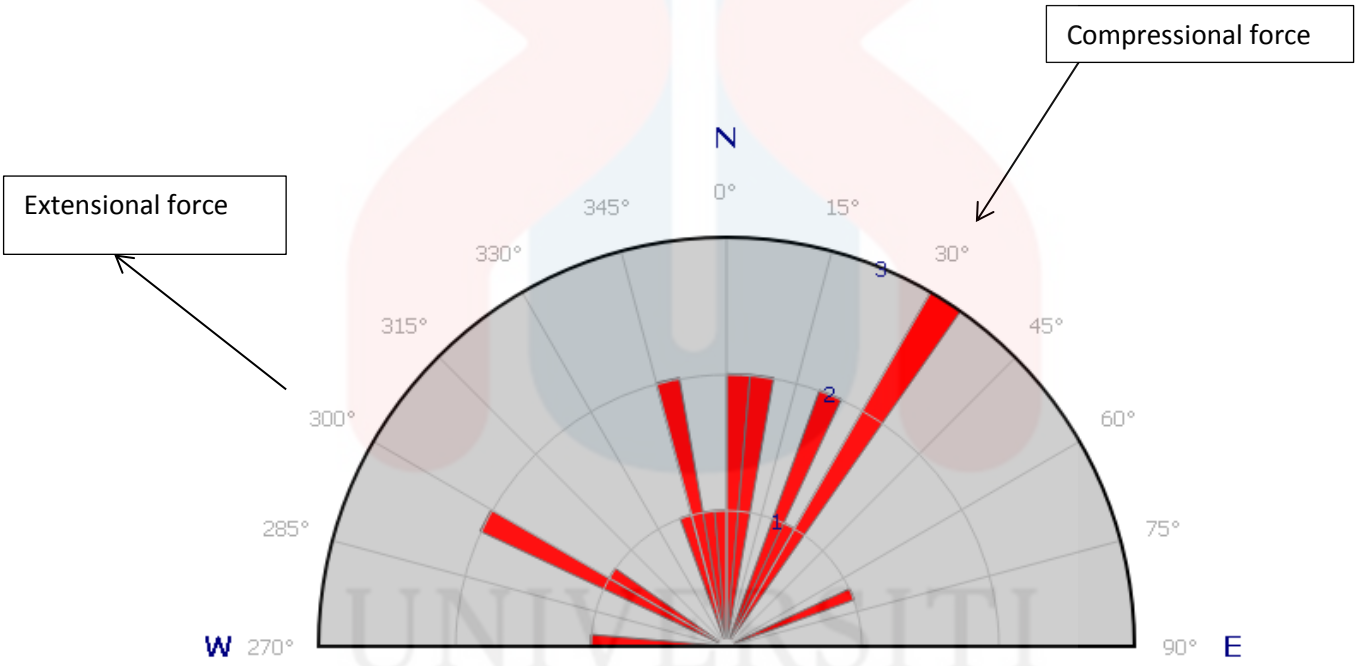


Figure 4.27: Rose diagram of granite joint 1

Based on figure 4.26 the compressional force are coming from North and East direction. The strike reading was taken on Granite joint. The extensional forces are towards West and North direction.

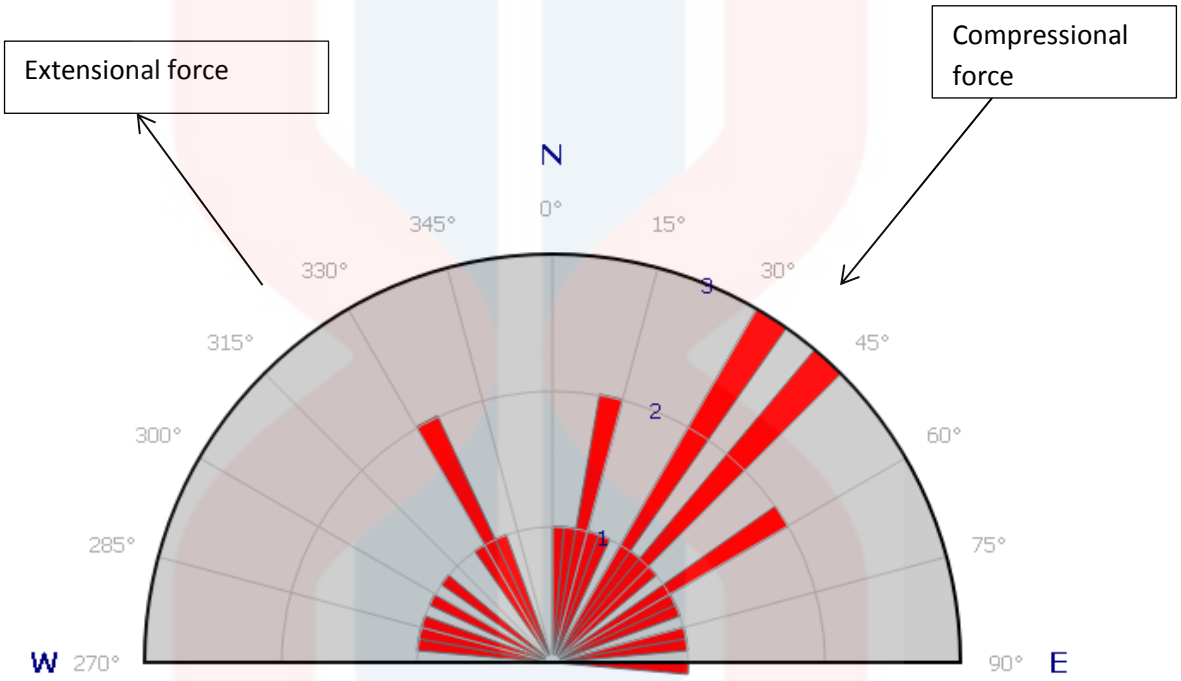


Figure 4.28: Rose diagram of quartzite joint 2

Based on figured 4.5.2 is the strike reading on Quartzite joint. The direction of compressional force are from North and East direction. The extensional force are measured by taking perpendicular of compressional force therefore the extensional force towards West and North.

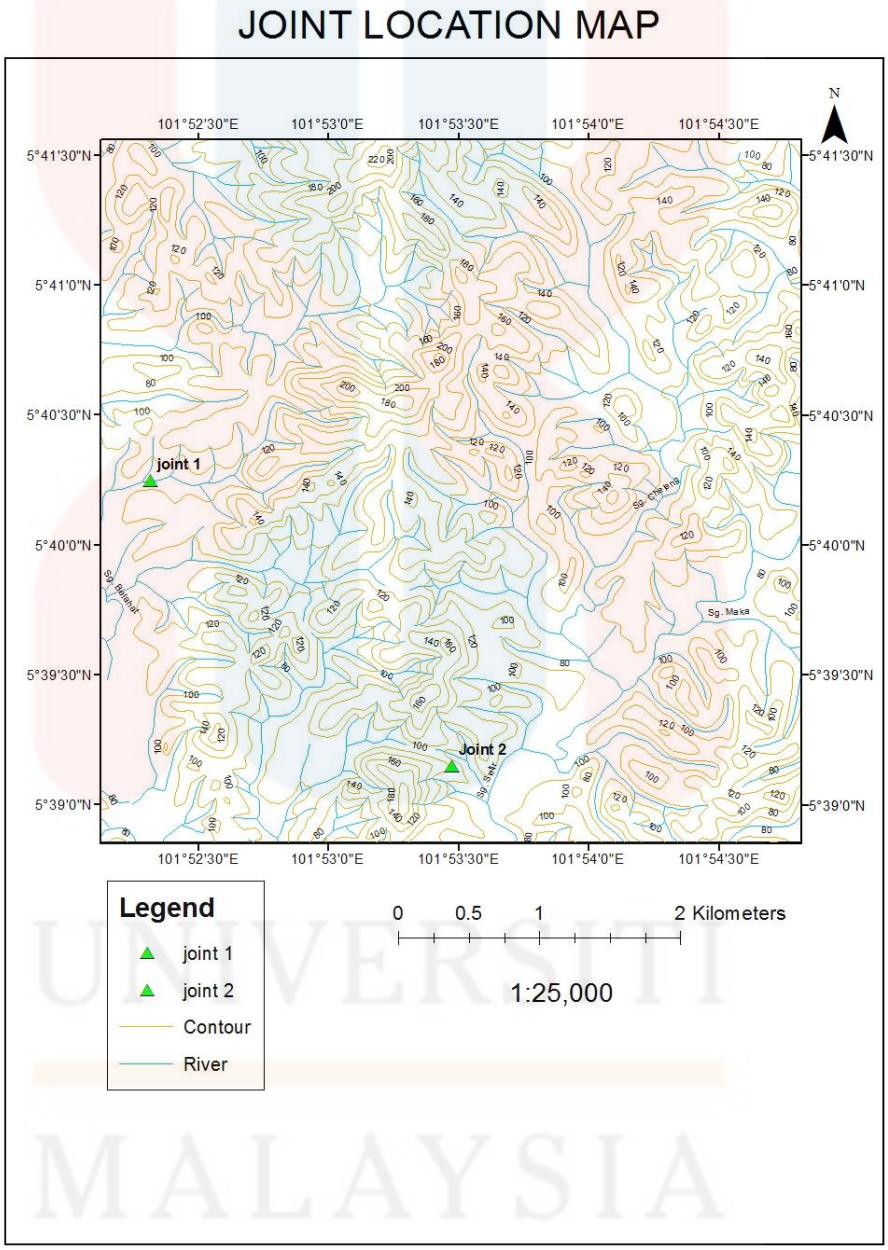


Figure 4.29 Location of map joint

4.4.3 Fault and Fold Analysis

A fault is a planar fracture or discontinuity in a volume of rock, across which there has been significant displacement as a result of rock mass movement. Large faults within the Earth's crust result from the action of plate tectonic forces, with the largest forming the boundaries between the plates, such as subduction zones or transform faults. Energy release associated with rapid movement on active faults is the cause of most earthquakes .A fault plane is the plane that represents the fracture surface of a fault. A fault trace or fault line is the intersection of a fault plane with the ground surface. A fault trace is also the line commonly plotted on geologic maps to represent a fault

A geological fold occurs when one or a stack of originally flat and planar surfaces, such as sedimentary strata, are bent or curved as a result of permanent deformation. Folds are those due to slumping of sedimentary material before it is lithified. Folds in rocks vary in size from microscopic crinkles to mountain-sized folds. They occur singly as isolated folds and in extensive fold trains of different sizes, on a variety of scales.Folds form under varied conditions of stress, hydrostatic pressure, pore pressure, and temperature gradient, as evidenced by their presence in soft sediments, the full spectrum of metamorphic rocks, and even as primary flow structures in some igneous rocks. A set of folds distributed on a regional scale constitutes a fold belt, a common feature of orogenic zones. Folds are commonly formed by shortening of existing layers, but may also be formed as a result of displacement on a non-planar fault.

Based on the basemap of study area, for structure analysis the contour has been analysed there are 2 type of structure existed in study area. The anticline fold and fault. The type of fault cannot been determined. But based on topography and elevation between the formation can clearly distinguish.The anticline fold is known as a ridge-shaped fold of stratified rock in which the strata slope downward from the crest.

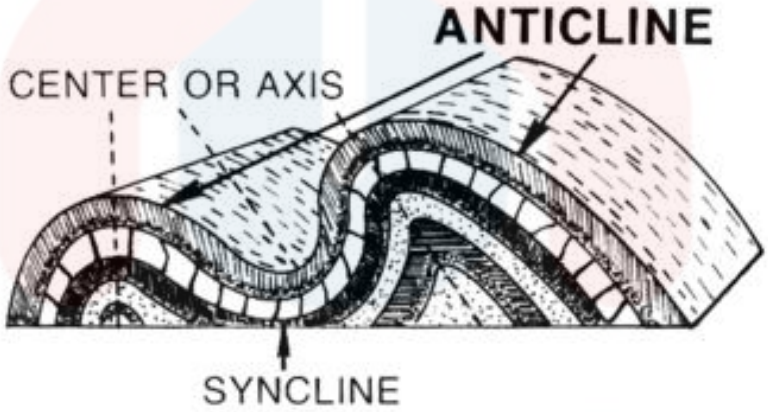


Figure 4.30 Schematic of Anticline

4.5 Historical Geology

Based on the lithology, the type of rock that dominant in in study area is mudstone. Mudstone are form where environmental conditions in which fine sediment is abundant and water energy is sufficiently. It gives silt to deposited (Boggs, 2006). The depositional environment of mudstone and shale closely related. On other hand, the limestone indicated that environment at that time are shallow marine and rise up during the collision of SIbumasu plate and Indocina plate. After hundred years ago, the magmatic has intruded this sedimentary rock area. The limestone had been contact with magma and changes the mineral in limestone to marble.

Chapter 5

Distribution of metal deposits in stream sediments

5.1 Introduction

The analysis of metal deposits by using Inductive Couple Plasma-OES start with preparation of sample and standard solution. For this analysis, the sediment sample need to prepared in solution. It will explain in part procedure. The raw data has been analysed present in table. The anomalies map will produce.The sediment sample has been collected at eight different up stream. The sample was dug at point bar and river bed.

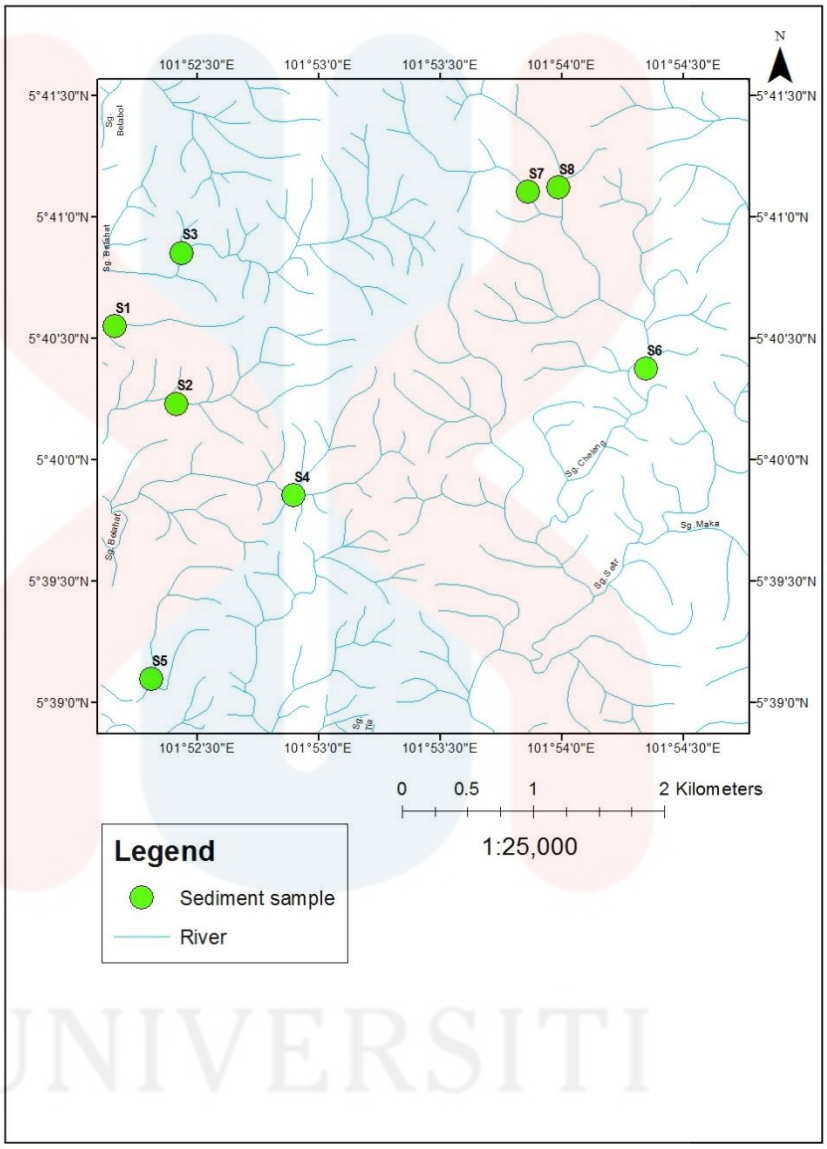


Figure 5.1 Location of sediment sampling

5.2 Sampling and Sample preparations

The analytical result of metal deposit from Inductive couple plasma (OES) has been analysed and classified based on parameter given. Each sediment sample were collected from different river. Before the sample going through analysis. The sample sediment need to follow sample preparation procedure in order to produce sample in liquid.

Procedure sample preparation

1- Each sediment left out overnight in oven at 100 Celcius

2- After the sediment completely dried. Filter the sediment into 120 µm.

3- The sediment was weighed 1.0 g for all the sediment and placed in a 250ml beaker.

4- 10ml of nitric acid (HNO_3) was added and been heated on hot plate at 90 Celsius for about 15minutes.

5- The sample are allowed to cool and added another 5ml of nitric acid (HNO_3). Make sure the sample are not evaporated more than 5ml.

6- The sample was added with 2ml of distilled water and 3ml of 30% Hydrogen Peroxide (H_2O_2).

7- The sample was added with distilled water until up to 30ml.

8. The sample are poured into the falcon tube 50ml. Centrifuge the sample at speed 2000rpm

9- The sample was filter with No 41 Whatmann filter paper to filter balanced sediment and poured into medium beaker. The distilled water are added up to 80ml.

10- The sample was poured about 5ml into test tube on the ICP-OES machine.

11- The sample start to be analysed.

Figure 5.2 The sample was being heated at 90 Celsius

Figure 5.3 The centrifuge

Figure 5.4 The sample was rotated at speed 2000rpm

Figure 5.5 The sample was being filter

Figure 5.6 The icp-oes machine

5.3 Distribution of metal deposits

Table 5.1 The result of ICP-OES

NO.SAMPLE	ELEMENT in (ppm)				
	Zinc	Lead	Copper	Gold	Silver
1	0.094	0.171	0.056	0.005	0.123
2	-0.012	0.041	0.029	0.001	0.134
3	-0.048	0.047	0.044	0.001	0.136
4	0.117	0.100	0.070	0.004	0.132
5	-0.028	0.063	0.038	0.006	0.116
6	0.075	0.308	0.057	0.002	0.131
7	0.007	0.091	0.039	0.002	0.129
8	-0.055	0.063	0.035	0.002	0.132

The distribution of element Lead (Pb) in study area are found in all sediment sample. The highest ppm value are in sample 6 which has 0.308ppm and the lowest ppm value are in sample 2 which has 0.041ppm.The distribution of element Zinc (Zn) in study area are found only in sample 1, sample 4, sample 6 and sample 7. The balanced sample showed negative value. The highest ppm value are sample 4 which has 0.117ppm while the lowest ppm value are sample 7 which has 0.007ppm.The distribution of element Copper (Cu) in study area are found in all sample. The highest ppm value is sample 4 which is 0.070ppm and the lowest sample 2 which has 0.029ppm.The distribution of element Silver (Ag) in study are found in all sample.The highest sample ppm value is sample 3 which is 0.136ppm value and the lowest is sample 5 which has 0.116ppm value.

The distribution of element Gold (Au) in study area found in all sample. The highest ppm value is sample 5 which has 0.005ppm and the lowest ppm value are sample 2 and sample 3 which has 0.001ppm value.

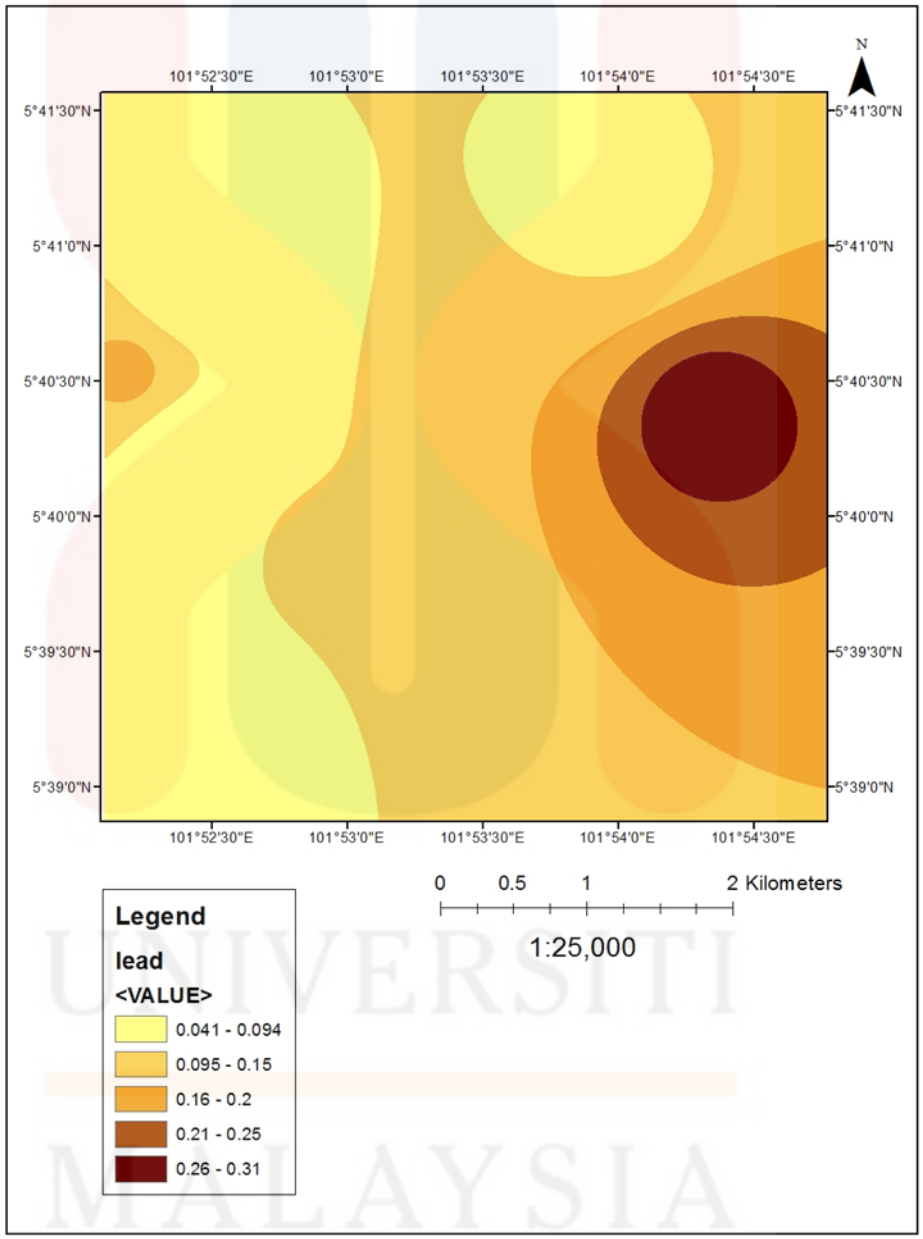


Figure 5.7 Anomalies map for Lead

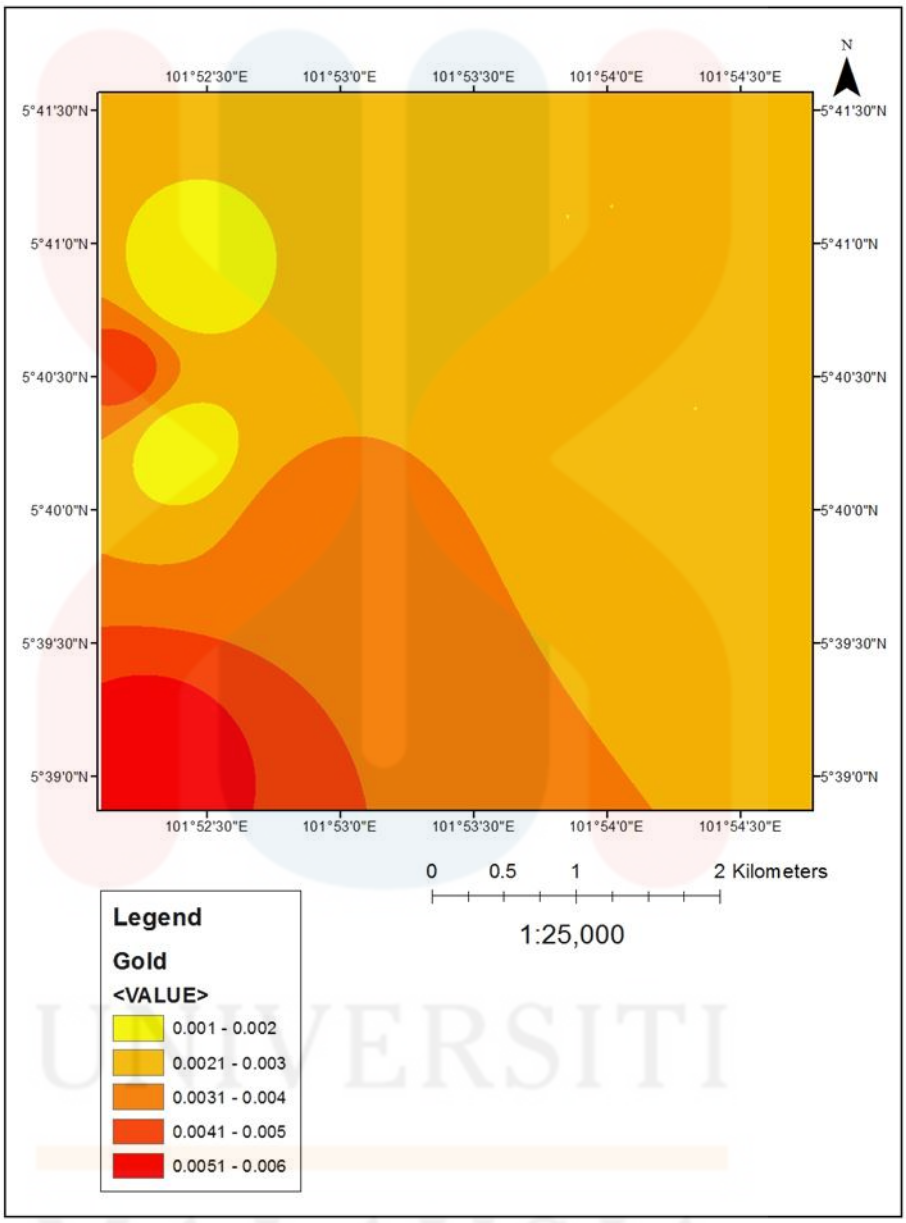


Figure 5.8 Anomalies map of Gold

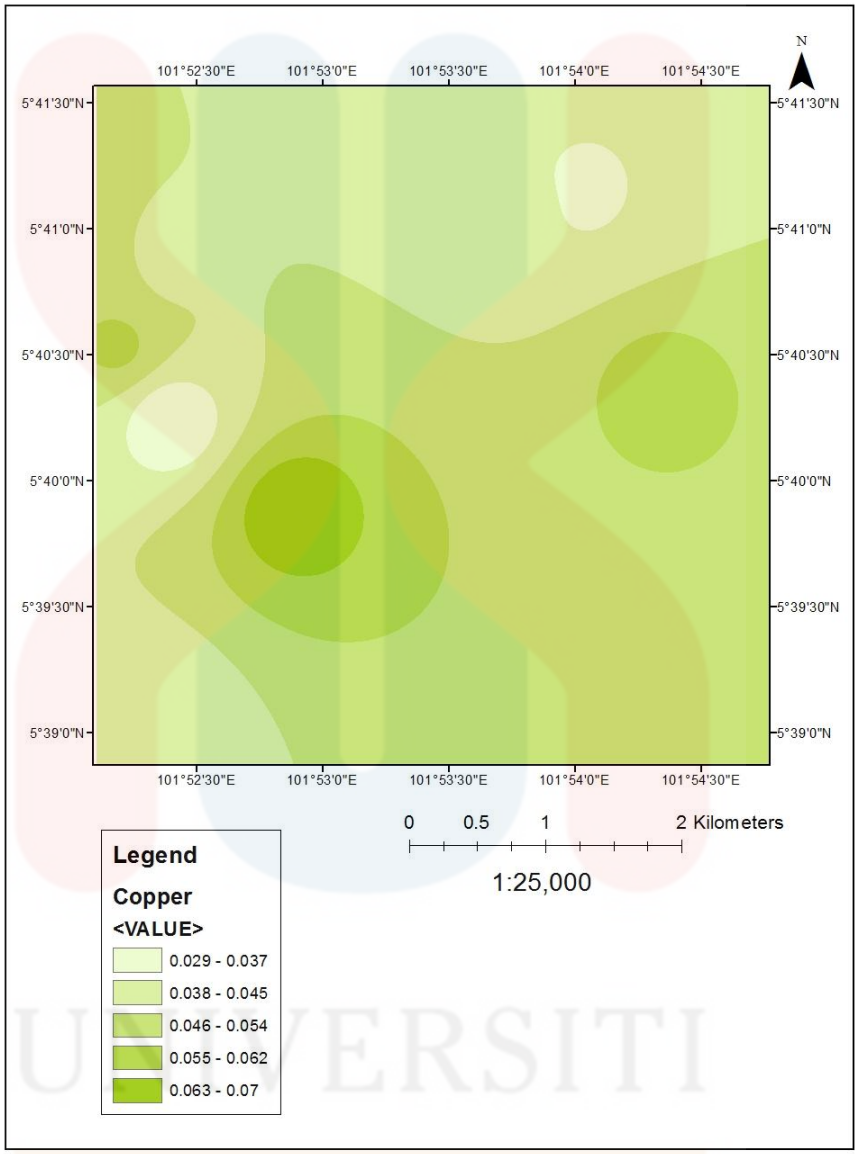


Figure 5.9 Anomlies map of Copper

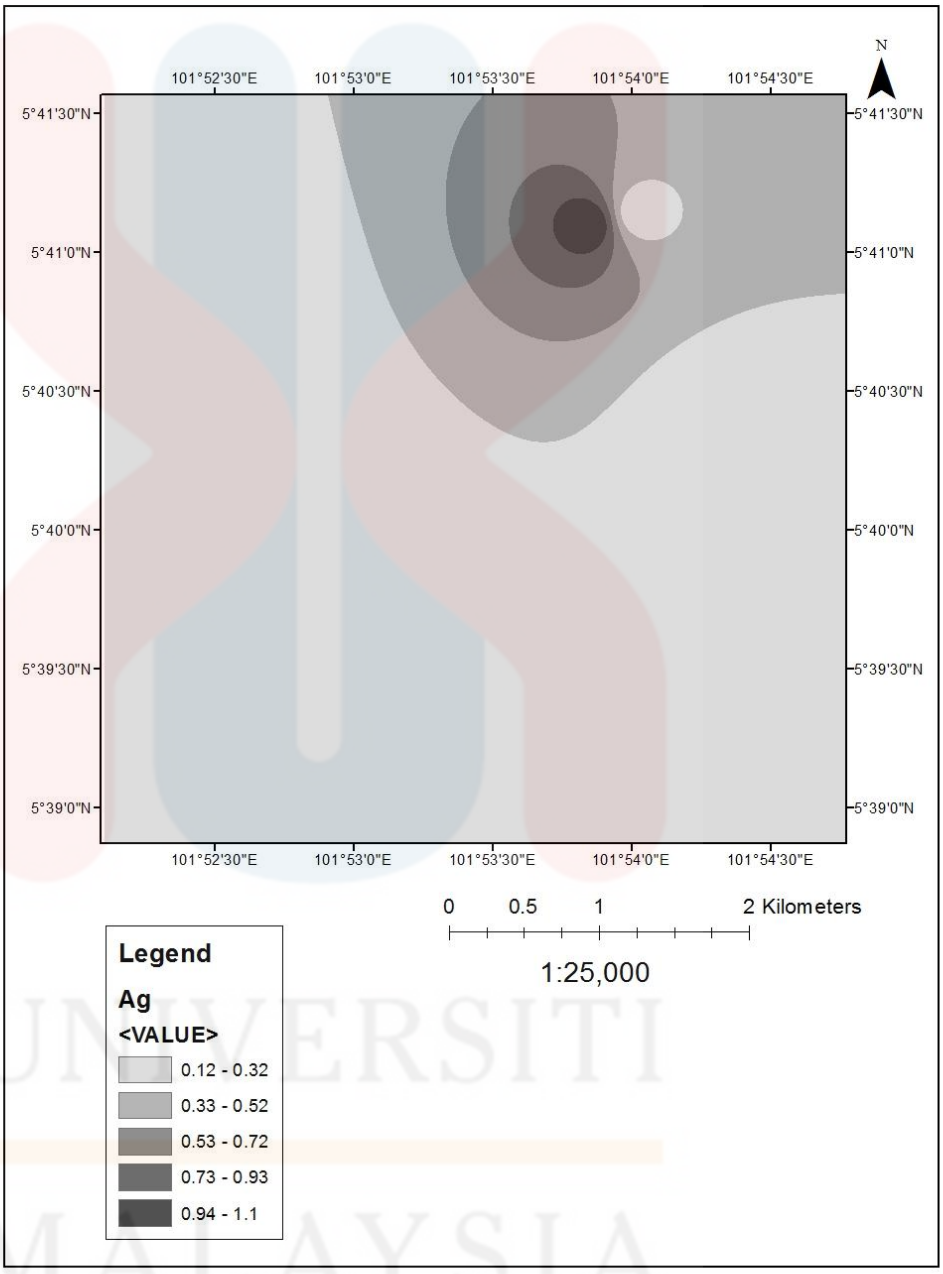


Figure 5.10 Anomalies map of Silver

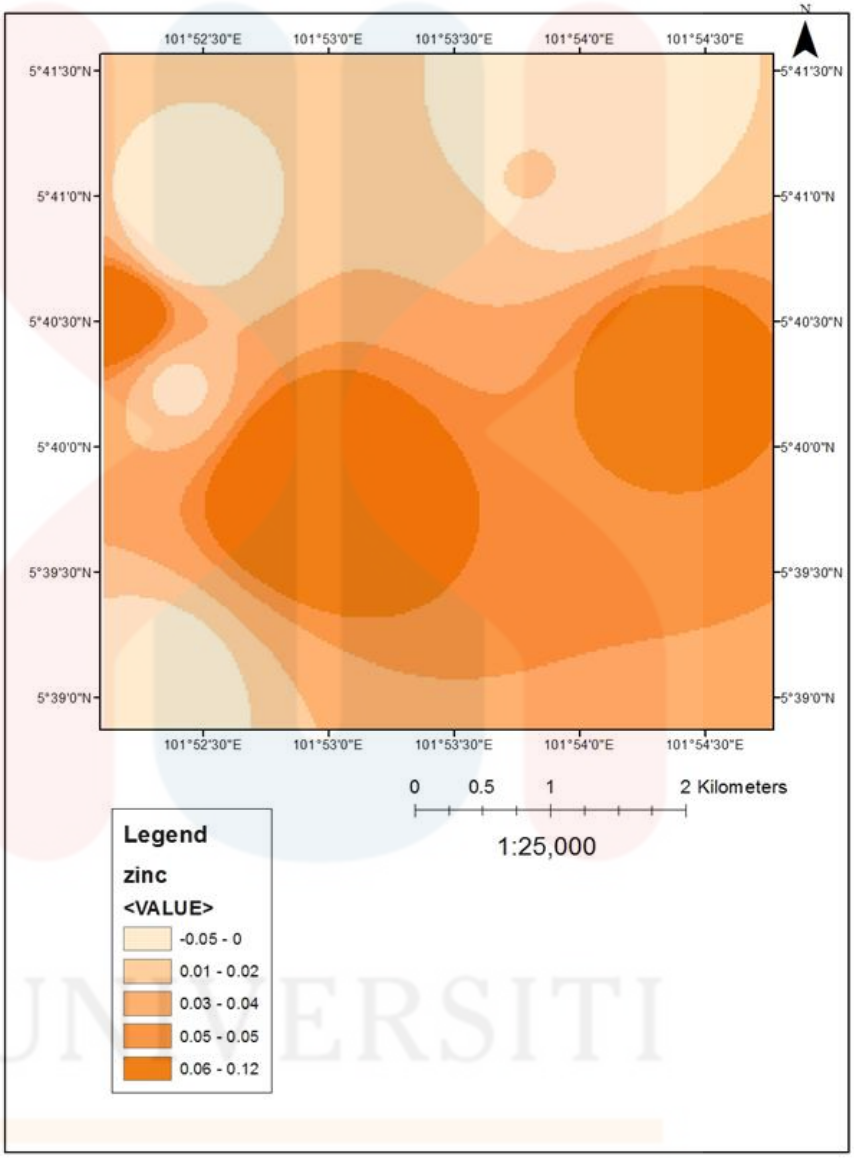


Figure 5.11 Anomalies map of Zinc

Table 5.3 The ore of geological setting

	Depth	Temperature (°C)	Occurrence	Metals
Telethermal	Near surface	±100	In sedimentary rocks or lava flows; open fractures, cavities, joints. No replacement phenomena	Pb, Zn, Cd, Ge
Epithermal	Near surface to 1.5 km	50–200	In sedimentary or igneous rocks; often in fault systems; simple veins or pipes and stockworks; little replacement phenomena	Pb, Zn, Au, Ag, Hg, Sb, Cu, Se, Bi, U
Mesothermal	1.2–4.5 km	200–300	Generally in or near intrusive igneous rocks; associated with regional faults; extensive replacement deposits or fracture fillings; tabular bodies, stockworks, pipes	Au, Ag, Cu, As, Pb, Zn, Ni, Co, W, Mo, U etc.
Hypothermal	3–15 km	300–600	In or near deep-seated felsic plutonic rocks in deeply eroded areas. Fracture-filling and replacement bodies; tabular or irregular shapes	Au, Sn, Mo, W, Cu, Pb, Zn, As

Source : (N. Arndt , 2015).

The result of anomalies map of each element had showed different style. There are many kind of geological setting theory from other research . One of the opinion, has stated that classifications of ore deposited were based on the types of rocks that host the ore deposits or on the geological context such as the geometry of the deposit and its relation to its host rocks. (N. Arndt , 2015). Based on figure 5.2.3 showed that ore deposited will be determined by depth and temperature.The depth can be differentiation into 4 level which is near surface, near surface to 1.5km, 1.2-4.5km and 3-15km. The

temperature are directly proportional to a depth. Therefore, in study area can possibly classify as near surface and near surface deposited which called as Telethermal and Epithermal.The Telethermal deposited introduced by American geologist it is hydrothermal mineral deposited formed as a result of the precipitation of a mineral mass from hot mineralization soloution flowing at shallow depth below earth's surface and having temperature of 50-200 Celcius.There we usually sheetlike.

Based on the result and relationship of geological map. In study area. skarn deposits are posibble main type of deposited. Skarn deposits are one important sources of base and precious metals (Hammarstrom, 1991) In general Skarns are coarse-grained metamorphic rocks composed of calcium, iron, magnesium, manganese, aluminum silicate that form by replacement of carbonate-bearing rocks during contact or regional metamorphism and metasomatism. It related to magmatic hydrothermal activity, granitoid plutons in orogenic tectonic setting. Eventhough limestone outcrop was not found but the float or outcrop of marble was found in study area. Thus, the limestone outcrop could buried depth in earth's crust and contact with magma.

Chapter 6

Conclusion and Suggestion

6.1 Conclusion

In conclusion, The objective of this research are to determine the distribution of metal deposits are accomplished. Based on the result and analysis that has been done,, the research can give possibility geological setting of ore deposited are skarn deposits.

6.2 Recommendation

In order to get precisely geological data of that area. This research suggest for to do a research in field such as geophysic analysis, structural analysis and sedimentology analysis. This is because the area of study has lot of sedimentary and metamorphic rock that has almost 90 degree dip direction. Otherwise for structure analysis, based on map we can see fault line but this research failed to obtained structure data due to problems that cannot avoided.

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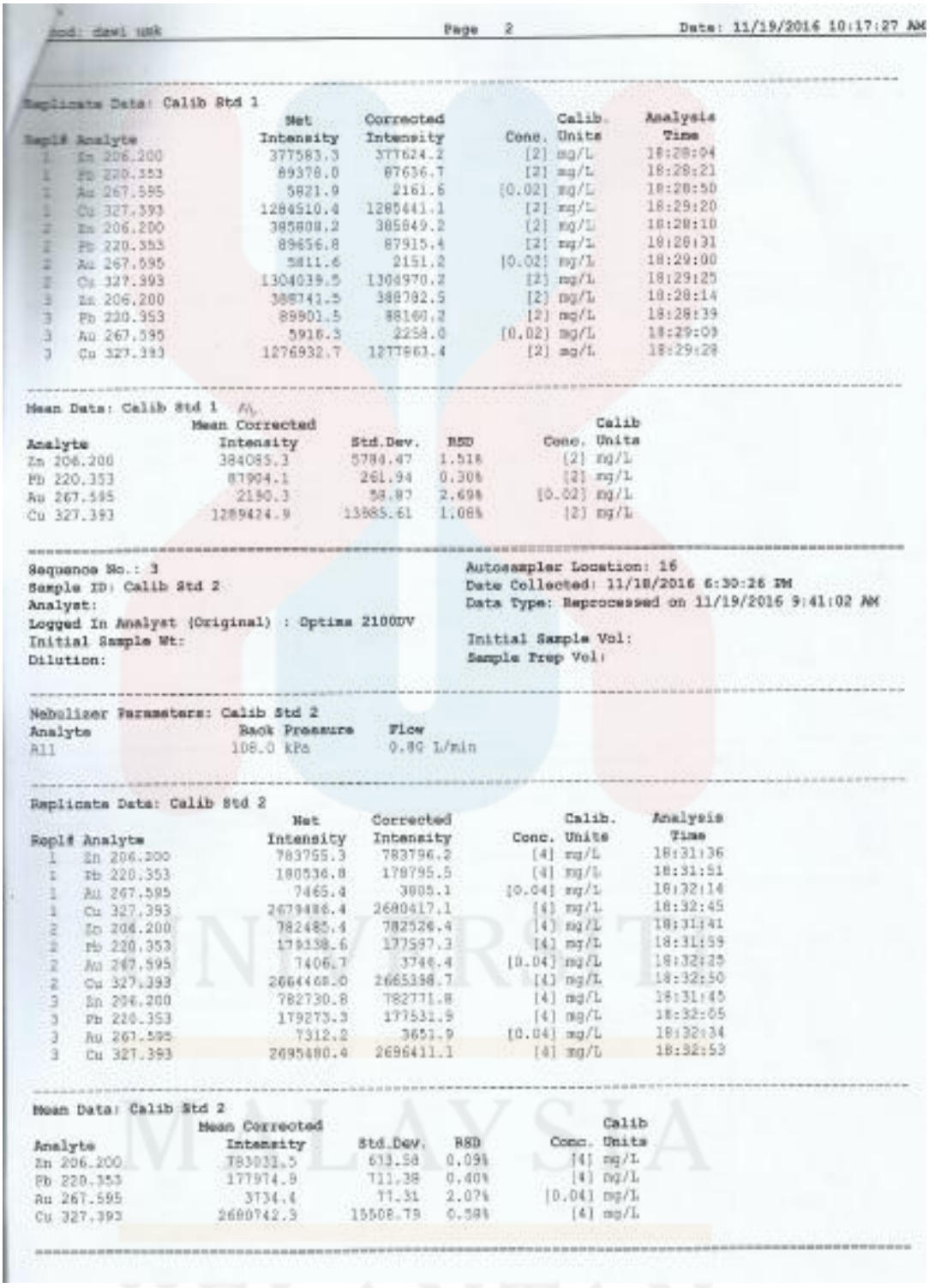
APPENDIX



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1	Pb 220.353	89378.0	87636.7	[2]	mg/L	18:29:21
1	Au 267.595	5821.9	2161.6	[0.02]	mg/L	18:28:50
1	Cu 327.393	1284510.4	1285441.1	[2]	mg/L	18:29:20
2	Zn 206.200	385808.2	385849.2	[2]	mg/L	18:28:10
2	Pb 220.353	89656.8	87915.4	[2]	mg/L	18:28:31
2	Au 267.595	5811.6	2151.2	[0.02]	mg/L	18:29:00
2	Cu 327.393	1304039.5	1304970.2	[2]	mg/L	18:29:25
3	Zn 206.200	388741.5	388782.5	[2]	mg/L	18:28:14
3	Pb 220.353	89901.5	88160.2	[2]	mg/L	18:28:39
3	Au 267.595	5916.3	2256.0	[0.02]	mg/L	18:29:09
3	Cu 327.393	1276932.7	1277963.4	[2]	mg/L	18:29:28

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Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc.	Units
Zn 206.200	384085.3	5784.47	1.51%	[2]	mg/L
Pb 220.353	87904.1	261.94	0.30%	[2]	mg/L
Au 267.595	2189.3	58.87	2.69%	[0.02]	mg/L
Cu 327.393	1289424.9	13885.61	1.08%	[2]	mg/L

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Sample Prep Vol:

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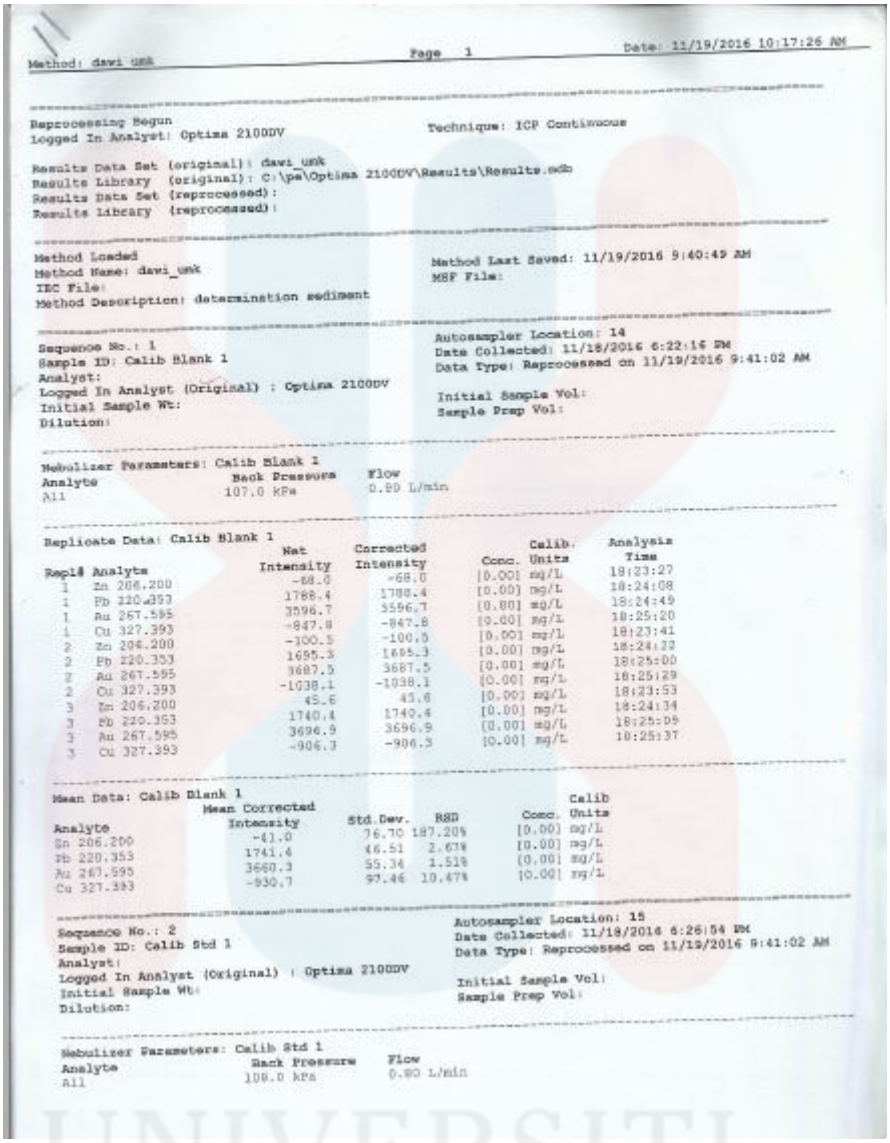
1	Pb 220.353	180536.8	178795.5	[4]	mg/L	18:31:51
1	Au 267.595	7465.4	3805.1	[0.04]	mg/L	18:32:14
1	Cu 327.393	2679486.4	2680417.1	[4]	mg/L	18:32:45
2	Zn 206.200	782485.4	782526.4	[4]	mg/L	18:31:41
2	Pb 220.353	179138.6	177597.3	[4]	mg/L	18:31:59
2	Au 267.595	7406.7	3746.4	[0.04]	mg/L	18:32:25
2	Cu 327.393	2664468.0	2665398.7	[4]	mg/L	18:32:50
3	Zn 206.200	782730.8	782771.8	[4]	mg/L	18:31:45
3	Pb 220.353	179273.3	177531.9	[4]	mg/L	18:32:05
3	Au 267.595	7312.2	3651.9	[0.04]	mg/L	18:32:34
3	Cu 327.393	2695480.4	2696411.1	[4]	mg/L	18:32:53

Mean Data: Calib Std 2

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc.	Units
Zn 206.200	783031.5	613.58	0.09%	[4]	mg/L
Pb 220.353	177974.9	711.38	0.40%	[4]	mg/L
Au 267.595	3734.4	77.51	2.07%	[0.04]	mg/L
Cu 327.393	2680742.3	15508.79	0.58%	[4]	mg/L



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1	Au 267.595	3596.7	3596.7	[0.00]	mg/L	18:24:49
1	Cu 327.393	-847.8	-847.8	[0.00]	mg/L	18:25:20
2	Zn 206.200	-100.5	-100.5	[0.00]	mg/L	18:23:41
2	Pb 220.353	1695.3	1695.3	[0.00]	mg/L	18:24:22
2	Au 267.595	3687.5	3687.5	[0.00]	mg/L	18:25:00
2	Cu 327.393	-1038.1	-1038.1	[0.00]	mg/L	18:25:29
3	Zn 206.200	45.6	45.6	[0.00]	mg/L	18:23:53
3	Pb 220.353	1740.4	1740.4	[0.00]	mg/L	18:24:34
3	Au 267.595	3696.9	3696.9	[0.00]	mg/L	18:25:05
3	Cu 327.393	-906.3	-906.3	[0.00]	mg/L	18:25:37

Mean Data: Calib Blank 1

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc.	Units
Zn 206.200	-41.0	76.70	187.20%	[0.00]	mg/L
Pb 220.353	1741.4	46.51	2.67%	[0.00]	mg/L
Au 267.595	3660.3	55.34	1.51%	[0.00]	mg/L
Cu 327.393	-930.7	97.46	10.47%	[0.00]	mg/L

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Initial Sample Vol:
Sample Prep Vol:

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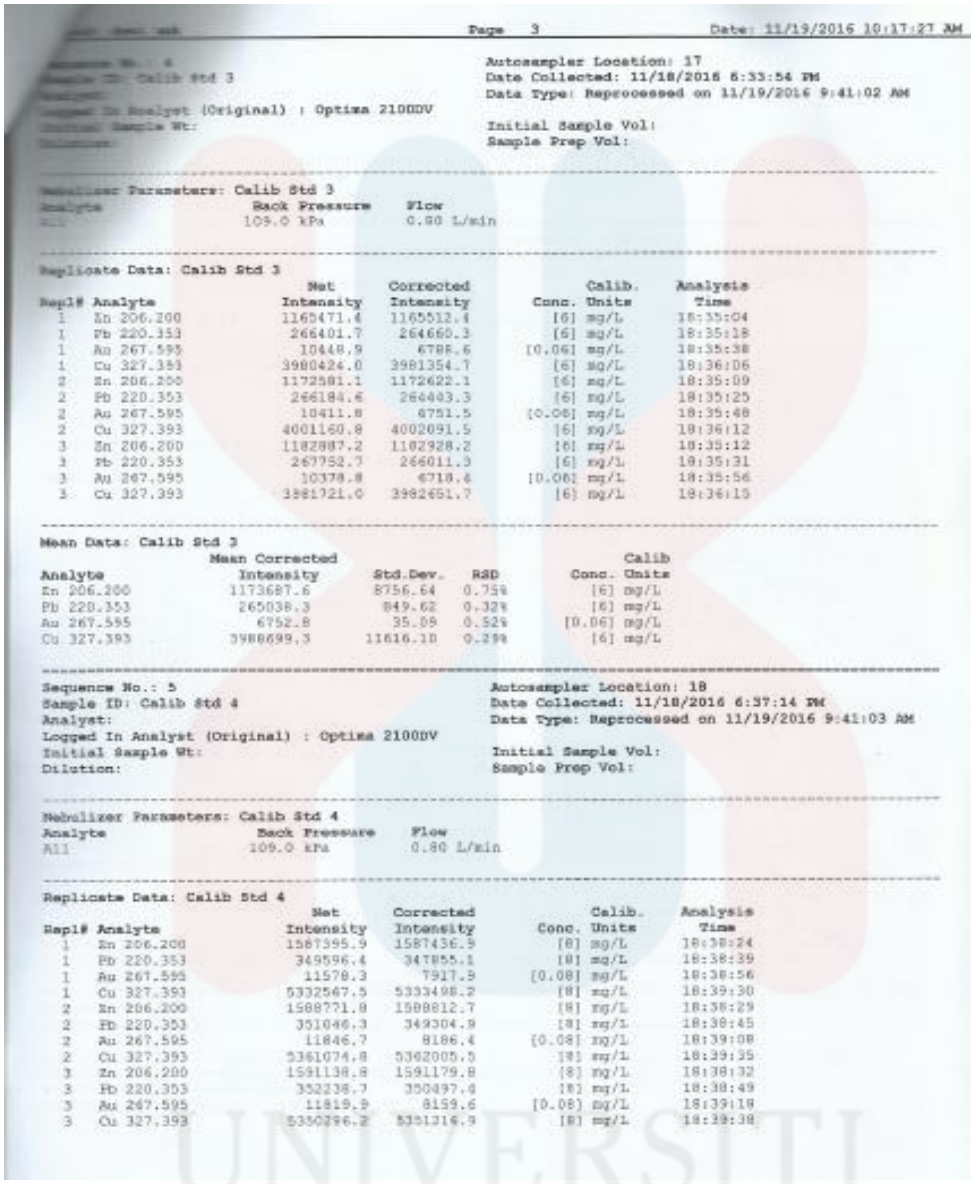

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Logged In Analyst (Original) : Optima 2100DV

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: Calib Std 3

Analyte	Back Pressure	Flow
All	109.0 kPa	0.80 L/min

Replicate Data: Calib Std 3

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Analysis Time
1	Zn 206.200	1165471.4	1165512.4	[6]	mg/L	18:35:04
1	Pb 220.353	266401.7	266460.3	[6]	mg/L	18:35:18
1	Au 267.595	10448.9	6788.6	[0.06]	mg/L	18:35:38
1	Cu 327.393	3980424.0	3981354.7	[6]	mg/L	18:36:06
2	Zn 206.200	1172581.1	1172622.1	[6]	mg/L	18:35:09
2	Pb 220.353	266184.6	266403.3	[6]	mg/L	18:35:25
2	Au 267.595	10411.8	6751.5	[0.06]	mg/L	18:35:48
2	Cu 327.393	4001160.8	4002091.5	[6]	mg/L	18:36:12
3	Zn 206.200	1182887.2	1182928.2	[6]	mg/L	18:35:12
3	Pb 220.353	267752.7	266011.3	[6]	mg/L	18:35:31
3	Au 267.595	10378.8	6718.4	[0.06]	mg/L	18:35:56
3	Cu 327.393	3981721.0	3982651.7	[6]	mg/L	18:36:15

Mean Data: Calib Std 3

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc.	Units
Zn 206.200	1173687.6	8756.64	0.75%	[6]	mg/L
Pb 220.353	265038.3	849.62	0.32%	[6]	mg/L
Au 267.595	6752.8	35.09	0.52%	[0.06]	mg/L
Cu 327.393	3988699.3	11616.10	0.29%	[6]	mg/L

Sequence No.: 5
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Initial Sample Wt:
Dilution:

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Data Type: Reprocessed on 11/19/2016 9:41:03 AM

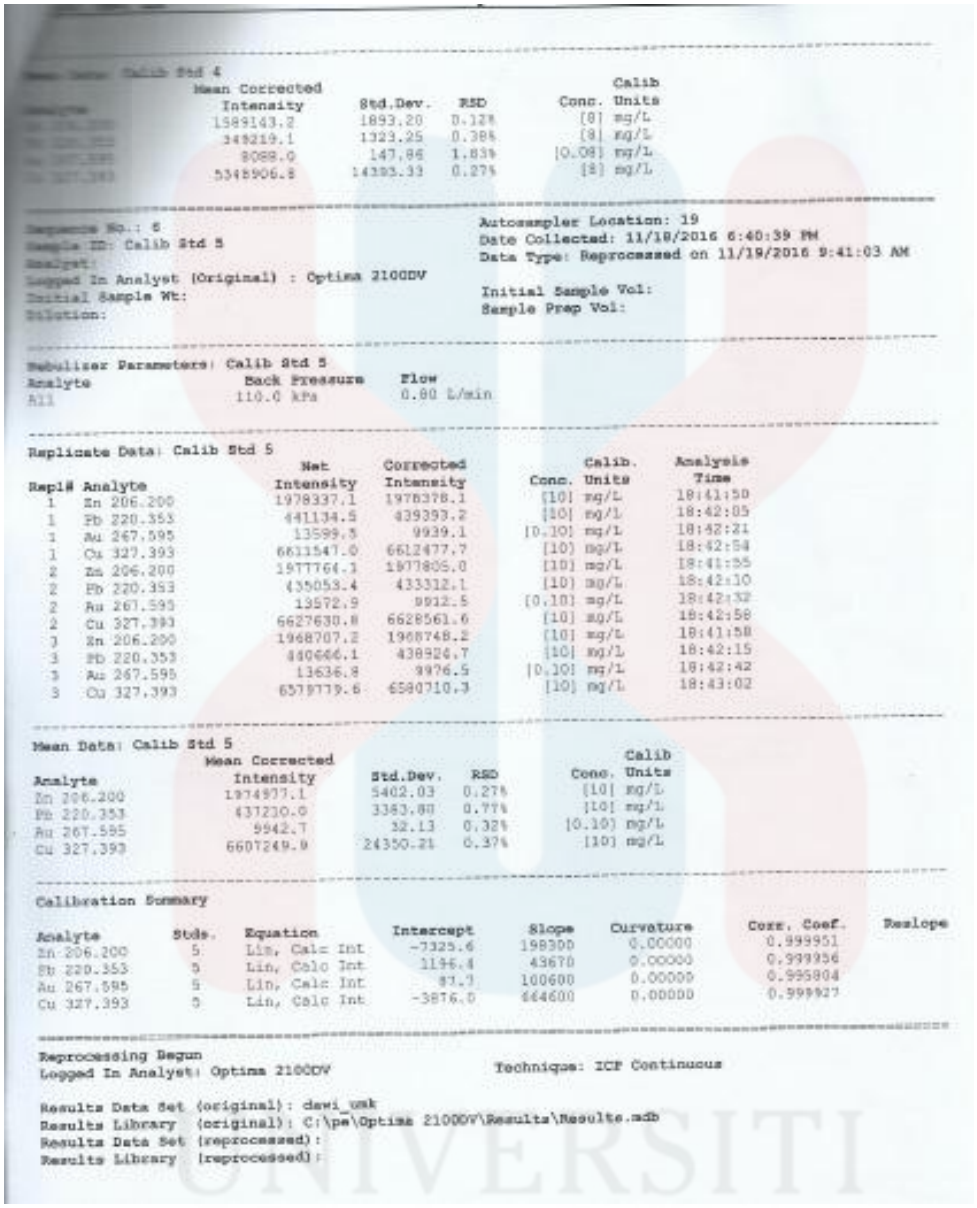
Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: Calib Std 4

Analyte	Back Pressure	Flow
All	109.0 kPa	0.80 L/min

Replicate Data: Calib Std 4

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Analysis Time
1	Zn 206.200	1587395.9	1587436.9	[8]	mg/L	18:38:24
1	Pb 220.353	349596.4	347855.1	[8]	mg/L	18:38:39
1	Au 267.595	11578.3	7917.9	[0.08]	mg/L	18:38:56
1	Cu 327.393	5332567.5	5333498.2	[8]	mg/L	18:39:30
2	Zn 206.200	1588771.8	1588812.7	[8]	mg/L	18:38:29
2	Pb 220.353	351046.3	349304.9	[8]	mg/L	18:38:45
2	Au 267.595	11846.7	8186.4	[0.08]	mg/L	18:39:08
2	Cu 327.393	5361074.8	5362005.5	[8]	mg/L	18:39:35
3	Zn 206.200	1591138.8	1591179.8	[8]	mg/L	18:38:32
3	Pb 220.353	352238.7	350497.4	[8]	mg/L	18:38:49
3	Au 267.595	11819.9	8159.6	[0.08]	mg/L	18:39:18
3	Cu 327.393	5350296.2	5351216.9	[8]	mg/L	18:39:38



Mean Data: Calib Std 4

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc.	Units
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	348219.1	1323.25	0.38%	[8]	mg/L
	8088.0	147.86	1.83%	[0.08]	mg/L
	5348906.8	14393.33	0.27%	[8]	mg/L

Sequence No.: 6
Sample ID: Calib Std 5
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 19
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Data Type: Reprocessed on 11/19/2016 9:41:03 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: Calib Std 5

Analyte	Back Pressure	Flow
All	110.0 kPa	0.80 L/min

Replicate Data: Calib Std 5

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Analysis Time
1	Zn 206.200	1978337.1	1978378.1	[10]	mg/L	18:41:50
1	Pb 220.353	441134.5	439393.2	[10]	mg/L	18:42:05
1	Au 267.595	13599.5	9939.1	[0.10]	mg/L	18:42:21
1	Cu 327.393	6611547.0	6612477.7	[10]	mg/L	18:42:54
2	Zn 206.200	1977764.1	1977805.0	[10]	mg/L	18:41:55
2	Pb 220.353	435053.4	433312.1	[10]	mg/L	18:42:10
2	Au 267.595	13572.9	9912.5	[0.10]	mg/L	18:42:32
2	Cu 327.393	6627630.8	6628561.6	[10]	mg/L	18:42:58
3	Zn 206.200	1968707.2	1968748.2	[10]	mg/L	18:41:58
3	Pb 220.353	440446.1	438924.7	[10]	mg/L	18:42:15
3	Au 267.595	13636.8	9976.5	[0.10]	mg/L	18:42:42
3	Cu 327.393	6579779.6	6580710.3	[10]	mg/L	18:43:02

Mean Data: Calib Std 5

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc.	Units
Zn 206.200	1974977.1	5402.03	0.27%	[10]	mg/L
Pb 220.353	437230.0	3383.88	0.77%	[10]	mg/L
Au 267.595	9942.7	32.13	0.32%	[0.10]	mg/L
Cu 327.393	6607249.9	24350.21	0.37%	[10]	mg/L

Calibration Summary

Analyte	Stds.	Equation	Intercept	Slope	Curvature	Corr. Coef.	Reslope
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Pb 220.353	5	Lin, Calc Int	1196.4	43670	0.00000	0.999956	
Au 267.595	5	Lin, Calc Int	81.7	100600	0.00000	0.999804	
Cu 327.393	5	Lin, Calc Int	-3876.0	664600	0.00000	0.999927	

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Technique: ICP Continuous

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Results Library (reprocessed):

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Sample Prep Vol:

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1	Pb 220.353	10449.5	8708.1	0.172	mg/L	0.172	mg/L	09:49:19
1	Au 267.595	4211.6	551.2	0.005	mg/L	0.005	mg/L	09:49:55
1	Cu 327.393	32727.7	33658.4	0.056	mg/L	0.056	mg/L	09:50:24
2	Zn 206.200	11284.9	11325.8	0.094	mg/L	0.094	mg/L	09:48:58
2	Pb 220.353	10366.9	8625.5	0.170	mg/L	0.170	mg/L	09:49:31
2	Au 267.595	4308.5	648.2	0.006	mg/L	0.006	mg/L	09:50:05
2	Cu 327.393	31906.6	32837.4	0.055	mg/L	0.055	mg/L	09:50:29
3	Zn 206.200	11217.2	11258.2	0.094	mg/L	0.094	mg/L	09:49:07
3	Pb 220.353	10340.5	8599.2	0.170	mg/L	0.170	mg/L	09:49:42
3	Au 267.595	4095.7	435.3	0.003	mg/L	0.003	mg/L	09:50:13
3	Cu 327.393	33283.5	34214.2	0.057	mg/L	0.057	mg/L	09:50:33

Mean Data: 1

Analyte	Mean Corrected Intensity	Calib. Conc.	Units	Std.Dev.	Sample Conc.	Units	Std.Dev.	RSD
Zn 206.200	11278.5	0.094	mg/L	0.0002	0.094	mg/L	0.0002	0.22%
Pb 220.353	8644.3	0.171	mg/L	0.0013	0.171	mg/L	0.0013	0.76%
Au 267.595	544.9	0.005	mg/L	0.0011	0.005	mg/L	0.0011	23.31%
Cu 327.393	33570.0	0.056	mg/L	0.0010	0.056	mg/L	0.0010	1.85%

Reprocessing Begun
Logged In Analyst: Optima 2100DV
Technique: ICP Continuous

Results Data Set (original): dawi_umk
Results Library (original): C:\pe\Optima 2100DV\Results\Results.mdb
Results Data Set (reprocessed):
Results Library (reprocessed):

Sequence No.: 1
Sample ID: 2
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 27
Date Collected: 11/19/2016 9:51:18 AM
Data Type: Reprocessed on 11/19/2016 9:55:48 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 2

Analyte	Back Pressure	Flow
All	109.0 kPa	0.80 L/min

Replicate Data: 2

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Sample Conc.	Units	Analysis Time
1	Zn 206.200	-9788.6	-9747.7	-0.012	mg/L	-0.012	mg/L	09:52:29
1	Pb 220.353	4679.2	2937.9	0.040	mg/L	0.040	mg/L	09:53:03

	Au 267.595	3818.9	158.5	0.001 mg/L	0.001 mg/L	09:53:38
1	Cu 327.393	14337.8	15268.5	0.029 mg/L	0.029 mg/L	09:54:07
2	Zn 206.200	-9842.3	-9801.3	-0.012 mg/L	-0.012 mg/L	09:52:40
2	Pb 220.353	4835.6	3094.2	0.043 mg/L	0.043 mg/L	09:53:15
2	Au 267.595	3955.5	295.1	0.002 mg/L	0.002 mg/L	09:53:48
2	Cu 327.393	15936.3	16867.0	0.031 mg/L	0.031 mg/L	09:54:12
3	Zn 206.200	-9816.7	-9775.8	-0.012 mg/L	-0.012 mg/L	09:52:51
3	Pb 220.353	4656.8	2915.5	0.039 mg/L	0.039 mg/L	09:53:26
3	Au 267.595	3909.5	249.2	0.002 mg/L	0.002 mg/L	09:53:57
3	Cu 327.393	14094.6	15025.3	0.028 mg/L	0.028 mg/L	09:54:16

Mean Data: 2

Analyte	Mean Corrected Intensity	Calib. Conc.	Units	Std.Dev.	Sample Conc.	Units	Std.Dev.	RSD
Zn 206.200	-9774.9	-0.012	mg/L	0.0001	-0.012	mg/L	0.0001	1.10%
Pb 220.353	2982.5	0.041	mg/L	0.0022	0.041	mg/L	0.0022	5.45%
Au 267.595	234.3	0.001	mg/L	0.0007	0.001	mg/L	0.0007	47.41%
Cu 327.393	15720.2	0.029	mg/L	0.0015	0.029	mg/L	0.0015	5.11%

Reprocessing Begun
Logged In Analyst: Optima 2100DV Technique: ICP Continuous

Results Data Set (original): dawi_umk
Results Library (original): C:\pe\Optima 2100DV\Results\Results.mdb
Results Data Set (reprocessed):
Results Library (reprocessed):

Sequence No.: 1
Sample ID: 3
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 28
Date Collected: 11/19/2016 9:55:01 AM
Data Type: Reprocessed on 11/19/2016 10:13:44 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 3

Analyte	Back Pressure	Flow
All	109.0 kPa	0.80 L/min

Replicate Data: 3

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Sample Conc.	Units	Analysis Time
1	Zn 206.200	-16777.5	-16736.5	-0.047	mg/L	-0.047	mg/L	09:56:12
1	Pb 220.353	5091.0	3349.6	0.049	mg/L	0.049	mg/L	09:56:47
1	Au 267.595	3767.0	106.6	0.000	mg/L	0.000	mg/L	09:57:21
1	Cu 327.393	24554.1	25484.8	0.044	mg/L	0.044	mg/L	09:57:54
2	Zn 206.200	-16835.0	-16794.1	-0.048	mg/L	-0.048	mg/L	09:56:23
2	Pb 220.353	4948.0	3206.7	0.046	mg/L	0.046	mg/L	09:56:59
2	Au 267.595	3845.1	184.7	0.001	mg/L	0.001	mg/L	09:57:32
2	Cu 327.393	23947.9	24878.6	0.043	mg/L	0.043	mg/L	09:57:59
3	Zn 206.200	-16788.0	-16747.1	-0.048	mg/L	-0.048	mg/L	09:56:34
3	Pb 220.353	4899.0	3157.7	0.045	mg/L	0.045	mg/L	09:57:09
3	Au 267.595	4007.8	347.5	0.003	mg/L	0.003	mg/L	09:57:42
3	Cu 327.393	24516.7	25447.4	0.044	mg/L	0.044	mg/L	09:58:02

Mean Data: 3

Analyte	Mean Corrected Intensity	Calib. Conc.	Units	Std.Dev.	Sample Conc.	Units	Std.Dev.	RSD
Zn 206.200	-16759.2	-0.048	mg/L	0.0002	-0.048	mg/L	0.0002	0.32%
Pb 220.353	3238.0	0.047	mg/L	0.0023	0.047	mg/L	0.0023	4.89%
Au 267.595	212.9	0.001	mg/L	0.0012	0.001	mg/L	0.0012	98.10%
Cu 327.393	25270.3	0.044	mg/L	0.0005	0.044	mg/L	0.0005	1.17%

Sequence No.: 2
Sample ID: 4
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 29
Date Collected: 11/19/2016 9:58:47 AM
Data Type: Reprocessed on 11/19/2016 10:13:44 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 4

Analyte	Back Pressure	Flow
All	110.0 kPa	0.80 L/min

Replicate Data: 4

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Sample Conc.	Units	Analysis Time
1	Zn 206.200	15961.1	16002.1	0.118	mg/L	0.118	mg/L	09:59:58
1	Pb 220.353	7242.0	5500.7	0.099	mg/L	0.099	mg/L	10:00:27
1	Au 267.595	4095.5	435.2	0.003	mg/L	0.003	mg/L	10:00:58
1	Cu 327.393	41533.5	42464.2	0.070	mg/L	0.070	mg/L	10:01:32
2	Zn 206.200	15700.0	15741.0	0.116	mg/L	0.116	mg/L	10:00:08
2	Pb 220.353	7404.7	5663.3	0.102	mg/L	0.102	mg/L	10:00:37
2	Au 267.595	4191.0	530.7	0.004	mg/L	0.004	mg/L	10:01:10
2	Cu 327.393	42259.8	43190.5	0.071	mg/L	0.071	mg/L	10:01:38
3	Zn 206.200	15865.8	15906.8	0.117	mg/L	0.117	mg/L	10:00:16
3	Pb 220.353	7203.2	5461.9	0.098	mg/L	0.098	mg/L	10:00:47
3	Au 267.595	4142.3	482.0	0.004	mg/L	0.004	mg/L	10:01:20
3	Cu 327.393	41689.9	42620.6	0.070	mg/L	0.070	mg/L	10:01:43

Mean Data: 4

Analyte	Mean Corrected Intensity	Calib. Conc.	Units	Std.Dev.	Sample Conc.	Units	Std.Dev.	RSD
Zn 206.200	15883.3	0.117	mg/L	0.0007	0.117	mg/L	0.0007	0.57%
Pb 220.353	5541.9	0.100	mg/L	0.0024	0.100	mg/L	0.0024	2.46%
Au 267.595	482.6	0.004	mg/L	0.0005	0.004	mg/L	0.0005	12.09%
Cu 327.393	42758.5	0.070	mg/L	0.0006	0.070	mg/L	0.0006	0.82%

Sequence No.: 3
Sample ID: 5
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 30
Date Collected: 11/19/2016 10:02:28 AM
Data Type: Reprocessed on 11/19/2016 10:13:44 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 5

Analyte	Back Pressure	Flow
All	110.0 kPa	0.80 L/min

Replicate Data: 5

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Sample Conc.	Units	Analysis Time
1	Zn 206.200	-12886.7	-12845.8	-0.028	mg/L	-0.028	mg/L	10:03:40
1	Pb 220.353	5684.7	3943.4	0.063	mg/L	0.063	mg/L	10:04:11
1	Au 267.595	4250.7	590.4	0.005	mg/L	0.005	mg/L	10:04:51
1	Cu 327.393	20151.7	21082.4	0.038	mg/L	0.038	mg/L	10:05:23
2	Zn 206.200	-12854.4	-12813.5	-0.028	mg/L	-0.028	mg/L	10:03:51
2	Pb 220.353	5704.0	3962.6	0.063	mg/L	0.063	mg/L	10:04:25
2	Au 267.595	4378.1	717.7	0.006	mg/L	0.006	mg/L	10:05:02
2	Cu 327.393	20463.9	21394.6	0.038	mg/L	0.038	mg/L	10:05:29
3	Zn 206.200	-12911.5	-12870.5	-0.028	mg/L	-0.028	mg/L	10:04:00
3	Pb 220.353	5733.2	3991.9	0.064	mg/L	0.064	mg/L	10:04:37

Au 267.595	4323.3	663.0	0.006 mg/L	0.006 mg/L	10:05:12
Cu 327.393	21329.6	22260.3	0.039 mg/L	0.039 mg/L	10:05:33

Mean Data: 5

Analyte	Mean Corrected Intensity	Calib. Conc.	Units	Std.Dev.	Sample Conc.	Units	Std.Dev.	RSD
Zn 206.200	-12843.2	-0.028	mg/L	0.0001	-0.028	mg/L	0.0001	0.52%
Pb 220.353	3965.9	0.063	mg/L	0.0006	0.063	mg/L	0.0006	0.88%
Au 267.595	657.0	0.006	mg/L	0.0006	0.006	mg/L	0.0006	11.22%
Cu 327.393	21579.1	0.038	mg/L	0.0009	0.038	mg/L	0.0009	2.40%

Sequence No.: 4
Sample ID: 6
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 31
Date Collected: 11/19/2016 10:06:19 AM
Data Type: Reprocessed on 11/19/2016 10:13:45 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 6

Analyte	Back Pressure	Flow
All	111.0 kPa	0.80 L/min

Replicate Data: 6

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Sample Conc.	Units	Analysis Time
1	Zn 206.200	7636.8	7677.8	0.076	mg/L	0.076	mg/L	10:07:30
1	Pb 220.353	16373.0	14631.7	0.308	mg/L	0.308	mg/L	10:08:05
1	Au 267.595	3921.4	261.0	0.002	mg/L	0.002	mg/L	10:08:36
1	Cu 327.393	33092.3	34023.0	0.057	mg/L	0.057	mg/L	10:09:09
2	Zn 206.200	7494.8	7535.8	0.075	mg/L	0.075	mg/L	10:07:42
2	Pb 220.353	16344.3	14603.0	0.307	mg/L	0.307	mg/L	10:08:17
2	Au 267.595	4017.8	357.5	0.003	mg/L	0.003	mg/L	10:08:48
2	Cu 327.393	33374.4	34305.2	0.057	mg/L	0.057	mg/L	10:09:15
3	Zn 206.200	7593.7	7634.7	0.075	mg/L	0.075	mg/L	10:07:52
3	Pb 220.353	16396.7	14655.3	0.308	mg/L	0.308	mg/L	10:08:25
3	Au 267.595	4021.0	360.7	0.003	mg/L	0.003	mg/L	10:08:57
3	Cu 327.393	33367.8	34298.5	0.057	mg/L	0.057	mg/L	10:09:19

Mean Data: 6

Analyte	Mean Corrected Intensity	Calib. Conc.	Units	Std.Dev.	Sample Conc.	Units	Std.Dev.	RSD
Zn 206.200	7616.1	0.075	mg/L	0.0004	0.075	mg/L	0.0004	0.49%
Pb 220.353	14630.0	0.308	mg/L	0.0006	0.308	mg/L	0.0006	0.20%
Au 267.595	326.4	0.002	mg/L	0.0006	0.002	mg/L	0.0006	23.73%
Cu 327.393	34208.9	0.057	mg/L	0.0002	0.057	mg/L	0.0002	0.42%

Reprocessing Begun
Logged In Analyst: Optima 2100DV

Technique: ICP Continuous

Results Data Set (original): dawi_umk
Results Library (original): C:\pe\Optima 2100DV\Results\Results.mdb
Results Data Set (reprocessed):
Results Library (reprocessed):

Sequence No.: 1
Sample ID: 7
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 32
Date Collected: 11/19/2016 10:10:04 AM
Data Type: Reprocessed on 11/19/2016 10:17:20 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 7

Analyte	Back Pressure	Flow
All	111.0 kPa	0.80 L/min

Replicate Data: 7

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Sample Conc.	Units	Analysis Time
1	Zn 206.200	-5945.1	-5904.1	0.007	mg/L	0.007	mg/L	10:11:16
1	Pb 220.353	6949.7	5208.3	0.092	mg/L	0.092	mg/L	10:11:50
1	Au 267.595	4015.2	354.8	0.003	mg/L	0.003	mg/L	10:12:29
1	Cu 327.393	21003.0	21933.7	0.039	mg/L	0.039	mg/L	10:13:02
2	Zn 206.200	-6054.3	-6013.3	0.007	mg/L	0.007	mg/L	10:11:27
2	Pb 220.353	6907.0	5165.6	0.091	mg/L	0.091	mg/L	10:12:03
2	Au 267.595	3940.7	280.4	0.002	mg/L	0.002	mg/L	10:12:40
2	Cu 327.393	20542.9	21473.6	0.038	mg/L	0.038	mg/L	10:13:07
3	Zn 206.200	-6078.0	-6037.0	0.006	mg/L	0.006	mg/L	10:11:37
3	Pb 220.353	6844.2	5102.8	0.089	mg/L	0.089	mg/L	10:12:15
3	Au 267.595	3989.7	329.4	0.002	mg/L	0.002	mg/L	10:12:50
3	Cu 327.393	21413.6	22344.3	0.039	mg/L	0.039	mg/L	10:13:11

Mean Data: 7

Analyte	Mean Corrected Intensity	Calib. Conc.	Units	Std.Dev.	Sample Conc.	Units	Std.Dev.	RSD
Zn 206.200	-5984.8	0.007	mg/L	0.0004	0.007	mg/L	0.0004	5.29%
Pb 220.353	5158.9	0.091	mg/L	0.0012	0.091	mg/L	0.0012	1.34%
Au 267.595	321.5	0.002	mg/L	0.0004	0.002	mg/L	0.0004	16.18%
Cu 327.393	21917.2	0.039	mg/L	0.0007	0.039	mg/L	0.0007	1.69%

Sequence No.: 2
Sample ID: 8
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 33
Date Collected: 11/19/2016 10:13:56 AM
Data Type: Reprocessed on 11/19/2016 10:17:20 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 8

Analyte	Back Pressure	Flow
All	111.0 kPa	0.80 L/min

Replicate Data: 8

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Sample Conc.	Units	Analysis Time
1	Zn 206.200	-18278.3	-18237.3	-0.055	mg/L	-0.055	mg/L	10:15:08
1	Pb 220.353	5675.6	3934.2	0.063	mg/L	0.063	mg/L	10:15:43
1	Au 267.595	3878.0	217.7	0.001	mg/L	0.001	mg/L	10:16:22
1	Cu 327.393	18298.7	19229.4	0.035	mg/L	0.035	mg/L	10:16:54
2	Zn 206.200	-18161.3	-18120.3	-0.054	mg/L	-0.054	mg/L	10:15:20
2	Pb 220.353	5684.8	3943.4	0.063	mg/L	0.063	mg/L	10:15:56
2	Au 267.595	3977.4	317.0	0.002	mg/L	0.002	mg/L	10:16:33
2	Cu 327.393	18094.1	19024.8	0.034	mg/L	0.034	mg/L	10:16:59
3	Zn 206.200	-18318.7	-18277.8	-0.055	mg/L	-0.055	mg/L	10:15:30
3	Pb 220.353	5666.6	3925.2	0.062	mg/L	0.062	mg/L	10:16:08
3	Au 267.595	3924.2	263.9	0.002	mg/L	0.002	mg/L	10:16:43
3	Cu 327.393	18092.6	19023.3	0.034	mg/L	0.034	mg/L	10:17:03

Mean Data: 8

Analyte	Mean Corrected Intensity	Calib. Conc.	Units	Std.Dev.	Sample Conc.	Units	Std.Dev.	RSD
Zn 206.200	-18211.8	-0.055	mg/L	0.0004	-0.055	mg/L	0.0004	0.75%

220.353	3934.3	0.063 mg/L	0.0002	0.063 mg/L	0.0002 0.33%
267.595	266.2	0.002 mg/L	0.0005	0.002 mg/L	0.0005 27.84%
327.393	19092.5	0.035 mg/L	0.0002	0.035 mg/L	0.0002 0.52%

Reprocessing Begun
Logged In Analyst: Optima 2100DV Technique: ICP Continuous

Results Data Set (original): ag
Results Library (original): C:\pe\Optima 2100DV\Results\Results.mdb
Results Data Set (reprocessed):
Results Library (reprocessed):

Method Loaded
Method Name: Ag Test Method Last Saved: 11/14/2016 6:57:34 PM
IEC File: MSF File:
Method Description: determination of sediment

Sequence No.: 1 Autosampler Location: 14
Sample ID: Calib Blank 1 Date Collected: 11/14/2016 7:06:36 PM
Analyst: Data Type: Reprocessed on 11/19/2016 10:26:02 AM
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt: Initial Sample Vol:
Dilution: Sample Prep Vol:

Nebulizer Parameters: Calib Blank 1

Analyte	Back Pressure	Flow
All	106.0 kPa	0.80 L/min

Replicate Data: Calib Blank 1

Repl#	Analyte	Net Intensity	Corrected Intensity	Conc.	Calib. Units	Analysis Time
1	Ag 328.068	-2987.2	-2987.2	[0.00]	mg/L	19:07:43
2	Ag 328.068	-2904.8	-2904.8	[0.00]	mg/L	19:07:53
3	Ag 328.068	-2952.2	-2952.2	[0.00]	mg/L	19:08:01

Mean Data: Calib Blank 1

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Conc.	Calib Units
Ag 328.068	-2948.1	41.39	1.40%	[0.00]	mg/L

Sequence No.: 2 Autosampler Location: 15
Sample ID: Calib Std 1 Date Collected: 11/14/2016 7:08:50 PM
Analyst: Data Type: Reprocessed on 11/19/2016 10:26:02 AM
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt: Initial Sample Vol:
Dilution: Sample Prep Vol:

Nebulizer Parameters: Calib Std 1

Analyte	Back Pressure	Flow
All	106.0 kPa	0.80 L/min

Replicate Data: Calib Std 1

Repl#	Analyte	Net Intensity	Corrected Intensity	Conc.	Calib. Units	Analysis Time
1	Ag 328.068	2034171.3	2037119.4	[2]	mg/L	19:09:53
2	Ag 328.068	2021874.8	2024822.8	[2]	mg/L	19:09:57
3	Ag 328.068	2029586.9	2032535.0	[2]	mg/L	19:10:00

Mean Data: Calib Std 1
Mean Corrected Calib

alyte	Intensity	Std.Dev.	RSD	Conc. Units
g 328.068	2031492.4	6214.23	0.31%	[2] mg/L

Sequence No.: 3
Sample ID: Calib Std 2
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 16
Date Collected: 11/14/2016 7:10:44 PM
Data Type: Reprocessed on 11/19/2016 10:26:03 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: Calib Std 2

Analyte	Back Pressure	Flow
All	107.0 kPa	0.80 L/min

Replicate Data: Calib Std 2

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc. Units	Analysis Time
1	Ag 328.068	4103244.3	4106192.4	[4] mg/L	19:11:47
2	Ag 328.068	4188930.1	4191878.2	[4] mg/L	19:11:51
3	Ag 328.068	4102004.5	4104952.6	[4] mg/L	19:11:55

Mean Data: Calib Std 2

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc. Units
Ag 328.068	4134341.1	49832.48	1.21%	[4] mg/L

Sequence No.: 4
Sample ID: Calib Std 3
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 17
Date Collected: 11/14/2016 7:12:39 PM
Data Type: Reprocessed on 11/19/2016 10:26:03 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: Calib Std 3

Analyte	Back Pressure	Flow
All	107.0 kPa	0.80 L/min

Replicate Data: Calib Std 3

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc. Units	Analysis Time
1	Ag 328.068	6128288.4	6131236.4	[6] mg/L	19:13:43
2	Ag 328.068	6057202.4	6060150.5	[6] mg/L	19:13:47
3	Ag 328.068	6103143.6	6106091.7	[6] mg/L	19:13:51

Mean Data: Calib Std 3

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc. Units
Ag 328.068	6099159.5	36046.40	0.59%	[6] mg/L

Sequence No.: 5
Sample ID: Calib Std 4
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 18
Date Collected: 11/14/2016 7:14:36 PM
Data Type: Reprocessed on 11/19/2016 10:26:03 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: Calib Std 4

Analyte	Back Pressure	Flow
All	107.0 kPa	0.80 L/min

Replicate Data: Calib Std 4

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Analysis Time
1	Ag 328.068	7356988.9	7359937.0	[8]	mg/L	19:15:39
2	Ag 328.068	7285338.7	7288286.7	[8]	mg/L	19:15:43
3	Ag 328.068	7300701.2	7303649.2	[8]	mg/L	19:15:47

Mean Data: Calib Std 4

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc.	Units
Ag 328.068	7317291.0	37722.83	0.52%	[8]	mg/L

Sequence No.: 6
Sample ID: Calib Std 5
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 19
Date Collected: 11/14/2016 7:16:32 PM
Data Type: Reprocessed on 11/19/2016 10:26:03 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: Calib Std 5

Analyte	Back Pressure	Flow
All	108.0 kPa	0.80 L/min

Replicate Data: Calib Std 5

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Analysis Time
1	Ag 328.068	11160863.2	11163811.3	[10]	mg/L	19:17:35
2	Ag 328.068	11118215.2	11121163.2	[10]	mg/L	19:17:40
3	Ag 328.068	11206275.0	11209223.0	[10]	mg/L	19:17:44

Mean Data: Calib Std 5

Analyte	Mean Corrected Intensity	Std.Dev.	RSD	Calib Conc.	Units
Ag 328.068	11164732.5	44037.13	0.39%	[10]	mg/L

Calibration Summary

Analyte	Stds.	Equation	Intercept	Slope	Curvature	Corr. Coef.	Reslope
Ag 328.068	5	Lin, Calc Int	-135917.0	1052000	0.00000	0.990028	

Sequence No.: 7
Sample ID: 1
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 26
Date Collected: 11/19/2016 10:18:04 AM
Data Type: Reprocessed on 11/19/2016 10:26:03 AM

Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 1

Analyte	Back Pressure	Flow
All	112.0 kPa	0.80 L/min

Replicate Data: 1

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Units	Sample Conc.	Units	Analysis Time

1	Ag 328.068	-9154.5	-6206.4	0.123 mg/L	0.123 mg/L	10:19:09
2	Ag 328.068	-9473.9	-6525.8	0.123 mg/L	0.123 mg/L	10:19:14
3	Ag 328.068	-9419.4	-6471.3	0.123 mg/L	0.123 mg/L	10:19:18

Mean Data: 1

Analyte	Mean Corrected Intensity	Calib. Conc. Units	Std.Dev.	Sample Conc. Units	Std.Dev.	RSD
Ag 328.068	-6401.2	0.123 mg/L	0.0002	0.123 mg/L	0.0002	0.13%

Sequence No.: 8
Sample ID: 2
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 27
Date Collected: 11/19/2016 10:20:03 AM
Data Type: Reprocessed on 11/19/2016 10:26:03 AM
Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 2

Analyte	Back Pressure	Flow
All	112.0 kPa	0.80 L/min

Replicate Data: 2

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc. Units	Sample Conc. Units	Analysis Time
1	Ag 328.068	2351.0	5299.1	0.134 mg/L	0.134 mg/L	10:21:06
2	Ag 328.068	2693.0	5641.0	0.135 mg/L	0.135 mg/L	10:21:10
3	Ag 328.068	1991.9	4939.9	0.134 mg/L	0.134 mg/L	10:21:14

Mean Data: 2

Analyte	Mean Corrected Intensity	Calib. Conc. Units	Std.Dev.	Sample Conc. Units	Std.Dev.	RSD
Ag 328.068	5293.4	0.134 mg/L	0.0003	0.134 mg/L	0.0003	0.25%

Sequence No.: 9
Sample ID: 3
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:

Autosampler Location: 28
Date Collected: 11/19/2016 10:21:59 AM
Data Type: Reprocessed on 11/19/2016 10:26:03 AM
Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 3

Analyte	Back Pressure	Flow
All	112.0 kPa	0.80 L/min

Replicate Data: 3

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc. Units	Sample Conc. Units	Analysis Time
1	Ag 328.068	3898.3	6846.4	0.136 mg/L	0.136 mg/L	10:23:03
2	Ag 328.068	4204.9	7152.9	0.136 mg/L	0.136 mg/L	10:23:07
3	Ag 328.068	3788.3	6736.3	0.136 mg/L	0.136 mg/L	10:23:10

Mean Data: 3

Analyte	Mean Corrected Intensity	Calib. Conc. Units	Std.Dev.	Sample Conc. Units	Std.Dev.	RSD
Ag 328.068	6911.9	0.136 mg/L	0.0002	0.136 mg/L	0.0002	0.15%

Sequence No.: 10
Sample ID: 4

Autosampler Location: 29
Date Collected: 11/19/2016 10:23:55 AM

Analyst:
Data Type: Reprocessed on 11/19/2016 10:26:03 AM
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Initial Sample Vol:
Dilution:
Sample Prep Vol:

Nebulizer Parameters: 4

Analyte	Back Pressure	Flow
All	112.0 kPa	0.80 L/min

Replicate Data: 4

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc. Units	Sample Conc. Units	Analysis Time
1	Ag 328.068	707.0	3655.0	0.133 mg/L	0.133 mg/L	10:24:57
2	Ag 328.068	380.2	3328.3	0.132 mg/L	0.132 mg/L	10:25:02
3	Ag 328.068	349.0	3297.0	0.132 mg/L	0.132 mg/L	10:25:07

Mean Data: 4

Analyte	Mean Corrected Intensity	Calib. Conc. Units	Std.Dev.	Sample Conc. Units	Std.Dev.	RSD
Ag 328.068	3426.8	0.132 mg/L,	0.0002	0.132 mg/L	0.0002	0.14%

Reprocessing Begun
Logged In Analyst: Optima 2100DV
Technique: ICP Continuous

Results Data Set (original): ag
Results Library (original): C:\pe\Optima 2100DV\Results\Results.mdb
Results Data Set (reprocessed):
Results Library (reprocessed):

Sequence No.: 1
Autosampler Location: 30
Sample ID: 5
Date Collected: 11/19/2016 10:25:52 AM
Analyst:
Data Type: Reprocessed on 11/19/2016 10:32:12 AM
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Initial Sample Vol:
Dilution:
Sample Prep Vol:

Nebulizer Parameters: 5

Analyte	Back Pressure	Flow
All	112.0 kPa	0.80 L/min

Replicate Data: 5

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc. Units	Sample Conc. Units	Analysis Time
1	Ag 328.068	-16040.7	-13092.7	0.117 mg/L	0.117 mg/L	10:26:56
2	Ag 328.068	-15637.2	-12689.1	0.117 mg/L	0.117 mg/L	10:27:01
3	Ag 328.068	-18538.4	-15590.4	0.114 mg/L	0.114 mg/L	10:27:06

Mean Data: 5

Analyte	Mean Corrected Intensity	Calib. Conc. Units	Std.Dev.	Sample Conc. Units	Std.Dev.	RSD
Ag 328.068	-13790.7	0.116 mg/L	0.0015	0.116 mg/L	0.0015	1.29%

Sequence No.: 2
Autosampler Location: 31
Sample ID: 6
Date Collected: 11/19/2016 10:27:52 AM
Analyst:
Data Type: Reprocessed on 11/19/2016 10:32:12 AM
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Initial Sample Vol:
Dilution:
Sample Prep Vol:

Nebulizer Parameters: 6

Analyte	Back Pressure	Flow
All	112.0 kPa	0.80 L/min

Replicate Data: 6

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Calib. Units	Sample Conc.	Sample Units	Analysis Time
1	Ag 328.068	-400.8	2547.3	0.132	mg/L	0.132	mg/L	10:28:55
2	Ag 328.068	-797.1	2151.0	0.131	mg/L	0.131	mg/L	10:28:59
3	Ag 328.068	-874.0	2074.1	0.131	mg/L	0.131	mg/L	10:29:04

Mean Data: 6

Analyte	Mean Corrected Intensity	Calib. Conc.	Calib. Units	Std.Dev.	Sample Conc.	Sample Units	Std.Dev.	RSD
Ag 328.068	2257.4	0.131	mg/L	0.0002	0.131	mg/L	0.0002	0.18%

Reprocessing Begun
Logged In Analyst: Optima 2100DV
Technique: ICP Continuous

Results Data Set (original): ag
Results Library (original): C:\pe\Optima 2100DV\Results\Results.mdb
Results Data Set (reprocessed):
Results Library (reprocessed):

Sequence No.: 1
Sample ID: 7
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:
Autosampler Location: 32
Date Collected: 11/19/2016 10:29:49 AM
Data Type: Reprocessed on 11/19/2016 10:33:26 AM
Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 7

Analyte	Back Pressure	Flow
All	112.0 kPa	0.80 L/min

Replicate Data: 7

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Calib. Units	Sample Conc.	Sample Units	Analysis Time
1	Ag 328.068	-3097.0	-149.0	0.129	mg/L	0.129	mg/L	10:30:54
2	Ag 328.068	-2226.4	721.7	0.130	mg/L	0.130	mg/L	10:30:58
3	Ag 328.068	-2684.0	264.1	0.129	mg/L	0.129	mg/L	10:31:02

Mean Data: 7

Analyte	Mean Corrected Intensity	Calib. Conc.	Calib. Units	Std.Dev.	Sample Conc.	Sample Units	Std.Dev.	RSD
Ag 328.068	278.9	0.129	mg/L	0.0004	0.129	mg/L	0.0004	0.32%

Sequence No.: 2
Sample ID: 8
Analyst:
Logged In Analyst (Original) : Optima 2100DV
Initial Sample Wt:
Dilution:
Autosampler Location: 33
Date Collected: 11/19/2016 10:31:47 AM
Data Type: Reprocessed on 11/19/2016 10:33:26 AM
Initial Sample Vol:
Sample Prep Vol:

Nebulizer Parameters: 8
Analyte Back Pressure Flow

112.0 kPa 0.80 L/min

Replicate Data: 8

Repl#	Analyte	Net Intensity	Corrected Intensity	Calib. Conc.	Calib. Units	Sample Conc.	Sample Units	Analysis Time
1	Ag 328.068	-109.0	2839.0	0.132	mg/L	0.132	mg/L	10:32:51
2	Ag 328.068	-586.9	2361.2	0.131	mg/L	0.131	mg/L	10:32:56
3	Ag 328.068	625.4	3573.5	0.133	mg/L	0.133	mg/L	10:32:59

Mean Data: 8

Analyte	Mean Corrected Intensity	Calib. Conc.	Calib. Units	Std.Dev.	Sample Conc.	Sample Units	Std.Dev.	RSD
Ag 328.068	2924.6	0.132	mg/L	0.0006	0.132	mg/L	0.0006	0.44%