GEOLOGY AND DEPOSITIONAL ENVIRONMENT OF THE OYO FORMATION IN NGALANG AREA, GEDANGSARI DISTRICT, GUNUNG KIDUL REGENCY, YOGYAKARTA, INDONESIA

By

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

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DECLARATION

I declare that this thesis entitled "**GEOLOGY AND DEPOSITIONAL ENVIRONMENT OF OYO FORMATION IN NGALANG AREA, GEDANGSARI DISTRICT, GUNUNG KIDUL REGENCY, ,YOGYAKARTA, INDONESIA**" 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 :

APPROVAL

"I/We hereby declare that I/we have read this thesis and in our opinion, this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Geoscience) with Honours"

Signature : ……

Name of supervisor :

Date :

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Date :

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Geology and Depositional Environment of Oyo Formation in Ngalang Area, Gedangsari District, Gunung Kidul Regency, Yogyakarta, Indonesia.

ABSTRACT

This study is conducted at Ngalang area that is located at Gedangsari district of Gunung Kidul Regency in Yogyakarta Special Region, Indonesia. This research is concern with objectives to produce and update a geological map of a study area (5km X 5km) with smaller scale 1:25 000 as the data from preliminaries study lasted on 1992 with larger scale which is 1:100 000. This research paper also conducted to interpret a facies association data collected in geological mapping of depositional environment of Oyo Formation. Stratigraphically, the study area is consists of Sambipitu formation, Oyo formation and Wonosari formation which in early to late Miocene. Methodology used for this research are geological and geomorphological mapping, remote sensing (ArcGIS) interpretation and laboratory analysis. General geology of study area and basic petrology which also include picture and description of sample in thin section under microscope also presented in this research paper. Geomorphology map, lithology and stratigraphy unit of Sambipitu formation, Oyo formation and Wonosari formation were discussed in this paper. Macrofossils and microfossils found in the study area also presented in this paper and were used as an advantage in order to gain more information and contribute a detail data regarding Oyo formation in Ngalang area. The depositional environment of the Oyo Formation is interpreted to be in the middle to outer ramp of shallow marine environment. The parameters used in data interpretation are facies association and foraminifera fossils analysis presence in the carbonates rocks in study area.

Keywords: Gunung kidul, Oyo Formation, middle ramp and outer ramp, shallow marine, foraminifera

Geologi dan Sistem Pengendapan Formasi Oyo di kawasan Ngalang, Daerah Gedangsari, Kabupaten Gunung Kidul, Yogyakarta, Indonesia.

ABSTRACT

Kajian ini dijalankan di kawasan Ngalang yang terletak di Kabupaten Gedangsari, Gunung Kidul, Daerah Istimewa Yogyakarta, Indonesia. Objektif bagi kajian ini adalah untuk menghasilkan dan mengemas kini peta geologi kawasan kajian (5km X 5km) dengan skala yang lebih kecil iaitu 1:25 000 kerana data terakhir dari kajian sebelum ini dijumpai pada tahun 1992 dengan skala yang lebih besar iaitu 1: 100 000. Selain dari itu, kertas penyelidikan ini dijalankan untuk mentafsir data analisa fasies yang dikumpulkan dalam pemetaan geologi dan geomorfologi bagi sistem pengendapan bagi kawasan persekitaran Formasi Oyo. Secara stratigrafinya, kawasan kajian terdiri daripada Formasi Sambipitu, Formasi Oyo dan Formasi Wonosari iaitu pada waktu awal hingga akhir Miosen. Metodologi yang digunakan untuk penyelidikan ini ialah pemetaan geologi dan geomorfologi, interpretasi pengesan jarak jauh (ArcGIS) dan analisis makmal. Geologi umum bagi kawasan kajian dan kajian petrologi asas bagi setiap unit batuan termasuk gambar dan sampel dalam bahagian nipis di bawah mikroskop juga dibentangkan dalam kertas penyelidikan ini. Peta geomorfologi, lithologi dan unit stratigrafi bagi Formasi Sambipitu, Formasi Oyo dan Formasi Wonosari turut dibincangkan dalam kertas kajian ini. Macrofossils dan mikrofosil yang terdapat di kawasan kajian ini juga dibentangkan di dalam kertas ini dan digunakan sebagai maklumat tambahan bagi mendapatkan lebih banyak maklumat dan menyumbang data yang baik mengenai pembentukan Oyo di kawasan Ngalang. Sistem pengendapan persekitaran di Formasi Oyo ditafsirkan berada di dalam kawasan tengah ke hujung terumbu permukaan laut yang cetek. Parameter yang digunakan bagi mentafsir data ialah pengumpulan data fasies dan analisa fossil foraminifera yang terdapat dalam batu karbonat di kawasan kajian.

Kata kunci: Gunung Kidul, Formasi Oyo, kawasan tengah hingga ke hujung laut dangkal, foraminifera

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CHAPTER 1

INTRODUCTION

1.1 General Background

Yogyakarta city is the capital of Yogyakarta Special Province which situated at the southern part of the volcanic arc island of Java. The geology of the city and province is controlled by active plate tectonic phenomena such as the active volcano and active subduction of Indo-Australia oceanic plate below the Euro-Asian continental plate (Karnawati, Pramumijoyo, & Hendrayana, 2006).

Yogyakarta city centre is located in a flat land at the slope of Merapi Volcano. In broader landscape, it is situated in between the Merapi Volcano and the South Sea or Indian Ocean which are considered as two significant elements in Javanese cosmology.

My study area is focusing in Ngalang, Gedangsari which is the administrative centre of Gunung Kidul Regency, in Yogyakarta Special Region on Java, Indonesia. Ngalang in Special Region of Yogyakarta is located in Indonesia about 452 km south-east of Jakarta, the country's capital town (Tripmondo, 2008-2018). Wonosari is bordered to the north by the district of Nglipar, to the east by the district of Karangmojo Semanu, to the south by the district of Tanjungsari, and the west by the districts of Paliyan and Playen to the west of Yogyakarta. My study area basically is a part of geopark as Yogyakarta is known as historically and culturally part of the Central Java.

Regional mapping for this research involve mainly the study of the structural geology, lithology and stratigraphy and also the geomorphology of the study area. Specifically, the research is more focusing on the depositional environment of Oyo Formation in my study area. The study is concerned with the basic geological mapping and geomorphological study.

The specification of this research involve measuring section at the Oyo formation in order to interpret and study regarding the depositional environment of Oyo Formation. Basically, the basic geological mapping is the preliminary approaches in order to update the map at the study area. In terms of geomorphologic study, we have to do the field observations around the study area and continue with the observation of the landform.

1.2 Study area

1.2.1 Base map of study area

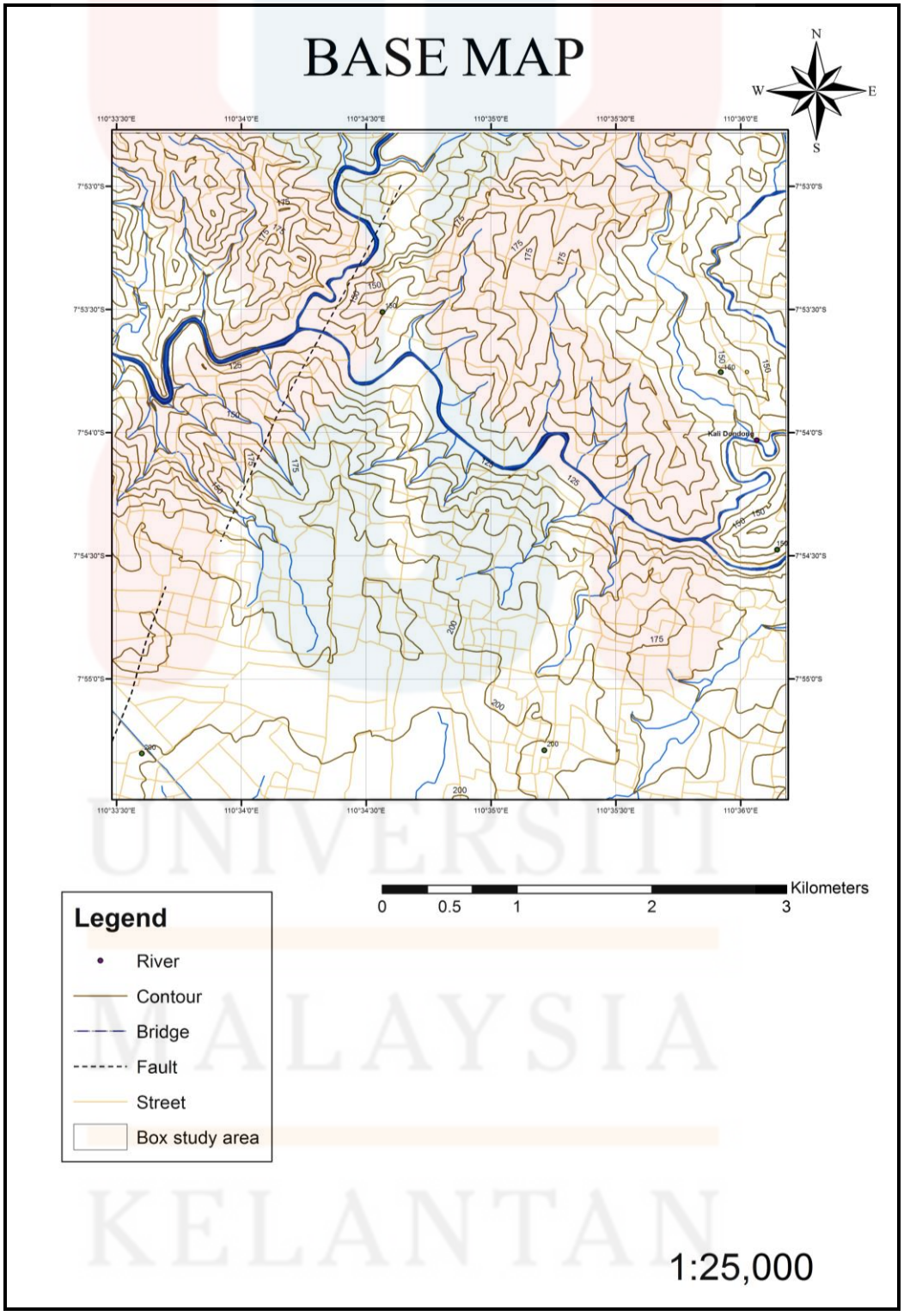


Figure 1.1 Base map of the study area

1.2.2 Accessibility

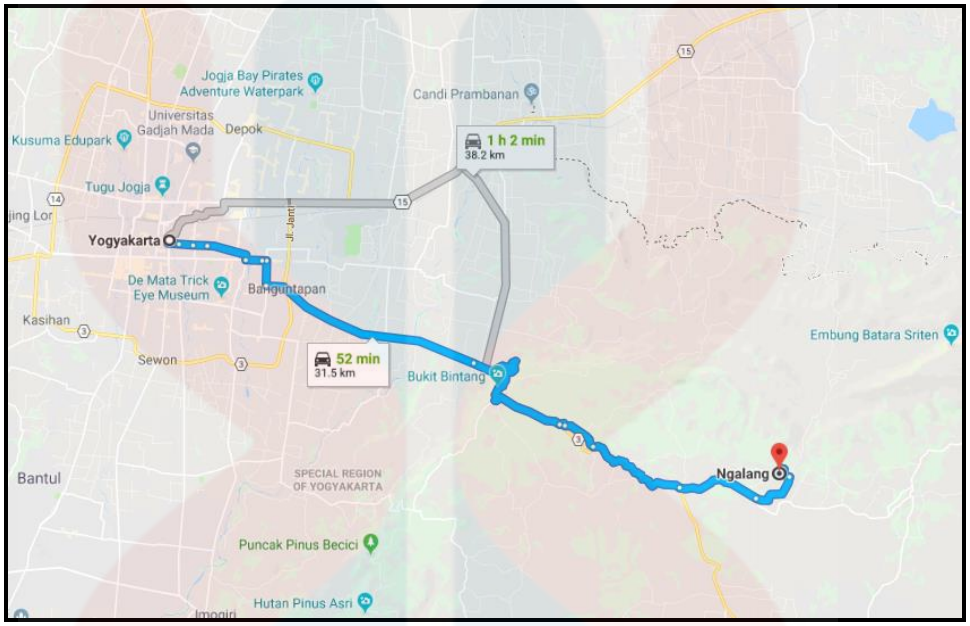


Figure 1.2 Accessibility to study area

Source: googlemaps

Ngalang is a rural area which locate quite far from the Yogyakarta city. Total distance of Ngalang area to the city of Yogyakarta is around 30-40 kilometres which it takes about 50 minutes to one hour. There is no train available from Yogyakarta to Ngalang area as it located a high hill area but there are many other vehicles such as bus, car and taxi that can be found.

In order to go to Ngalang area, usually motorcycle are used to access to a small area such as farm, small hill and to the forest. They usually use motorcycle in most places as the street is quite small and the geomorphology are consists of small hills and plantatio area.

1.2.3 Demography

Ngalang region is located in the district of Kabupaten Gedangsari Gunungkidul. Border area at the west of Ngalang region is Nglegi, Patuk, while the border at the east is Pengkol, Nglipar. Border area at the north of Ngalang region is Hargomulyo, Gedangsari while the border at the south is Gading, Playen.

Table 1.1 statistics of population in Ngalang region

No	Padukuhan	Jumlah KK	Jumlah Penduduk		
			Total	Laki-laki	Perempuan
1	BOYO	175	561	270	291
2	MAGIREJO	223	671	327	344
3	BUYUTAN	281	845	421	424
4	MANGGUNG	201	613	291	322
5	KARANGANYAR	217	678	331	347
6	SAMBENG	207	672	328	344
7	KARANG	170	490	239	251
8	SUMBERJO	263	841	422	419
9	PLOSODOYONG	307	990	479	511
10	NGALANG	181	522	245	277
12	NGLARAN	290	891	453	438
13	KENTENG	216	675	320	355
14	WARENG	118	386	206	180
15	NGASEM	165	533	276	257
JUMLAH		3 014	9 368	4 608	4 760

Source: Retrieved from https://desangalang.wordpress.com/about/ (2013, September 31)

Table 1.1 shows the statistic of the population in Ngalang region and the region around the study area on 31 September 2013. Based on the statistic, it shows that Ngalang's population is around 522 which consists of 245 man and 277 women. Ngalang region is one of the area that have a small population compare to the other area that have an average of 600 population.

Table 1.2 Data of villagers based on religion

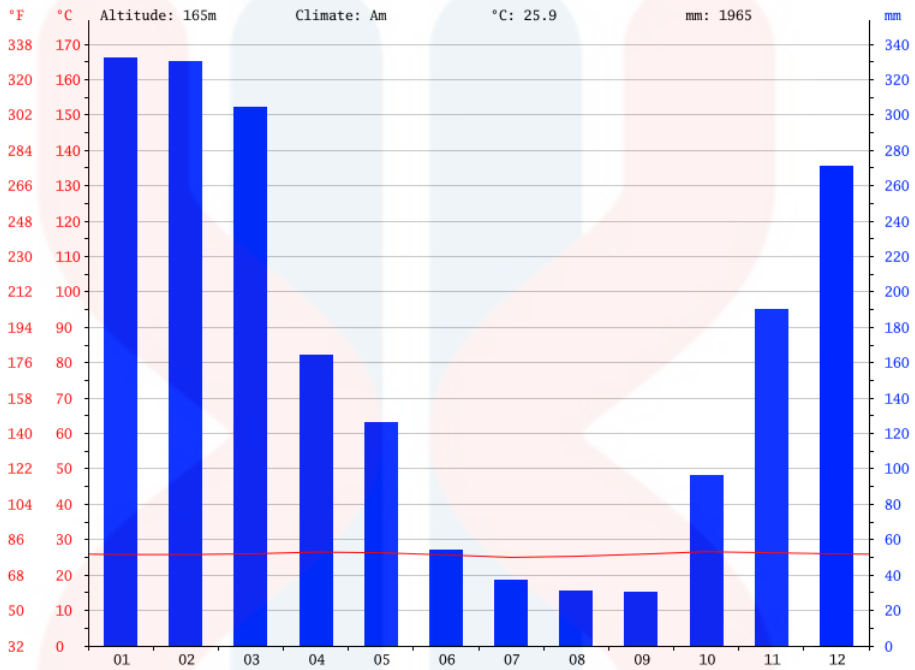
No	Agama	Jumlah
1	Islam	9.314
2	Kristen	32
3	Katholik	22
4	Hindu	–
5	Budha	–
6	Kepercayaan	–

Source: Retrieved from https://desangalang.wordpress.com/about/ (2013, September 31).

Based on table 1.2 that shows the data of the villagers based of the religion, most of the residents of Ngalang are Muslim and the others are Kristen and Katholik, while the other religion is rarely be found.

1.2.4 Climate and Rainfall distribution in Ngalang, Wonosari

Table 1.3 Climate and rainfall distribution in Ngalang area



Source: *CLIMATE-DATA.ORG*. (n.d.). Retrieved from https://en.climate-data.org/location/616496/

Table 1.3 shows the climate and rainfall distribution in Ngalang, Wonosari, Yogyakarta, Indonesia. Ngalang area has a tropical climate. There is significant rainfall in most months of the year. Therefore, the short dry season in that area has little effect on the overall climate. The average annual temperature in Ngalang is 25.9 °C. About 1965 mm of precipitation falls annually. The least amount of rainfall occurs in September. The average in this month is 30 mm. With an average of 332 mm, the most precipitation falls in January.

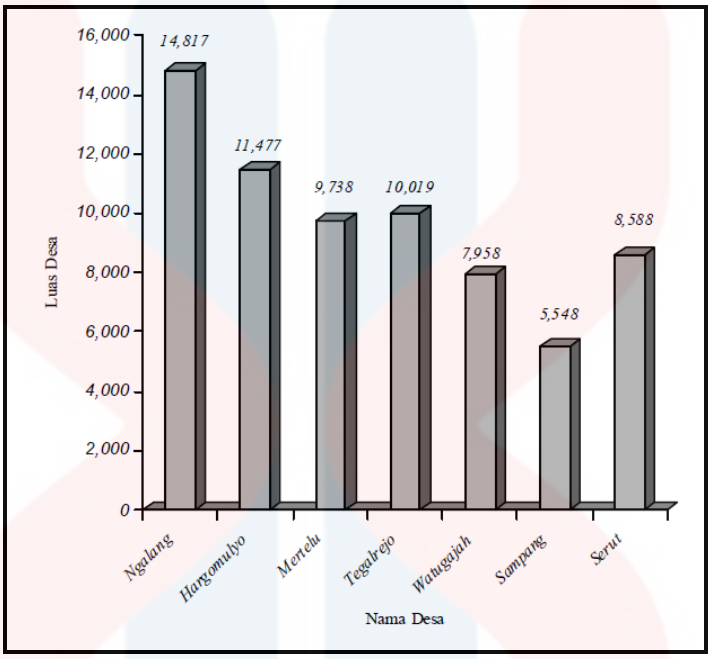
Table 1.4 Data of temperature in Ngalang area

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	25.8	25.8	26	26.5	26.3	25.7	25	25.3	25.9	26.6	26.3	26
Min. Temperature (°C)	22.4	22.3	22.4	22.4	22.1	21	20.3	20.3	21.3	22.2	22.4	22.4
Max. Temperature (°C)	29.2	29.4	29.7	30.7	30.5	30.4	29.7	30.3	30.6	31.1	30.2	29.6
Avg. Temperature (°F)	78.4	78.4	78.8	79.7	79.3	78.3	77.0	77.5	78.6	79.9	79.3	78.8
Min. Temperature (°F)	72.3	72.1	72.3	72.3	71.8	69.8	68.5	68.5	70.3	72.0	72.3	72.3
Max. Temperature (°F)	84.6	84.9	85.5	87.3	86.9	86.7	85.5	86.5	87.1	88.0	86.4	85.3
Precipitation / Rainfall (mm)	332	330	304	164	126	54	37	31	30	96	190	271

Based on table 1.4, it show that the temperatures are highest on average in October, at around 26.6 °C. While, July has the lowest average temperature of the year which is 25.0 °C.The variation in the precipitation between the driest and wettest months is 302 mm. During the year, the average temperatures vary by 1.6 °C.

1.2.5 Landuse

Table 1.5 Villages Area in Gedangsari District, Gunungkidul Regency 2008 (Ha)



Source retrieved from: https://anzdoc.com/kecamatan-gedangsari-dalam-angka-gedangsari-district-in-figu.html

Table 1.5 show the villages area in Gedangsari district which consists of Ngalang, Hargomulyo, Mertebu, Tegalrejo, Watugajah, Sampang and Serut. Ngalang has the largest amount area which is about 14 817 hektar compare to the other village which have the smaller area. Other villages total area is mostly have less than 10 000 Ha excepts for Ngalang, Hargamulyo and Tegalrejo.

Table 1.6 Landuse area of village by Area in Gedangsari District (Ha)

Desa *Villages*		Tanah Sawah *Wetland*	Tanah Kering *Dryland*	Bangu-nan *Building*	Hutan Rakyat *Public Forest*	Hutan Negara *Country Forest*	Lainnya *Others*	Jumlah */Total*
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Ngalang		198,4	781,9	375,4	-	-	126,0	1481,7
2. Hargomulyo		472,7	385,1	221,3	-	-	68,6	1147,7
3. Mertelu		185,7	319,9	322,8	-	-	145,4	973,8
4. Tegalrejo		90,6	485,2	375,1	31,9	-	19,1	1001,9
5. Watugajah		28,6	443,7	241,4	3,4	-	78,7	795,8
6. Sampang		160,2	255,1	106,6	-	-	32,9	554,8
7. Serut		180,5	412,7	210,0	-	-	55,6	858,8
Jumlah *Total*	2009	1316,7	3083,6	1852,6	35,3	-	526,3	6814,5
	2008	1316,7	3083,6	1852,6	35,3	-	526,3	6814,5

Source retrieved from: (BPS - Statistics of Gunungkidul Regency , 2009)

Ngalang villages consists of 781.9 Ha of Dryland. Based on table 1.5, main social economic at Ngalang area is farmer and gardener which explain why the largest area in Ngalang is a dryland. Dryland farming and dry farming are agricultural techniques for non-irrigated cultivation of crops. Dryland farming is associated with drylands - dry areas characterized by a cool wet season followed by a warm dry season. Examples of farm in dryland are rubber tree, cane, corn, soybean and other fruits or vegetable that can be planted in dryland.

About 375 Ha in Ngalang area is consists of building. The building include, officers, mall, tower and houses. While around 198 Ha is wetland which may being used to planted paddy.

1.2.6 Social economics

Table 1.7 Data statistics of villagers based on jobs

No	JENIS PEKERJAAN	JUMLAH
1	FARMER/GARDENER	3 316
2	UNEMPLOYED	1 891
3	STUDENTS	1 138
4	ENTREPRENEUR	906
5	CASUAL WORKER	886
6	MENGURUS RUMAH TANGGA	614
7	PRIVATE EMPLOYEES	422
8	GOVERNMENT EMPLOYEES	65
9	RETIRED	34
10	VILLAGE HEAD	23
11	TRADER	18
12	TEACHER	18
13	DRIVER	10
14	POLICE	9
15	INDONESIAN NATIONAL ARMY	4
16	EMPLOYEE HONORER	3
17	WASTE MANUFACTURER / PLANTATION	2
18	USTADZ/MUBALIGH	2
19	LECTURER	1
20	NURSE	1

Source: Retrieved from https://desangalang.wordpress.com/about/

Table 1.5 represent the statistics data of the villagers based on jobs. The data shows that the main occupation in the study area is farmers and gardener while the amount of unemployed and students in the study area is about the same.

1.3 Problem Statement

Various studies have being conducted in Yogyakarta as it is full with history and related to many geological factor. This can be relate to its location which situated at the southern part of the volcanic arc island of Java. The geology of the city and province is controlled by active plate tectonic and exposed to the phenomena such as the active volcano and active subduction of Indo-Australia oceanic plate below the Euro-Asian continental plate.

General geology of Ngalang might undergo some changes due to the major or minor natural processes of the Earth. Therefore, an update of geological map of Ngalang area is necessary.

The geological map of the study area with smaller scale were limited as the recent updated map on Gunung Kidul regency are lasted on 1992 with the scale 1: 100 000. The preliminaries study on Ngalang area were quite difficult as there were not much researched were done in the study area.

1.4 Expected Outcome

The outcome of this research is to improve the geological study on the study area. Therefore the geological map in Ngalang, Gedangsari can be improved based on the recent research and geological mapping in the study area.

Besides that, the study is conduct in order to observe and identify the depositional environment of Oyo Formation at the study area. Geological and geomorphological mapping at study area will be done in order to identify and to study in detail regarding Oyo formation and relationship with the other formation in Ngalang, Gedangsari, Yogyakarta.

1.4 Objectives

- To produce a geological map of the study area with the scale of 1:25 000
- To analyse depositional environment of Oyo formation in Ngalang area, Gedangsari district, Gunung Kidul regency, Yogyakarta, Indonesia

1.5 Scope of Study

This study focuses on research and study of depositional environment in Ngalang area. The aspects that will be study are lithology, sedimentology, stratigraphy, geomorphology and structural geology elements found on field. Besides that, geological data found on field such as fossils and sedimentology structures will be record and interpret to relate with the depositional environment in the study area.

One of the important methods that will assist this study are geological mapping, identifying of fossils and thin section of the sample. Geological mapping will help to obtain the data in order to produce geological map, describe structural geology and everything that relate to geology.

1.6 Significant of Study

The sedimentology and stratigraphy of study area will be describe and summarized by integrating the sedimentology facies and depositional environment within the study area. Based on this study, the geological map with 1:25 000 scale will be produce and it will be more detail compared to the previous research data as it more focusing in Ngalang area with larger scale. This study will help the readers to identify and gain information regarding the past environment of study area and also help interpreting data in relate with fossils and other geological features found on field.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In Depositional sedimentary environment book by Professor Dr. Hans-Erich Reineck Dr. Indra Bir Singh explain about the depositional environment. It state that there is a wide range of geological environments which can be study and interpret such as environment of igneous rocks and environment of metamorphic rocks and minerals. Environment of igneous rocks relate to the physic-chemical environment while environment of metamorphic rocks and minerals is more dealing with the study of stability of rocks and minerals under various pressure and temperature conditions (HE Reineck, 1980). Usually study of depositional environment is more focusing on metamorphic rocks as it also involve and more relate to the study of erosional, and depositional processes under the condition of hydrodynamic, biological, and chemical conditions a given rock were deposits. Depositional environment is more interesting to geologist compare to erosional environment as state in Depositional Sedimentary Environment book as it can be defined in terms of physical, biological, chemical or geomorphic variables.

2.2 Geological method

In geological mapping, there are many method used in order to gain and collect data in the study area such as geological mapping and geomorphological mapping. Geological structure were recorded and measure as they are important to understanding a geological history of a region (Steven Earle, 2015). Measuring a stratigraphic secrion is a best method in order to interpret a depositional environments in term of variations in sediment type and changes in sedimentation rate in space and time. Data recorded for measuring a stratigraphic section are include an accurate thickness of bedding, characteristics of lithology for each bedding and also each rock type present to get detailed interpretation in depositional environment at that region (Robert R., 1985).

Geological mapping were done as the geologic mapper strives to collect a data in order to understand the composition and the structure of geological event and material at the Earth's surface and also at depth (David R.Soller, 2004). Data on field were recorded on field notebooks which refer to their observations which including sketches, measurements (for example, the angle of tilted strata), note the environment at that area.

Geomorphological mapping is important and appropriate ways in order to show a spatial distriction of landforms, surface and near-surface deposits, processes that acted on landforms and also the time of the action of these processes.

2.3 Regional Geology and tectonic setting

Indonesia is one of the country that popular with its geological events as it is located above the grinding and mashing of several tectonic plates, with an active volcanoes and located in one of the most volatile regions in the world (Israel, 2010). The world's greatest earthquake belt is The Pacific Ring which basically called as the Circum-Pacific belt due to its series of fault lines stretching about 40 000 kilometres from Chile in the Western Hemisphere through Japan and Southeast Asia.

Usually, earthquake occur along the fault line which breaks in the rocky plates of the Earth's crust. Most of the largest earthquake strike along the Ring of Fire while some of them occur along the Alpide belt. Indonesia lying between the Pasific Ring of Fire along the northeast and the Alpide belt along the south and west from Sumatra down to Timor.

In broad tectonic setting this area is classified as outer arc basin, and it is a megatectonic feature associated with all island arc systems and may vary considerably in its complexity. The area contains two Neogene sedimentary basins whose structural outlines were determined during a Late Oligocene phase of folding, faulting and volcanism. The basins were filled with clastics of deep marine facies. The high areas surrounding the depocenters were covered mainly by an incomplete section of Neogene shallow marine limestones (including reefs). Three Neogene tectonic events of possibly regional importance are deduced from stratigraphic and seismic records: a minor Early Miocene event, a Mid Miocene event, and a Late Pliocene event. None of these events however, has considerably deformed the offshore Neogene.

South of Central Java the deeper part of the outer arc basin proper shallows steadily northwards and seismic records show that a “basement” ridge and sediment filled basin are traversed before reaching the Java coast. A simplified mega-structural sense be considered part of the “southern mountains” of west and east Java which in the broad embayment south of Central Java runs beneath the sea (Bolliger & De Ruiter, 1975).

Yogyakarta is located at the Central Java which is the central part of Java Island. There are many active volcanoes that can be found in Yogyakarta. As Yogyakarta situated at the southern part of the volcanic arc island of Java, the geology of the city and province is controlled by active plate tectonic and exposed to the phenomena such as the active volcano and active subduction of Indo-Australia oceanic plate below the Euro-Asian continental plate. As the subduction continued, it also resulted in the formation of the active Merapi volcano and also brought about the formation of morphology of volcanic and carbonate rocks.

Apparently, based on preliminary study, it also discuss about the geological conditions in the city and province give rise to the specific geo-resources and geo-hazards phenomena that significantly control the life and environment in the province and city. Advantages which obtained from the geo-resources and also the threats due to geo-hazards also being discussed in the article of Geology of Yogyakarta, Java: The dynamic volcanic. Product obtained by the volcanic products which abundance and good quality such as fertile soils, valuable minerals, and groundwater are considered geo-resources which give benefits and fulfil human needs. Geo-hazards, such as landslides, floods, volcanic eruption, earthquake, and

tsunamis, are the geological processes which threaten human life due to its potential negative impact to destroy the structures and be harmful for people.

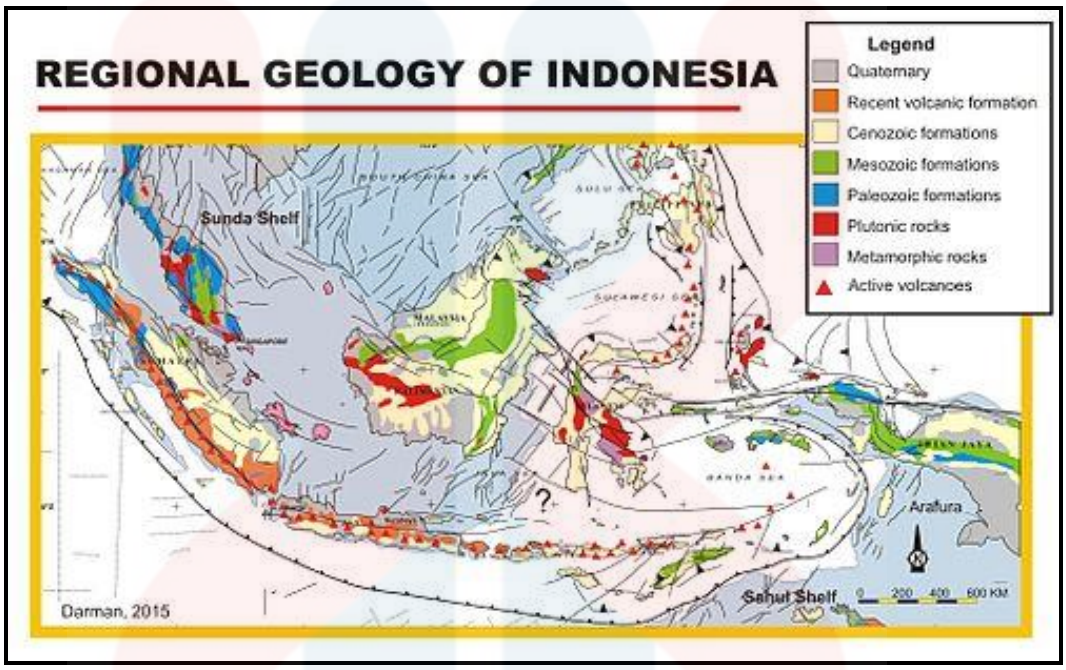


Figure 2.1 Regional geology of Indonesia

2.4 Structural Geology

An active margin of the interaction between Eurasia continental plate and Indian oceanic plate that converge since Cretaceous to each other have occupies Java Island. Due to the convergence event, the main tectonic elements that resulted are subduction trenches, magmatic-volcanic arcs, accretionary prisms and back-arc and fore-arc basins. The basement rocks are covered by the sedimentary and volcanic-clastic rocks intruded by some magmatic intrusions. While, Central Java occupies a transition between dominantly continental basement at West Java and dominantly intermediate basement at East Java.

Gunungkidul regency consists of is divided into three development zones which are North zone, Central zone and South zone. North Zone or also called as Batur Agung region has an altitude of 200 m - 700 m above sea level. This zon has higher elevation compare to the other zone. This area includes Patuk district, Gedangsari district, Nglipar district, Ngawen district, Semin district, and Ponjong district in the northern part.

Next is Central Zone and also called as Ledok development Wonosari region, with an altitude of 150 m - 200 m above sea level. This area includes Playen district, Wonosari district, Karangmojo district, Ponjong district in the middle part and Semanu district in the northern part. Lastly is South Zone called a Thousand Mountain area development which has an altitude of 0 m - 300 m above sea level. The South Zone includes Saptosari district, Paliyan district, Girisubo district, Tanjungsari district, Tepus district, Rongkop district, Purwosari district, Bake district, Ponjong district in the southern part, and Semanu district in the southern part (Culture and tourism potential of Gunungkidul Regency, 2016).

2.5 Historical Geology

Gunungkidul regency is influenced by the existence of the karst of Seribu Mountain Range. Mostly of the region consists a formation of limestone. On the west part that borders Bantul there are folded zones that also become physical hindrance to access to Gunungkidul Regency. While on the north zone which is a Baturagung Mountain Range, there are geological formations of andesite at Gunungwungkal, Wuni, Semilir, Nglangran and Mandalika (Arisumarsono, 2014).

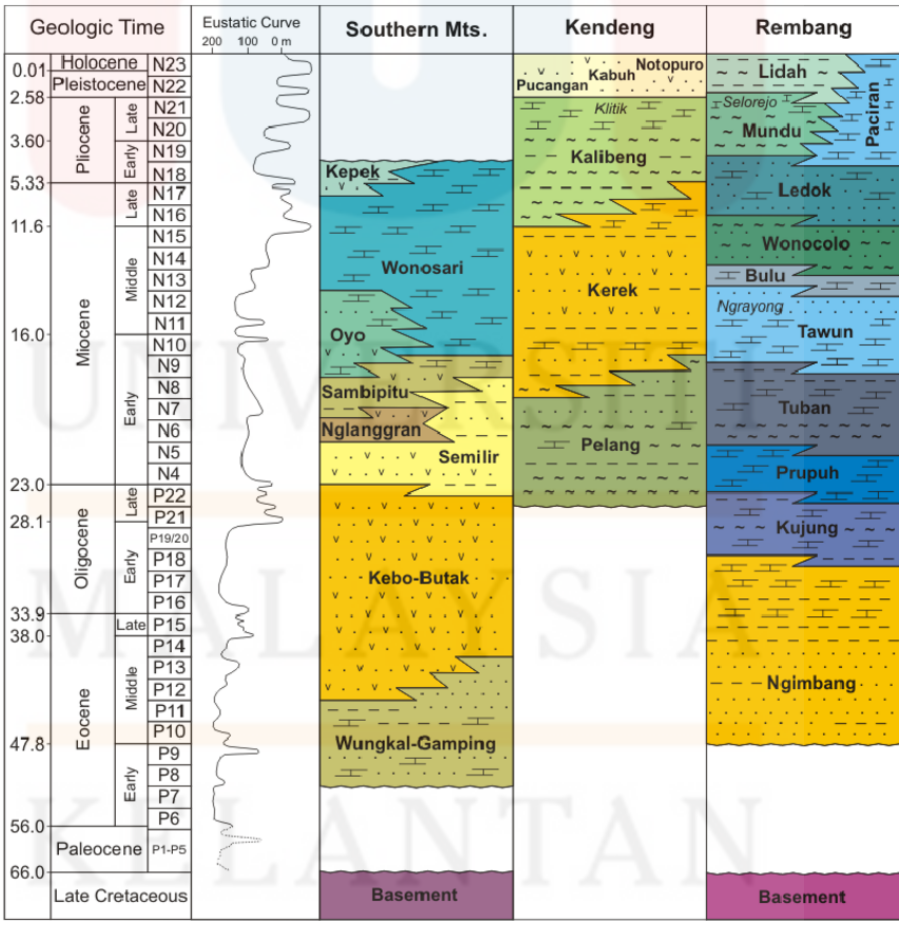
Physiographically, the Gunung Kidul karst is part of the southern plateau of Java Island. While, Geologically it is dominated by Miocene limestones of the Wonosari Formation, which consists of massive coral reef limestones in the south and bedded chalky limestones in the north (Haryono & Day, August 2004). Based on preliminaries study, it state that Wonosari Formation was uplifted during the late Pliocene and/or early Pleistocene and dips gently southward at about a 2% gradient.

North-south compression associated with tectonic plate convergence produced deformation including intensive northwest-southeast and northeastsouthwest jointing and faulting (Balazs 1968; van Bemmelen 1970; Surono et al. 1992; Sutoyo 1994). The structure is most complex along the northern boundary, and the northeastern part was downfaulted, forming the Wonosari Basin, within which karstification is limited. The prevailing contemporary climate in the Gunung Kidul is strongly influenced by the Northwest and Southeast monsoons, which produce a distinct wet season from October to April and a dry season, which may be extremely arid, between May and September.

2.6 Stratigraphy

Stratigraphy from the oldest to the youngest of Gunungkidul regency are composed of Semilir formation, Nglanggran formation, Sambipitu formation, Oyo formation, Wonosari formation, Kepek formation, and locally Terrarosa deposit (Kusumayudha S. B., Setiawan, Ciptahening, & Septianta , 2015). Semilir formation, Nglanggran formation and sambipitu formation are consists of combination of igneous and sedimentary rocks that affected by volcanic activity from the age of oligomiocene to Middle Miocene. While Oyo formation and Wonosari formation are mostly composed of limestone.

Table 2.1 Stratigraphy of formation in Yogyakarta



(Husein, 2015)

Ngalang area is around the age from early to late of Miocene. Semilir formation, Nglanggran formation and Sambipitu formation are the formation from the early Miocene. Oyo formation is in early to middle Miocene while Wonosari formation is from middle to late Miocene age.

Stratigraphically, southern mountain which located along the southern part of Jawa Island are formed by a mixture of clastic sediments**,** carbonates and volcanic materials. It also can be divided into three major periods of sedimentary processes which are prevolcanism, syn-volcanism and post-volcanism periods (Surono & Permana, Litostratigraphic and Sedimentological Significants of Deepening Marine Sediments of the Sambipitu Formation Gunung Kidul Residence, Yogyakarta , June 2011)**.**

In postvolcanism sequence, Sambipitu Formation is a lowest unit and it is spread along the southern slope of the Baturagung Mountains. Sambipitu Formation is conformably underlain by dominated unit of marl of the Oyo formation. The lithostratigraphy of Sambipitu Formation indicates as a transitional zone between the volcanic activity and carbonate sedimentary process. The volcanic products and activity believed to end at the Sambipitu Formation while starting with Oyo formation the carbonate sedimentary start to dominate.

2.7 Depositional environment

Based on preliminaries studies, Kebo-Butak Formation is Late Olgocene and earlymost Miocene in age and deposited in an open marine environment (Satyana & Purwaningsih, Oligo-Miocene Carbonates of Java : Tectonic Setting and Effects of Volcanism, 2003). Sambipitu formation is a marine sediment in which is influenced by turbid currents. (D. Santy, A. Koesworo, R. Fakhruddin, R. Setiawan, & D. Irawan, 2007). The interpretation was made based on the patters of lithologic sequences and mixed shallow marine fauna and deep sea in several places. Oyo members from Wonosari formation are generally recognisable in the field as a layered limestone rich with ichnofossil. Ichnofossil is a trace fossil, such as that of an animal's track or burrow that found in field.

Based on preliminaries studies on journal and articles, there are several information which explain regarding a Sambipitu formation. Stratigraphy of Sambipitu formation is mainly dominated unit of volcanic breccias of Nglanggran formation and overlain by dominated unit of marl of the Oyo formation. Sambipitu Formation also can be divided into lower member and also upper member. Lower member is dominated by sandstone and siltstone which alternated by breccias while upper member is dominated by siltstone and mudstone and intercalated by sandstone, marl and conglomerate. Lower member of Sambipitu formation is deposited on an environment influenced by tidal current which was lightly affected by gravity flows of volcanic material. This depositional environment was setting deeper to be an inner shelf, were upper member was deposit.

Entering the Middle Miocene, sea has reached maximum transgression and carbonate deposition and development started to replace the volcaniclastic

dominance. The declined in volcanism and increasing in transgression during the Middle Miocene had provided good environment for development of carbonate sedimentation (Satyana & Purwaningsih, Oligo-Miocene Carbonates of Java : Tectonic Setting and Effects of Volcanism, 2003). In early Middle Miocene, the interbedded of carbonates starting to begin along with the Sambipitu turbidites, It continued with Oyo Formation which shows firstly in the area the contemporaneous sedimentation between carbonate and volcanism as expressed by wellbedded tuffaceous limestones, tuffaceous marls, and andesitic tuffs.

In Middle-Late Miocene, Wonosari Formation which consists of carbonated bedded and reefs that interbedded with tuffaceous sandstones, tuffaceous and marly limestones, and siltstones started to appear. The dominance of carbonate sedimentation over volcanism is shown by thick bedded. Paleogene volcanics is considered to provide sites for shallow-water Wonosari reefs. To the north of the Wonosari formation, extensive subaerial and subaqueous andesitic volcanism took place along an island-arc. South of the volcanically active island-arc, in a forearc setting, a shallow-water carbonate platform developed under moderate to high energy conditions.

Volcaniclastic sediments derived from the volcanic-arc north of the area initially dominated deposition in this basin. These sediments were emplaced by debris flows, turbidity currents and as subaerial ash falls. Later there was a reduction in volcaniclastic activity and deposition of redeposited carbonates derived from the shallow marine platform south of the basin occurred. These carbonates were emplaced as a series of turbidites. Where the volcaniclastic and carbonate lithologies interacted an inter-fingering relationship developed. However, in some localities

extensive bioturbation has resulted in the mixing of sediments (Lokier, The Development of the Miocene Wonosari Formation, South Cenral Java, October 1999).

2.7.1 Lithology

Kebo Putak lithology made up of andesitic to dacitic tuffaceous shale, fine bedded fine bedded silts, sandstones, conglomerates and tuffites while basaltic andesite sills was intruded between the sequence. Andesitic to basaltic lava is found in the middle part while andesitic breccia is in the upper part. Kebo Putak formation believed in a late Oligocene to early Miocene in age (Satyana & Purwaningsih, Oligo-Miocene Carbonates of Java : Tectonic Setting and Effects of Volcanism, 2003).

Semilir Formation is overlying the Kebo Putak formation and age around early Miocene. It consists of white tuffaceous material alternating with bright tuffites, clayey glass tuffs and pumice-tuff breccias. Next, interfingering with the Semilir Formation, is the Nglanggran Formation that comprising of volcanic breccia, agglomerate, poorly bedded tuff, and andesitic to basaltic pillow lava, and ‘autoclastic’ and ‘hyaloclastic’ breccia. Nglanggeran formation age around early to middle Miocene. Nglanggeran formation is conformably overlain by sambipitu formation that comprises marl, claystone, calcareous siltstone, calcareous sandstone and tuffaceous sandstone.

Oyo formation is spread around Oyo river valley between the Baturagung Mountain and the hills of Nglanggeran and the Wonosari ridges. It conformably overlays Sambipitu formation. The unit lithology is composed of alternating tuffs of sandstone with volcanic-limestone or silt size of the central and upper carbonates clay interbedded while at the bottom part there are limestone insertation (Prastistho, Massora, Rodhi, C.Prasetyadi, & Pratiknyo). In the other sources, Oyo formation also consists of calcarenite, bedded limestone, calcareous sandstone and tuffaceous-calcareous sandstone and the age of the formation is Middle Miocene to Mio-Pliocene. Next is Wonosari formation consists of reef, massive and bedded limestones that age from Middle Miocene to Pliocene (Kusumayudha S. B., Setiawan, Ciptahening, & Septianta , 2015).

2.7.2 Depositional Environment of Sambipitu Formation

At the Lower Member of Sambipitu Formation, the sedimentary structures found are erosion surfaces, normal gradded, planar cross-beds, parallel lamination, wavy beddings, lenticular beds, bioturbations, and burrows. Erosion surface has been detected under sandstone layer. Coal, shale fragments and very thin layers of intercalated coals are found in some places (Surono & Permana, June 2011).

The Lower Member was deposited on a tidal current environment. Volcanic activities that resulted in steep topography brought breccias down to the above environment. This environment deepened offshore, where most of the Upper Member was deposited. During the deposition time of the Upper Member, carbonate material had developed well due to ceased volcanic activity.

Based on previous study, the sedimentary structures found in the Upper Member of the Sambipitu Formation, are borrows, bioturbations, gradded bedding, shale clasts, planar cross-beds, parallel lamination, and erosion surfaces. Coal fragments and mollusks have been found, especially on erosion surfaces. Bioturbation and shale clasts have distributed to the entire part. Foraminifers are commonly existed, especially within the upper portion. Erosion surfaces take place underneath conglomerate beds and very thin intercalated layers of coal also found.

2.7.3 Paleontology

Rare fossil found at the Lower Member of the Sambipitu Formation but foraminifers found abundantly in the Upper Member. Based on paleontological analyzes of 11 samples from Upper Member, it shows that the planktonic foraminifers, especially index fossil of P. glomerosa is classified around Early Meocene age. While in 2009, first appearance of index pollen fossil (Florschuetzia meridionalis) were found.

There is a research were conducted in order to understanding of temperatures from the past, present and future which can be possible to do by analysis abundance of fossil foraminifera. This research was conducted in Sambipitu Formation, Ngalang River, Nglipar, Gunung Kidul Regency (Harman Dwi, Avirsa, & Abraham Ivan, 2018).

CHAPTER 3

MATERIALS AND METHOD

3.1 Introduction

This chapter will explain on how this research was carried out by using a few methods with the help of materials that will be used in order to complete this research. Figure 3.1 conclude and illustrate flow chart of methods that will be used in this research.

3.2 Materials

There are a few tools and materials that will be used in order to carry out this research study. Each materials have their own purpose which will help to complete the study.

3.2.1 Topographic map (base map)

Topographic map is a type of map that represent the earth which characterized a large-scale detail and filled with a contour lines to show the shape of the earth's surface. It also show the other feature such as railroads, roads, stream, river, mountains, elevation, buildings, vegetation and much more. The base map will help the researcher to analyse the lineation, fault, folds and other geological features

before starting their field work. The base map of the study area can be made using GIS software and the topographic data system can be obtained from the internet.

3.2.2 Global Positioning System (GPS)

GPS is one of the most important equipment in geological mapping. GPS is a satellite navigation system used to determine the ground position of an object. It is possible for people using GPS to pinpoint their geographic location with accuracy is anywhere from 100 to 10 meters for most equipment. In geological mapping, GPS were used to keep the track and save data such as elevation and coordinate. This device also used in order to mark the point of intersect in term of longitude, latitude and elevation along with the coordinate for finding position of sampling collection, mapping lithology and tracking structure.

3.2.3 Hammer

Geological hammer is basic equipment for any geologist as it is the tool used for collecting samples. The best geological hammer that always being used in geological mapping is chisel-tip rock hammer. In geological mapping, hammer were used for splitting and breaking rocks in order to obtain a fresh surface to determine its composition, bedding orientation, minerals as a sampling. Sometimes, hammer also being used as a scale to take a photograph of sample or any geological features found in the study area.

3.2.4 Compass

Compass is important in geological mapping as it is an instrument used for navigation and orientation that shows direction relative to the geographic cardinal directions (or points). Symbol of north, south, east and west were shown on the compass. It is an instrument that used to measure strike and dip direction of the exposed outcrop.

3.2.5 Hydrochloric acid

Hydrochloric acid (HCl) is used to test on limestone rock where calcite minerals need to be distinguish. Limestone rocks will produce bubble as a result of the reaction between HCl and calcite minerals in the rocks.

Research flow chart

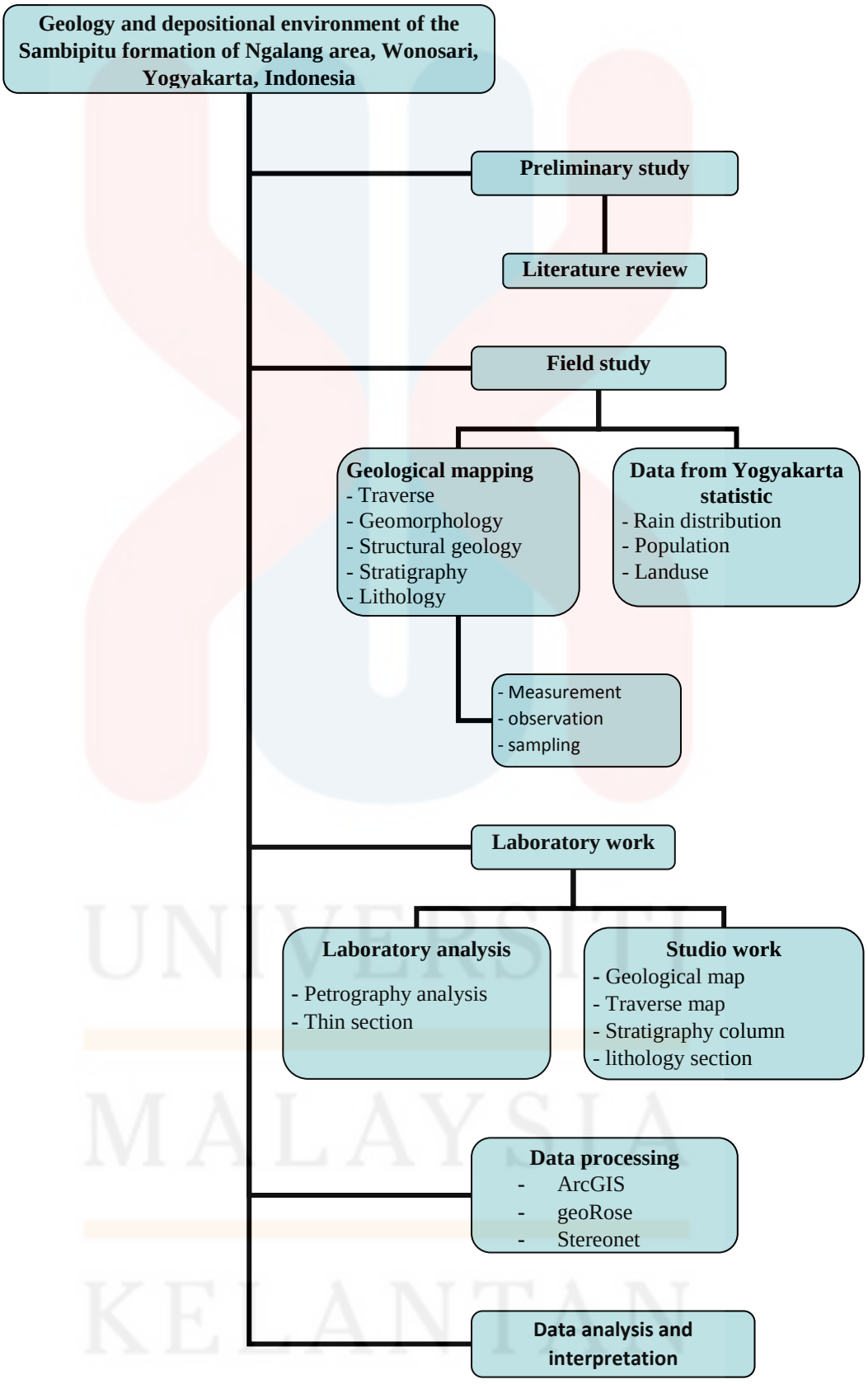


Figure 3.1: Flow chart of the research

3.3 Methodologies

3.3.1 Preliminary study

Preliminary study is one of the early task that have to be done in research proposal and it is an early stage which will influence the study carried out by narrow things down to the scope of the topic relate to the research study. As the topic for the research have being confirm, one of the essential task to do is undertaking a research study to review the existing literature based on the topic related to identify and construct the new study. Based on the study of past articles, journals and books, it will improve the methodology and help the researcher to gain a knowledge in detail regarding their findings.

The literature review is crucial as the researcher have to search any sources that relate to their area of interest, review the selected study and compare one's findings with the others. Besides that, study the base map of the study area is also part of the preliminary study to view the condition and observe the topography of the study area.

3.3.2 Field Study

Record data that related to the study area and specification are collected in several ways which are geological mapping and data from the statistics. As the study area is located at Ngalang, Wonosari, Yogyakarta, Indonesia, my statistic data will

focus on this area. Data obtained from internet regarding my study area is rain distribution, population, data regarding the religious of the villagers also the temperature and climate of the study area.

Geological mapping involves plotting the location and attitude of the various rock units, faults, and folds on a base map. Geologic maps are used to investigate and record the structural geology such as fault, obvious fold and the lithology in study area. During geological mapping, the observation of karst formation and landforms have to done while traversing the route. All the measurement and data will be record.

Besides that, geomorphological mapping and measuring section also will be done in order to complete the specification of the research study. Measuring section is one of the method used to acquire fundamental geologic information which needed for basic characterization of an area. The result and data gain from measuring section will be a great help in mapping in order to facilitate correlations and identify relative ages of the facies and lithology.

3.3.3 Sampling

Sampling is important as the rocks or samples obtain from the study area will be used to carry out in laboratory experiments. Sample will be taken while doing geological mapping in order to gain information regarding the type, mineral composition and characteristics of rocks to complete the lithology in study area. The amount of sample is depends on the types of rocks found and the sample taken should be fresh in order to observe and identify unaltered mineral in rocks. The data

such as location have to be record and the size of sample taken also need to follow the standard that have being set.

3.3.4 Laboratory Analysis and studio work

Each rock sample specimen taken from the field will be cut by a specific rock cutting machine and were thinned by specific method for thin section. Thin section were used on order to identify and investigate the texture and composition of rock sample for detail description and petrographic analysis.

Studio work consists of produce the geological map, traverse map and geomorphological map from the result obtain in geological mapping in study area. The map produce is in the scale 1:25 000 in order to make it more precise and detail. Geomorphology data include the interpretation and description of landforms and geological process including the lithology in the study area.

3.3.5 Data Processing

Data processing is the conversion of the raw data from field or other sources to another form which is more usable which helped in order to obtain the good result (Planning tank, 2017). This conversion or processing is carried out by using operations either manually, software or automatically. Most of the data were done by

using computers and software. The output were obtained in various forms such as image and diagram.

Software that were used in this research are ArcGIS software which is coraldraw and arcMap. This Software is used to create maps, compiling geographic data, analysing mapped information and also managing geographic information in a database. Geology data such as lineament analysis, drainage system, geomorphological map and lithology are also recorded in ArcGIS this software.

Besides that, geoRose software also being used in order to interpret joint data from field. The result and output from this software is in the form of diagram which helped in order to explain and relate with the geological event in the study area. Stereonet software also being used in order to analyse the geological data on field such as fault and fold.

3.3.6 Data Analysis and Data Interpretation

The purpose of analysing data is to obtain more specific and useful data and information. All the data collected during field study and in laboratory will be used to relate and interpret to obtain the good outcome for the report. Data obtain from field study and data processing were interpret and relate to each other. Map produced from the ArcGIS software which are lithology map, geomorphological map and geological map were interpret and include in the report.

Rose diagram data and stereonet which is an outcome from geoRose software that using raw joint data from field were used to analyse and interpret the geological

event occur at the study area. The depositional environment of Ngalang were analyse using all the data obtained and the preliminary study that have being done.

3.3.7 Report writing

A report is written for a clear purpose and to attract the attention of particular audience. All the important information must be present clearly in the report in order to ensure that the other people will be able to understand the content of the report. All data from earlier studies, field studies, maps, diagram, photograph and the results from the laboratory studies will be explain and present in this report writing.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

4.1.1 Brief content of chapter 4

This chapter explained a general geology of the study area by using all data recorded on field and data from preliminaries study. The study area is focusing in Ngalang area which located at Gedangsari which is a part of Gunung Kidul Regency, in Special province of Yogyakarta in Central Java, Indonesia.

Regional mapping for this research involve mainly the study of the structural geology, lithology and stratigraphy and also the geomorphology of the study area. The study is concerned with the basic geological mapping and geomorphological study. In this chapter, all data recorded in field mapping such as geologic structure (fault, fold, and cleavage), geomorphology of study area, stratigraphy, lithology and fossils will be explained and discussed.

4.1.2 Accessibility

There is only one main road that connect Ngalang area to Yogyakarta city which it will take around 40 minutes to one hour by bus, motorcycle or any four-legged vehicles. There is no train or any other public transport available except for

bus and grab car. Peak hour for the main road from Yogyakarta city to Ngalang area are around seven to eight thirty in the morning and four to five thirty in the evening. Majority of the people live in Ngalang area use motorcycle as their routine and the roads are quite smalls as shown in figure 4.1. Villagers moreover old people usually walking from one place to another place which the route is not far as they were used to it. Futhermore, Ngalang, Gedangsari is located at a rural area which mostly of the villagers just doing a village works such as farmers, fisher and shepherd.

Figure 4.1 small roads in Ngalang area

4.1.3 Settlement

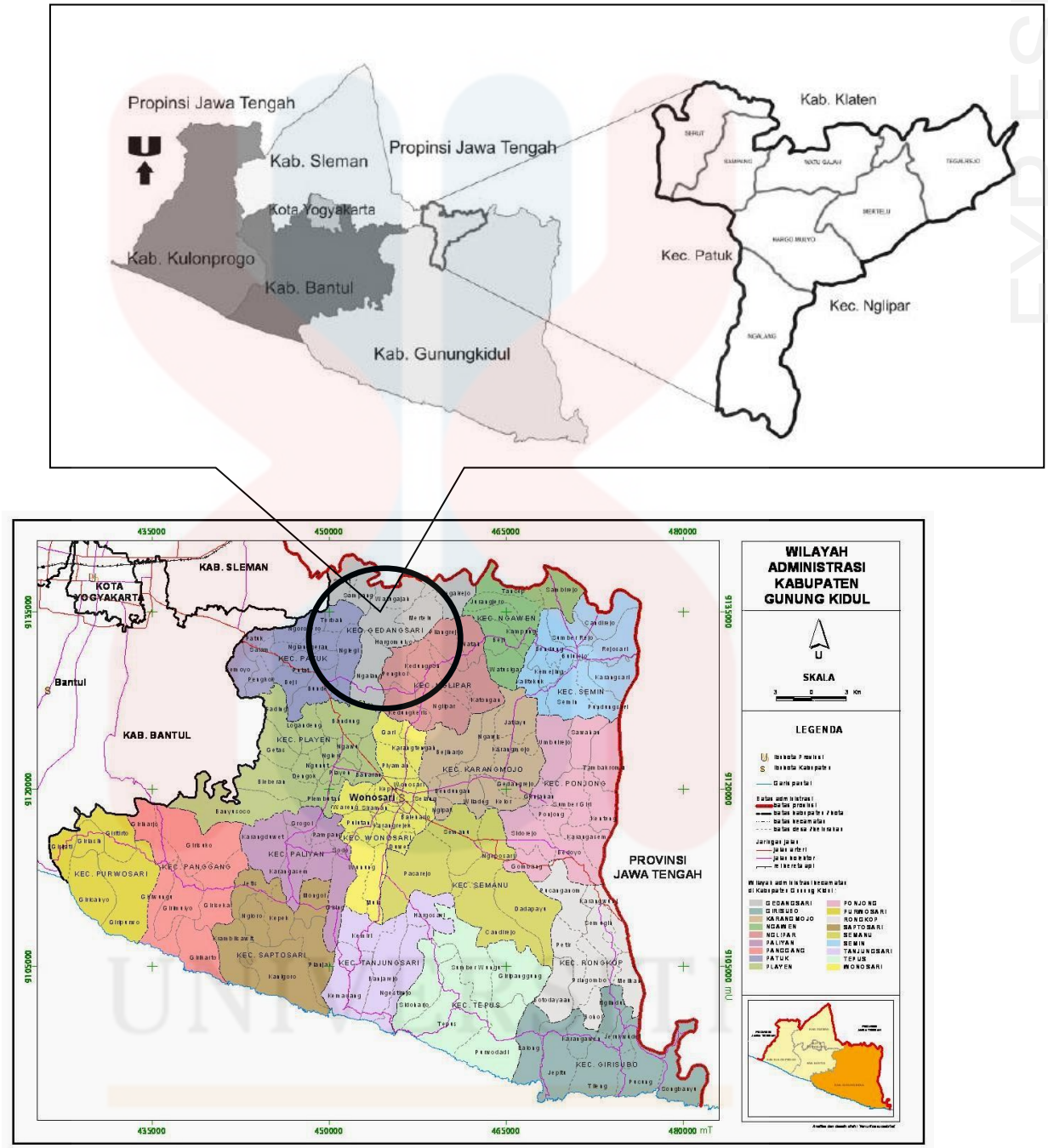


Figure 4.2 Gunung Kidul administrative region map

(retrieved from http://peta-kota.blogspot.com/2017/01/peta-kabupaten-gunungkidul.html)

Ngalang is located in Gedangsari sub distric of Gunung Kidul regency, Special region of Yogyakarta Indonesia (figure 4.2). Gunung Kidul regency is one of regencies in Yogyakarta and its capital is Wonosari district. Wonosari is located in

the southeast of the city of Yogyakarta. The total area of Gunung Kidul Regency is about 1485.36 km2, or approximately covers 46.63% of the area of Yogyakarta province.

Gunung Kidul Regency is divided into 18 districts, namely Wonosari, Playen, Paliyan, Saptosari, Bake, Purwosari, Tanjungsari, Tepus, Rongkop, Girisubo, Semanu, Ponjong, Karangmojo, Semin, Ngawen, Nglipar, Gedangsari and Patuk. Gunung Kidul Regency is divided into 144 villages, comprising 16 villages, including the village and 128 are still self-sufficiency.

4.1.4. Forestry (vegetation map)

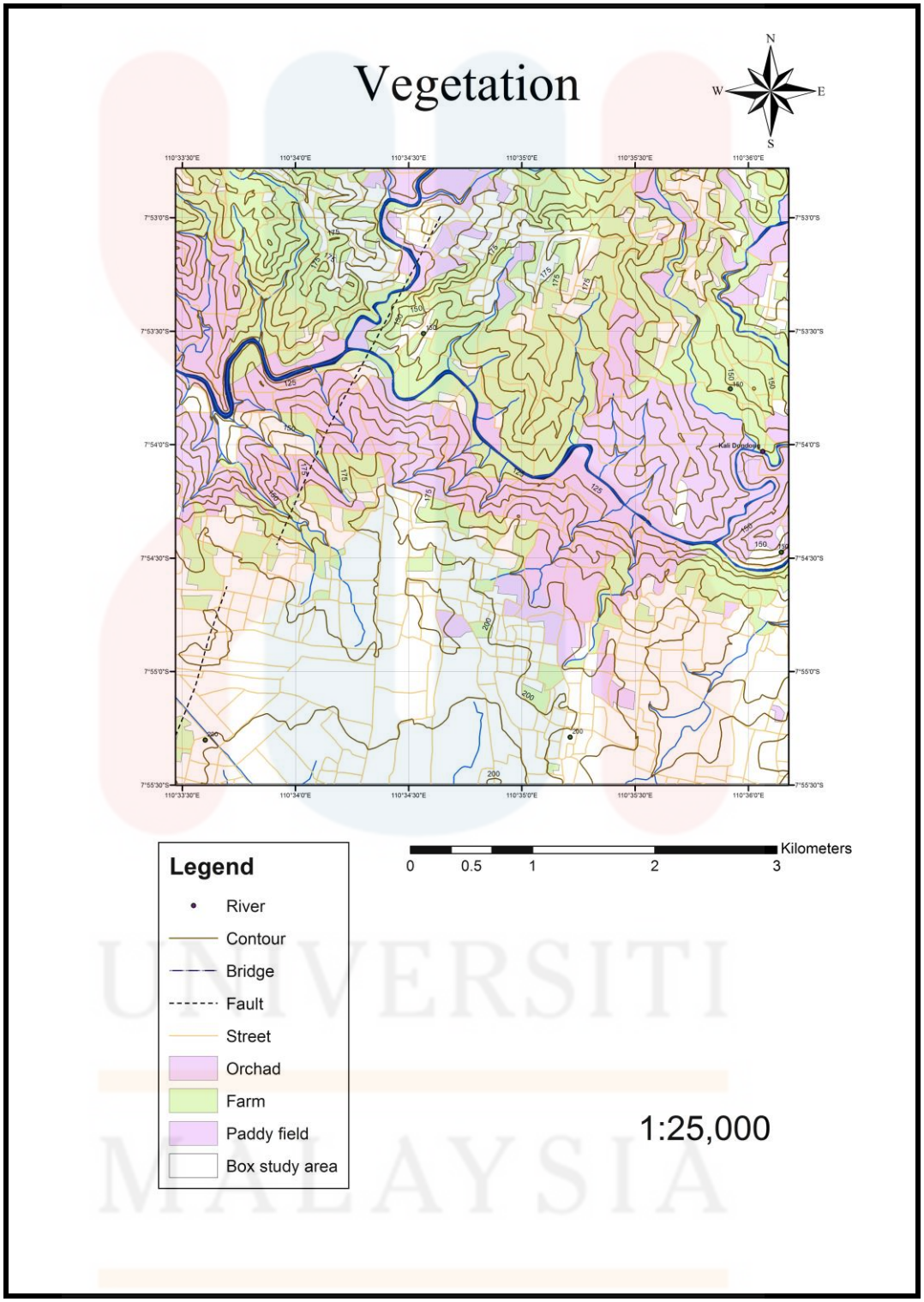


Figure 4.3 Vegetation map of study area

Based on the vegetation map above (figure 4.3), most of the study area are covered with orchard and farm. At the southern part of the study area, it is a flat areas which covered with soil type which dominated by various grain size of limestone. So although it's long dry season, the water particles are still able to survive. There is a river on the land, but it will dry up in the dry season. The southern part of the study areas consists of the houses areas and small villagers so it is quite difficult to find an outcrop and hills areas. There is a small garden around the houses which villagers keep to grow their vegetables that they need for their daily life.

As for the northern and middle part of the study areas, it consists of small hills and flat areas. It also consists of villager's settlements with many houses, farms and garden which we can observe obviously near to the Main River and small stream as the villagers use it as their main source of water for their daily use. During dry season, they use water from natural resources for washing clothes, cooking, take care of their garden and farm, shepherds and also for many more uses.

Types of soil in the middle part of study area are mainly consists of soil types which dominated by sedimentary host rocks such as tuff and sandstone. It also contains a high level of calcium carbonates. While for the northern part of study area, it consists of soil which slightly affected by volcanic activity such as siltstone, breccia, claystone and sandstone. The soil in these area are more fertiles and we can observed there are many vegetation in orchad and farms in this areas.

Figure 4.4 Vegetation and plantation in study area

The development of vegetation and cassava industry really shows a very promising agricultural product-based economy. In Gedangsari district, there are many white eucalyptus, cassavas and soybean plantation near the rivers (figure 4.4). It is one of the main plantation owned by the villager's orchard as it give benefits and quite promising in the agriculture industry nowadays. Besides that, villagers also rearing animals in their housing areas while their take care of their plantation and fruits orchard and farms. Paddy fields also can be seen in the study areas but it mostly harvested at the end of the year.

4.1.5 Traverse and observation map

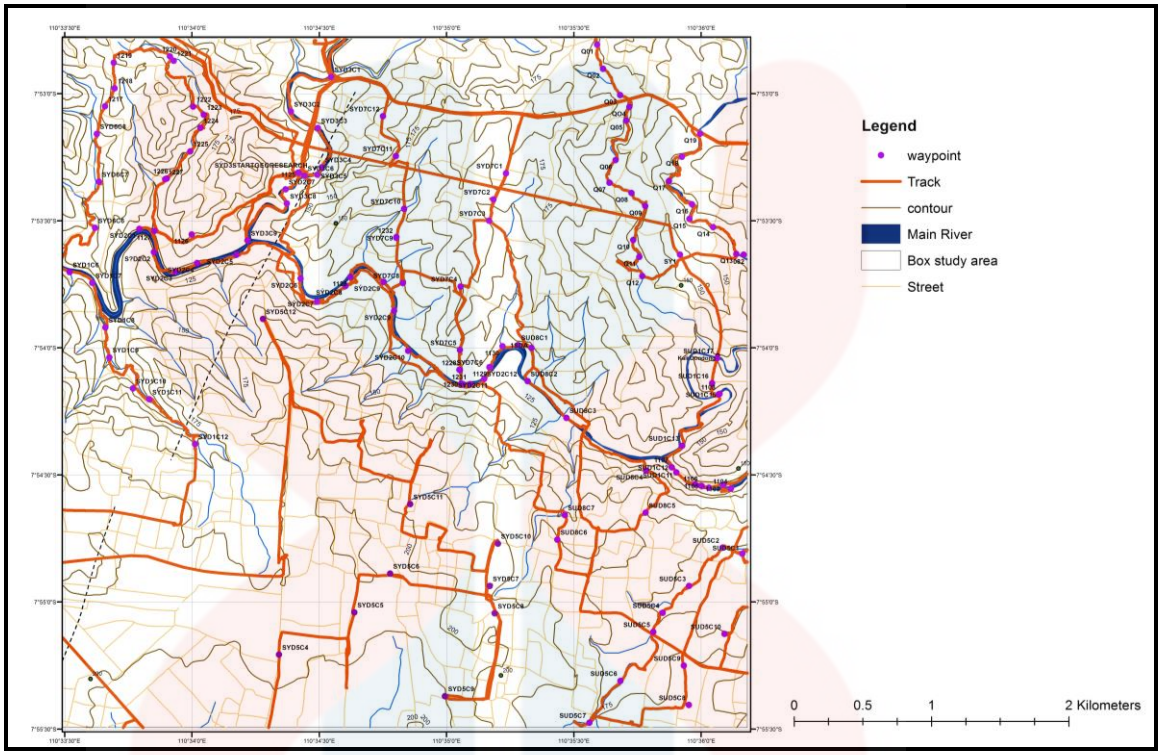


Figure 4.5 show the traverse map of the study area

In order to complete my geological mapping and specification for my research study, it took me around seven to ten days to gather the informations and complete my mapping. Geological and geomorphological mapping were done around a week and it cover about 60% to 70% of my study area.

At first, main target location to complete the geological mapping is the main river in the study area which is Oyo River which located at the middle of the study area (figure 4.6). Once the main river was completed, the mapping were continued to the small rivers which are the branches of the main river. As the geological mapping were done during dry season in Yogyakarta Indonesia, the small rivers (figure 4.6) were dried and the mapping can be done along the river with not much disturbances. All the geological structures and bedding can be observed clearly and it facilitate the research while reduce the time (figure 4.7).

Figure 4.6 Main river (Oyo River) in study area

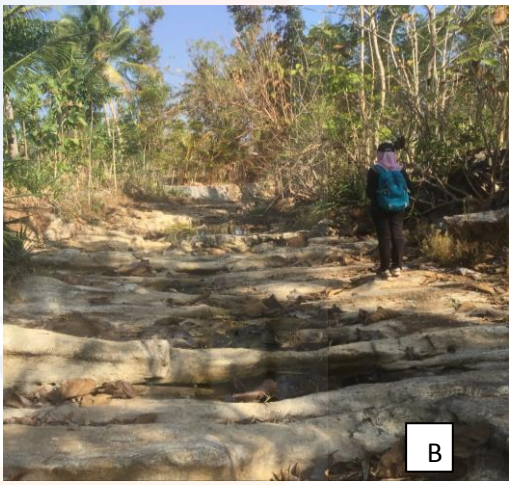


Figure 4.7 A) show a small river in study area that covered with plantation B) show the small river that dried due to the hot weather and dry season

4.2 Geomorphology

4.2.1 Geomorphologic classification

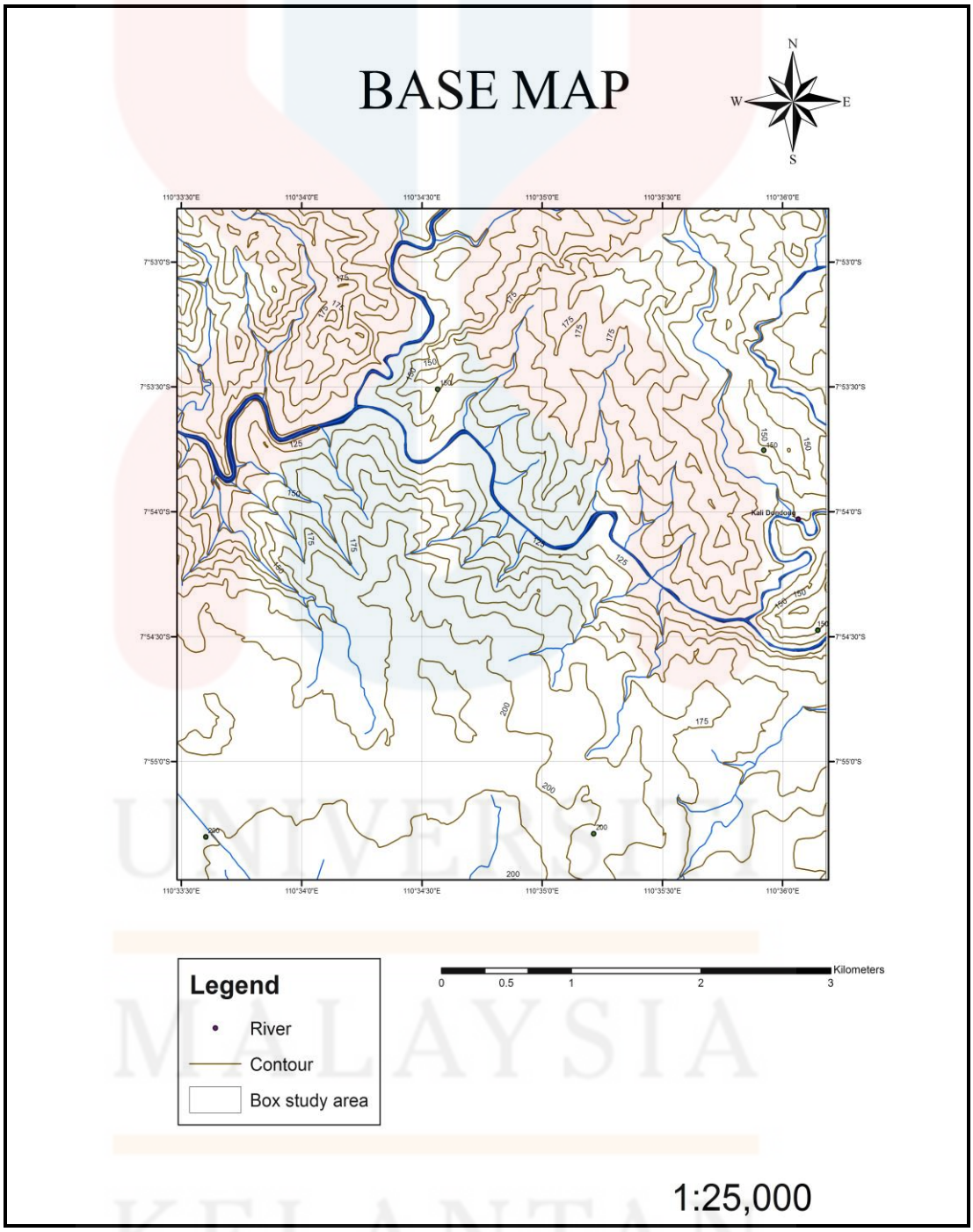


Figure 4.8 Map of study area

Geomorphological classification refer to the categorization and description of nature, origin and developments of landforms in the areas. It can be classified based on its origin and developments (process), its general structure and landforms, on measurements of its dimensions and characteristics. There are several components which have to be highlight in this geomorphological classification which are Process, landform, morphometric and geomorphic generation (Haskins, et al., February 1998, version 1.4).

Geomorphic processes relate to the changes in the surface of the earth caused by a continuous internal and external forces. Landforms refer to natural features on the earth surface while geomorphic generation is a component focusing in the recognition and documents of the status of more than one geomorphic type at any given location on the ground. Morphometric is most often applied to a geomorphic map unit to provide the quantification needed to ensure consistent application for mapping, interpretation, and correlation purposes.

The research area is located in the Southern Mountains in eastern Central Java which generally show homocline hills that tilt southward. Morphologically, the study area was consists of medium to steep mountainous morphology which involve several formation which are Sambipitu formation, Oyo formation and Wonosari formation.

As the study area (figure 4.8) mostly consists of low elevation so there is not much explanation and description on geomorphology classification. The highest elevation in the study area is around 180m to 200m which can be seen on the northern west of the map. The elevation varies from the centre to the northern of the study area while at the southern part, there is not much different in elevation and

quite high which is around 160m to 200m. The southern part of the study area is mostly covered with residential areas and small town which consists of houses, shops, stalls, school, hospitals and farm/garden. It also covered with small roads and soil from limestone in the garden and farm area. The hill and river is rarely be seen in this area as the area is developed with many buildings and infrastructures.

Figure 4.9 Geomorphology of study area

The northern part of the map, mostly covered with forests, roads, residential area and small rivers (figure 4.9). Many geological structures and outcrops were founds in this part as it surrounded with rivers and forest area which full with farm and plantations such as rubber plantation, cassava plantation, eucalyptus plantation and many other vegetables and fruits plantation.

4.2.2 Weathering

Weathering refer to the alteration and breakdown of rock minerals and rock masses at the Earth's surface when they are exposed to the atmosphere. It occur due to the action of rainwater, extremes of temperature, and biological activity. It usually do not involve the removal of rock material at the same place with no major

movement (CEDD Hong Kong Geology, 2016). Weathering is a fundamental Earth process which changes the state of rocks from hard to much softer and weaker which make them easily eroded. It quite different from erosion which it involves no moving agent of transport while erosion is the process which soil and rock particles are worn away moved elsewhere by other factors. There are three main types of weathering which are physical weathering, chemical weathering and biological weathering.

Physical weathering is also known as mechanical weathering. It is the weakening of the rocks that followed by disintegration due to the physical or mechanical forces without any chemical changes. External environmental forces such as wind, water waves, and rain also consistently exert pressure on the rock structures resulting in accelerated disintegration (Madaan, n.d.).

In the study area, physical weathering that can be found is a potholes (figure 4.10). Potholes is a cylindrical pit that formed in the rocky channel of a turbulent stream which enlarged by abrading action of pebbles and cobbles that are carried by circular water. It most commonly found at the bottoms of eddies in river. As at the study are is a dry season, the river is usually dried and the structure around the stream can be seen clearly. Therefore, many potholes in various shape and size were found.

Figure 4.10 Potholes

Next, chemical weathering is a process by which rocks are broken down by chemical reactions. The minerals in the rocks become unstable resulted from the chemical changes when they are exposed to surface conditions (Earle, 5.2 Chemical Weathering, 2015). The kinds of changes that take place are highly specific to the mineral and the environmental conditions.

Trace of chemical weathering found in the study area is a rust of iron on the rocks along the river that formed due to oxidation process (figure 4.11). Oxidation occurs when oxygen reacts with iron to form iron oxide (rust). Rust then will change the colour of the affected spot on the rocks to brownish orange.

Figure 4.11 Oxidation process of chemical weathering

Biological weathering also means organic weathering which it is the disintegration of rocks as a result of the action by living organisms. Figure 4.12 shows the biological weathering caused by the roots of trees, grasses and other plants that grow into small spaces and gaps in rock in order to find moisture. When these roots occupies the space in the rocks, they will exert pressure on the rock around them which causing the gaps to widen or even crack.

Figure 4.12 Biological weathering

4.2.3 Drainage pattern

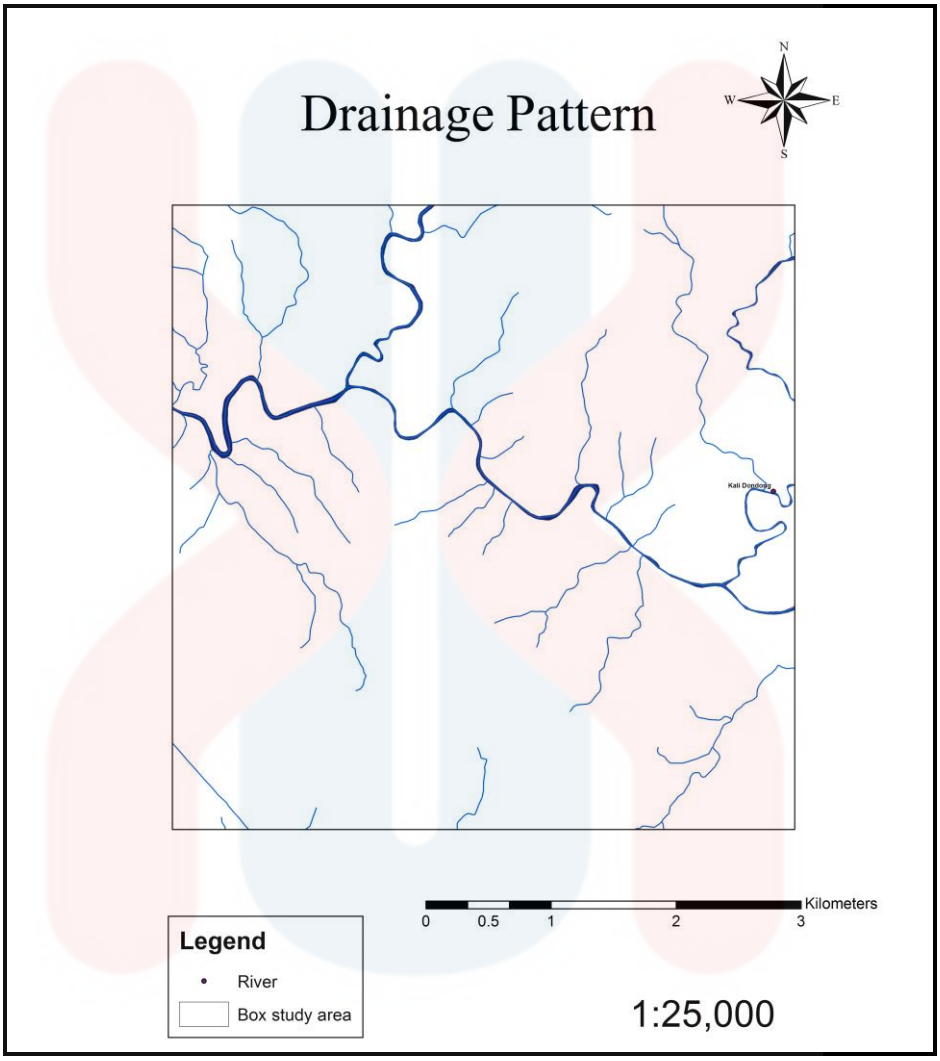


Figure 4.13 Drainage pattern map of study area

Drainage patterns are classified based on their form and texture which determined by local geologic factors. Their pattern and shape develops where the surface runoff is enhanced and earth materials provide the least resistance to the erosion. It also formed in response to the local topography and subsurface geology. The result information of the drainage pattern in the area are varies as the topographic map and the study area is larger. The pattern of tributaries within a drainage basin depends largely on the type of rock beneath, and on structures within that rock (folds, fractures, faults, etc.).

Based on the drainage pattern map (figure 4.13), the drainage pattern of the study area is trellis pattern. Trellis drainage patterns typically develop where sedimentary rocks have been folded or tilted and then eroded to varying degrees depending on their strength. The study area is mostly consists of sedimentary rocks which are sandstones and limestone. Small streams enter the main river at sharp angles which nearly right angles as they run down sides of parallel ridges were called anticlines.

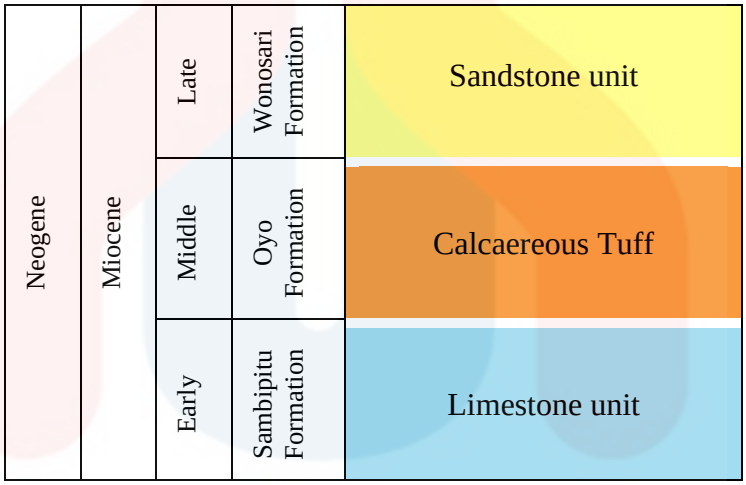
4.3 Lithostratigraphy

Lithostratigraphy refer to the classification of bodies of rock based on the observable lithological properties of the strata and their relative stratigraphic positions. It also includes information regarding processes, geographical distributions, and the palaeo-environment of the area (Davies, 2014). It involves an attempt to determine the chronological sequence of geological events over a wide area.

4.3.1 Stratigraphic position

Stratigraphy is the study of stratified rocks which is a branch of geology that deals with the correlation, interpretation, and description of stratified sediments and rocks that are found on or below the surface of the earth. Stratigraphy is deals with the study of layered sedimentary rocks (called strata) which may also include layered igneous rocks. Layered rocks may result from many sources such as successive lava flows or from the formation of extrusive igneous rocks.

Table 4.1 Stratigraphy table of study area



Based on the table 4.1, the study area consists of three formation that can be identified which are Sambipitu Formation, Oyo Formation and Wonosari Formation. All three formation are from early to late Miocene epoch in Neogene period which is in Cenozoic era. The oldest formation among the three formation id Sambipitu Formation followed by Oyo Formation and the youngest is Wonosari Formation.

Stratigraphic position of Sambipitu Formation is between syn-volcanism and post-volcanism periods. It is conformably underlain by dominated unit of volcanic breccias of Nglanggaran Formation and also overlain by marl lithology unit of Oyo formation. Lithostratigraphy of Sambipitu Formation indicates a transitional zone

between volcanic activity and carbonate sedimentary products (Surono & Permana, June 2011). Lithologically, Sambipitu formation can be divided into Lower member and Upper member.

Lower Member of Sambipitu Formation is overlain by Ngalanggaran formation which consists of volcanic breccia, agglomerate with interbedding of claystone. At the lower part of Lower Member Sambipitu Formation, sandstone and siltstone start to dominate with several bed intercalation of volcanic breccia bedding. While, Upper Member of Sambipitu Formation is mainly dominated by conglomerate, marl and limestone at the uppermost part.

Oyo formation represent the early to middle part of Miocene age. It consists of predominantly very fine to medium grain size of calcareous sandstone which intercalation with tuff and pebble conglomerate at the upper part which underlain with Sambipitu Formation. As it goes toward the lower part, it consists of calcarous tuff, marl and limestone with high contain of calcium carbonates. It reacts well with hydrochloric acid.

The youngest formation in the study area which is Wonosari Formatio is dominated by carbonated rocks that consists of layered limestone and reef limestone with interbedding of marl and calcareous tuff. Wonosari formation is exposed in the Wonosari area. The limestone unit from Wonosari Formation with calcareous tuff and sandstone from Oyo Formation is interfingering at the lower part of Wonosari Formation.

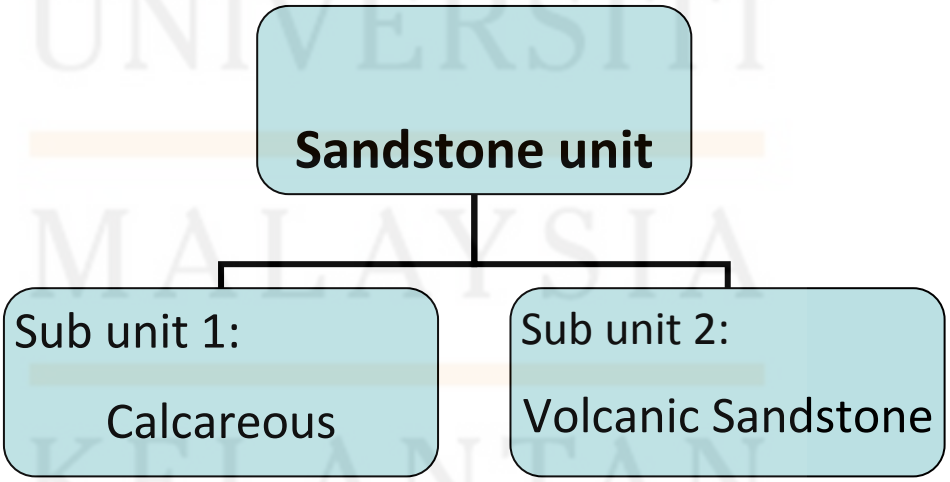
4.3.2 Unit explaination

Lithology unit for every formation in figure 4.13 will be explained and describe further in this chapter. The description also include the image under microscope, minerals distribution and sample on field.

A) Sandstone unit

Sandstone is one of the most common types of sedimentary rocks which can be found in sedimentary basin. It composed of sand-size grains of mineral, rock, or organic material. It also contains a cementing material that binds the grain together and also contain a matrix of silt or clay sized grain that occupy the spaces between the sand grains in the rocks. This sedimentary rocks is usually used in mining and construction material as a raw material used in manufacturing.

Sandstone unit in this research are mostly from Sambipitu Formation and Oyo Formation that deposited around Early to Middle Miocene. Generally, sandstone unit in the research area can be divided into several sub unit which depends on its grain size and other composition.



Sub unit 1 is calcareous sandstone that mostly found in Oyo formation at the middle part of the study area. Outcrop of calcareous sandstone found usually consists of various grain size and have different physical characterization. It usually interbedded with limestone at the lower part of Oyo Formation which overlain with Wonosari Formation.

Calcareous sandstone found in both Sambipitu Formation and Oyo Formation but have a slightly difference in physical and chemical composition. Calcareous sandstone in Sambipitu Formation which found at the northern part of study area more compact and contain less calcites compare to the calcareous sandstone found in Oyo Formation. Usually outcrop found are mostly light grey and light brown colour with the texture from very fine grain to medium grain. It also react well with Hydrochloric acid as it contain calcium carbonates. The estimated age of calcareous sandstone is in middle Miocene.

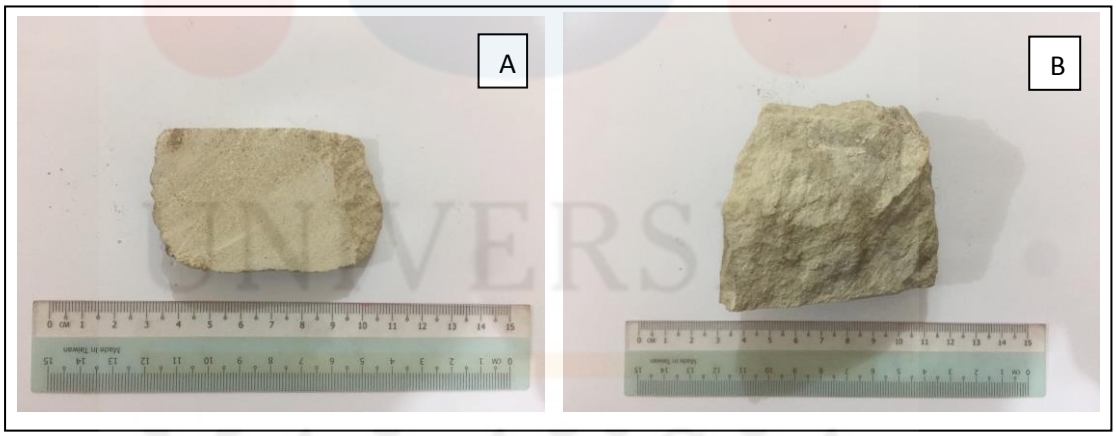


Figure 4.14 A) show the calcareous sandstone sample (RESYSAMB) with fine and medium grain B) show the sample of calcareous sandstone (MS3C5B) with very fine grain size

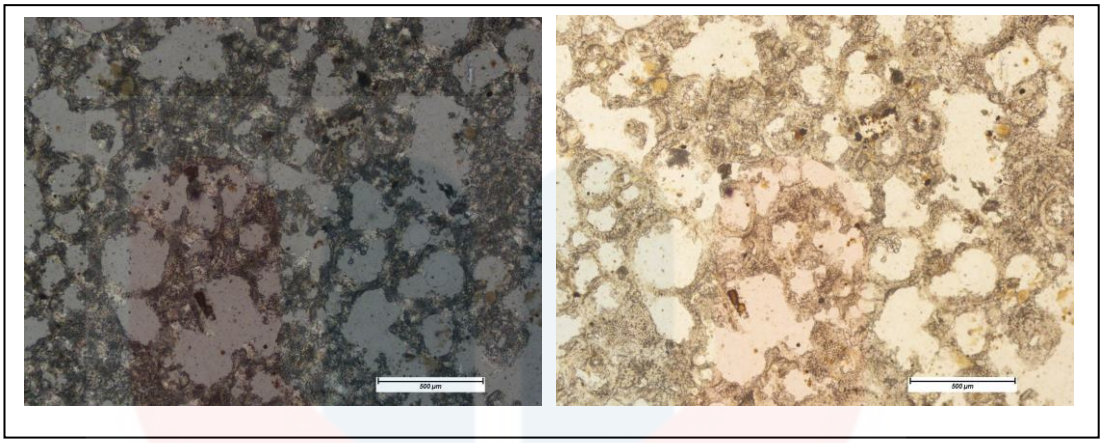


Figure 4.15 the petrographic analysis of calcareous sandstone with medium grain sandstone in sub unit 1with code RESYSAMB A) Show the image of sample from plane polarized light under microscope B) show the image of the sample from cross polarized light under microscope

Based on the petrographic image of calcareous sandstone with code RESYSAMB in figure 4.15, the mineral composition of the rocks is quite hard to be seen. This sample has medium grain size and cemented by calcium carbonate. It also contain foraminifera nannofossils which filled the space between the grain.

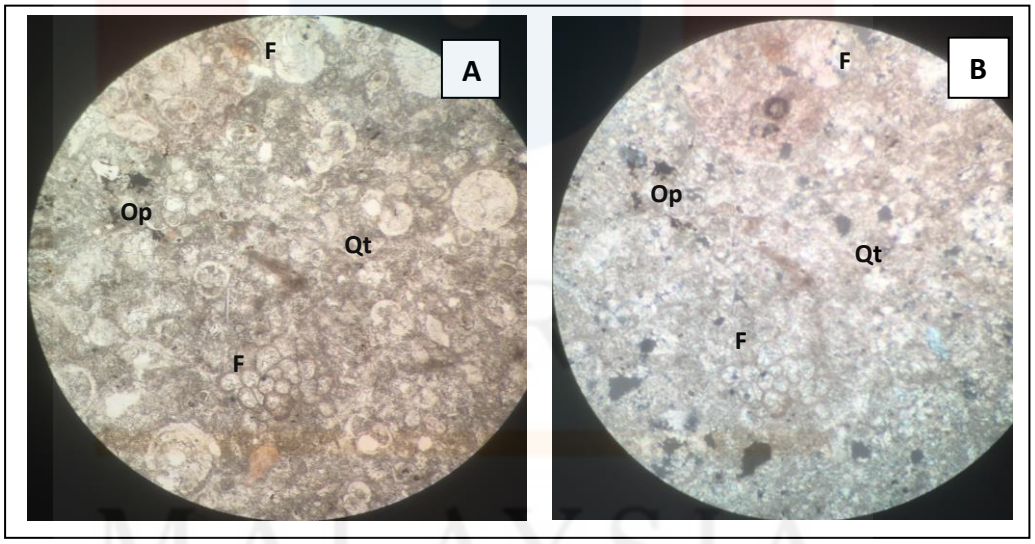


Figure 4.16 show the sample of MS3C5B using (10x0.25P) lens A) the image of sample from plane polarized light under microscope B) the image of sample from cross polarized light under microscope

Sample of massive Calcareous sandstone with fine to very fine grain were observe under microscope. Under microscope, it shows 85% of the thin section were covered by groundmass that consists of many types of foraminifera fossils and were

cemented by calcium carbonates (calcites). It shows that it contain high composition of calcites and react well with Hydrochloric acid.

Around 5% of thin section part covered by opaque (Op) minerals. Opaque minerals is a secondary minerals which show the traces of previous pre-dominantly minerals. It is black in colour with irregular shape in both cross polarized light and polar polarized light under microscope. While another 15% consists of quartz minerals. Quartz displays low interference colour which are grey and white and low relief under microscope. It also lack of cleavage and twinning.

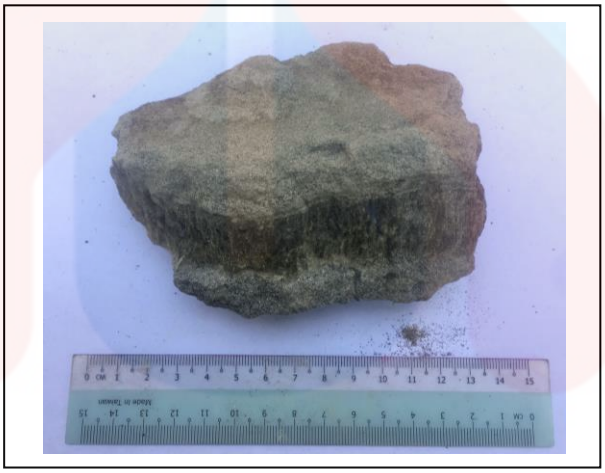


Figure 4.17 sample of volcanic sandstone that interbeded with claystone sg Ngalang

Sub-unit 2 of sandstone unit is a volcanic sandstone as shown in figure 4.17. It can be found at the northern part of the study area which is in Sambipitu Formation. This rock unit were affected by volcanic activity in Nglanggeran Formation. The grain size for volcanic sandstone are usually from medium to very coarse grain size. This rock unit is interbedded with claystone, siltstone and sandstone. The colour of volcanic sandstone are brown and grey. The age for this rock unit is around early to middle Miocene.

The volcanic sandstone unit were deposited in the same environment as pyroclastic breccia in Sambipitu Formation. The volcanic sediments were carried by water current and believed it was deposited at the shallow marine environment.

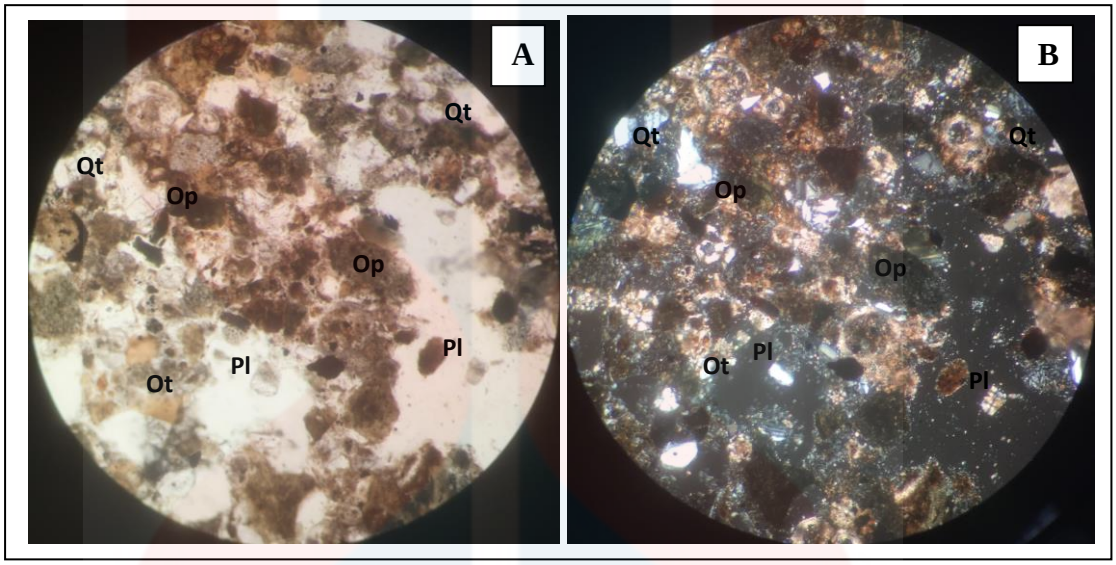


Figure 4.18 shows the sample of volcanic sandstone under microscope with (10x0.25P) A) image of the sample from plane polarized light while B) show the image of the sample from cross polarized light

Figure 4.18 show the image of volcanic sandstone in plane and cross polarized light under microscope. It consists of 60% of groundmass of the sandstone is phaneric texture that associated with the rock fragment. Opaque (Op) minerals covered about 10% of the thin section. Both in polar and cross polarized light under microscope, it shows black colour with subangular shape. Besides, quartz (Qt) covered about 10% and has a subangular shape. In plane polarized light, the colour is colourless while in cross polarized light the colour change to colourless and black.

Percentage of both plagioclase and Orthoclase can be found in the rocks thin section is about 5%. Orthoclase sometimes quite easily mistaken as quartz as it do not show a twinning. Under plane polarized light, orthoclase can be seen in brownish yellow colour while in cross polarized light it is in black colour with the angular shape. Plagioclase show a twinning in both polarized light moreover in cross

polarized light under microscope. When the thin section is rotate, an obvious twinnng can be seen.

B) Calcareous tuff unit

Calcareous tuff unit is in milky white to light grey colour as shown in figure 4.21. It mostly can be found at the middle of the study area and mainly in Oyo Formation. It has an ash texture the grain is consists of pumice and tuff. The presence of calcareous tuff unit is indicate the start of the shallow marine environment.

Mostly calcareous tuff found contain high composition of calcium carbonates and react well with Hydrochloric acid (HCl). Calcarous tuff unit usually interbedded with sandstone at the upper part of Oyo Formation with overlain by Sambipitu Formation and also interbedded with limestone in the lower part of Oyo Formation that overlain with Wonsoari Formation. The calcareous unit age is around early to middle Miocene.

Figure 4.21 calcareous tuff sample in the study area

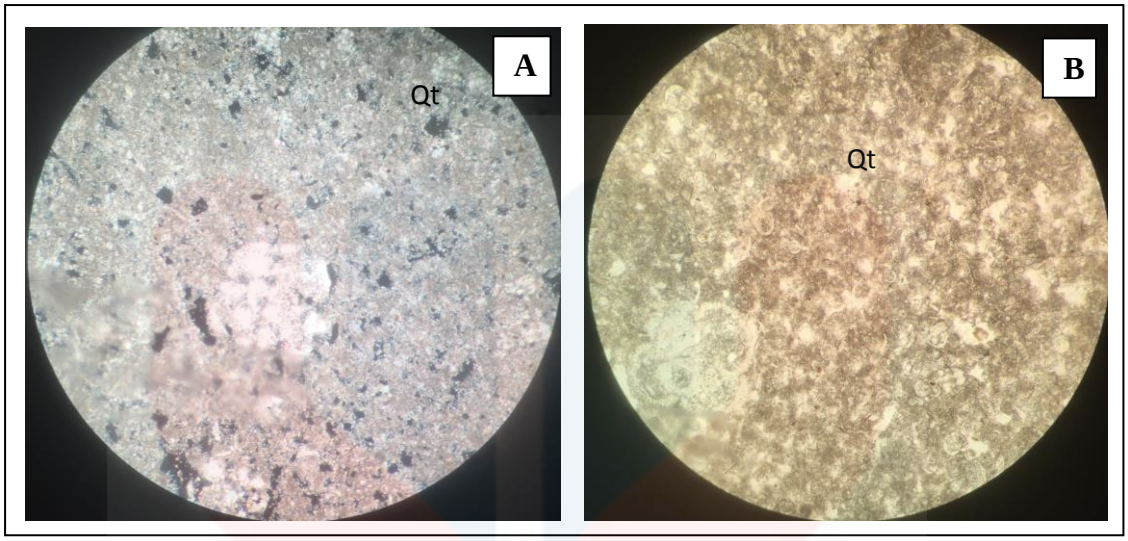


Figure 4.22 sample of calcareous tuff with code MS3C1A under microscope A) image of sample from cross polarized light and B) image of sample from plane polarized light

There is not much mineral composition can be seen in calcareous tuff unit under microscope as shown in figure 4.22. Most of the thin section part were covered about 85% of groundmass which is composed of calcium carbonates and foraminifera fossils. Percentage of quartz can be estimated around 10% in the figure 4.22. Quartz is colourless in plane polarized light while black in colour in cross polarized light.

C) Limestone unit

Limestone in this unit has a colour of pale white to grey in Oyo Formation while in Wonosari Formation it usually found in light blue to light grey. The grain size of limestone unit is varies from clay size to medium grain size. As for clay size limestone it can be consider as marl, while for very fine and fine grain limestone can be classify as packestone and wackestone. It usually contain many types of planktonic and benthic foraminifera in the state of nannofossils. Limestone unit average age is from Middle to Late Miocene. Basically, limestone unit cannot be

found in Sambipitu Formation and start to appear in Oyo Formation and main lithology in Wonosari Formation.

Figure 4.23 sample of limestone with code MSC1D in the study area

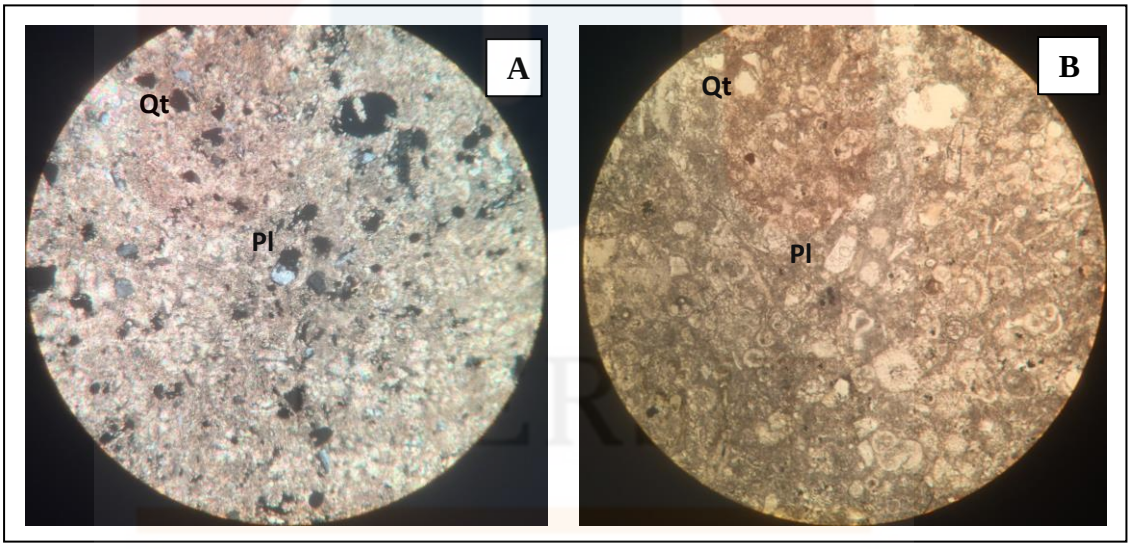


Figure 4.24 sample of limestone in study area with code MSC1D under microscope A) image of sample from cross polarized light and B) image of sample from polar polarized light

Percentage of groundmass in the limestone unit in figure 4.24 is around 70% and covered by foraminifera fossils and cemented by calcium carbonates. The blue colour with angular shape in cross polarized light is a plagioclase which covered around 10% of the sample. The colour of plagioclase under plane polarized light

change to colourless and the twinning also can be seen only under microscope with cross polarized light. Quartz covered about 5% of the sampel and the size of the quartz is quite small compared to the plagioclase. In cross polarized light, quartz mineral is black in colour while in plane polarized light it change to colourless. Lastly, opaque minerals also were observed and covered about 5% of the sample.

4.4 Structural Geology

Structural geology is the study of three dimensional of large bodies of rock, their surfaces, and the composition of their inside in order to try and learn about their tectonic history It also involve their past geological environment and events that could have changed or deformed them. The time and dated can be estimated based on their process, composition and all geological structures at that area. Besides that, structural geology also aims to characterise deformation structures (geometry) in order to know the flow paths followed by particles during deformation process (kinematics). The directions and magnitude of the forces also can be identify in driving deformation. Generally, in geology deformation refer to the alteration of the size or shape of rocks that caused by stress.

4.4.1 Lineament analysis

Lineament is a long and extractable linear features on the surface of Earth from aerial images, which usually correlated with geological structures such as faults. Based on figure 4.25, shows that the direction of major force can be interpreted comes from north and south direction. During preliminary study, lineament analysis were done before start the geological mapping. This is because, lineament analysis is important in order to predict the geological structure at the study area. It will help in order to locate and estimate the structure at certain area.

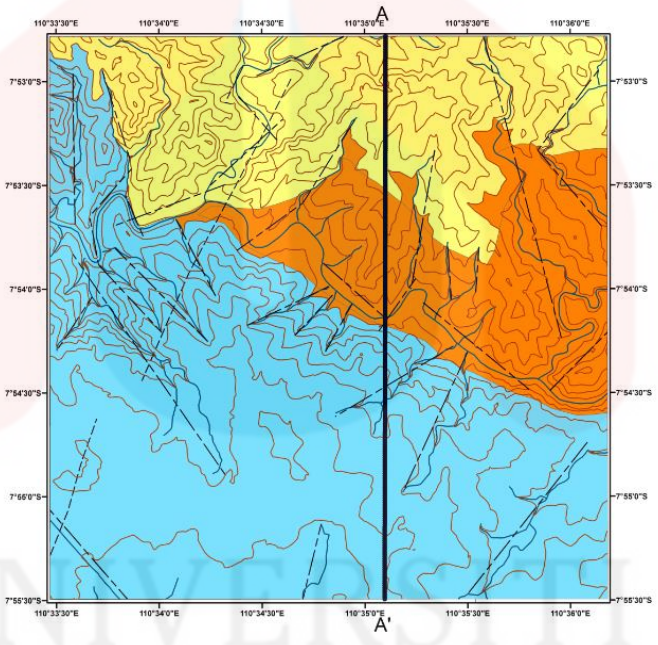


Figure 4.25 The lineament analysis of the study area

Based on the figure 4.25, the lineament are mostly plotted at the valleys, ridges and rivers. Geological map shows that the river and small stream in the study area are in straight lines and it is indicate that geological structures are mostly can be found in that areas. Mostly, the direction of lineaments are repetitively from southern west and southern east. It can be interpret that the force are mainly from right and left of the study area, Therefore there are many strike slip fault found in the study area.

4.4.2 Vein

Vein is refer to a mineral that deposits in the space that formed from a pre-existing fracture or fissure which occur in a wide variety of geologic settings and and varies temperature. It usually filled with crystals of minerals precipitated from an (aqueous) fluid. The deposition of minerals is typically performed by circulating aqueous solutions. Many ore deposits of economic importance occur in veins.

In the study area, the type of vein found is a quartz vein (figure 4.26). Quartz is often found in veins or fracture that cut through rocks. It usually found in the thin of fracture or crack which were filled with white milkfish colour of quartz. It often found around the river and small stream.

Figure 4.26 a quartz vein found in the study area

4.4.3 Fault

A most common geological structure that can be observed is fault (figure 4.27). It also refer as the evidence of the relative movement of rock fracture. Faults usually caused by the compressional or tensional forces that caused a relative displacement of the rocks on the opposite sides of the fracture. The length of faults is varies and range from a few centimetres to many hundreds of kilometres. Fault plane refer to the plane or surface that formed between two blocks of rocks during an earthquake or a movement of the plate at that area. It also can refer as the site where the fault can be seen or located on the Earth's surface.

Figure 4.27 red straight line indicate the major fault plane on the outcrop in the study area

A) Strike-slip Fault

Strike slip which also called as lateral faults is usually caused by horizontal compression as the force and energy that released by rock displacement in a horizontal direction and almost parallel to the compressional force.

Figure 4.29 and figure 4.30, show the strike slip fault that mostly found at the main river, Oyo River. The image on figure 4.29 show that the right side of outcrop

were slightly moved to the front and there is a fault plane which labelled in red straight line, at the middle of the outcrops. While figure 4.30 show another type of strike slip fault which is strike slip dextral. This fault show the movement of the rocks at the left side of the outcrop. Therefore it were called dextral which refer to the direction and side of the fault move.

Strike slip fault is one of the common types of fault found in the study area. Both type of strike slip fault are usually found around the main river, Oyo River. On map we can observe that the faults can be detected at an area with straight line river such as shown in the map in figure 4.28.

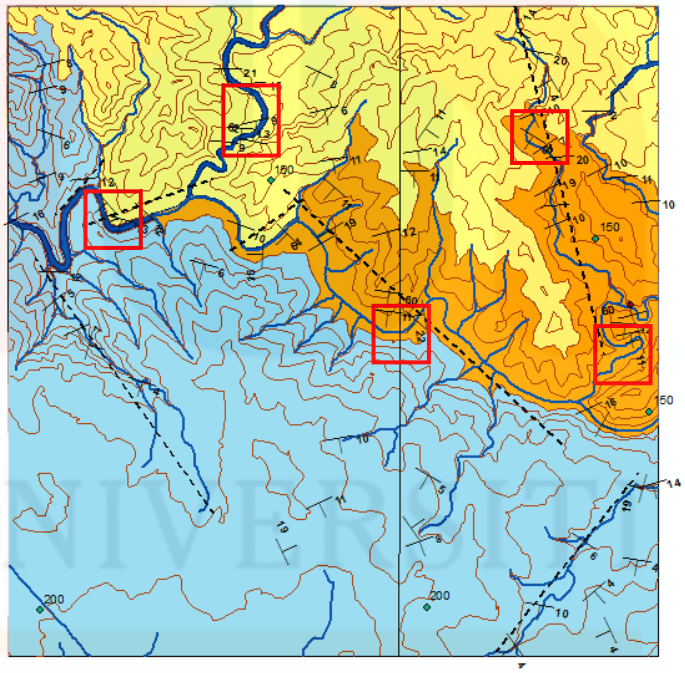


Figure 4.28 show an examples area that strike slip were found in the study area

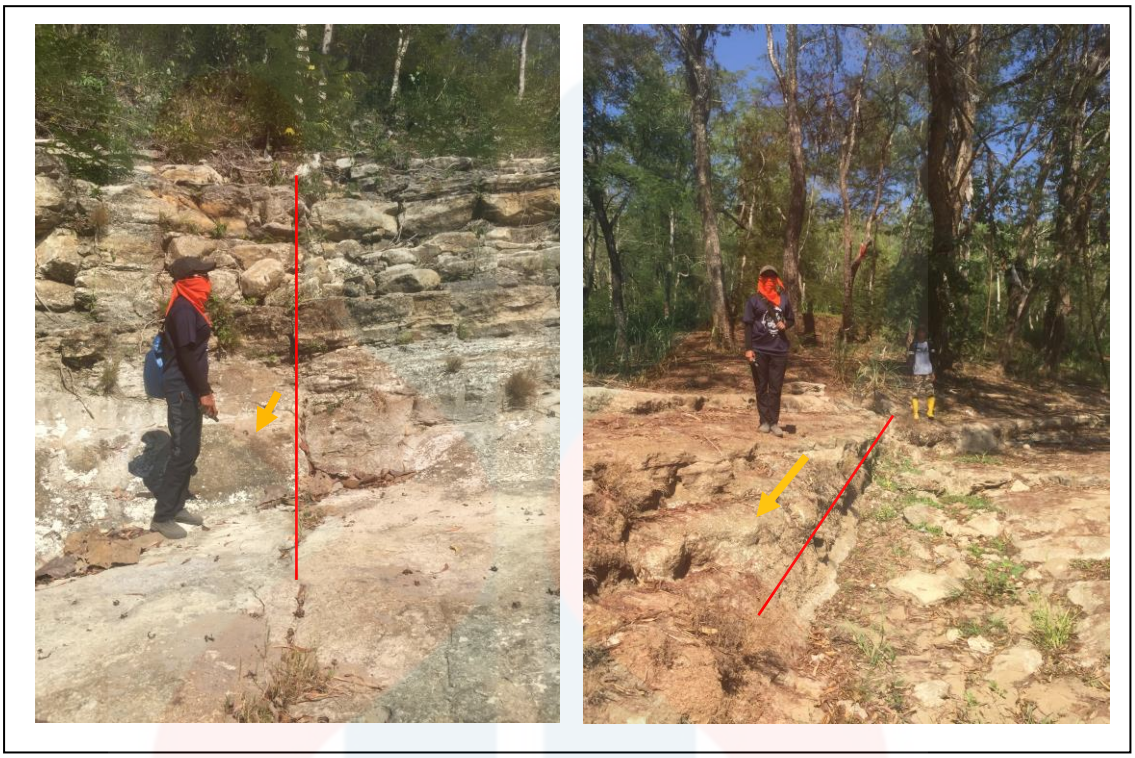


Figure 4.29 Strike slip sinistral

Figure 4.30 strike slip dextral

B) Normal Fault

Normal fault usually occur in an area where the lithosphere is being stretched or a force were applied at that area. Normal fault on field can be detected if hanging wall of an outcrops moves down. Based on figure 4.31, that show a normal fault found at the small river in the study area, it show that the hanging wall is moving slightly down and the fault plane was covered with the calcites from the reaction of the water and limestone.

Figure 4.31 show a normal fault found in the study area

C) Oblique Fault

Oblique fault basically combined both dip-slip (normal and reverse/thrust) fault and strike slip as it involve shearing and tension or compressional forces act on outcrop or rocks. It have simultaneous displacement up or down the dip and along the strike. The displacement of the blocks on the opposite sides of the fault plane usually is measured in relation to sedimentary strata or other stratigraphic markers,

such as veins and dikes. The movement along a fault may be rotational, with the offset blocks rotating relative to one another.

Figure 4.32 show the oblique fault found in Sg Ngalang. It show that there are more than one movement acted on the rocks. The red straight line refer to the fault plane and the yellow arrow indicates the direction of the outcrops movement. In the figure, it obviously show that hanging wall moves up and the foot wall moves slightly forward.

Figure 4.32 oblique fault found at the Sg Ngalang that connected to main river (Sg Oyo)

4.4.4 Fold

Fold is defined as a wave-like structure that bending instead of breaking due to the force acting on it. The rocks were squeezed from the sides by tectonic forces, then it resulted to fracture and/or become faulted if it is cold and brittle, or become folded if it is warm enough to behave in a plastic manner. Folds usually found at the area where there is a fault plane. It can be an indicator of the fault movement at that

area. As shown in figure 4.33, there are many folding structure were found around Main River and small stream in the study area.

Anticlines and syncline are an examples of folds. Anticlines are arch-shaped folds in which rock layers are upwardly convex. The oldest rock layers form the core of the fold, and outward from the core progressively younger rocks occur. While, syncline is opposite from anticline. It fold downwardly and in convex layer with young rocks in the core. Normally, folds occur in both anticline and syncline as shown in figure 4.34 that found in the study area. The hinge is a maximum point in curvature of a fold. The limbs refer to the side of the fold hinge and the imaginary surface bisecting the limbs of the fold is called as axial surface. Axial surface called

Figure 4.33 show the folding structure in the river in study area

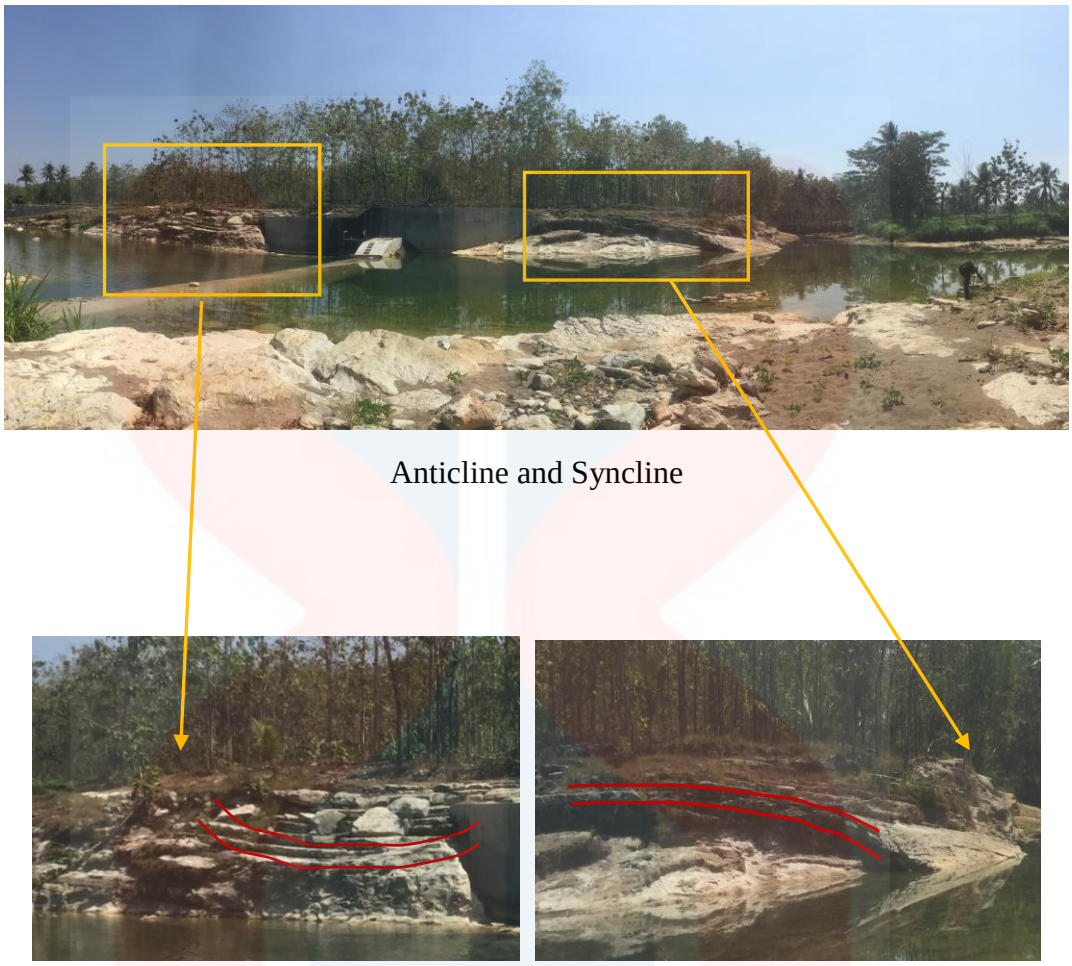


Figure 4.34 anticline and syncline found on field

4.5 Historical Geology

The study area is divided into three Formation which are Sambipitu Formation, Oyo formation and Wonosari Formation. The oldest formation is located at the northern part of study area which is Sambipitu Formation. As going down toward the southern part, it start to change toward the younger formation which is Oyo Formation and Wonosari Formation. The distribution of bedding and lithology unit is horizontal across the study area.

Ngalang area which is a subdistrict of Gedangsari district located at the Southern Mountain of Yogyakarta were divided into three major periods of

sedimentary processes which are pre-volcanism, syn-volcanism and post-volcanism. Sambipitu Formation is a lowest unit in the post-volcanism sequence under Nglanggeran Formation. Stratigraphically, Sambipitu Formation is divided into Lower Members and Upper Members. Lower Member of Sambipitu Formation is conformably underlain with Nglanggeran Formation and dominated with sandstone unit, mudstone unit and also volcanic breccia unit which resulted from the volcanic event from the older formation such as Nglanggeran Formation. This phase indicates the transitional zone between volcanic activity and carbonate sedimentary process.

The Upper Member of Sambipitu Formation is overlain with Oyo Formation which dominated with siltstone and mudstone and is intercalated by sandstone, marl and conglomerate. In this phase, the rock unit start to contain high composition of calcium carbonates and contain many foraminifera nannofossils. Based on previous study, the lower member was deposited in an environment that influenced by tidal current which affected by gravity flows of volcanic material. While the depositional environment of Upper Member is getting deeper to an inner shelf toward the shallow marine.

During Middle Miocene, the sediments start to contain higher composition of carbonates. Volcanic breccia and volcanic sandstone start to decrease and disappear in Oyo Formation and limestone start to interbedded with the sandstone and tuff. The Lower part Oyo Formation is overlain with Wonosari Formation. As it going down toward Wonosari Formation, limestone unit start to dominate and consists of various grain size.

Limestone unit is mainly dominated Wonosari Formation. Foraminifera fossils is abundant in limestone and calcareous tuff units. It consist of many type planktonic and benthic foraminiferas that indicates that it is a shallow marine

environment. The southern part of study area is indicate as a shallow-water carbonate platform that developed under moderate to high energy conditions. Calcareous algae and larger benthic foraminifera packstones, rudstones and grainstones dominated the carbonate lithologies on this platform.

4.6 Summary

The study area basically consists of flat and small hill area with the highest elevation of 200 metres. The drainage pattern in study area also only consists of one type which is Trellis drainage pattern due to the types of lithology and landforms as a parameters. Main types of faults found is strike slip fault which can clearly seen along the Main River and small stream. The other types of fault also found such as normal fault and oblique fault. There are 3 main unit of lithology that dominated the study area which are sandstone unit, calcareous tuff unit and limestone unit.

Sambipitu Formation that covered the northern part of study area is interpreted as the transitional zone between volcanic activity and carbonate sedimentary processes due to the lithology and geological structure at that area. As it going down the study area, the depositional environment start to change to the shallow marine environment due to the abundance presence of planktonic and benthic foraminifera.

CHAPTER 5

DEPOSITIONAL ENVIRONMENT OF OYO FORMATION IN NGALANG AREA

5.1 Introduction

Sedimentary environment or also called as depositional environment usually refer to the accumulation of large volumes of sediments on the Earth's surface. All environment of deposition on Earth's surface belong to one of main settings which area terrestrial, coastal and marine. Sedimentary environment play a great sources and complexity which hold variations in environmental factors which are latitude, climate, subsurface geology, surface topography and sediment supply help determine the characteristics of a particular sedimentary environment, and the resulting sedimentary deposits.

In particular sedimentary environment, sedimentary environment is the specific depositional setting and unique in terms of chemical, physical and biological characteristics. Examples of physical features of sedimentary environment are water depth, velocity, persistence of currents and also energy level. While, chemical characteristics involve salinity (proportion of dissolved salts), acidity or basicity (pH), oxidation potential (Eh), pressure, and temperature. Lastly, biological characteristics are mainly consists of flora and fauna that populate the settings (Missell & Schwab, n.d.).

Specifically, this research is more focusing on the depositional environment of Oyo Formation in Ngalang district, Gunung Kidul regency, special province of Yogyakarta, Indonesia. It is concern with the basic geological mapping, geomorphological mapping and also measuring section or called as biostratigraphy and lithostratigraphy measure/mapping. This research also concern and involve with some parameters such as facies association, sedimentary structures and fossils analysis.

5.2 Stratigraphic Section

There are three formation involve in this study area which are Sambipitu Formation, Oyo Formation and Wonosari Formation. Based on figure 5.1, The yellow part in map above refer to the sandstone unit mostly from Sambipitu Formation and a few part from intercalation of upper part of Oyo formation and lower member of Sambipitu Formation. While, the orange part in the map below indicate the calcareous tuff unit in Oyo Formation and blue part represent the limestone unit that mostly cover Wonosari Formation.

The map (figure 5.2) were separated by different colour represent a different rock unit. At the northern part of study area show that it covered with the sandstone unit which is the oldest unit of rocks. It usually interbedded with claystone/mudstone, and a few volcanic breccia bedding. Going down toward the middle of the study area, there is an orange colour distribution which represent calcareous tuff rock unit. Calcareous tuff were found in Oyo Formation around middle to late Miocene. It mostly found interbedded with marl, limestone and

calcareous sandstone. The youngest rock unit in study area is at the southern part of study area which is limestone unit. It usually found in Wonosari Formation at Late of Miocene. Wonosari Formation only composed of limestone with varies grain size such as marl, packstone and wackestone.

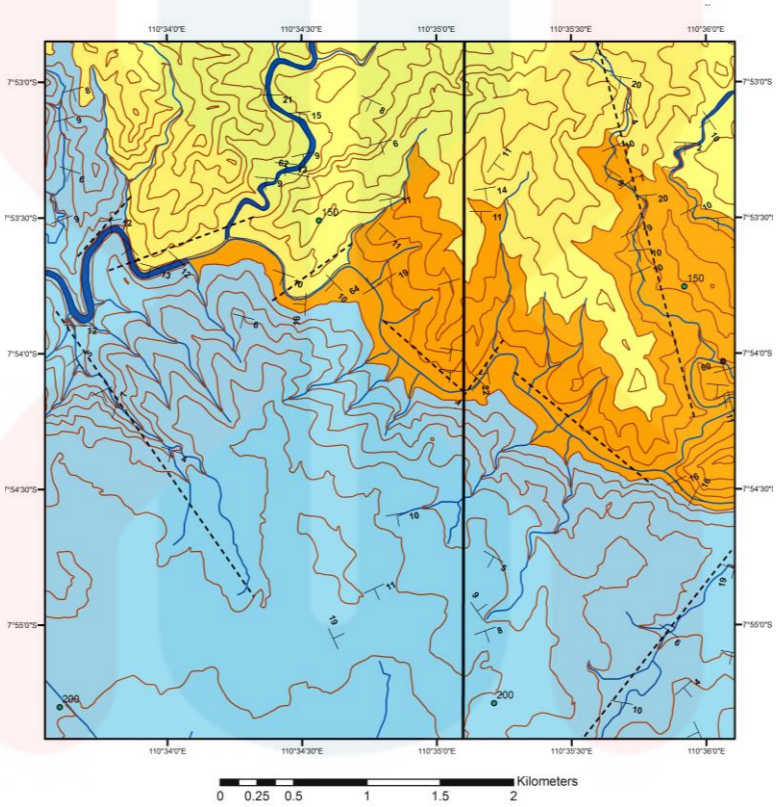


Figure 5.1 There are three formation involve in the study area which are Sambipitu Formation, Oyo Formation and Wonosari Formation

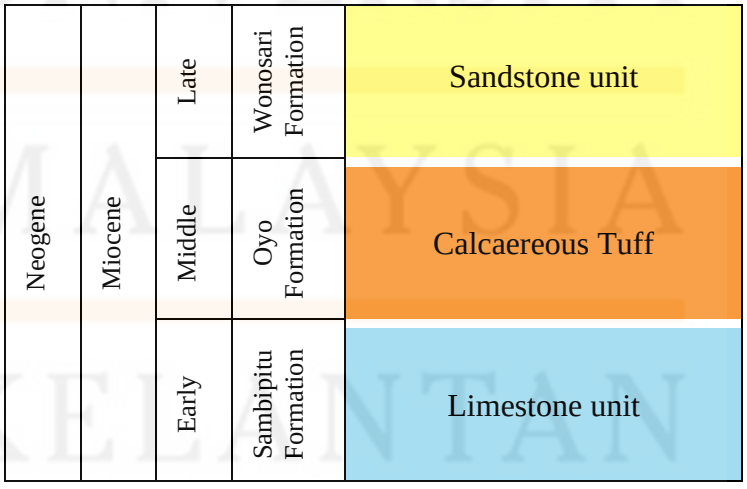


Figure 5.2 the stratigraphy column of formations in study area

5.3 Facies analysis

Based on figure 5.3, there are two areas with label A-A’ and B-B’ that were selected for the facies analysis in order to interpret the depositional environment of Oyo Formation. The facies association on both two selected were divided into five and named as sub-unit 1, sub-unit 2, sub-unit 3, sub-unit 4 and sub-unit 5 where sub-unit 1 until sub-unit 3 in A-A’ area (figure 5.4) while sub-unit 4 and sub-unit 5 in B-B’ (figure 5.5).

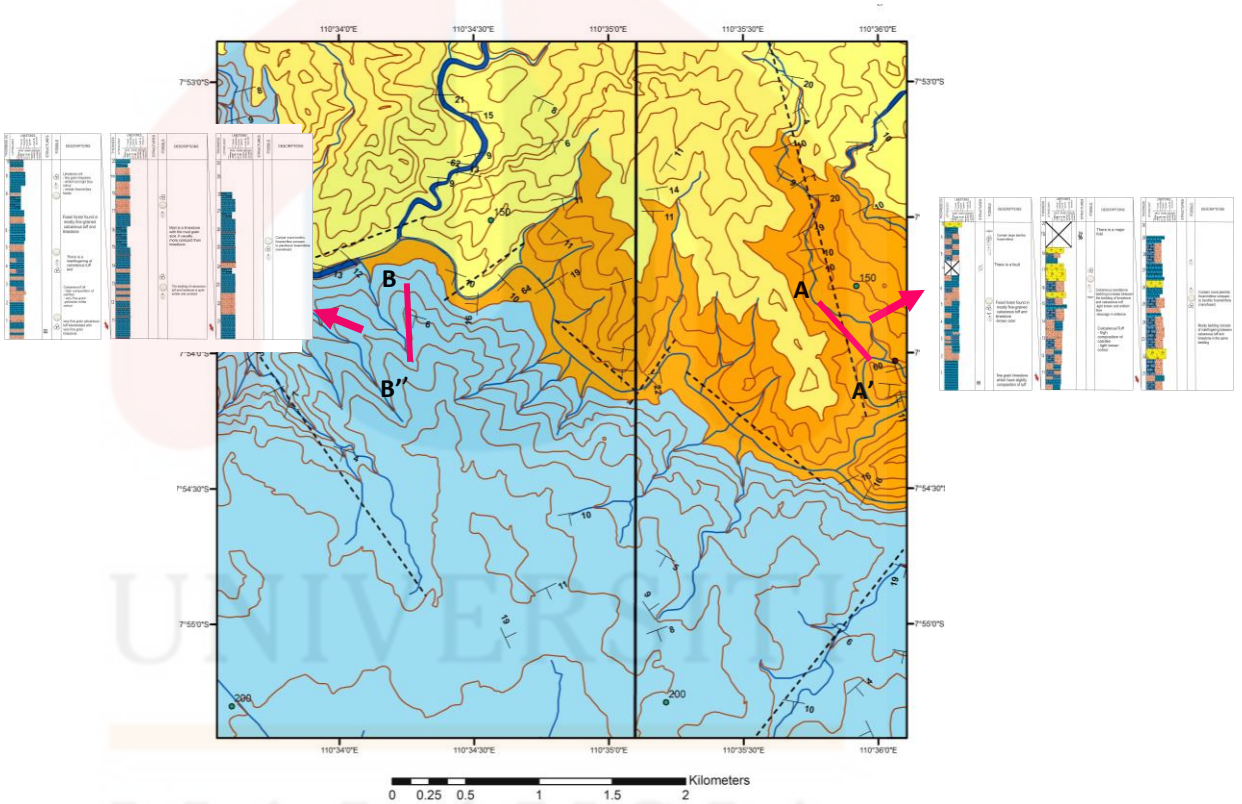


Figure 5.3 show the distribution of facies association in two different area in Oyo Formation in study area

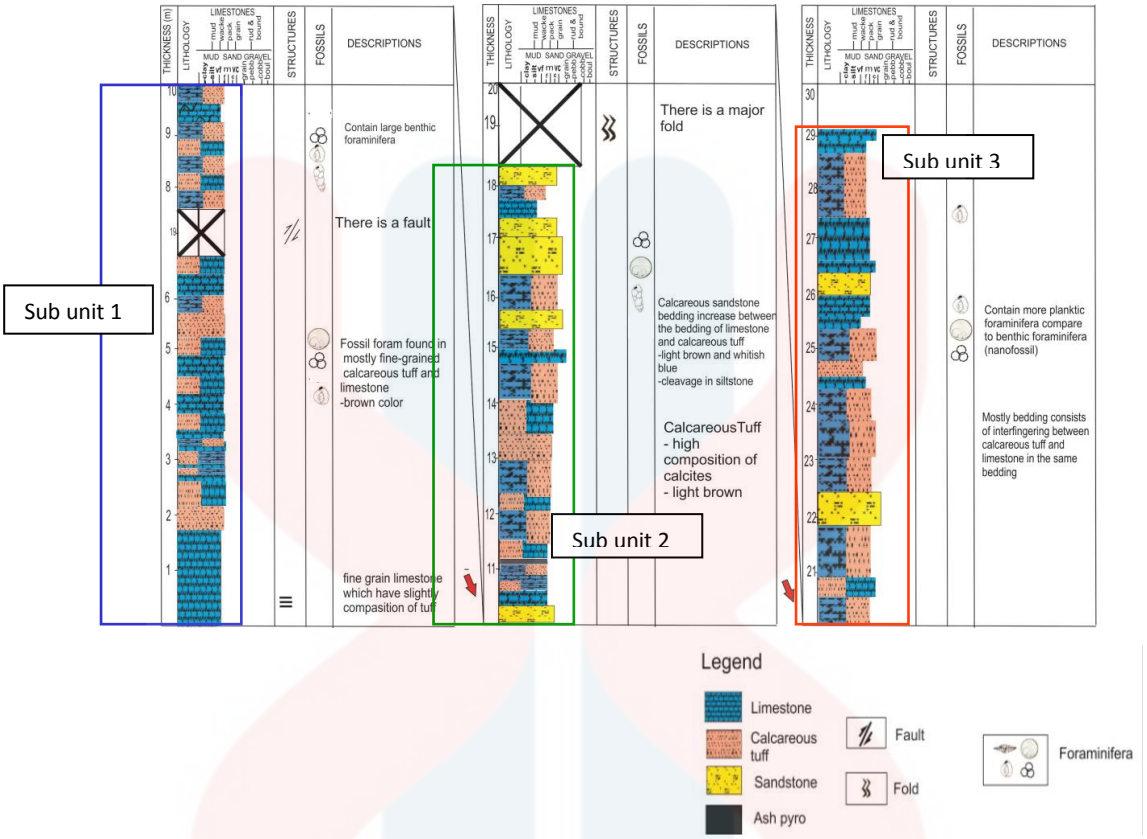


Figure 5.4 stratigraphic log that carried out in the area labeled with A-A'

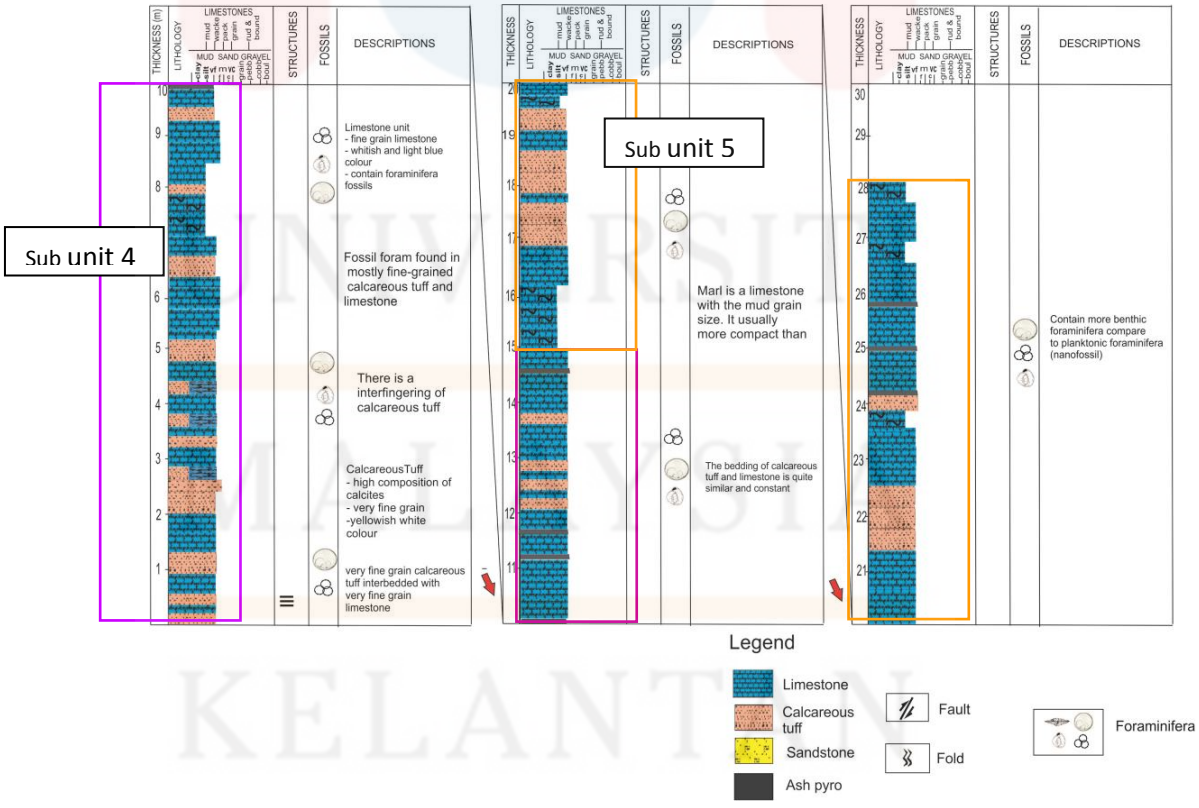


Figure 5.5 stratigraphic log that carried out in the area labelled B-B'

5.3.1 Facies association of Oyo Formation at A-A'

Sub-unit 1, sub-unit 2 and sub-unit 3 were done in the exposed bedding alongside of the road area with elevation 150m as in figure 5.4. The lithologies of sub-unit 1 are consists of limestone and calcareous tuff. The interfingering of limestone and calcareous tuff also can be seen clearly which show that the limestone and calcareous tuff were found in the same bedding as in figure 5.6. The thickness of sub-unit 1 is about 10 metres**.**

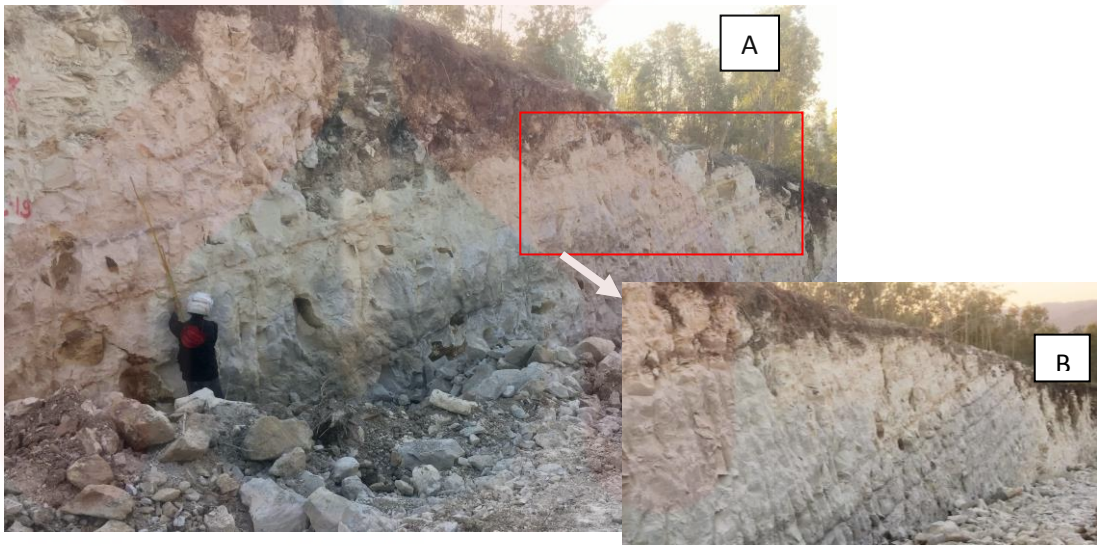


Figure 5.6 A) show the facies association taken at A-A' area B) interfingering of limestone and calcareous tuff

Calcareous tuff found in the facies association at A-A' has milky white colour with very fine and fine grain size. Calcareous tuff is really light, has an ash-texture and cemented by calcites. Therefore, it react well with Hydrochloric acid (HCl).

Meanwhile, limestone unit has light blue colour and range from very fine to medium grain size. In detail, limestone unit can be divided into smaller unit based on its grain size. Very fine grain limestone usually classified as wackestone while fine

grain limestone were called packstone and for the clay or mud grain size of limestone usually called as marl.

Sandstone unit start to appear when moving up to sub-unit 2 and sub-unit 3. Physical characteristics of sandstone unit is it consists of grey to light yellow in colour with medium to coarse grain size. Mostly of the bedding in sub-unit 2 consists of interfingering of limestone and calcareous tuff. Half of the bedding was covered by limestone unit while the other part covered with calcareous tuff unit as shown in figure 5.6 (B).

In sub-unit 1, the grain size for the facies are mostly very fine to fine grain which suggest low to medium energy depositional environment that dominated by the weak waves and currents. The microfossils found in this are Orboluni Universa, Globigerina and Globorotalia which is a planktonic forms. The fossils found with the types of lithology at the area suggest that it is an open marine mid-ramp depositional setting.

Basically, sub-unit 2 and sub-unit 3 have a quite similar facies distribution. Sandstone unit start to appear at the end of the A-A' area, and the grain size is varies from very fine grain to coarse grain. It shows that the energy in this area is higher in this area compare to the sub-unit 1. Physical characteristics of limestone and calcareous tuff unit are still not much differences from before but grain size for limestone start to varies which indicates moderate water circulation in the shallow marine. In the thin section of the sampling from sub-unit 2 and sub-unit 3, many fossils found such as Orboluni Universa, Globigerina and Globorotalia which also can be found in sub-unit 1.

The thickness of bedding in sub-unit 1 and sub unit 2 are quite similar and constant which can be related to the sedimentary supply at that area. Massive and compact limestone bedding starting to appear obviously in sub-unit 3. The grain size of limestone also varies from clay to fine grain size and the thickness start to increase. Based on this observation, we can conclude that starting from the sub-unit 3 the water level at that area is increase and the water level is higher. Therefore, the sediment supply increase and leave the thickness bedding compare to sub-unit 1 and sub-unit 2.

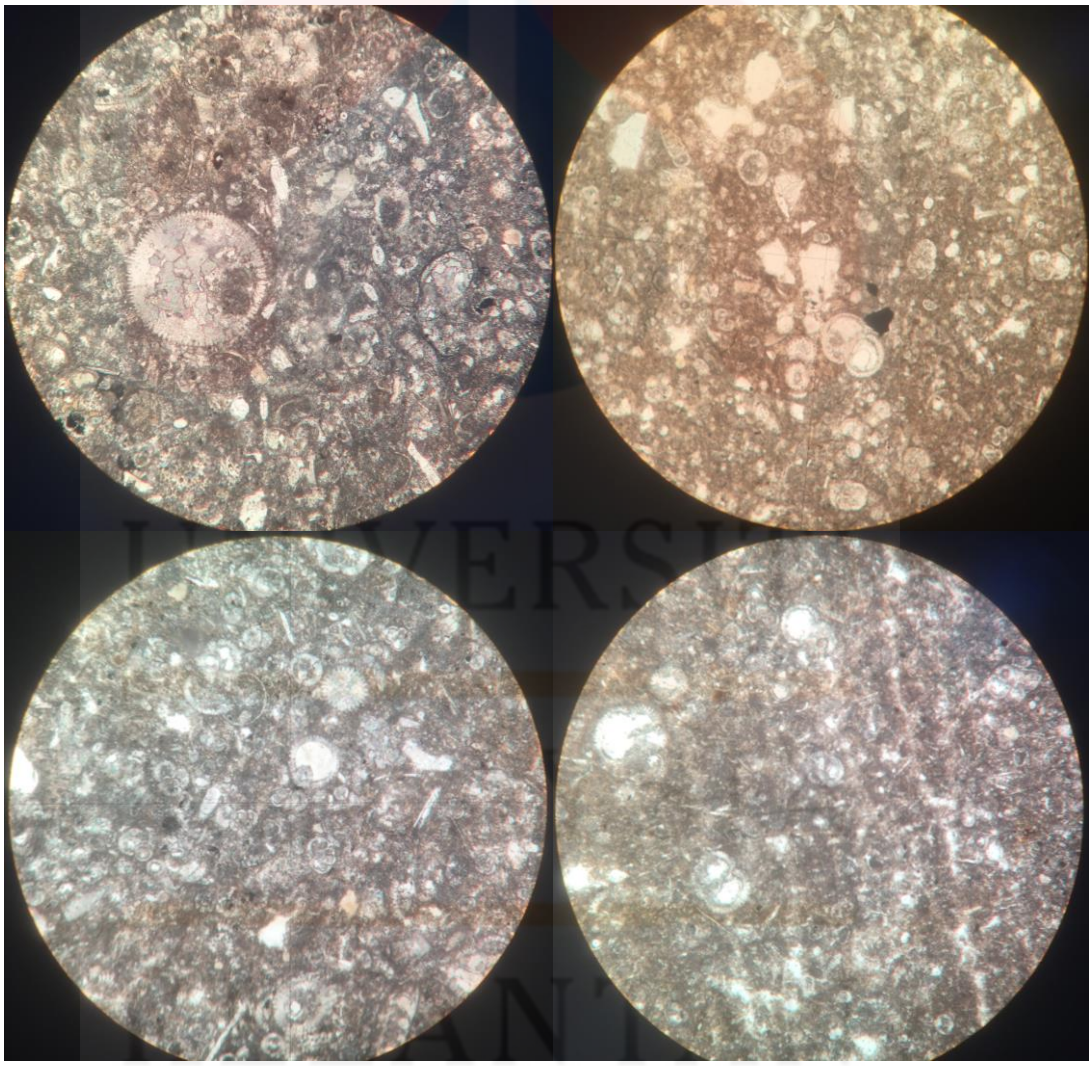


Figure 5.7 nanofossils found in the facies association in A-A' area

5.3.2 Facies association of Oyo Formation at B-B'

Facies association of sub-unit 4 and sub-unit 5 which located at area labelled B-B' were done in the small stream as shown in figure 5.8. The small stream is dried due to the dry season without any rain in Gunung kidul at that times. The lithology for sub-unit 4 and sub-unit 5 are consists of calcareous tuff and limestone.

Figure 5.8 show the environment of small stream at the location of B-B' for facies association of sub-unit 4 and sub-unit 5

As we can see in the figure 5.5, the distribution of the facies is quite different from sub-unit 1 until sub-unit 3. There is no more sandstone unit in this facies distribution. Interfingering of limestone and calcareous tuff bedding is decrease and the grain size of the rocks also different as it only consists of clay/mud grain size to fine grain size. It suggest that this area is deeper and the energy level at this area is decrease and weaker than A-A' area.

The nanofossils founds in this area as shown in figure 5.9 are predominantly consists of larger benthonic foraminifera which are miliolids, nummulites and planorbulina mediterranensis sp. Benthic foraminifera mostly found in area B-B' but not at A-A' area. This show that this area is a shallow marine area. Planktonic foraminifera also found such as orboluni universa and globigerina and were discussed in detail in subchapter 5.4.

Both area A-A' and B-B' has an alternation and interbedded of packstone and wackestone which it represent a largely low energy depositional environment such as back-reef flank facies which experienced phases of weak influence events. This is also supported by the presence of benthic and planktonic fossils which mostly can be found at shallow marine with low to moderate water circulation or energy.

In sub-unit 4, the thickness of bedding start to increase and the limestone unit start to dominate. Increasing of bedding can be interpret as the increasing of sediment supply at that area may be due to the increasing of water level or at the calmer area. The presence of massive calcareous tuff bedding that clearly increase in sub-unit 4 indicate that at this time, the calcareous tuff unit may be resulted from volcanic activity. Therefore, the bedding of calcareous tuff start to increase and thickness also varies in size.

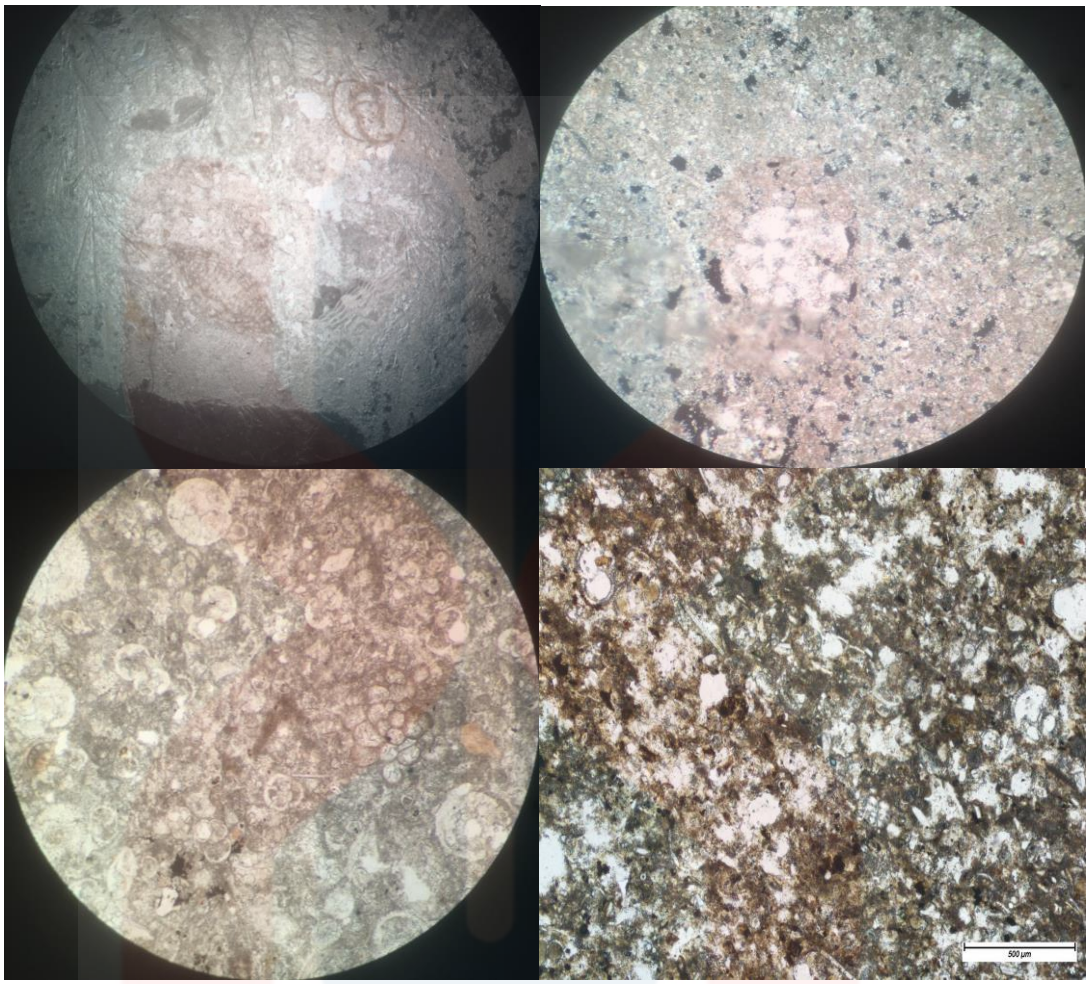


Figure 5.9 nanofossils found in the rock samples at the B-B' area

5.4 Fossils analysis

Fossils analysis using calcareous nannofossils used as a parameters give many advantages in order to give an estimation age of the sediments at that area. Calcareous nannofossils in sediments are useful for dating open marine beds which is the same facies in which planktonic foraminifera occur and with the same zonal resolution. As the sample of fossils is small, therefore not much sample needed in order to interpret data at that area.

Planktic Foraminifera

(A) Orbulina Universa

Orbolina Universa that usually found in sediments only left with the spherical shell which surrounded by abundance of delicate spines. Under microscope, it can be seen in a large spherical shape which quite same with shape as Globigerinoides. The shells and spines of this fossils are made up of calcium carbonate like most of other foraminifera (University of California, 2002). It also contain a numerous bright spots along with the spines which are smaller symbiotic organism that called dinoflagellates. Most of foraminiferas are consists of single cell heterotrophs, this species is bound to live within the shallow photic zone because of its photosynthetic symbionts. Orbolina Universa is exist around Middle Miocene to Present.

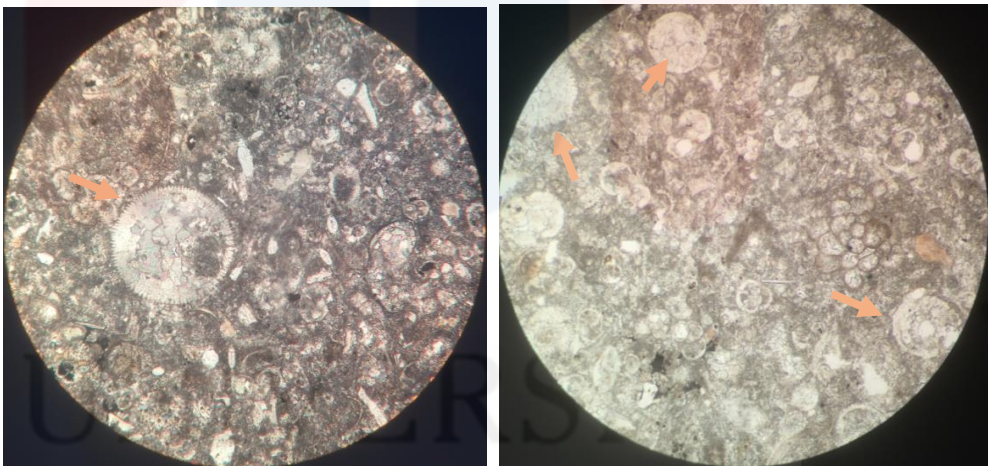


Figure 5.10 examples of orbulina universa fossils in the thin section under microscope

(B) Globigerina

Globigerina is a heterotrophic planktonic foraminifera species with a wide distribution in the photic zone. It also able to tolerate with various range of sea surface, temperature, water density and salinities. This fossils are abundance during winter and spring month. It has a globose, trochospirally enrolled test composed of

spherical to ovate but not radially elongate chambers that enlarge rapidly as added. The shell (test wall) of globigerina is calcareous with cylindrical pores. This nannofossils usually found in the marine sediment cores.

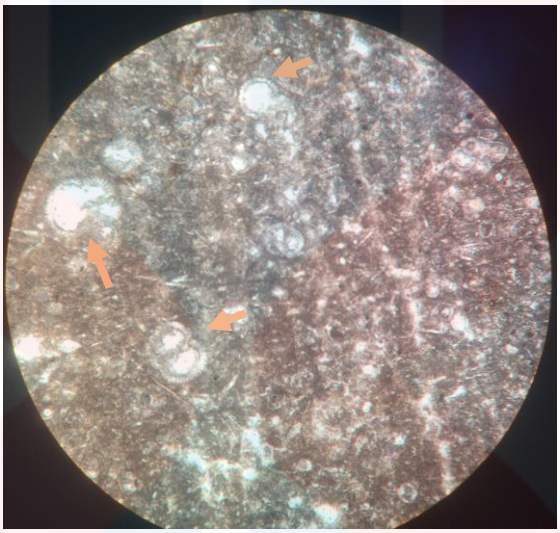


Figure 5.11 show an examples of globigerina fossils from cross polarized light under a microscope

Benthic Foraminifera

(A) Milliolids

Milliolids are an order of foraminifera which contain calcareous which is high in calcites. It commonly it has a test wall structure which described as porcelaneous and has a distinctive appearance which being yellow or brown when viewed with plane-polarized light. It also show low birefringence by polar cross and sometimes characterized by lost and walls appear micritic. Milliolid is dominantly range a Mesozoic and Cenozoic group and abundant in shallow water and along the coastline. It also can be found in a deep water oceanic forms and especially common in slightly restricted back-reef or bank facies.

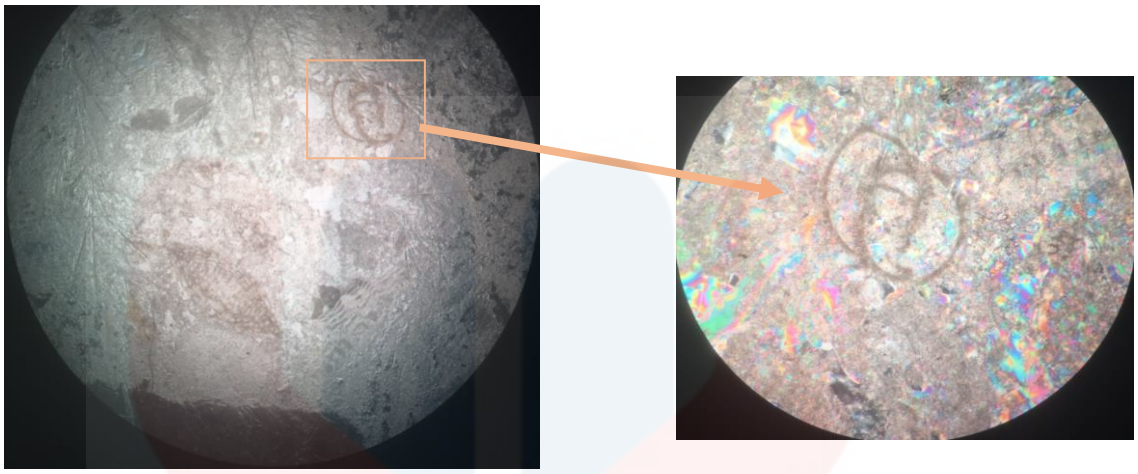


Figure 5.12 milliolids nannofossils in rocks under microscope

(B) Nummulites sp

Nummulites sp is large lenticular fossil which characterized with its numerous coils that subdivided by septa into chambers. It is small, trigonal or suborbicular in plan. Its shape similar to embryonic apparatus which excentric in position, composed of two equal or subequal chambers whose features are intermediate in character between the embryonic. It is a type of foraminifera that have a shells and known as marine protozoan. They are common in Eocene to Miocene marine rocks and they are valuable as index fossils.

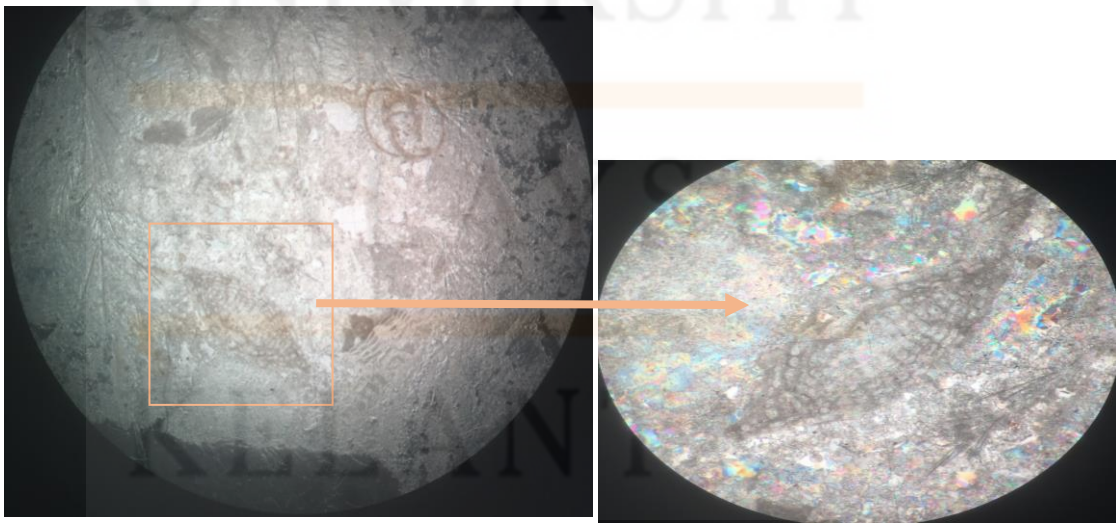


Figure 5.13 nummulites fossils found in the thin section sample under microscope

5.5 Interpretation of Depositional Environment

Depositional Environment of Oyo Formation can be interpreted based on the parameters of facies associations and foraminifera found in the selected area. In sub-unit 1 of A-A' area, the lithology dominated are the inter-fingering of calcareous tuff and limestone that indicates the intercalation of Oyo Formation and Wonosari Formation. The grain size of rock unit in sub-unit 1 is from very fine to fine grain size which show that the energy low to medium energy depositional environment that dominated by the weak waves and currents. Based on the foraminifera dominated and also the parameter of facies association, the sub-unit 1 is at the open marine middle ramp depositional setting environment as shown in figure 5.14.

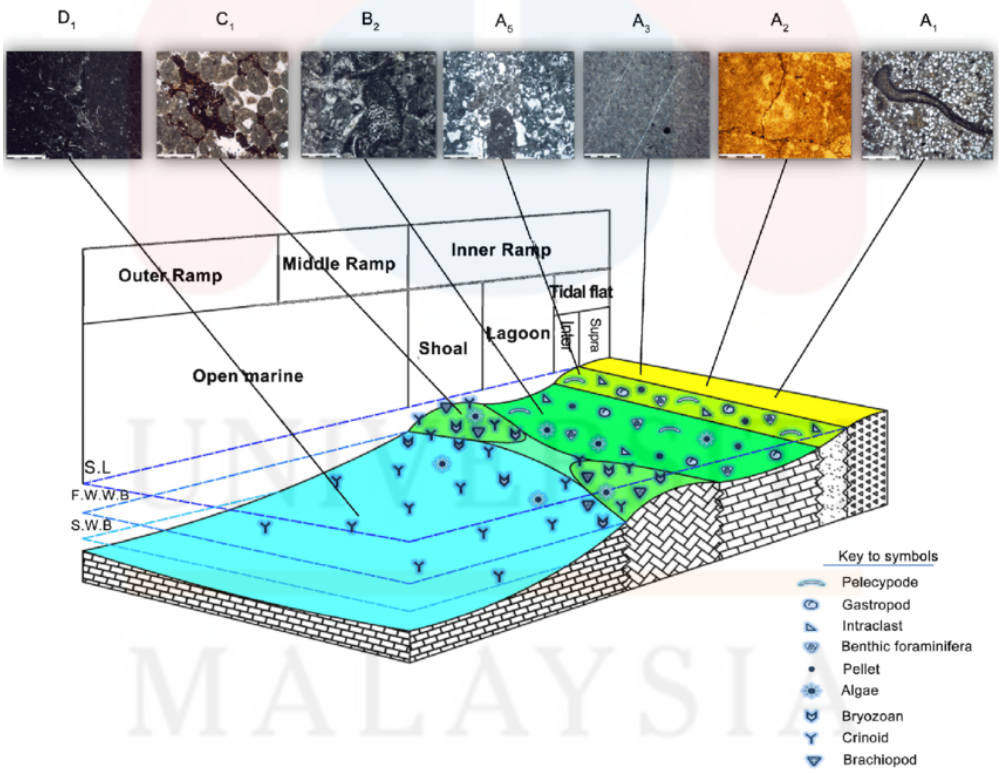


Figure 5.14 show the model of the depositional environment of shallow marine

While in sub-unit 2 and sub-unit 3, the sandstone unit start to appear with a grain size from medium to coarse. It show that the energy is from medium and

slightly stronger at some part compare to the sub-unit 1. There is not much difference in the presence of foraminifera found in both lithology unit in sub-unit 1 and sub-unit 2 and sub-unit 3. Therefore the sub-unit 2 and 3 is interpret as the transition from middle to outer ramp of shallow marine.

Next is the second selected area, B-B' which divided into sub-unit 4 and sub-unit 5. Sub-unit 4 show that the inter-fingering of limestone and calcareous tuff were decrease and the bedding of limestone unit is thicker. The grain size of rock unit in sub-unit 4 also constant and range from very fine to fine grain size. The thicker the bed, it indicates that depositional environment turning deeper compared to the sub-unit 1 to sub-unit 3. The benthic foraminifera start to increase in this sub-unit and foraminifera is increase due to the availability of oxygen content is higher.

The bedding in sub-unit 5 getting thicker and grain size is constant. It indicate that the energy level is lower compare to the previous sub-unit. Benthic foraminifera also increase in this part and even larger in size.

Planktonic foraminifera are represented at a broad latitudinal and temperature belts, floating in the surface or near-surface waters of the open ocean as part of the marine zooplankton. While, benthic foraminifera are abundant in modern seas and can live attached or free, at all depths. As benthic foraminifera have complicated internal structures it occur abundantly in the shelf regions of most tropical and subtropical shallow marine, carbonate-rich environments (Castle, 2014).

Based on all the parameters that have studied, the depositional environment of sub-unit 4 and sub-unit 5 is at outer ramp in the shallow marine. Therefore, it can be interpret that Oyo Formation in the study area is consists of the middle ramp to

outer ramp of shallow marine as shown in figure 5.14 based on the parameters used in this study.

5.6 Summary

Based on the parameters and evidence elaborates in sub-chapter 5.5, the depositional environment of Oyo Formation in the study area is interpret to be at middle ramp to outer ramp in the shallow marine as mark in red part shown in the figure 5.15. Data of foraminifera in the rock unit under microscope and the facies assosiation of Oyo Formation in research area give an evidence and data to produce the result interpretation of depositional environment of Oyo Formation in Ngalang area.

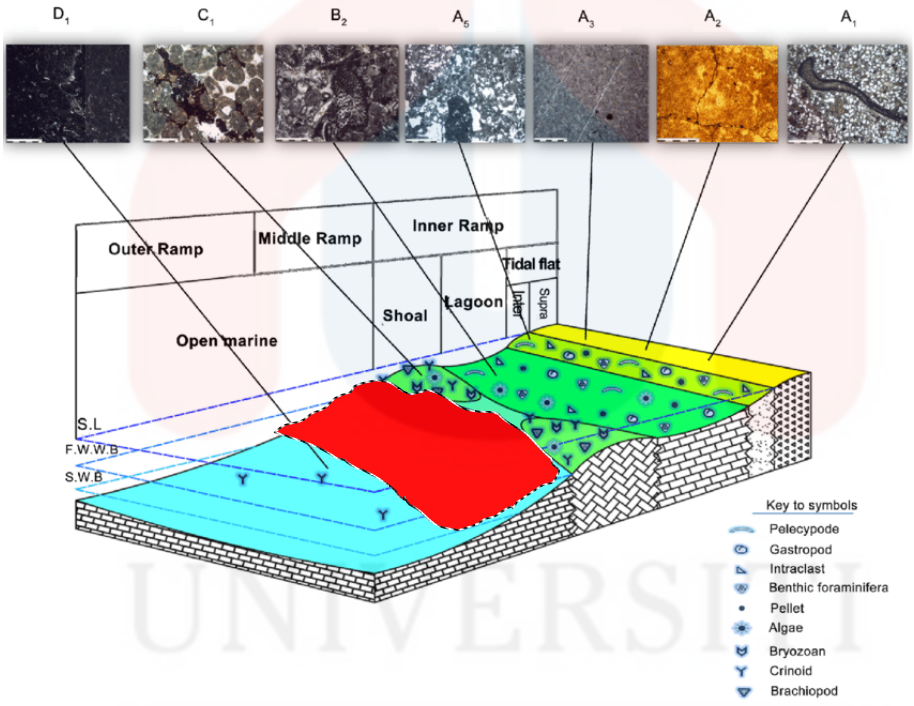


Figure 5.15 the red part represent the interpretation of an area of Oyo Formation in study area

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The objectives of this research study were able to accomplish within the time given. A geological map with scale 1:25 000 was produce and update with more detail information using ArcGIS software. Depositional environment of Oyo Formation in Ngalang area, Gedangsari district were analyse and interpret using the data collected on field using parameters such as foraminifera fossils on rocks and facies association data recorded at selected area.

Methodology involve in order to complete this research area geological mapping, geomorphological mapping, lithostratigraphic data on field and structural geology. All data collected were interpret a general geology of the study area and also th specification of this research which is to study the depositional environment of Oyo Formation in Ngalang area.

Stratigraphically, three formation involve in this study area, those are Sambipitu Formation, Oyo Formation and Wonosari Formation. All the formations and structural geology related to general geology of study area were discussed and explained in detail in this research. The boundaries of every formation can be identify on field based on the specific lithology unit and other geological structures found.

The depositional environment of Oyo Formation in study area were interpreted and explained in detail based on the evidence and data collected on field such as facies association and fossils analysis. All data and parameters used in this research give a great information and were helping in order to interpret and identify the depositional environment of Oyo Formation. At the end of the discussion in chapter 5, it can be conclude that the depositional environment of Oyo Formation in study area is at middle ramp to outer ramp of shallow marine environment.

6.2 Recommendation

Gedangsari district is a good location in order to study regarding the difference between depositional environment of transition from volcanic activity to carbonates sedimentary processes. The data collected on field and geological mapping will be great help in order to study in detail regarding the depositional environment. There are many geological structures can be observe and Gedangsari will be a great field mapping in dry season as the small stream will dry and give an opportunities to explore the obvious structure which covered before.

Besides, research which focusing on paleontology on macrofossils and microfossils also can be proposed at this area. This is because, there are many fossils can be observed in this area. Macrofossils is abundant in Sambipitu and Oyo Formation while microfossils can be observe and study in Wonosari Formation through petrographic analysis in the form of thin section. This will be great research on the fossils in Miocene epoch and Neogene periods.

The depositional environment study in this research is lack in the geological structure and sedimentary structure data. Therefore, I would like to propose the next researcher in this area to explore and study more regarding both structure data in order to get the best result. The interpretation of depositional environment using sedimentary structure on field and paleocurrent data will help in order to get the precise and best result.

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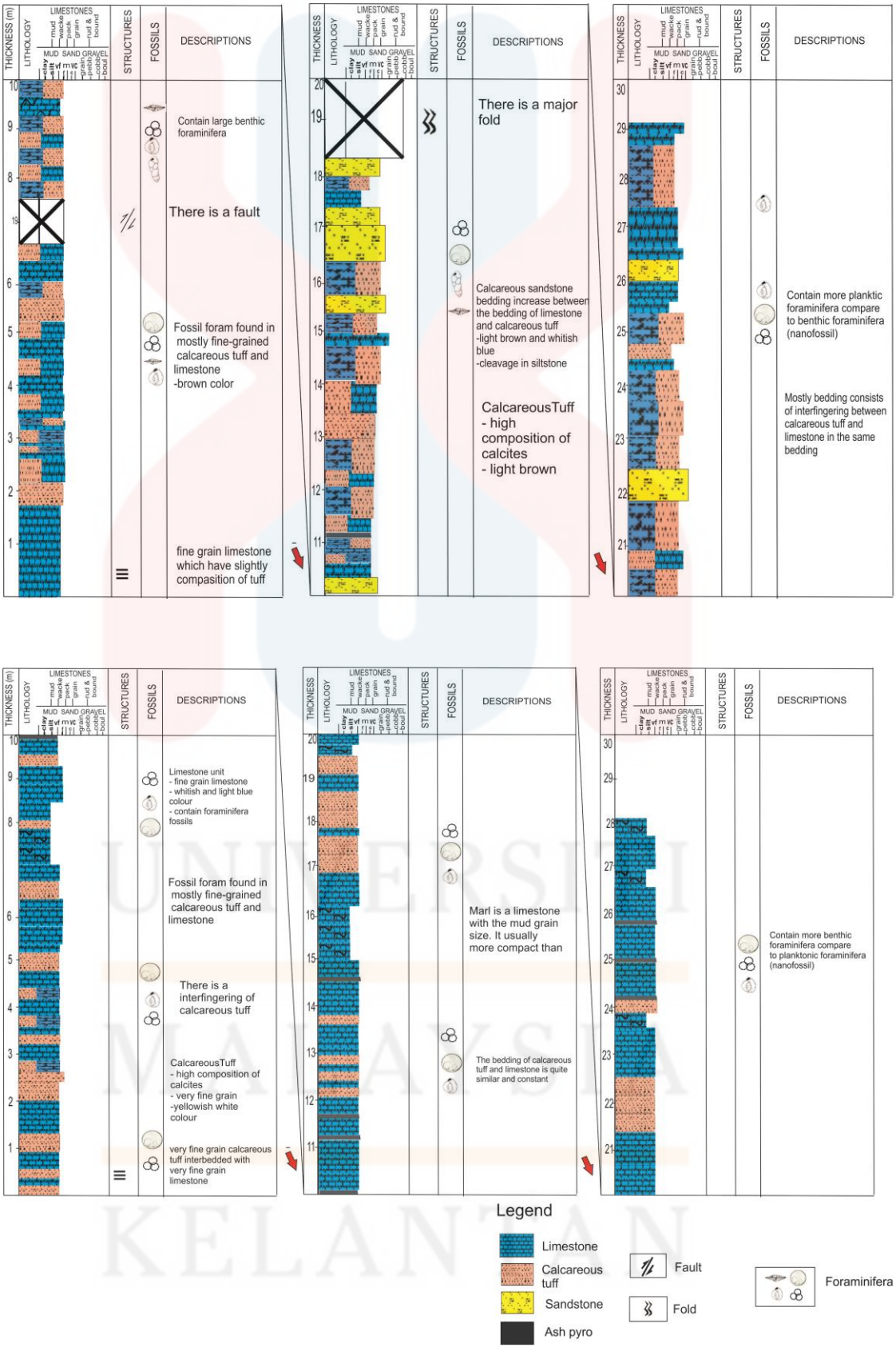
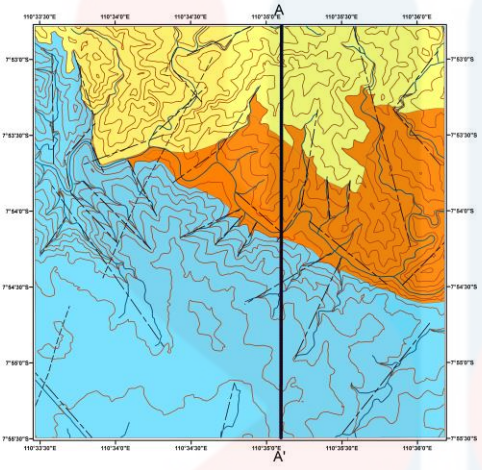
APPENDIX


THICKNESS (m)
LITHOLOGY
LIMESTONES
STRUCTURES
FOSSILS
DESCRIPTIONS
Contain large benthic foraminifera
There is a fault
Fossil foram found in mostly fine-grained calcareous tuff and limestone
-brown color
fine grain limestone which have slightly compasition of tuff
There is a major fold
Calcareous sandstone bedding increase between the bedding of limestone and calcareous tuff
-light brown and whitish blue
-cleavage in siltstone
CalcareousTuff
- high composition of calcites
- light brown
Contain more planktic foraminifera compare to benthic foraminifera (nanofossil)
Mostly bedding consists of interfingering between calcareous tuff and limestone in the same bedding
Limestone unit
- fine grain limestone
- whitish and light blue colour
- contain foraminifera fossils
Fossil foram found in mostly fine-grained calcareous tuff and limestone
There is a interfingering of calcareous tuff
CalcareousTuff
- high composition of calcites
- very fine grain
-yellowish white colour
very fine grain calcareous tuff interbedded with very fine grain limestone
Marl is a limestone with the mud grain size. It usually more compact than
The bedding of calcareous tuff and limestone is quite similar and constant
Contain more benthic foraminifera compare to planktonic foraminifera (nanofossil)
Legend
Limestone
Calcareous tuff
Sandstone
Ash pyro
Fault
Fold
Foraminifera



Universiti Malaysia KELANTAN

DEPARTMENT OF GEOSCIENCE
FACULTY OF EARTH SCIENCE
UNIVERSITI MALAYSIA KELANTAN

GEOLOGY AND DEPOSITIONAL ENVIRONMENT OF OYO FORMATION OF NGALANG, GUNUNG KIDUL, YOGYAKARTA, INDONESIA

by :

NUR SYAZA BINTI AZAHAR
E15A0207

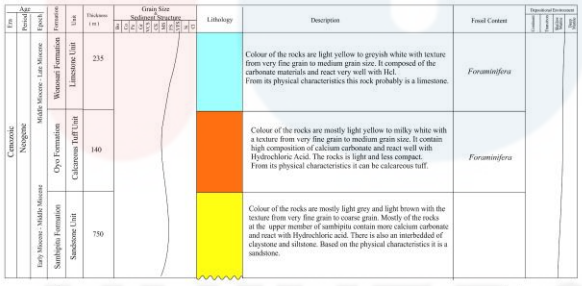
Legend

- Lineament
- Contour
- Main River
- Calcareous tuff unit
- Sandstone unit
- Limestone unit
- Box study area

N
W E
S

Neogene	Miocene	Late	Wonosari Formation	Sandstone unit
		Middle	Oyo Formation	Calcareous Tuff unit
		Early	Sambipitu Formation	Limestone unit

STRATIGRAPHIC COLUMN OF NGALANG, GEDANGSARI, GUNUNG KIDUL REGENCY
SPECIAL PROVINCE OF YOGYAKARTA, INDONESIA



Neogene	Miocene	Late	Wonosari Formation	Limestone unit: Limestone with the grain composition of clay (marl) and also very fine to medium grain
		Middle	Oyo Formation	Calcareous Tuff unit: Mostly tuff found with high composition of calcium carbonate
		Early	Sambipitu Formation	Sandstone unit: calcareous sandstone which sandstone that contain high composition of calcium carbonate and sandstone which interbedded with claystone and siltstone.

INDEKS LOKASI PETA
INDEX MAP LOCATION

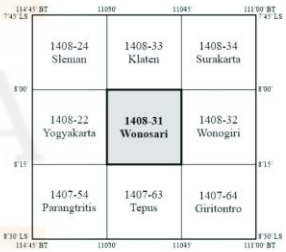


DIAGRAM DEKLINASI DI PUSAT LEMBAR PETA
DECLINATION DIAGRAM ON THE CENTER OF THE SHEET

US : Utara Sebenarnya (Geografi)
UG : Utara Grid (UTM)
UM : Utara Magnetik

Hubungan dengan Utara Sebenarnya, Utara Grid, dan Utara Magnetik ditunjukkan secara diagram untuk pusat peta ini. Deklinasi Magnetik rata-rata pada tahun 2016 di pusat peta. Deklinasi tersebut tiap tahun bertambah 1'.

Relationship with True North, Grid North, and Magnetic North showed diagrammatic for this map center. Average magnetic declination at the center of the map in 2016. This Declination is increased 1' each year.

PETA LOKASI
LOCATION MAP