GEOMORPHOLOGIC AND STRATIGRAPHIC DETERMINATION USING OUTCROP DATA, THIN SECTION AND MICROFOSSIL ANALYSIS IN BENTARSARI AREA, BREBES DISTRICT, CENTRAL JAVA

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ABSTRACT

Administratively, Bentarsari area was located in Salem Sub-District and Brebes District in Central Java Province with coordinate 108°46'45,15" - 108°49'28.29" BT - 108°39'32.4" BT and 7°7'40.34" LS - 7°10'22.22" LS. This research aims is to give an understanding about geological condition in geomorphology and stratigraphy aspects which are described by thematic map in 1:12.500 scale within an area of 25km^2. This research was accomplished with surface data (outcrop) and field orientation method using of GPS, geological compass, loop, geological hammer, comparator, and any other tools. Afterward, thin section and fossil analysis were also collected to determine the type of rocks and the age of the stratigraphy unit. This research will include the classification of geomorphology unit based on 3 aspects, which are morphography, morphometry, and morphogenetic and also classification of stratigraphy unit, based on characteristics of rocks such as rock texture, mineral contents and fossil contents. The geomorphology of the Bentarsari region can be divided into 3 (three) geomorphological units, namely: the alluvium high altitude fluvial unit, high hills of steep structural sediments unit, and very steep high structural sedimentary hills unit. While the Litho-stratigraphic on research area divided into 4 (four) units, from the oldest to the youngest stratigraphy position is sandstone unit (Tbp), claystone unit (Tbl), fine-grained sandstone unit (Tpbph), and breccia unit (Qpbx). Thus, by having the result of this research, can be useful as a reference to have further studies in this located area.

Keywords: Bentarsari, Geomorphology, Stratigraphy, Petrography, Fosil Analysis

INTRODUCTION

Administratively, Bentarsari area was located in Salem Sub-District and Brebes District in Central Java Province with coordinate 108°46'45,15" - 108°49'28.29" BT - 108°39'32.4" BT and 7°7'40.34" LS - 7°10'22.22" LS. According from preliminary studies, this located research area has interesting and various types of rocks to study.

Geomorphology is the study of land forms and processes that influence their formation and investigate the relationship between forms and processes in their spatial order (Van Zuidam,1979) while Stratigraphy in the broadest sense is the science that discusses rules, relationships and events (genetic) kinds in nature in space and time while in meaning bottom layer. (SSI, 1996).

Both of these aspects are interconnecte. Since geomorphology and stratigraphy are one of important geological aspects, a geomorphology and stratigraphy studies was conducted to give a better knowledge understanding, in order to be a reference for a further studies regarding to the geological potential that may occur in the research area.

This research will include the classification of geomorphology unit based on 3 aspects, which are morphography, morphometry, and morphogenetic. Also a classification of stratigraphy unit, based on characteristics of rocks such as rock texture, mineral contents and fossil contents.

LITERATURE STUDY

Physiographically, Van Bemmelen (1949) divided Central Java into five physiographic zones :

1. North Java Alluvial Plain
2. Rembang Anticllinorium
3. Bogor Zone, North Serayu Mountains
4. Southern Serayu Mountains
5. Central Java Depression Zona

The Salem area, located in Brebes Regency, Central Java, based on the fisographic division of Central Java (Van Bemmelen, (1949) belongs to the eastern Bogor Zone and is almost bordered by the Northern Serayu Mountains in the west. (Figure 1).

Regional stratigraphy is focused on rock groups exposed in the Salem area according to previous experts. The stratigraphic units revealed in the Salem area according to

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Kastowo & Suwarna (1996) in the Majenang Geological Map scale 1: 100,000 from old to young (Figure 2) are:

1. Kumbang Formation (Tmpk)
2. Tapak Formation (Tpt)
3. Kalibiuk Formation (Tpb)
4. Kaliglagah Formation (Tpg)
5. Linggopodo Formation (pt)
6. Alluvium

The research area has a geological history that is controlled by geological structures on the island of Java. The geological structure formed is produced from the collision of the Indian-Australian plate and the Eurasian plate during the late Cretaceous or Early Tertiary. The structure formed in the study area in general is tectonic compression which causes the formation of fault blocks. The Australian-Indian plate collision that occurred caused the formation of spaces or containers where sediment was deposited, one of which was a container formed in the study area, namely the Bentarsari basin. During the Middle and Late Paleocene the compression process that came from the south to the north resulted in the fault blocks, main shear joint, Bancuh in the South as well as Bentarsari basin. Then in Eocene, shallow sea deposits began to occupy parts of the Early Paleocene sediment which had eroded.

Figure 1. Central Java Physiography of Central Java (Van Bemmelen, 1949)

METHODS

A literature study was conducted to understand the geological setting and stratigraphy of Bentarsari District and surroundings. The research area on the map is from part of Bakosurtanal Map sheet 1304-541 Salem. A geomorphology study was also conducted using contour map and SRTM (*Shuttle Radar Topographic Mission)* image to interpret the lithologies and structures that occur in the research area.

Field data was obtained from the outcrop using surface geological mapping method and field orientation within an area of 25 km^2 which were assisted with thematic map in the scale of 1:12.500, geological compass, GPS, geological hammer, comparator, loop, etc. Samples of rocks were gained from the field to be then accomplished with petrography and fossil analysis.

Afterward, the geomorphology studies were analyzed within the 3 aspects which are morphography; including landform, valley shape, drainage system, and original landform. Morphography; including slope value. And morphogenetic; the aspect that related to the process of the recent geological condition along with its materials. This analysis were accomplished with ArcGis10.3 software.

Then, the stratigraphy studies were analyzed within 2 aspects which are petrography using the thin section analysis and also the microfossil analysis. As a resul, the type of the rock along with mineral and microfossil contents were classified to determine the depositional environment, age, and the name of the rocks.

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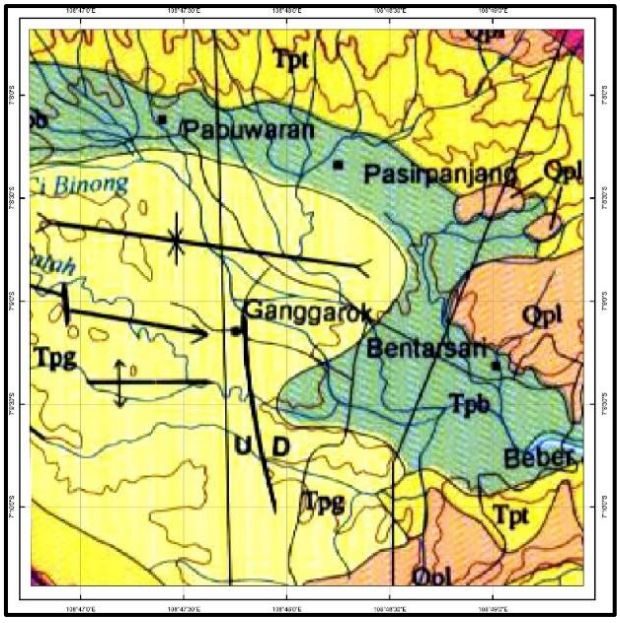

Figure 2. Regional Geology of Majenang Sheet (Kastowo & Suwarna, 1996)

RESULT AND DISCUSSION

Geomorphology

Geomorphology is one branch of geology that studies the processes that occur on the surface of the earth starting from its formation until recent. The research area has a height between 274.5 - 715.8 meters above sea level. Based on the data obtained, the study area was dominated by areas of hills. About 45% of the study area has a fairly high surface and contour. Areas that have a relatively sloping surface are located in the middle of the study area.

The shape of the valleys found in the study area based on topographic analysis and appearance in the field belongs to the type of U-shape valley and V-shape balley. The U-shape valley is found in rivers with horizontal erosion, while the V-shape valley is around the hills with vertical erosion. Drainage system also known as river systems that develop in the research area are parallel, dendritic, and subdendritic according the geographic and landform features.

Table 1. Geomorphology unit of the research area.

Geomorphology Units	Colour Symbol	Geomorphology aspects								
		Morphography				Morphometry		Morphogenetic		
		Drainage System	Landform	Valley Shape	Altitude (mdpl)	Slope		Endogenous	Exsogenous	Materials
						Class	Degree (°)			
The alluvium high altitude fluvial unit		Dendritic	High Plain	U	275 - 425	Flat - Rather Steep	0° - 16°	Tektonik	Pelapukan dan Erosi	Claystone, Sandstone, Coal
The High hills of steep structural sediments unit		Sub Dendritic	High Hill	V	553-702	Gentle - Steep	6° - 25°	Tektonik	Pelapukan dan Erosi	Sandstone, Breccia
The Very steep high structural sedimentary hills unit		Parallel	Perbukitan Tinggi	V	557-695	Very Gentle - Very Steep	10° - 42°	Tektonik	Pelapukan dan Erosi	Sandstone

According to the 3 aspects of geomorphology, the unit of geomorphology in Bentarsari region can be divided into 3 (Table 1 and Figure 3):

1. The alluvium high altitude fluvial unit. This unit occupies around 50% of the total area of the study, that has a high plain landform which consist of dendritic drainage system characterized by the shape of U-shape valley. Based on the results of morphometric analysis, this geomorphological unit has an elevation

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value of 275 - 425 mdsl, the slope ranges from 0^0 to 16. Based on morphogenetic aspects, this unit is composed by lithology of claystone, sandstone, coal, and alluvium.

2. The High hills of steep structural sediments unit. This unit occupies around 20% of the total area of the study, that has a high hill landform which consist of subdendritic drainage system characterized by the shape of V-shape valley. This geomorphological unit has an elevation value of 553 - 702 mdpl, the slope ranges from 6^0 to 25 and composed by lithology breccia and sandstone.The Very steep high structural sedimentary hills unit. This unit occupies around 30% of the total area of the study, that has a high hill landform which consist of subdendritic drainage system characterized by the shape of V-shape valley. This geomorphological unit has an elevation value of 557 - 695 mdpl, the slope ranges from 10^0 to 42^0 and composed by lithology sandstone.

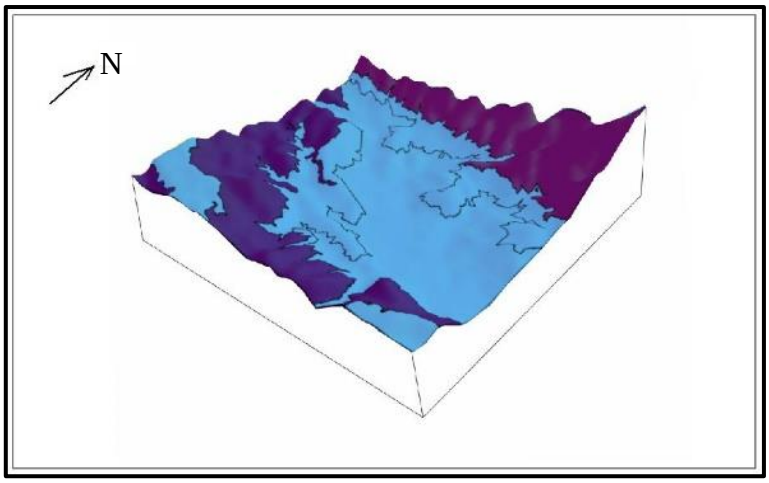

Figure 3. Picture of research area and geomorphology unit

Stratigraphy

In determining the stratigraphy of the research area, the nomenclature of an unofficial lithographic unit (Indonesian Stratigraphic Code, 1996) is used in determining rock units. Lithostratigraphic division is used to classify rocks systematically and is based on rock characteristics observed in the field, including rock types, rock type combinations, uniformity of rock lithology symptoms and other symptoms in rocks in the field so that the name of the rock unit is determined by the main rock as the most dominant constituents occupy the entire strata.

Application of Superposition Law is also used in determining unofficial rock units to determine the relative age of the unit. In addition, paleontological analysis is also used in determining the relative age of rocks through the fossil content in rocks.

In the research area, the determination of unit boundaries is based on topographic conditions and position of the layers, and contact between rock units. Based on consideration of the above, the authors divide the research area into four rock units (Figure 4). Rock units from the oldest to the youngest rock units, namely:

1. Sandstone unit (Tpbp)
   The distribution of this unit occupies around 20% of the total of the research area and spread in the northern part of the research area. This unit is composed of fine-sized sandstones - very fine and conglomerates in several places. In some location, sandstone is found with shells fossils of mollusks which are gastropods and bivalves. Based on the thin section analysis, the percentage of fragments in sandstone from sample V.87 are Q (22,7%), F (68,2%), RF (9,1%). Thus, it can be concluded that the name of the rock is Feldspathic Graywacke (Pettijohn, 1975).

   Then relative age determination is also based on the presence of plantonic foraminifera, which refers to Postuma (1971). Based on the plantonic foraminifera found, it is known that this unit has relatively the age of late Miocene - Early Pliocene. While the determination of the bathymetry zone refers to the general bathymetry zone in the Tipsword et al table. (1966) in Pringgoprawirodkk. (1994), where

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it is known that this unit is in the bathymetry zone of the inner Neritic range.

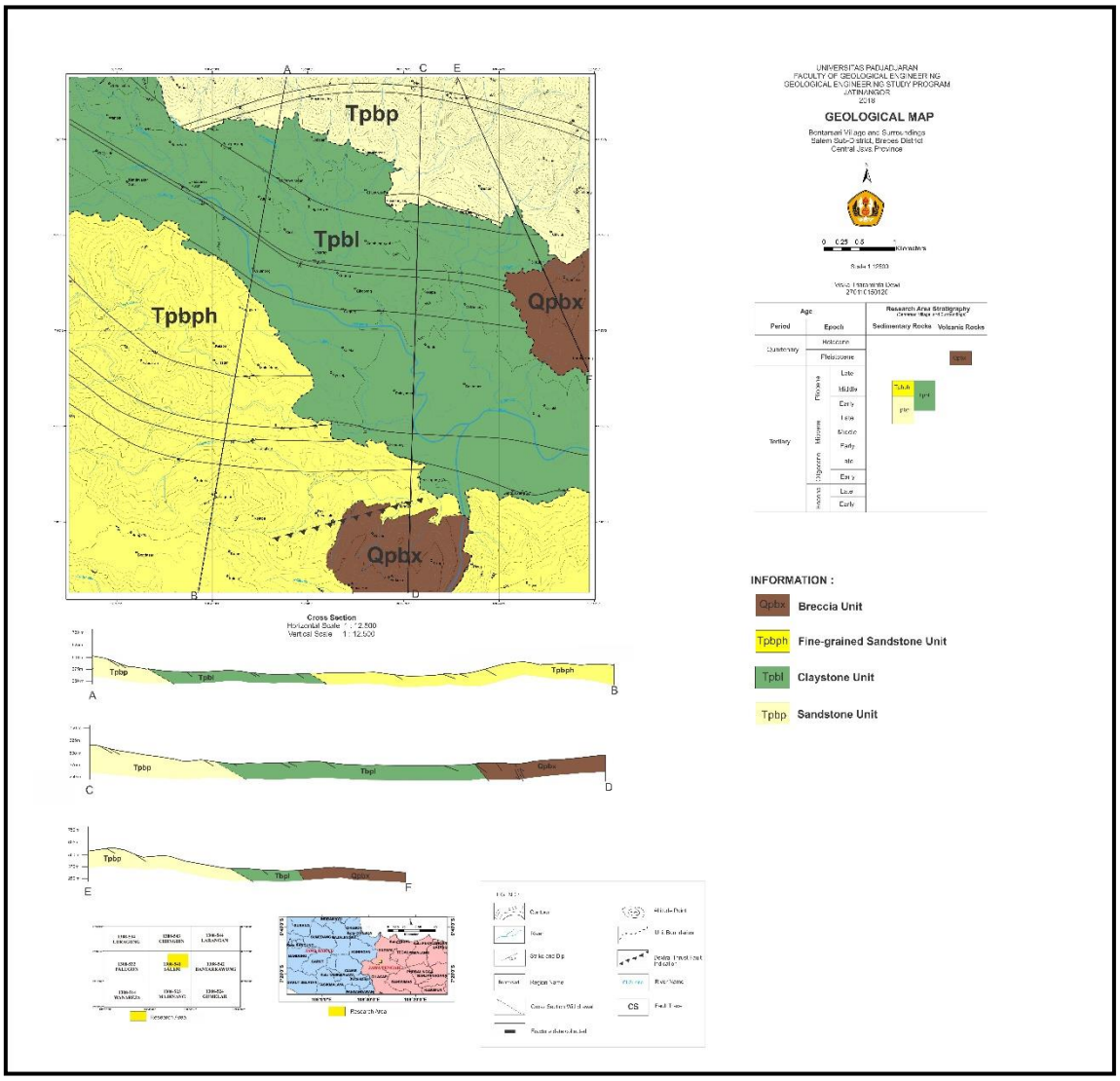

Figure 4. Geological Map of Research Area that shows stratigraphy unit

2. Claystone unit (Tpbl)
   The distribution of this unit is in the north to the middle of the research area, and occupies around 35% of the total area of the research area. This unit is composed of claystone, and in some locations coal is found layered with claystone and sandstones, In several location sandstones were found with shells fossils of molusk. Coal is found as well as claystone and conglomerate coatings which are all dominated by claystone. Based on age and reconstruction of the geological cross section, this unit occupies above the sandstone unit. Based on the thin section analysis, the percentage of fragments in claystone on sample V 3.3 are Q (22,22%), F (55,55%), RF (22,22%). Thus, it can be concluded that the name of the rock is Mudstone (Pettijohn, 1975).
   Based on the plantonic foraminifera found from claystone on sample V 3.8, it is known that this unit has relatively the age of Early Pilocene - Middle Pliocene. While the determination of zones in Pringgoprawirodkk. (1994), known that this unit is in the deep neritic bathymetry range.
3. Fine-grained Sandstone unit (Tpbph)
   The distribution of this unit is in the north to the middle of the research area, and occupies around 35% of the research area. This unit is composed of sandstones, sandstone inserted with coal, and is also found in a location that is limestone and layered conglomerates and sandstones which are entirely dominated by sandstones. Based on age and reconstruction of geological cross sections, this unit occupies over claystone units in

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the study area. According to the thin section analysis, the percentage of fragments in sandstone on samples V 8.3 are Q (31,25%), F (46,87%), RF (21,87%) where it is named as Feldsphatic Graywacke (Pettijon, 1975).

The sandstone was found layered and inserted by brownish-gray colored coal, the gloss was dull with brownish old black strokes, hardness was brittle, cleared right into the rank of lignite coal (George, 1975). The weathering level is very weathered and the structure is layered and the contact is bold. Other than that, carbonate rocks was also found in this unit, fresh grayish white and light brownish weathered gray, matrix supported and it was found with fossils of gastropod mollusks. Based on the thin section analysis, it is named as a Wackestone (Dunham, 1962).

Based on the plantonic foraminifera found from sandstone on sample V 6.6, it is known that this unit has relatively age of Middle Pliocene while the determination of the bathymetry is in the deep littoral-neritic range bathymetry zone.

4. Breccia Unit (Qpbx)
   The distribution of this unit is in the eastern and southern part of the research area, and occupies around 10% of the research area. This unit is composed by breccia and tuff in one location. Based on the reconstruction of the geological cross section, this unit occupies the youngest position of the entire rock unit in the study area.

   This unit is composed of breccias and tuffs. Breccia found in this unit is in the form of monomical breccias dominated by components classified as Grain Supported. The components are the size of granules until cobbles, having fresh gray light and dark gray color. The texture is hypocrystalline and has porphyritic granulity. The color is mesocratic which which indicate andesitic. From the thin section analysis, result came as Andesite (Streckeisen,1967) is the name of the rock which has the percentage of on samples V 5.1; the components are Q (3,5%), F (85,3%), RF (11,2%) then it is named as Andesite (Streckeisen, 1967). The precentace of the matrix of breccia are Q (20,83%), F (58,3%), RF (20,83%) then it is named as Feldsphatic Graywacke (Pettijohn, 1975).

Determination of the age of this unit is determined based on Superposition Law, and cross section reconstruction where sandstone units have relatively older ages compared to claystone units, fine-grained sandstone units, and breccias.

CONCLUSION

From the result above, we can conclude:

1. According to the 3 aspects of geomorphology, the unit of geomorphology in Bentarsari region can be divided into 3; the alluvium high altitude fluvial unit in the central of the research area, high hills of steep structural sediments unit in the southern side of the research area and very steep high structural sedimentary hills unit in northern side of the research area.
2. Litho-stratigraphic on research area divided into 4 (four) units, from the oldest to the youngest stratigraphy position is sandstone unit (Tbp) that was deposited in of late Miocene - Early Pliocene, claystone unit (Tbl) in Early Pilocene - Middle Pliocene, fine-grained sandstone unit (Tpbph) in Middle Pliocene, and breccia unit (Qpbx).

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