Lithofacies And Depositional Environment Of Halang Formation On Part Of Cihikeu River Section, Majalengka, North Java

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Abstract

This study about lithofacies and depositional environment is located at Cihikeu River, Village Area of Mekarwangi Village, Bantarujeg District, Majalengka, West Java. Geographically, the research area is located at 6^0 56' 11,7" latitude and 6^0 57' 09,3" latitude and 108^0 11' 22,3" BT until 108^0 12' 20,3" BT. Based on Arjawinangun Geological Map (Djuri, 1995), the research area is located at Upper Parts of Halang Formation. This research show that the lithology that dominantly occur in the research area is sandstones, mudstones, and breccia.

The methods that been used in this research are stratigraphics cross section measurements, lithofacies analysis, and based on secondary data which is paleontology analysis, it can be concluded that there are 8 lithofacies refers to the submarine facies classification by Stow, 1985 that occur in research area, which are facies A1-1, facies A1-3, facies B1-1, facies C2-2, facies C2-3, facies E1-1, facies E2-1, and facies F2-2. Based on the secondary data, the age of research area can be concluded into middle miocene to late miocene.

Based on the lithofacies analysis, the lithofacies association concluded into 3 lithofacies association, which are FA-1, FA-2, and FA-3. From those lithofacies associaton characteristics, thereafter the depositional environment can be interpretated into 4 sub-depositional environments which are lower slope, upper fan, middle fan, and lower fan that refers to submarine depositional environments classification by Walker, 1984.

Keywords : Lithofacies, Lithofacies association, Depositional environments, Submarine fan

Introduction

On Cihikeu River, Mekarwangi Village, Bantarujeg District, Majalengka Region, North Java, consist of interbedded layers of sandstone and mudstone, massive sandstone, mudstone, and breccia that were part of Upper Halang Formation. Author assumed that the outcrops that found on research area were turbidite deposits on Halang Formation. Based on that assumption, it encourages researchers to do research in these area that supported by literature. Based on Djuri (1995), Halang Formation was deposited at Middle Miocene-Early Pliocene.

Based on previous researchers, the source of Halang Formation deposits came from south (Martodjojo, 1984; Martodjojo, 1994; Clements and Hall, 2007). Halang Formation outcrops indicated the turbidite facies characteristics that assumed this formation was deposits in submarine fan environment.

This research will discuss about the characteristics of turbidite deposits in Upper Halang Formation on Cihikeu

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River, Mekarwangi Village, Bantarujeg. Besides that, for better understanding about stratigraphy in this area, measured section was done on parts of Cihikeu River in research area.

Methodology

1. Conducted measured section on parts of Cihikeu River in research area.
2. Lithofacies analysis reffering to deep sea lithofacies classification (Stow, 1985)
3. Age interpretation of the research area based on secondary data
4. Lithofacies association interpretation based on lithofacies characteristics that occur on research area
5. Depositional environment analysis that refered on deep sea depositional environment model (Walker, 1984)

Regional Fisiography

According to Van Bemmelen (1949), North Java was divided into 5 physiography units that is part of physiography path and structural that in general have north to east direction. 5 of those physiography are :

1. Jakarta Zone
2. Bogor Zone
3. Bandung Zone
4. Bayah Mountains Zone
5. South Mountains Zone

Regional Stratigraphy

Djuri and Silitonga (1973), that have done research and mapped the Arjawinangun Geological Map and Bandung, stated that the stratigraphy order from the oldest to youngest units are Cinambo Formation (Early Miocene), Halang Formation (Middle Miocene), Subang Formation (Late Miocene), Kaliwangu Formation (Pliocene), Citalang Formation (Pliocene), Deposits of Paleo Vulcanic Mountain (Pleistocene), and Deposits of Recent Vulcanic Mountain (Pleistocene)

Regional Geological History

Van Bemmelen (1970) stated that on Early Oligocene, the Bogor Zone was a deep sea basin that characterized by the flysh deposits, deep sea deposits with intercalated of volcanic deposits which is known as Pemali Formation. After the non-volcanic evolution end, continue by volcanic activity included by decline that form few deep sea volcanic mountains on Early Miocene that produce andesitic and basaltic deposits. In Middle Miocene, the volcanic activity has reduce and the deposits of mudstone, marl, and coral limestone occur that characterized deep sea environment. In Bogor Zone at that time, Cidadap Formation and Halang Formation occurs. South facies consist of breccia and tuffaceous sandstone, while the North facies consist of mudstone and marl.

At the end of Middle Miocene, anticline was formed at the south mountains followed by the launch of its peak towards the northern part of Java Basin. At the end of Late Miocene, this volcanic activities shifted towards Bandung Zone and South Bogor that produce Kumbang Formation's breccia deposits. This showed that the subduction zone has shifted to south. When the volcanic activity in Middle Miocene occur, Bandung Zone and Bogor Zone suffered strong erosion. Meanwhile, Jakarta Shore Landform continues to subduct that characterized by the deposits of mudstone and marl that known as Kaliwangu Formation that occured at Pliocene.

At Late Miocene, can be assumed that the Bogor Basin has turned into shallow. This is shown by the sandstone unit with ripple mark and mollusc fossils. On top of it, the Pliocene-Pleistocene volcanic deposits occur, in this case these activities clearly visible on transition track of Bandung Zone and Bogor Zone.

At Middle Pliocene, volcanic activity happened again and resulting in the

E-ISSN : 2579 - 3136

sediment facies of Kaliwangu Formation transform into andesitic volcanic facies, then on top of that the conglomerate of Ciherang Formation occur.

Result and Discussion

The trajectory of measured section was located at Cihikeu River, Northwest of Mekarwangi Village, Bantarujeg District. In general, the research area is consist of thick massive sandstone deposits, interbedded layers of sandstone and mudstone, mudstone, and breccia. Thick massive sandstone have dark grey weathered color, grey fresh color, with grain size from very coarse sand to coarse sand, medium sorted, carbonated, and hard compaction. The thickness of this outcrop approximately 90m.

In the interbedded layers of sandstone and mudstone, the sandstone have dark grey weathered color, grey fresh color, with grain size from coarse sand to fine sand, subangular-rounded grain shape. Medium to well sorted, carbonated, slightly hard compaction, and consist of gradded bedding, parallel lamination, cross ripple lamination, convolute lamination, and slump sedimentary structures. The thickness of this sandstone is approximately 10cm-100cm. The mudstone have grey weathered color, dark grey fresh color, shaly, and carbonated. This mudstone thickness approximately 10cm-200cm. Based on the characteristics of the outcrop and the sedimentary structures in it shows the Ta, Tb, and Tc facies (Bouma Sequence, 1962).

The mudstone have grey weathered color, dark grey fresh color, slightly shaly-massive, and carbonated. The thickness of this outcrops approximately 70m.

The breccia have dark grey weathered color, grey fresh color, and consist of igneous rock and some pebbly sandstone components with sandstone matrix, components size granule to pebble, matrix supported. Igneous rock as components have dark grey weathered color, grey fresh color, hard compaction, and afanitic. Sandstone as matrix have grey weathered color, dark grey fresh color, with coarse sand to fine sand grain size, poorly sorted, and hard compaction.

Turbidite sequence facies in submarine fan system controlled by the sediment materials for it source, especially the comparison of pebble, sand, and mud materials. In general, the turbidite facies in research area not showing the ideal Bouma Sequence (1962), in this case, the facies at research area experience the truncated sequence which is the lost of the upper parts of the Bouma Sequence facies.

The outcrops characteristics and the sedimentary structures within it show that the sedimentation of the research area which is Upper Halang Formation affected by turbidite current. The research at Cihikeu River show that the Upper Halang Formation composed by Ta, Tb, and Tc facies (Bouma Sequence, 1962).

From the characteristics of outcrops in research area, lithofacies analysis was conducted refered on deep sea facies classification (Stow, 1985). The analysis show that the research area consist of 8 lithofacies which are breccia facies (A1-1), interbedded layers of breccia and sandstone (A1-3), massive sandstone facies (B1-1), interbedded layers of thick sandstone and mudstone facies (C2-2), interbedded of thin sandstone and mudstone facies (C2-3), mudstone facies (E1-1), mudstone intercalated by sandstone facies (E2-1), and slump facies (F2-2).

Breccia facies (A1-1) characterized by breccia deposits which consist of igneous rock and pebbly sandstone components and sandstone matrix, the components size are granule to pebble, and matrix supported (Figure 1). In interbedded layers of breccia and

E-ISSN : 2579 - 3136

sandstone facies (A1-3) also consist of breccia with the same characteristics as breccia in A1-1 facies, the sandstone at this facies have grey weathered color and dark grey fresh color, with coarse sand to fine sand grain size, the grain shape is angular to subrounded, medium sorted, carbonated, and hard compaction. (Figure 2). Massive sandstone facies (B1-1) characterized by thick massive sandstone that have grey weathered color, dark grey fresh color, with very coarse sand to coarse sand grain size, angular to subrounded grain shape, medium sorted, carbonated, and hard compaction (Figure 3).

C2-2 and C2-3 facies characterized by the interbedded layers of sandstone and mudstone deposits. These two facies differentiate by the thickness of the sandstone. C2-2 facies consist of interbedded layers of thick sandstone and mudstone (Figure 4) with gradded bedding and parallel lamination sedimentary structures within it (Figure 5). These sedimentary structures show Ta and Tb facies which refered to Bouma Sequence, 1962 . Meanwhile C2-3 facies consist of interbedded layers of thin sandstone and mudstone (Figure 6) with gradded bedding, parallel lamination, cross ripple lamination, and convolute lamination sedimentary structures within it (Figure 7). These sedimentary structures in C2-3 facies show Ta-Tc facies that refered to Bouma Sequence, 1962. Both C2-2 and C2-3 facies not showing the ideal model of Bouma Sequence (1962). Which at the C2-2 facies there are no Tc-Te facies and at C2-3 facies there are no Td-Te facies.

Mudstone facies (E1-1) characterized by thick mudstone deposits (Figure 8). Mudstone are slightly shaly to massive, carbonated which by these characteristics show that this facies was suspension deposits. In mudstone intercalated by sandstone facies (E2-1) (Figure 9) also consist of mudstone that have the same characteristics as the mudstone in E1-1 facies. The sandstone in this facies have grey weathered color, dark grey fresh color, coarse sand to fine sand grain size, medium to well sorted, carbonated, and parallel lamination sedimentary structure (Figure 10) within it.

Slump facies (F2-2) characterized by interbedded layers of sandstone and mudstone which went through deformation because of slumping process (soft sedimentary deposition) (Figure 11).

Based on secondary data which are the fossil analysis results of few previous researchers. There are 3 spots which author use to interpretate when the deposition in research area occur. In point A (Figure 12), there are few fossils which are *Globigerinoides conglobatus* (Brady)*, Globigerinoides immaturus* (Leroy)*, Globorotalia plesiotumida* (Blow & Banner), *Orbulina universa* (d'Orbigny), *Globigerinoides trilobus* (Reuss), *Globorotalia pseudomiocenica* (Bolli & Bermudez), *Globorotalia scitula* (Brady), *Globorotalia dutertrel* (d'Orbigny), dan *Globigerinoides venezuelana* (Hadberg). From those fossils, the interpretation of the age is N18 (Qi Adlan, 2011).

In point B, there are few fossils which are *Globigerinoides acostaensis* (Bolli), *Sphaerodinella subdehiscens* (Cushman), *Globigerinoides trilobus* (Todd), dan *Globigerina psudopima* (Bolly). From those fossils, the interpretation of the age is N16 (Aliudin Achmad Giri Pangastama, 2016).

In point C, there are also few fossils which are *Globorotalia subquadratus* (Bronniman), *Globigerinoides obliquus obliquus* (Blow), *Hastigerina siphonifera* (d'Orbigny), dan *Schlumbergerina alveolinaformis* (Brady). From those fossils, the interpretation of the age is N12-N17 (Rafdi Yashelri Masri, 2013).

E-ISSN : 2579 - 3136

From points A-C, author draw conclusions that the deposition process of outcrops in research area occur at Middle Miocene to Late Miocene (N12-N18) which fit in the age of Halang Formation which is Middle Miocene to Late Miocene (Djuri, 1973).

From the characterisation of each lithofacies that occurs in research area, the lithofacies association can be interpreted to 3 lithofacies associations which are FA-1, FA-2, and FA-3 (Figure 13). This lithofacies classification are based on the characteristics of each lithofacies that can differentiate between each lithofacies association.

FA-1 consist of interbedded layers of sandstone and mudstone with turbidite characteristics. This lithofacies association most of it occur in the mid section interval of the stratigraphic cross section. FA-1 then divided to 2 sub-association lithofacies based on the thickness of the sandstone to FA-1a and FA-1b. FA-1a consist of interbedded layers of thin sandstone and mudstone which dominated by the mudstone. In FA-1a there are gradded bedding, parallel lamination, cross ripple lamination, and convolute lamination sedimentary structures. The vertical succesion that found in field tend to finning and thinning upward that characterized the turbidite deposits. The stratigraphic cross section show that the vertical succesion of coarse materials are finning upward that indicated the sediments supply and deposition energy decreasing. Meanwhile the FA-1b consist of interbedded of thick sandstone and mudstone with gradded bedding and parallel lamination sedimentary structures within it. The vertical succesion of FA-1b are finning and thinning upward of the soft materials indicated that there are lots of sediments supply and the increasing of deposition energy that produce the interbedded of thick sandstone and mudstone which dominated by the sandstone.

FA-2 consist of thick massive sandstone and breccia. This lithofacies association most of it occur in the upper section interval of the stratigraphic cross section. FA-2 interpreted as channel fill deposits. Which the outcrops in this association facies tend to coarse. From its characteristics, the deposition of this association facies occur by grain flow mechanism. Gravity has huge impact in the deposition process, therefore the deposition distance relatively closed to the source because the deposition of coarse materials need huge energy.

FA-3 occur at the middle section of the stratigraphic cross section, which consist of the interbedded layers of sandstone and mudstone which went through deformation because of slumping process (soft sedimentary deposition).

Then from each lithofacies association characteristics, the depositional environments was interpreted refered to the deep sea depositional environment model (Walker, 1984). FA-1 which have sedimentary structures that show Ta-Tc (Bouma Sequence, 1962) interpreted as turbidite deposits and deposited in middle fan to lower fan submarine fan. FA-2 consist of channel fill deposits was deposited in upper fan to middle fan channel. FA-3 consist of interbedded layers of sandstone and mudstone which went through deformation was deposited in lower slope to upper fan. The changes of the depositional environment possibly occured as the change of sea level and amount of the sediment materials supply.

Conclusions

From the research that have been done in Cihikeu River, Mekarwangi Village, Bantarujeg District, Majalengka, West Java that were parts of Upper

E-ISSN : 2579 - 3136

Halang Formation (Arjawinangun Geology Map, Djuri, 1995) with measured section methods, then obtained several conclusions which are :

1. Research area consist of few lithology, which are thick massive sandstone, interbedded layers of sandstone and mudstone, mudstone, and breccia.
2. There are 8 lithofacies in research area that refered to deep sea facies classification (Stow, 1985), which are A1-1, A1-3, B1-1, C2-2, C2-3, E1-1, E2-1, and F2-2.
3. The deposition in research area occur at Middle Miocene to Late Miocene (N12-N18), this interpretation was based on secondary data.
4. There are 3 lithofacies association that occur in research area, which are FA-1 (divided into FA-1a and FA-1b) that consist of interbedded layers of sandstone and mudstone, FA-2 which is channel fill deposits that consist of massive sandstone and breccia, and FA-3 which is slump deposit.
5. There are 4 sub-depositional environments that interpreted based on the lithofacies association characteristics in research area, which are lower slope, upper fan, middle fan, and lower fan that refered to submarine fan depositional environment model (Walker, 1984).

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E-ISSN : 2579 - 3136

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Figure 1. Breccia Deposits in A1-

Figure 2. Interbedded Layers of Breccia and Sandstone Deposits in A1-1

Figure 3. Thick Massive Sandstone Deposits in B1-1

E-ISSN : 2579 - 3136

Figure 4. Interbedded Layers of Thick Sandstone and Mudstone Deposits in

Figure 5. Parallel Lamination in C2-2

Figure 6. Interbedded Layers of Thin Sandstone and Mudstone Deposits in C2-3

Figure 7. Parallel Lamination, Cross Ripple Lamination, and Convolute Lamination in C2-3

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Figure 8. Thick Mudstone Deposit in E1-1

Figure 9. Mudstone Intercalated by Sandstone Deposit in E2-1

Figure 10. Parallel Lamination in E2-1

Figure 11. Slump Deposits in F2-2

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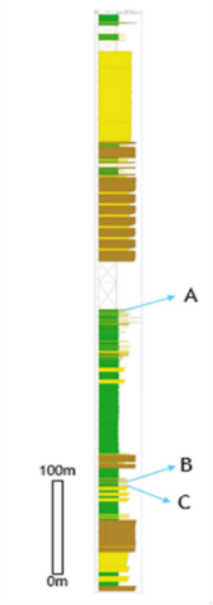

Figure 12. Fossil Analysis Points in Stratigraphic Cross Section

No.	Facies Association	Description	Interpretation	Log Type
1.	FA-1 : Sandstone and Mudstone	Interbedded layers of sandstone and mudstone with turbidite characteristics. Shaly mudstone. Sandstone with coarse sand to fine sand grain size with gradded bedding, parallel lamination, cross ripple lamination, and convolute lamination sedimentary structures within.	Deposited by turbidite current system	FA-1a
	FA-1a	Dominated by mudstone with thin sandstone. Mudstone massive with thickness approximately 30-200cm and thin sandstone with thickness approximately 10-20cm with parallel lamination, cross ripple lamination, and convolute lamination sedimentary structures within.	turbidite deposits in middle fan to lower fan depositional environment	FA-1b
	FA-1b	Interbedded of thick sandstone and mudstone with turbidite characteristics. Dominated by sandstone with thickness approximately 10-95cm and mudstone with thickness approximately 10-130cm with gradded bedding and parllel lamination sedimentary structures within	Deposited by turbidite current system in middle fan depositional environment	
2.	FA-2 : *Channel Fill Deposits*	Consist of combination of few lithofacies such as breccia facies (A1-1), interbedded layers of breccia and sandstone facies (A1-3), and massive sandstone facies (B1-1)	Channel fil deposits are formed by few sedimentary proccess that produced by the turbidite current in upper fan to middle fan channel	
3.	FA-3 : *Slump Deposits*	Consist of interbedded of sandstone and mudstone that .deformed by slumping process (soft sedimentary deposition). With thickness approximately 11m	Deposited by mass-transport in lower slop to upper fan	

Figure 13. Lithofacies Associations that Consist in Research Area

Figure 14. Stratigraphic Cross Section of Research Area Section A-B

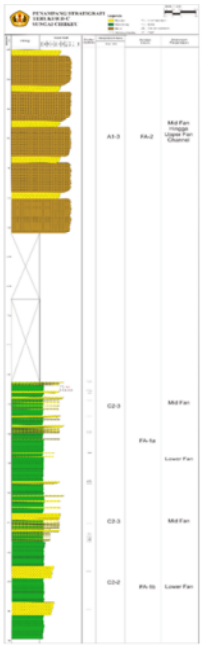

Figure 15. Stratigraphic Cross Section of Research Area Section B-C

E-ISSN : 2579 - 3136

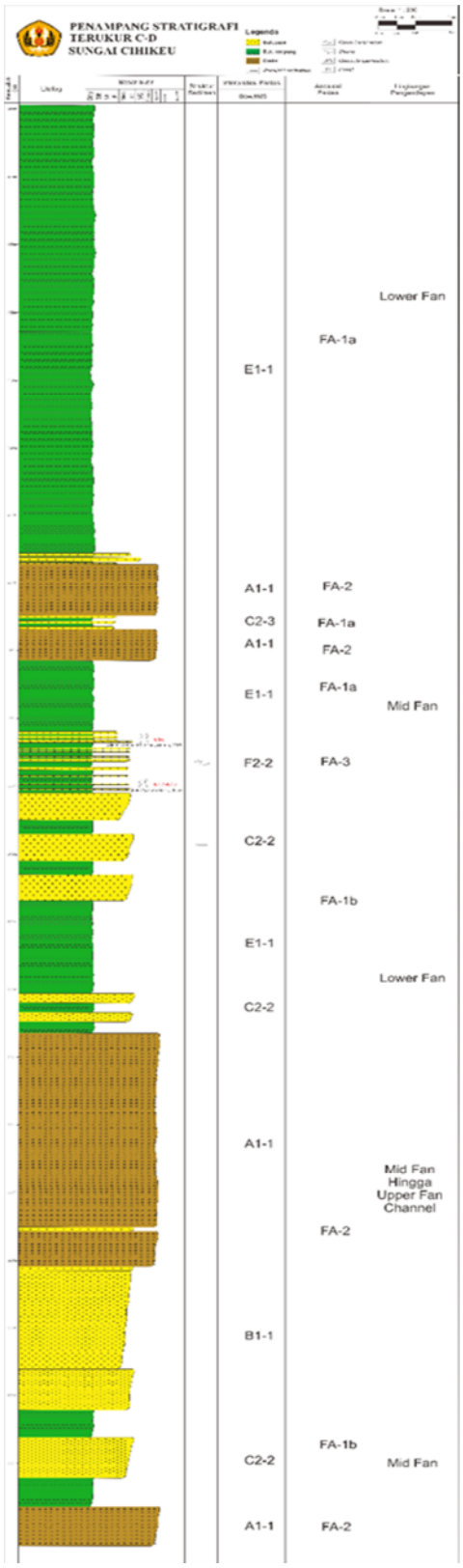

Figure 16. Stratigraphic Cross Section of Research Area Section C-D

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