ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

SEDIMENTATION OF THE CANTAYAN FORMATION IN SIRNASARI, BOGOR, WEST JAVA-INDONESIA

Yan Rizal*, Pamungkas G. M, Alfend Rudyawan
* Geological Department of Institut Teknologi Bandung, Jalan Ganesha 10 Bandung 40132, Indonesia

DOI: 10.5281/zenodo.167071

ABSTRACT

The study area is located in Sirnasari area, Tanjungsari District, Bogor Regency, West Java- Indonesia and geographically located at coordinates 6º36'30"- 6º39'30" Longitude and 107º08'15 " - 107º10'30" Latitude.

Stratigraphy of the study area consists of five lithology units (from old to young), they are mudstone unit, breccia unit, sandstone-claystone unit, Basalt unit, and Alluvial unit. The mudstone Unit was deposited in the inner to outer neritic environment dominated by wave shore face mechanism. The breccia and mudstone-sandstone units were udstone unit is equivalent to the Cibulakan Formation, while breccia and mudstone-sandstone Unit is the equivalent of the Cantayan Formation.

Turbidite facies which found in this unit are classic turbidite facies that consists of thinly-bedded and thickly-bedded sandstone, massive sandstone facies, conglomerates, and debris flow facies.

The facies change reflected a change of deposition environment, which is influenced by sea level change at the time of deposition.

KEYWORDS: Stratigraphy, facies, turbidite.

INTRODUCTION

Detailed information about Cantayan formation in Bogor basin are still very rare, especially due to their sedimentation system. This study was carried out to analyzed the sedimentation of the Cantayan Formation in relation to changes in sea level at the time of deposition. This research was conducted in the area Sirnasari, Bogor, West Java Province, Indonesia. Geographically, located at position 6º36'30 "LS - 6º39'30" LS and 107º08'15 "BT - 107º10'30" BT (Figure 1).

REGIONAL STRATIGRAPHY

Martodjojo (1984) divided West Java regions into 3 sedimentation groups, namely Continental Platform Group, Bogor Basin group, and Banten Group. The division of the group is made based on the characteristics and distribution of Tertiary sediments and regional stratigraphy in the western part of Java (Figure 2).

The sedimentation process in Bogor basin is characterized by gravity flow sediment characterized by built up of fragments of igneous and sedimentary rocks such as andesite, basalt, tuff, and limestone. Sedimentation in the Southern Mountains (Banten Group) zones is dominated by Late Oligocene - Middle Miocene andesitic volcanic clastic sediment, which also called as the old andesite (Baumann, 1972 op cit Darman and Sidi, 2000). Dioritic-granitic magma intrusion led to a local uplifted that resulted in high lands. Volcanic products are generally interpreted to be inter-fingering with carbonates complex such as Formation Rajamandala of the Early Miocene age and the Middle Miocene Cimandiri Formation. This statement corresponds with research of carbonate rocks distribution conducted by Adinegoro (1973). Carbonate rocks in this area are formed during the Late Oligocene - Early Miocene at Sukabumi platform Highland.

METHODOLOGY

This research was conducted in two ways, (1) field data collection which comprises detailed measurements of stratigraphic section and sampling and (2) data processing in the laboratory to determine the sedimentary facies using petrographic and paleontology analyses. Field data collection in the form of

RESULTS

Stratigraphy Research Areas

The stratigraphic unit in this paper is based recent field observation and their lithological characteristics based on petrography. Stratigraphy in the research area can be grouped into 6 unofficial lithostratigraphy units (Figure 3); rock unit distribution isshown in Figure 4

Mudstone unit

The main constituent of this unit is Mudstone with sandstones and limestones intercalation. Claystone unit is well exposed along the Cibeet RiverCibeet and Cigadung River. Sandstones found in some outcrops in the Gobang and Nanggung area.

Limestone is well exposed in the upstream of Cigadung River. The thickness of this unit is based on the reconstruction of the geological cross section is ± 1350 m.

Lithology Description

Overall, this unit is built up by claystone, sandstone, limestone.
Claystone, dark gray, brittle-fissile, calcareous with some carbonate nodules and slightly weathered. Sandstone, light gray, fresh, fine-medium sand size, open fabric, moderate sorting, angular- subangular, moderate porosity, calcareous, compact, parallel lamination and cross lamination sedimentary structures. Based on the Gilbert classification (1982), This sandstone is Quartz Wacke.

Limestone / mudstone (Dunham, 1962) is grayish white, fresh, grain less than 10%, matrix in the form of calcareous mud, poor porosity, compact. Carbonate nodules in the form of crystals, white, and are round and flat. This carbonate nodules were formed as a result of the process of drying the sediment (dewatering; Tucker, 1996).

Age and Depositional Environment

Based on analysis of planktonic foraminiferal microfossils such as *Globoquadrina dehiscens*, *Globorotalia menardii "A", Globorotalia Obesa, and Orbulina universals this unit was deposited between*the N12 - N15 (middle Miocene) age. Benthic foraminiferal analyses determined the association between *Gyroidina soldanii, Gyroidina sp and Cassidulina sp* which indicate middle - outer neritic depositional environment. The parallel and cross lamination on the sandstone which changed gradually upward into claystone with sandstone intercalation, showing transition depositional environment of the shoreface environment headed to offshore in shallow marine system. This argument is based on a model dominated Wave System shoreface (Walker and James, 1992).

Stratigraphy position

The direct relationship between this unit and the older strata is poorly known, partly because the older strata is not exposed in the study area.This unit is interpreted to be interfingering with the breccia unit based on the age similarity of both unit using planktonic foraminifera microfossils association. Based on it lithology characteristics, the unit is interpreted to be the equivalent of the Cibulakan Formation (Martodjojo, 1984).

Breccia unit

The main constituent of this unit is breccia alternation with mudstone intercalation. The rock unit is well exposed Cibeet River and Cigadung River. Measured thickness of this unit reaches 7 meter while based on the reconstruction of the geological cross section is ± 775 m.

Lithology Description

Overall, the unit is composed by breccia, mudstone with calcareous nodules.
Breccia, brownish gray, fresh, polimic, sized fragments gravel-block and consist of basalt, andesite, sandstone, limestone, open fabric, poorly sorted, compact, matrix: clay- very coarse sand, calcareous, reverse graded bedding of sedimentary structure.

Mudstone, gray, brittle-fissile, calcareous, slightly weathered.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Sandstone??

Ages and Depositional environment

Based on the planktonic foraminifera fossil associations of *Globigerina venezuelana, Globigerinoides trilobus immaturus, Globoquadrina dehiscens, Globorotalia menardii "B", and Orbulina universals,* the unit was deposited during N16 - N18 (Late Miocene - Early Pliocene) age. Benthic foraminifera association found in the unit consists of *Cibicides* sp, *Bulimina* sp, dan *Uvigerina Peregrina*; these indicate upper bathyal depositional environment (200 - 1000 m).

The reverse graded bedding sedimentary structure in breccias and followed by parallel lamination in the sandstone shows the characteristic of turbidite deposition. The Lithology with this characteristic is interpreted to be deposited in upper-middle fan of deep marine deposition (Walker, 1984).

Stratigraphy position

Gradual contact between this unit and the underlying mudstone unit suggest that the relationship between the two units is conformable. It is also supported by the fossil association analyses results. Gradual contact was also observed between this unit and the overlying mudstone-sandstone unit

Based it lithology characteristics the unit is interpreted to be the equivalent of the Cantayan Formation (Martodjojo, 1984).

Mudstone-sandstone unit

The main constituent of this unit is alternation of mudstone-sandstone with occasional intercalation of conglomerates and limestones. This rock unit is well exposed along Cibeet River River in Roke Hilir area.

The thickness of this unit based on the reconstruction of the geological cross section is ± 1700 m. 71.5 m measured thick was obtained from the field.

Lithology Description

Overall, the unit is built up by mudstone, sandstones, conglomerates, limestones.

Mudstone, gray, brittle-fissile, calcareous, contained calcareous nodules, slightly weathered.

Sandstone, light gray, medium-very coarse sand, open fabric, moderate sorting angular– subangular, moderate porosity, calcareous, compact, cement carbonate, sedimentary structures: parallel lamination, cross lamination and ripped-up mudstone clast, somewhat obsolete - quite fresh.

Conglomerate, brownish gray, fresh, polimict, granules-gravel fragment size and consist of basalt, andesite, sandstone, limestone, open fabric, poorly sortedsorted, moderate porosity, calcareous, compact, graded bedding sedimentary structure. Limestone / mudstone (Dunham, 1962) is grayish white, grain less than 10%, matrix in the form of calcareous mud, poor porosity, compact, fresh.

Ages and Depositional Environment

Planktonic foram association from this unit contains *Globigerina nephentes, Globigerina venezuelana, Globigerinoides conglobatus, Globorotalia plesiotumida, and Orbulina universals,* which indicate N18 - N19 (Early Pliocene) age. Benthic foram association analyses containsCibicides sp, Bulimina sp, and Uvigerina Peregrina which indicate depositional environment is upper bathyal (200 - 1000 m).

Turbidite facies and deep marine fans which shown in this unit succession indicates that the unit is deposited in upper bathyal of deep marine fan (200 - 1000 m) (Walker and James, 1992).

Stratigraphy position

This unit is interpreted to be deposited conformably above the Breccia Unit based on their age similarity and the gradual contact between the two units. There is an interpreted depositional time gap between this unit and the younger volcanic unit.

Based on it lithology characteristics, the unit is interpreted to be the equivalent of the Cantayan Formation (Martodjojo, 1984).

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Basalt unit

Basalt outcrops were found is in the form lava flow and intrusion. The basalt outcrops is well exposed in the Cipinang area and the southern banks of Cibeet River. It is difficult to estimate the thickness of the lava due to no exposures of contact between the basalt and the overlying younger units.

Lithology Description

Lithology of these rocks unit is basalt as lava flow and intrusions.
Basalt, black with white spots, aphanitic texture, hypocrystalin, inequigranular, euhedral-subhedral, vitrophyric, amigdaloidal structure, fresh condition and columnar joint structure was found in outcrop scale.

Thin section analysis shows the dominance of the glass in composition. In addition, existing plagioclase shows trachitic a special texture that is characteristic of flow igneous rocks.

Sedimentary rock under the lava appear to be undisturbed. It indicates that the basalt was deposited as a lava flow. Meanwhile, the basalt intrusion has grayish-black color, fresh condition, aphanitic texture, hypocrystalin, inequigranular, subhedral-anhedral.
The results of the analysis of thin section on the lithology shows phenocrysts surrounded ground mass and trends pyroxene crystals surrounding a plagioclase. This shows porphyritic and sub-ophytic texture.
These rocks are interpreted to have been derived from the same source.

Ages

The undisturbed nature of this rock unit suggest that it is not affected by tectonic activity that deformed older rock units. Well documented volcanic activity in West Java during Pleistocene time (Martodjojo, 1984) could be the geological event that formed the Basalt Unit.

Stratigraphy position

The relationship between the Basalt unit and the older units is interpreted to be unconformable.

Alluvium Unit

Alluvium unit found in flat area Cibeet Riveralong the Cibeet River. It consists of loose material in the form of river deposits that have not been consolidated. The fragment composition of this unit is mudstone, sandstone, conglomerate, breccia, limestone, basalt and andesite. This unit in deposited unconformably above the other units.

Sedimentary Facies

Stratigraphy column was developed based on stratigraphy measuring section data, which collected from traverse in Cibeet RiverCibeet River.

Based on stratigraphic cross-section measurements the bedding are generally east-west trending direction. The maximum measured thickness in the field is 78.5 meters thick (Figure 5).

The study of sedimentary facies is based on the concept of facies analysis, which states that a results of stratigraphic measuring section can be grouped into deposits of different facies than indicate different characteristics and thickness.

The facies association is a combination of meaningful relationship between facies. In this stratigraphic measure section, sedimentation analysis done based on the composition and characteristics of existing lithology Based on analysis of stratigraphy column, composition and characteristic of existing lithology (Walker & James, 1992) there are seven sediment facies, namely: (1) debris flow facies, (2) conglomerates facies, (3) sandstones massive facies, (4) turbidite classic thick - bedded 1 facies, (5) turbidite classic thin- bedded 1 facies, (6) turbidite classic thick - bedded 2 facies, and (7) turbidite classic thin- bedded 2 facies.

Debris Flow (Breccia) Facies

The lower part of the stratigraphic column of this traverse begins with Sediment debris flow facies . This sediment has about 7 m thick. Breccia occurs at the lower part and passes gradually tp sandstones and mudstones.

Breccia, brownish gray, polymict, grain sized from granule to blocks which consist of basalt, andesite, sandstone and limestone, open fabric, poorly sortedsorted, moderate porosity, matrix is dominated by very fine to medium sand, calcareous, compact, reverse graded bedding sedimentary structure. Thickness about 600 cm.

Sandstone, light gray, very fine to medium sand, open fabric, poorly sortedsorted , moderate porosity, calcareous, compact. The thickness is 40 cm.

Mudstone, dark gray, brittle – fissile, calcareous, thickness is 60 cm
The thick breccia has reverse graded bedding sedimentary structures. It indicated that debris deposit in the region near the slope is influenced by gravity flow.

The presence of fine sandstone and mudstone at the top of this breccia indicates a more prominent influence of suspension currents during sediment deposition. This shows the possibility of sedimentation occurs in the levee where the current velocity relatively slow and it produced suspension sedimentation. The nature of such sedimentation profile is interpreted as debris flow facies sediment.
Based on the model of turbidite and deep marine fans (Walker & James, 1992), debris flow facies estimated deposited in the upper fan deep marine on the levee area.

Conglomerate facies
The conglomerate facies sediment covered a debris flow facies with a thickness about 6.6 m. This conglomerate facies consist of alternation conglomerates and sandstones.

Conglomerates are gray brown, polymict, pebble to gravel, rounded – subrounded, compact, a fragment: basalt, andesite, sandstone, and limestone, open fabric, poorly sorted, moderate porosity, matrix: coarse - very coarse sand, calcareous, graded bedding sedimentary structure. Thickness ranges from 10-30 cm.

Sandstone, light gray, medium - very coarse sand, open fabric, poorly sorted, moderate porosity, compact, calcareous, sedimentary structure: graded bedding, parallel lamination, wavy and ripped-up mudstone clast. Thickness of sandstone ranges between 10-50 cm .

The presence of conglomerates become an important feature for determining these types of facies sediment. These deposits are interpreted as conglomerate fasies.

Based on the model of turbidite and deep marine fan (Walker & James, 1992), the conglomerate facies environment interpreted as a channel deposit in deep marine fan system.

Massive sandstone facies
Massive sandstone facies is deposited above of conglomerate facies. The thickness of this facies is about 8.8 m. It consisted of massive sandstone lithology with conglomerate intercalation.

Sandstone, light gray, coarse to very coarse sand, open fabric , poorly sorted , moderate porosity, compact, calcareous, ripped -up mudstone clast sedimentary structures. Thickness of this sandstone ranges from 50-150 cm.

Conglomerates, grayish brown, polymict, granules-pebbles, rounded – subrounded, compact, fragment: basalt, andesite, sandstone and limestone, open fabric, poorly sorted, moderate porosity, matrix: coarse to very coarse sand, calcareous, graded bedding sedimentary sructure. The thickness of the conglomerate is about 1.1 m.

Their erosional boundary to the conglomerate facies sediment and the presence of sedimentary structures ripped-up mudstone clast indicates that the sediment is deposited on the channel environments with a strong current.

The thickness of the sandstones is more than 50 cm and without mudstone intercalation becomes the next guide to determine the type facies on these deposits.

Based on the model of turbidite and deep marine fan (Walker & James, 1992), the environment of this massive sandstone facies interpreted as the channel - lobe section of deep marine fan.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Thick - Bedded 1 Turbidite Classic facies

Thick - Bedded turbidite Classic facies sediment deposited above of massive sandstone facies with about 12.1 m thickness. This facies is characterized by alternating sandstones and mudstone.

Sandstone, light gray, medium to very coarse sand, locally pebbly, open fabric, poorly sorted, moderate porosity, compact , calcareous, sedimentary structure: graded bedding, parallel lamination, cross lamination, wavy, and ripped-up mudstone clast. Thickness of sandstone ranges from 10-150 cm.

Mudstone, dark gray, brittle and fissile, calcareous. Thickness ranges from 10-70 cm .
A succession of sandstones which initially has a ratio of thickness more dominant against claystone gradually become thinner upwards. This indicates a gradation of depositional environments are slowly moving toward the center of the basin.

The sedimentary structure of sandstone which generally includes Bouma sequences Ta - b - c show the influence of the turbidite flows with traction mechanism is dominant, whereas the effect of the suspension flow is indicated by the presence of mudstone.

Because the sediment is dominated by a thick layer of sandstone that has an average of 100 cm, then these deposits belong to the classical turbidite facies thick - bedded .

Based on the model of turbidite and deep marine fan (Walker & James , 1992), the deposition environment of this thick - bedded facies turbidite classical interpreted as a proximal- lobe part of transition between in the middle fan and deep marine fan.

Thin - Bedded 1 Turbidite Classic facies

Thin – Bedded 1 turbidite classical facies deposited on the thick - bedded turbidite classic facies. The thickness of this facies is about 16 m which is characterized by alternating sandstones and mudstones.

Sandstone, light gray , medium to coarse sand, open fabric, poorly sorted, moderate porosity, compact ,calcareous, parallel laminated ssedimentary structure. Thickness of sandstone ranges between 5-30 cm .

Mudstone, dark gray , brittle and fissile, calcareous. Thickness of mudstone is ranges from 50-200 cm .
In general, these deposits consist of rhythmic alternating of thin sandstones and thick mudstone. At the lower part of the unit, the mudstone shows thinning upwards succession. Comparison of mudstone thickness which is much thicker than the sandstone shows the effect of the current suspension is more dominant than the effect of traction current. The absence of sedimentary structures of Bouma sequence in sandstone showed no effect of traction current on the turbidite mechanism. Sedimentary structures such as wavy lamination and convolute which indicate rapid suspension deposition as the deposition characteristics of the levee or channel limit (Walker and James, 1992) were also not found. This is expected because the distance was too far from the slope that is more to basinward.

Thick - Bedded 2 Turbidite Classic facies

Sediment of thick-bedded turbidite classic facies sediment deposited on thin-bedded the turbidite classical facies. The sediment which has a 14.5 m thick is characterized by monotonous alternation of sandstones and mudstone.
Sandstone gray light, medium to very coarse sand-sometimes gravelly, poorly sorted, open fabric, moderate porosity, compact, calcareous, sedimentary structure: graded bedding, parallel lamination, wavy and ripped-up mudstone clast. Thickness of sandstone ranges from 20-150 cm .

Mudstone, dark gray, brittle and fissile, calcareous. Thickness of mudstone ranges from 10-50 cm.
A succession of sandstones which initially has a ratio of thickness more dominant against claystone gradually become thinner upwards. This indicates a gradation of depositional environments are slowly moving to basinward.
Sedimentary structure of sandstone which includes sequences Bouma Ta - b and sometimes reaching Tc characterize the influence of traction current in turbidite flows mechanism is dominant, whereas the effect of the suspension flow is indicated by the presence of mudstone .

Thickening upward succession of the mudstone unit suggest that the depositional environment change over to basinward.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Because the sediment is dominated by a thick layer of sandstone that has an average of 100 cm, then these deposits is interpreted to be part of the thick-bedded turbidite classic facies.
Based on the model of turbidite and deep marine fans (Walker & James, 1992), thick - bedded turbidite classic facies estimated to be deposited in the proximal part – lobe, transition between the middle fan and the deep marine fan.

Thin-Bedded 2 Turbidite Classic facies
Thick-bedded turbidite Classic facies laid conformable above the thin-bedded turbidite Classic facies. This facies has a 13.5 m thick is characterized by monotonous alternation of sandstones and mudstone and occasional conglomerate intercalation.

Sandstone, gray light, medium to very coarse sand, sometimes gravelly, open fabric, poorly sorted, moderate porosity, compact, calcareous, sedimentary structure: graded bedding, parallel lamination, wavy lamination and ripped -up mudstone clast. Thickness of sandstone ranges between 50-70 cm.

Mudstone, dark gray, brittle and fissile, calcareous. Thickness of mudstone ranges from 60-190 cm .
Conglomerates, brownish gray, polymict , granules to gravel and rounded- subrounded, a fragment consist of basalt, andesite, sandstone, and limestone, open fabric, poorly sorted, moderate porosity, compact, matrix: coarse - very coarse sand, calcareous, graded bedding sedimentary structure.

Mudstone succession show thickening upward succession that is interpreted as the depositional environments change slowly to basinward. Sedimentary structures in Sandstone that include Bouma Ta - b sequences and sometimes reaching Tc, which reflected an dominant influence of traction current are typical of the turbidite sedimentation. The influence of traction current indicates that the deposition environment tend to be proximal.
Because the thickness of sandstone is dominated by a thin layer (< 100 cm), then these succession is included in the thin- bedded turbidite classical facies.

Based on the above explanations and turbidite models and deep marine fan (Walker & James, 1992), this thin-bedded turbidite classical facies estimated deposited in in the proximal part - lobe environment transition between fan middle and deep marine fan.

DISCUSSION
Stratigraphically can be seen the sequence of rock from old to young, where at the bottom of the succession is composed of mudstone units (Formation Cibulakan) age of N12 - N15 deposited in inner neritic – outer neritic environment. This unit covered by breccia unit (Debris Flow Facies) of lower Cantayan Formation, aged N16 - N18 deposited on upper part of the deep marine fan system / channel of the upper bathyal environment, Above of this rock unit laid conformably mudstone – sandstone unit of upper Cantayan Formation, aged N18 - N19 deposited on upper bathyal environment. This rock unit consisted of (From old - young): conglomerate facies, deposited in channel of deep marine fan environment and followed by massive Sandstone facies which deposited on the lobe of deep marine channel fan system, sea level shifted to landwards, thick-bedded 1 turbidite Classic deposited on proximal lobe, sea level shifted more to landwards (deeper), thin-bedded 1 turbidite Classic deposited on the distal lobe, sea level moved more to landwards. All of above sedimentation process is a phase of transgression. After that begun a short regression phase which shown by thick-bedded 2 turbidite Classic deposited on proximal lobe, where sea level shifted again to seawards (shallower), and continued by transgression that indicated by a thin-bedded 2 turbidite Classic which deposited on the distal lobe, sea level shifted again to landwards.

Vertically change of depositional environment is expected due to changes in sea level (transgression and Regression) where on the curve of south china sea level changes (Taylor, Hayes, 1983) seen the sea level fluctuations on the age of N18 – N19, are expected to affect the deposition Cantayan formations. (Figure 6)

CONCLUSION
Here can be concluded that:

[1] The stratigraphy of the study area is composed of five unofficial lithology units: (successively from old to young), mudstone unit, breccia unit, mudstone-sandstone unit , basalt unit, and Alluvium unit Mudstone Unit deposited by wave shorface dominated system, while the unit breccia and mudstone-

sandstone was deposited with the mechanism of turbidite fan system in the deep marine. Meanwhile, basalt unit formed in terrestrial environments and Alluvium deposition process still runs to present day.

[2] Sedimentation studies on the Cantayan Formation explained that the rock units that are taught in this sedimentation study deposited on the deep marine fan with turbidite mechanism. Based on the distribution of sediment facies type, this deposit stratigraphically divided into : Debris Flow facies, Conglomerates facies, Massive sandstone facies, Thick-bedded 1 turbidite classic facies, Thin-bedded 1 turbidite classical facies, Thick-bedded 2 turbidite classic facies, and Thin-bedded 2 turbidite classical facies.

[3] The deposition environment shift is strongly influenced by the movement of sea level change.

BIBLIOGRAPHY

[1] Adinegoro, U., 1973. Reef-Limestones in The Sukabumi Area (S.W. Java). *Indonesian Petroleum Association 2nd Anniversary Convention Proceeding*, hal 109 – 120, Jakarta.

[2] Bolli, H. M., Saunders, J.B., dan Perch-Nielsen, K., 1985. *Plankton Stratigraphy*, Cambridge University Press, New York

[3] Darman, H., dan Sidi, F. H, 2000. *An Outline of The Geology of Indonesia*. Ikatan Ahli Geologi Indonesia, hal 169 – 172, Jakarta.

[4] Dunham, R. J., 1962, Classification of carbonate rocks according to depositional texture, *Classification of carbonate rocks: American Association of Petroleum Geologists Memoir*, hal. 108-121, Oklahoma.

[5] Gilbert, C. M., Turner, F. J., dan William, H., 1982. *Petrography, An Introduction to the Study of Rocks in Thin Sections*, W.H. Freeman and Company, New York.

[6] Hamilton, 1979. *Tectonics of the Indonesian Region*, United States Government Printing Office, Washington.

[7] Martodjojo, S., 1984. *Evolusi Cekungan Bogor Jawa Barat*, Penerbit ITB, Bandung.

[8] Pulunggono, A. dan Martodjojo, S., 1994. Perubahan Tektonik Paleogen – Neogen Merupakan Peristiwa Tektonik Terpenting di Jawa, *Proceeding Geologi dan Geotektonik Pulau Jawa Sejak Akhir Mesozoik hingga Kuarter*, hal 37 – 50, Yogyakarta.

[9] Sudjatmiko., 1972. *Peta Geologi Lembar Cianjur, Jawa*, Pusat Penelitian dan Pengembangan Geologi, Bandung.

[10] Taylor B, Hayes DE (1983). Origin and history of the South China Sea Basin. In: Hayes D E ed. The Tectonic and Geologic Evolution of Southeast Asian Seas and Islands: Part 2, Geophysical Monograph. AGU, Washington, 27: 23-56

[11] Tucker, M. E., 1996. *Sedimentary Rocks in The Field*, Department of Geological Sciences University of Durham, John Wiley and Sons Ltd, United Kingdom.

[12] van Bemmelen, R. W., 1949. General Geology of Indonesia and Adjacent Archipelagoes, *The Geology of Indonesia, Vol. IA*, The Hague, Martinus Nijhoff, Netherlands.

[13] Walker, R. A., 1984. *Facies Models*, Geological Association of Canada Publication, Bussiness and Economic Service, Canada.

[14] Walker, R. G. dan James, N.P., 1992. *Facies Models, Response to Sea Level Change*, Geological Association of Canada Publication, Bussiness and Economic Service, Canada.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Figure 1. Map showing the study área (red box)

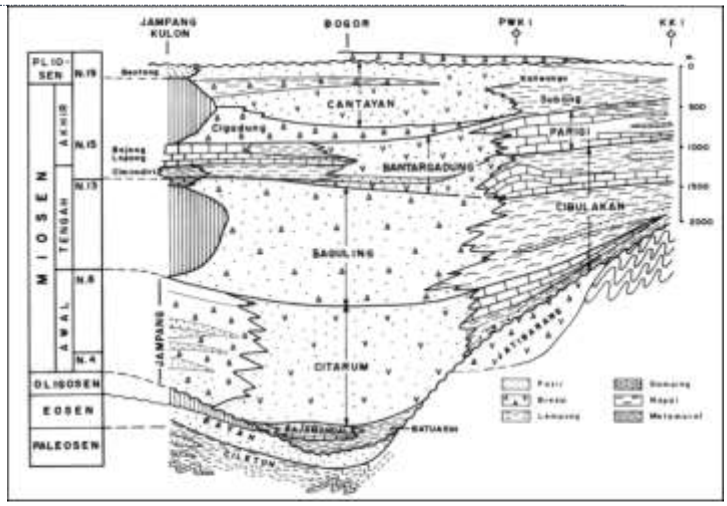

Figure 2. Stratigraphy of the Bogor Basin (Martodjojo, 1984)

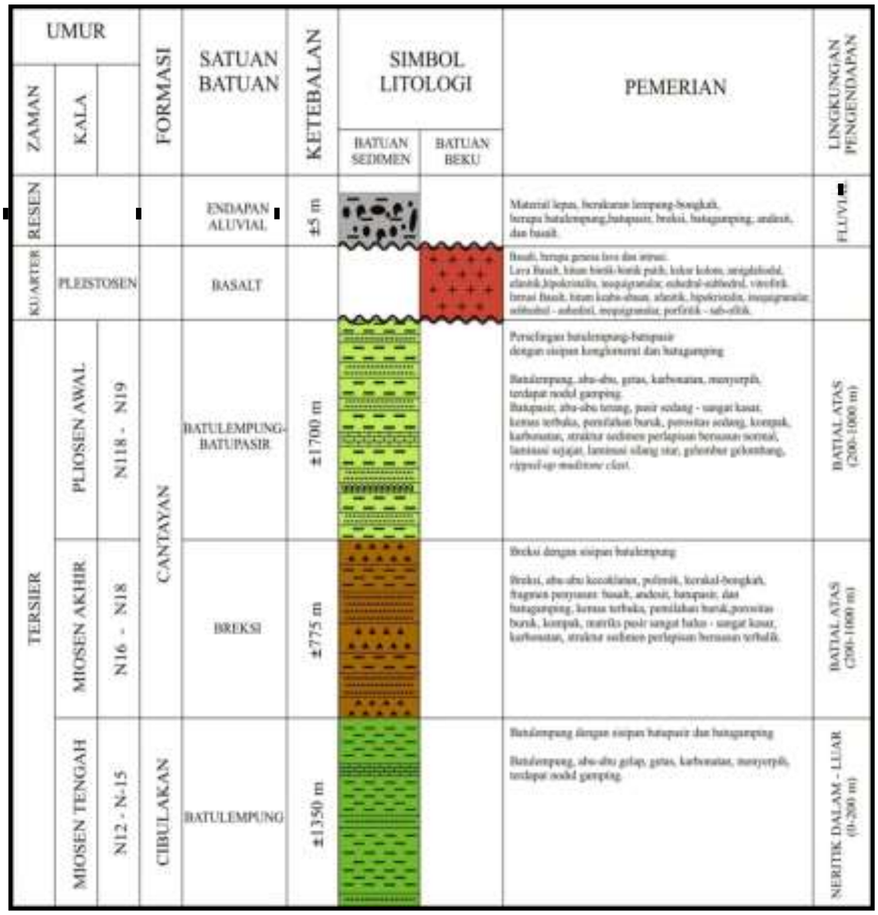

Figure 3. Stratigraphy of the study area.

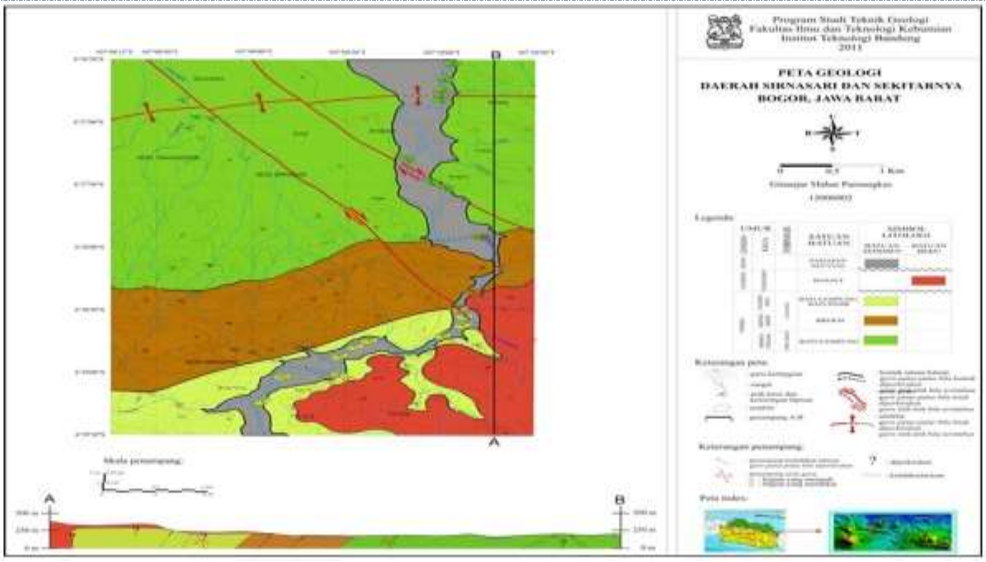

Figure 4. Map showing the geology of the study area

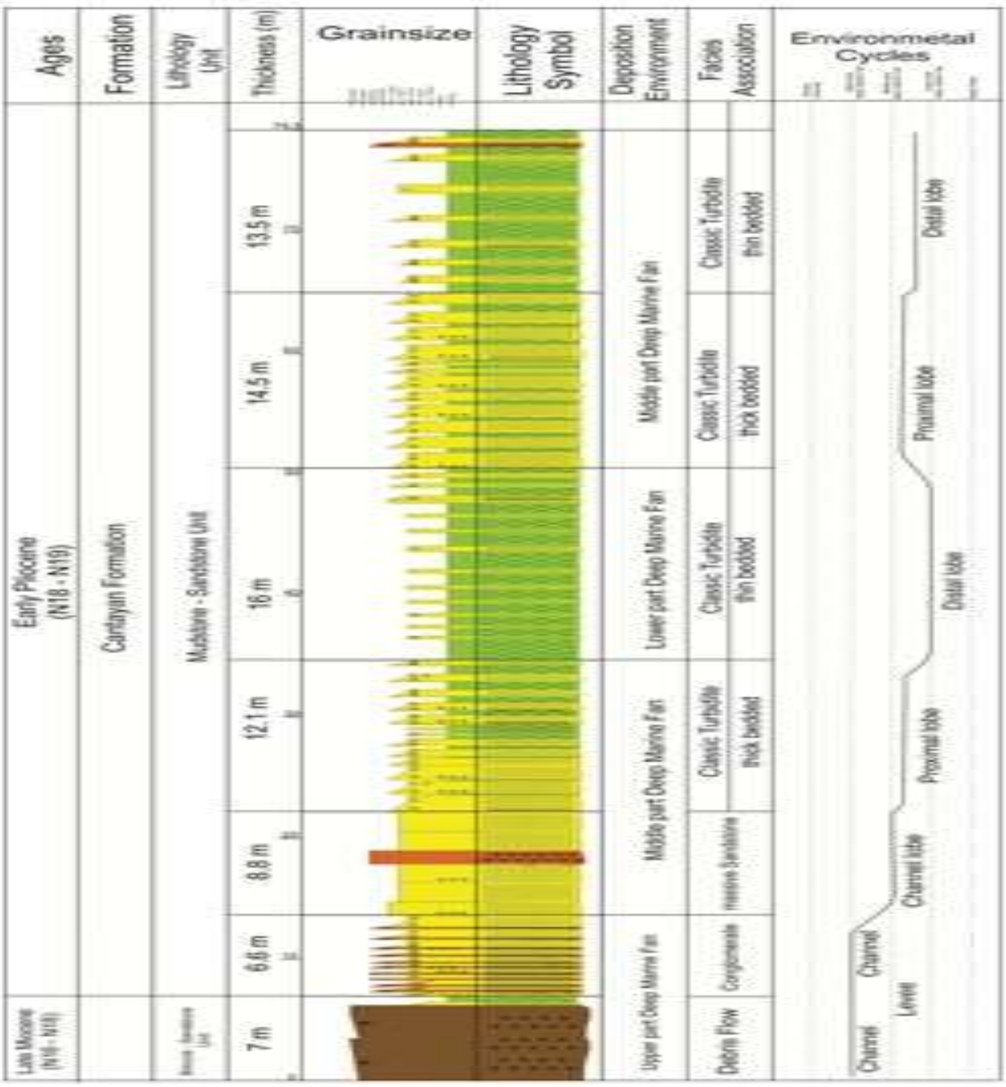

Figure 5. Stratigraphic column from the measured section in Cibeet River

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

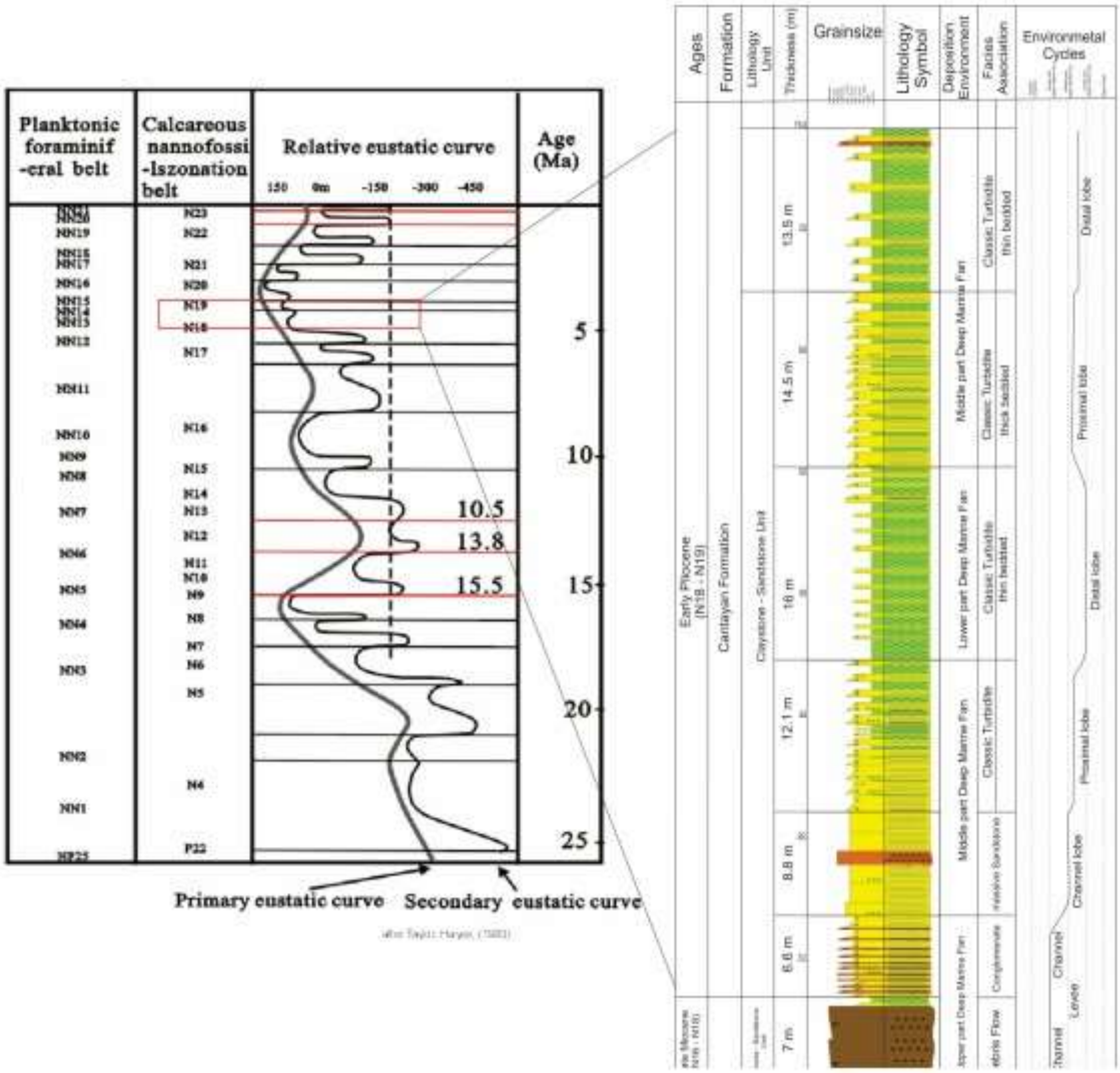

Figure 6 Curve of sea level changes of South China Sea in relation to deposition environmental changes