CARBONATE FACIES AND DEPOSITIONAL ENVIRONMENT ON BATURAJA FORMATION, "MK" FIELD, JATIBARANG SUB-BASIN.

Manwarjit [1*], Ildrem Syafri [2], Febriwan Mohamad[2], Asep Ginanjar[3]
[1]Undergraduate Student, Faculty of Geological Engineering, Universitas Padjadjaran
[2]Department of Applied Geology, Faculty of Geological Engineering, Universitas Padjadjaran
[3]PT.Pertamina Hulu Energi Offshore North West Java

*Corresponding author: manwarjit17001@mail.unpad.ac.id

ABSTRACT

Facies are defined as a rock body that have a combination of characteristics that are related to the physical, biological, or chemical aspects seen from rock lithology, sedimentary structures that distinguish the rock body from the rocks above, below or laterally in other parts (Walker, 1992). This paper aimed to determine the facies and depositional environment that developed in the upper part of Baturaja Formation. The facies distribution analysis can be used as an early interpretation for the characterization of carbonate reservoir. In this research, the facies and depositional environment analysis is carried out by integrating core data, thin section, and wireline log. Based on this analysis, it is identified that 4 facies were deposited in 4 different types of depositional environment and time, which are Facies Floatstone (Facies I), Facies Wackstone-Packstone (Facies II), Facies Floatstone- Framestone (Facies III), dan Facies Floatstone- Rudstone (Facies IV). All facies are correlated to every well using electrofacies analysis so that the facies distribution on every well can be shown. The output of facies distribution can be illustrated into a cross-section of well-correlation.

Keywords: Characterization, Facies distribution, Electrofacies, Well-correlation

1. INTRODUCTION

The needs of the hydrocarbon reserve in Indonesia are increasing every year. The subsurface studies are necessary to reveal the dimension and characteristics of the reservoir by interpreting of facies and depositional environment. The research area is located in "MK" Field, Jatibarang Sub-basin, Northwest Java Basin (Figure. 1). "MK" Field is one of the other fields that produce gas in Baturaja Formation. This study is focused to revealing the upper part of Baturaja Formation characteristics such as texture, composition, facies distribution, and depositional environment.

Regional Geology

Northwest Java Basin is located at northwest of Java and spreading to offshore northwest Java. NWJ Basin is a back-arc basin system that located between the micro-Sunda plate and the tertiary subduction of the Indo-Australia plate (Narpodo, 1996). This basin is being controlled by a block faulting system (normal fault) in the south east direction. This fault is producing host and graben that split this basin into 7 sub-basins, which are Ciputat, South Arjuna, Central Arjuna, Kepuh, Pasirbungur, Cipunegara and Jatibarang sub-basin (Sujatmoko, 2018).

Regional Stratigraphy

According to Aveliansyah (2016), there are 6 events tectonic that form the stratigraphy of North West Java Basin, especially Jatibarang Sub-basin. The Regional stratigraphy of this basin consists of 7 formations (Figure. 2). The sedimentation of this basin occurred from the Eocene to Quarter. Basement is the oldest formation in Jatibarang Sub-basin. This formation formed during Late Cretaceous– Early Paleocene because of magmatism and volcanism activities (Pre-Rift). During the Eocene period, tectonic activities are occurred and deposited Jatibarang Formation (early stages of rifting Syn-Rift I). Volcanic and rifting activities are decrease, endogenic force is occurring and stops at the end of Early Oligocene. During the Late Oligocene – Early Miocene, the Talangakar formation was deposited overlies the Jatibarang Formation and basement rocks. The formation is characterized as syn-rift II. The post-rift stage sedimentation occurs in the Early Miocene when transgression the Baturaja Formation was deposited. This formation consists of limestone with thin interlude of dolomite, shale, and limestone reef. This formation was deposited in shallow marine because there was *Spiroclypeus Sp.* abundantly. During the Middle Miocene is represented by the

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deposition of the Upper Cibulakan Formation. The transition from Middle Miocene to Late Miocene is marked by the deposition of Parigi Formation. When regression took place, Cisubuh Formation is being deposited during Pliocene-Pleistocene. This formation is the youngest formation in Jatibarang Sub-basin. After Post-Rift, sagging occurred and went along with major tectonism that was controlled by compression tectonic (Adnan, 1991).

2. RESEARCH METHOD

There are 4 stages carried out in this research, consist of preparation stage, data collection stage, interpretation and analysis stage, and report preparation.
The preparation stage includes study literature about regional geology in the research area and theories that are related to the research object. The object in the study is the upper part of Baturaja Formation.
The data collection stage includes collecting primary data and secondary data. The primary data consists of conventional core, thin section, and well log data. Whereas, the secondary data consist of seismic 2D cross-section.
The interpretation and analysis stages are stages where the researcher processes all the primary and secondary data that have been given into some outputs. All the outputs will resolve the problems that are shown.

3. RESULT AND DISCUSSION

Interpretation and analysis of conventional core, thin-section and well log data could obtain characteristics of carbonate facies in the research area. Facies distribution in each well can be explained by using electrofacies with interpretation of well log data. Depositional environments can be determined by using a carbonate depositional environment model by Pomar (2004) based on the characteristics of each facies**.**

Facies and Electrofacies in "MK" Field

Based on analysis of conventional core and thin section in well MK-6, can conclude 20 lithofacies on the upper part of Baturaja Formation. These lithofacies are associated into 4 facies based on characteristics of lithology and organism's composition (Table.1). For the facies distribution can using electrofacies analysis by the interpretation of gamma-ray log combined with density log and neutron log.

First facies is Floatstone facies, where this facies is dominated by lithofacies of floatstone. This facies can be seen in all research wells. Floatstone facies has dark brown color, hard, poorly-sorted, grain-supported, contains dominant of coral detrital, algae fragments, and bioclast fracture with foraminifera benthonic, echinoderms fragments and mollusk. This facies has floatstone texture based on Embry & Klovan (1971) and Dunham (1962) classification. Electrofacies analysis in this facies is show as bell-shaped based on Kendal (2003). The bell log pattern shows a change in depositional energy to be relatively low due to sea level rise which is interpreted as a retrogradation phase. In this condition, the water column is rising so that carbonate growth will be inhibited as the deepened of depositional environment. This phase has a pattern of give up carbonate stacking pattern.

Wackstone- packstone facies is dominated by lithofacies of wackstone and lithofacies of packstone. This facies can be seen in all research wells. Wackstone- packtone facies has brown-yellowish, brittle, poorly-sorted, mud-supported, contains dominant of foraminifera bentonitic, bioclast fracture, glauconite with some algae fragments, gastropods, miliolids, and brachiopods. This facies has wackstone- pacsktone texture based on Embry & Klovan (1971) and Dunham (1962) classification. Electrofacies analysis in this facies is show as funnel-shaped based on Kendal (2003). The funnel log pattern is interpreted as the end of the progradation phase due to a decrease in sea level. This pattern is characterized by a change in build-up from finer clastic to carbonates. This funnel pattern is also known as a catch-up carbonate stacking pattern where reef growth accompanies to the rate of sea level rise.

Floatstone- framestone facies is dominated by lithofacies of framestone. This facies can be seen in well MK-06 and well MK-03. Facies floatstone- framestone has white-yellowish color, hard to compact, poorly-sorted, grain-supported, contains dominant of massive coral, algae fragments, and some foraminifera benthonic. This facies has floatstone- framestone texture based on Embry & Klovan (1971) and Dunham (1962) classification. Electrofacies analysis in this facies is show as cylindrical-shaped based on Kendal (2003). This pattern is characterized by relatively similar lithological characteristics which produces an aggradation pattern. This log pattern is known as the keep-up carbonate stacking pattern, where the condition of the reef growth rate is same as the relative sea level rise rate. After passing the final phase of progression, carbonate growth in the "MK"

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Field entered a period of transgression which was marked by a cylindrical log pattern. In this phase, carbonate can grow well.

Floatstone- rudstone facies is dominated by lithofacies of floatstone and lithofacies of rudtsone. This facies can be seen in well MK-06 and well MK-03. Floatstone- rudstone facies has brown-yellowish color, hard, poorly-supported, grain-supported, contains of dominant algae fragments, coral, bioclast fracture, some foraminifera benthonic. This facies has floatstone- rudstone texture based on Embry & Klovan (1971) and Dunham (1962) classification. Electrofacies analysis in this facies is show as cylindrical-shaped based on Kendal (2003). Cylindrical shaped is represented as aggradation and show keep-up carbonate stacking pattern.

Facies and Depositional Enviroment Corrrelation

The facies correlation was performed using well data to reconstruct the horizontal facies distribution. The facies distribution can be obtained after doing the correlation on research wells that have the similar facies characteristics. Facies correlation was carried out using well-log patterns in the form of gamma-ray logs, density logs and neutron logs. This correlation is carried out by calibrating well logs that have complete data against other wells that do not have complete data using electrofacies analysis.
Based on the classification of Pomar (2004), the first facies association is deposited in the Outer Back-Reef Lagoon. This facies is the floatstone facies. Then, after the first facies was deposited, the second facies is deposited, wackstone- packstone facies is deposited in the Inner Back-Reef Lagoon based on the Pomar classification (2004). The presence of glauconite mineral distribution explains that the environment is in a shallow marine environment with low oxygen. After that, facies III is deposited, namely the Floatstone-Framestone facies with the Reef Core depositional environment based on the Pomar classification (2004). This facies is characterized by a decrease in sea level followed by depositional energy, which tends to be the same every time. This facies is deposited in the MK-6 and MK-3 wells and depleted towards the southwest. Then, the last facies is deposited on the upper part of Baturaja Formation is facies IV, namely the floatstone-rudstone facies in the Outer Back-Reef Lagoon (Pomar,2004). After facies III was deposited, the sea level increased, followed by high depositional energy, so the organism content consists of foraminifera benthonic and bioclast fracture. This facies was deposited in the MK-6 and MK-3 wells and was depleted towards the southwest. Facies in MK-6 and MK-3 wells are growing well due to the influence of topography high, which is controlled by structures in the form of faults that develop in the North West Java Basin. This topography high also affects the different facies formed in the "MK' Field (Figure 3.)

4. CONCLUSION

From the research that have been done in "MK" Field, Jatibarang Sub-basin, then obtained several conclusions which are:

1. The upper part of Baturaja Formation in the research area consists of 4 carbonate facies from the oldest to the youngest, which are floatstone facies, wackstone-packstone facies, floatstone- framestone facies, floatstone- rudstone facies.
2. The results of the electrofacies analysis in the "MK" Field consist of 3 carbonate stacking patterns, which are the Bell Pattern, Funnel Pattern, and Cylindrical Pattern. Each pattern of carbonate deposition marks a different facies and depositional environment.
3. From the four facies on the upper part of Baturaja Formation, it can be concluded that these facies were deposited in a shallow marine depositional environment, which are the Outer Back-Reef, Inner Back-Reef and Reef Core.

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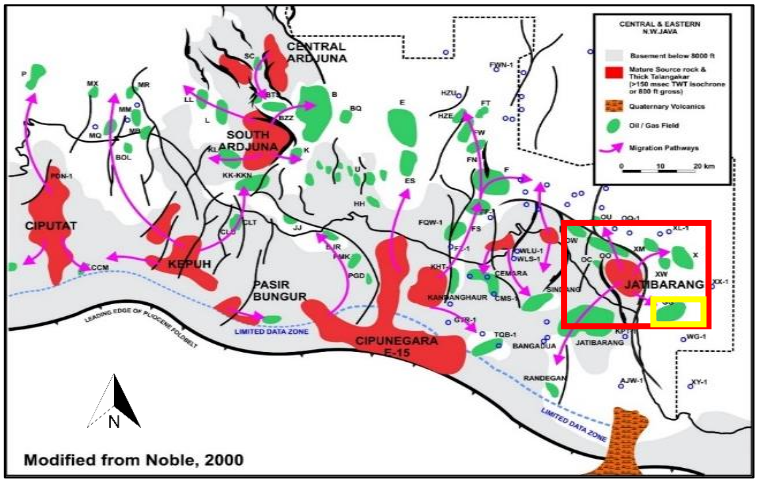

Figure 1. Illustration of Northwest Java Basin (PHE ONWJ Internal Report, modification of Noble,2000). Jatibarang Sub-basin is marked as red zone and "MK" Field is marked as yellow zone

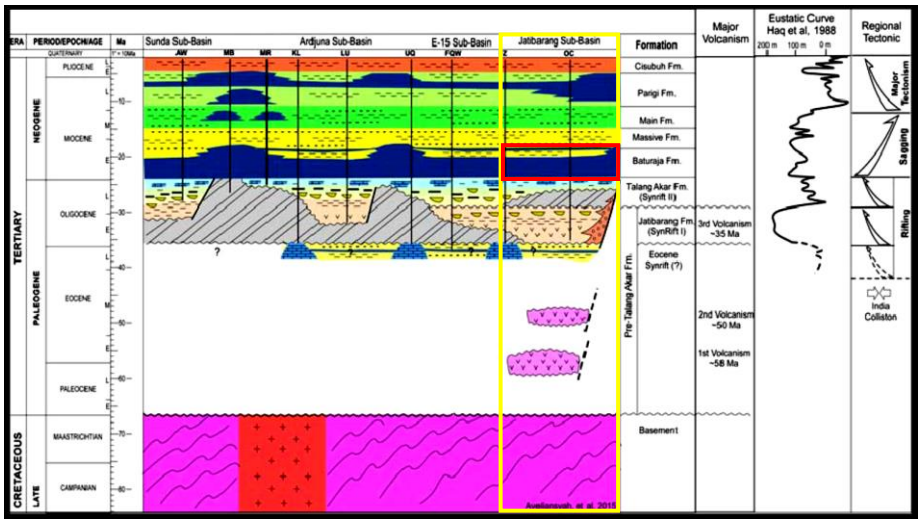

Figure 2. Stratigraphy cross- section of Northwest Java Basin (Aveliansyah, 2016). Jatibarang Sub-basin is marked as yellow zone and "MK" Field is marked as red zone

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Table 1. Facies Association on the upper part of Baturaja Formation, "MK" Field

Lithofacies	Facies Association	Depositional Environment (Pomar et al, 2004)
Rudstone	*Floatstone to Rudstone*	*Outer Back-Reef Lagoon*
Packstone		
Floatstone		
Wackstone		
Packstone		
Rudstone		
Wackstone		
Rudstone		
Framestone	*Floatstone to Framestone*	*Reef Core*
Floatstone		
Rudstone		
Wackstone	*Wackstone to Packstone*	*Inner Back-Reef Lagoon*
Packstone		
Floatstone		
Wackstone		
Floatstone		
Packstone		
Mudstone		
Floatstone	*Floatstone*	*Outer Back-Reef Lagoon*
Packstone		

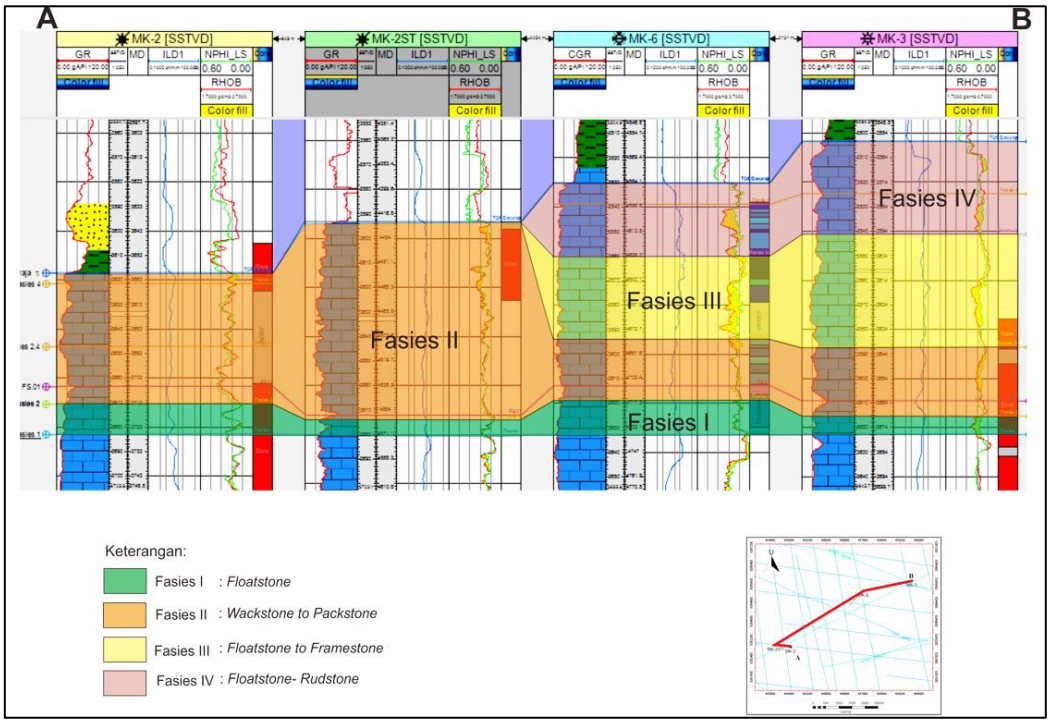

Figure 3. Well correlation cross- section of the facies association on the upper part of Baturaja Formation "MK" Field with southwest to northeast direction

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