

**FACIES AND DIAGENESIS OF TABALAR AND TENDEHANTU CARBONATE  
FORMATION IN MANGKALIHAT PENINSULA AREA: AN OUTCROP  
PRELIMINARY STUDY TO OLIGOCENE – MIOCENE RESERVOIR CANDIDATE  
PROSPECT**

**FASIES DAN DIAGENESIS FORMASI TABALAR DAN TENDEHANTU DI TANJUNG  
MANGKALIHAT: STUDI AWAL BERDASARKAN SINGKAPAN UNTUK KEPROSPEKAN  
KANDIDAT RESERVOIR BERUMUR OLIGOSEN - MIOSEN**

By:

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### **ABSTRACT**

Mangkalihat peninsula is located between Kutai and Tarakan basins, which known as two Hydro Carbon (HC) Prolific basins in Eastern Borneo. The petroleum system in this area is poorly known because of the different system between Kutai and Tarakan Basin. The field study is focusing in the eastern part of Mangkalihat Peninsula, where The Tabalar and Tendehantu Formation are exposed.

The data compilation is from outcrop, thin section and plug sample which permeability and porosity values were measured by Klickenberg method. Outcrop analysis showed that Tendehantu Formation can be divided into two lithofacies, while Tabalar Formation has only one lithofacies. The petrographic thin section analysis showed three microfacies from the two formations.

Pore destruction caused by diagenesis can be indicated with the presence of bladed and equant cement in vuggy pores, while the diagenetical development of porosity is marked by the microfracturing that was assumed to be formed by compaction and deep burial and matrix dissolution in some of the samples.

Petrography and plug sample data integration shows the quality value of those carbonate rock as a reservoir from the permeability and porosity parameter. Based on the microfacies grouping showed in three microfacies, the porosity value is 5.26 - 17.32 % (tight to good), and permeability value is 0.041 – 7.27mD (fair – poor). The carbonate rock quality is influenced by the whole diagenetic processes that happened in each lithofacies.

Keywords : facies, diagenesis, Tabalar Formation, Tendehantu Formation, carbonate

### **SARI**

*Tanjung Mangkalihat terletak di antara Cekungan Tarakan dan Kutai, yang dikenal sebagai 2 cekungan berpotensi hidrokarbon di bagian timur Kalimantan . Perbedaan sistem antara kedua cekungan tersebut menyebabkan sistem perminyakan di daerah ini tidak diketahui dengan baik. Studi lapangan difokuskan pada singkapan-singkapan Formasi Tabalar dan Formasi Tendehantu yang tersusun oleh batuan karbonat di bagian timur tanjung Mangkalihat.*

*Kompilasi data didapat dari singkapan, sayatan tipis dan conto batuan yang diukur angka porositas dan permeabilitasnya dengan Metode Klickenberg. Analisis singkapan menunjukkan bahwa Formasi Tendehantu tersusun oleh dua litofasies, sedangkan Formasi Tabalar hanya oleh satu litofasies. Petrografi sayatan tipis menunjukkan adanya tiga mikrofases dari kedua formasi ini.*

*Kerusakan pada pori-pori batuan akibat proses diagenesis terlihat dari adanya struktur bilah pada semen, sedangkan perkembangan diagenesis pada porositas ditandai oleh struktur mikrofraktur yang diasumsikan terbentuk oleh proses kompaksi akibat sedimentasi cukup dalam dan pelarutan matriks pada beberapa sampel.*

*Integrasi hasil analisis petrografi dan sampel batuan menunjukkan kualitas batuan karbonat dari parameter permeabilitas dan porositas batuan. Berdasarkan analisis dari tiga mikrofasies, didapat nilai porositas berkisar antara 5,26-17,32% (rendah – baik) dan permeabilitas antara 0,041 – 7,27 mD (sedang – buruk). Kualitas batuan karbonat dipengaruhi oleh proses diagenetik yang menyeluruh pada setiap litofasies.*

*Kata kunci : fasies, diagenesis, Formasi Tabalar, Formasi Tendehantu, karbonat*

## INTRODUCTION

Mangkalihat peninsula is located between Kutai and Tarakan basins, which known as two HC Prolific basin in Eastern Borneo. The petroleum system is poorly known because of the different system between Kutai and Tarakan (Figure 1). Field study is focusing in the eastern part of Mangkalihat Peninsula, where The Tabalar and Tendehantu are exposed. The location was chosen as a key to conduct the tectonic understanding related to petroleum system in this area. The study is a compilation of field study data for preliminary reservoir prediction based on outcrop data, petrographic thin section analysis and plug sample porosity, permeability estimation to predict the reservoir candidate.

## METHODOLOGY

This study is integrated from the result from field work, there are 29 spots of outcrop station for analysis in 10 km<sup>2</sup> area in Eastern Mangkalihat. The outcrop samples furthermore were selected and grouped by the lithofacies based on outcrop analysis. The representing samples from some facies of Tabalar and Tendehantu Formations, furthermore were made as plug sample to porosity and permeability analysis for reservoir candidate prospecting. For carbonates facies and microfacies analysis, this study used petrographic observation to understand the porosity, mineralogy, and carbonate fragment distribution. This analysis was also used in order to interpret the depositional environment and diagenetic history and feature (Figure 2).

## REGIONAL GEOLOGY & STRATIGRAPHY

Mangkalihat Peninsula located in eastern part of Borneo, physiographically this is a highland which separates Kutai and Tarakan basins into southern and northern area respectively. Tectonically, Mangkalihat is a microcontinent from Northern Gondwana which was drifted to equator in Late Jurassic, as an impact of the opening of Cenotethys Ocean (Metcalf, 1996). The other well known name of this microcontinent is Paternoster Terrain. This Terrain was continually accreted to early Sunda Terrain in their Southeastern segment (Continental core of Schwane Microplate) in 150-60 Ma (Satyana, 2003) (Figure 3).

This accretion is marked by the presence of Adio Suture or Suikerbrood High in Western Mangkalihat. The accretion that was happened in western part of Mangkalihat during the Early Tertiary implicated as sediment fill to the eastern part along the transgressive phase during the time.

Mangkalihat platform during Paleogene was dominantly filled by neritic – paludal sedimentary product, and in Neogene was dominantly filled by regressive phase sediment.

Regional stratigraphy of this study area is subdivided into four formations, from older to younger during Late Oligocene to Pliocene interval. They are Tabalar Formation, which is dominated by white – grey limestone, and Tendehantu Formation which consists of coralline limestone, with white – yellow colour, Lembak Formation which is dominated by marl and limestone and Golok Formation which is dominated by marl with interruption of claystone and marl-limestone

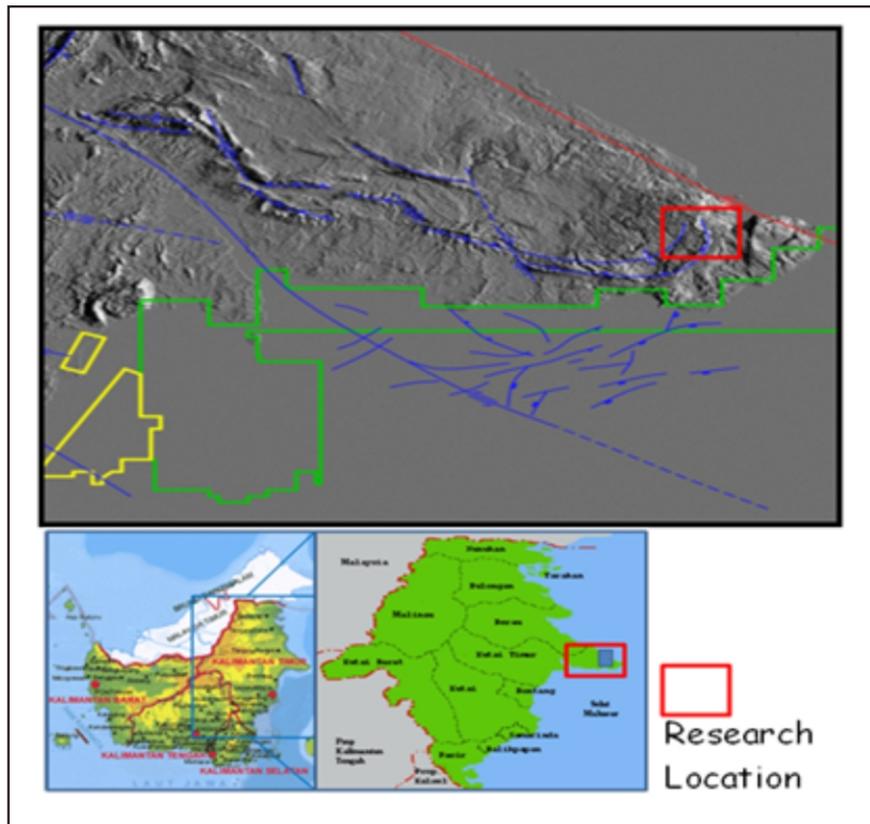


Figure 1 - Location index of the research area

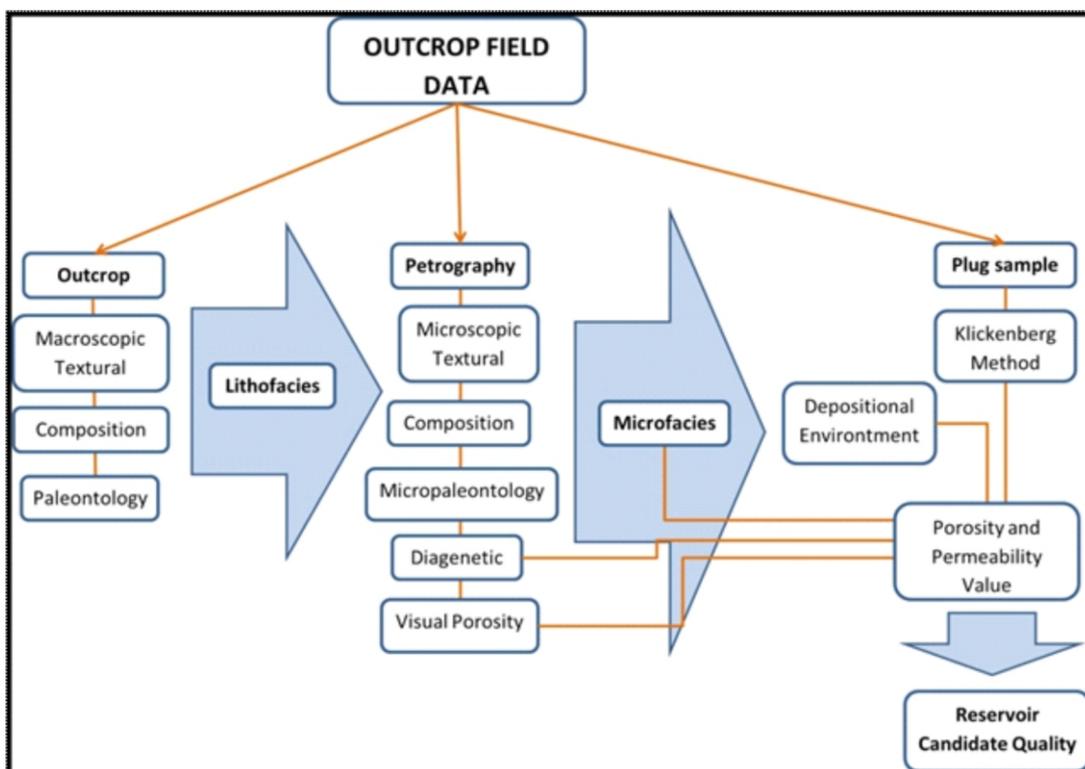


Figure 2 – Research workflow.

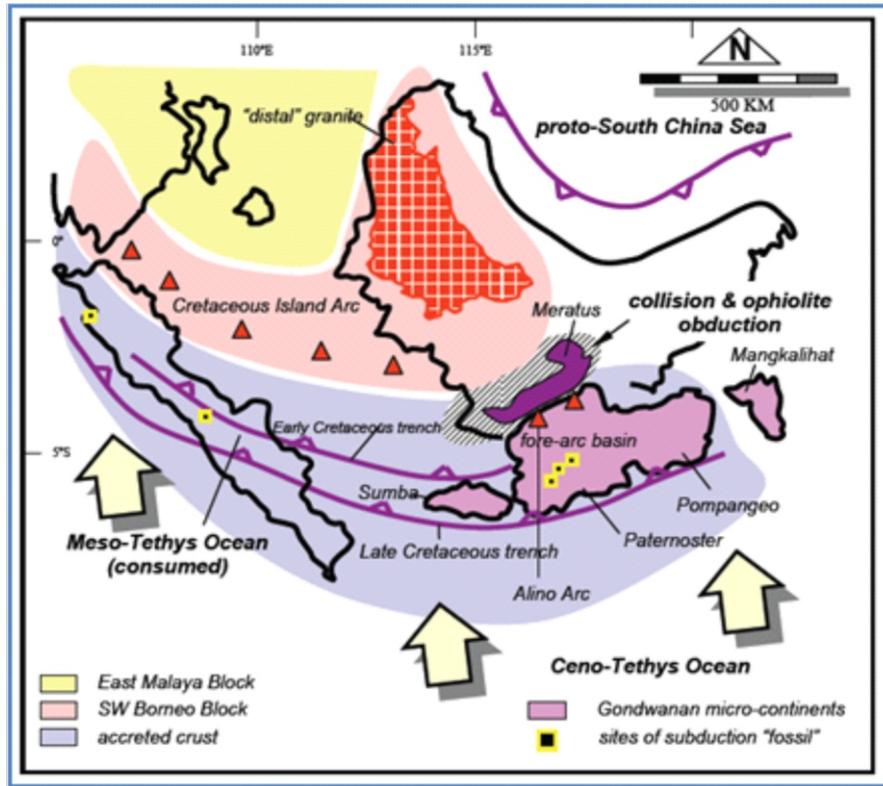


Figure 3 – Tectonic scheme of the Mangkalihit in Cretaceous – Paleogen (Satyana, 2003)

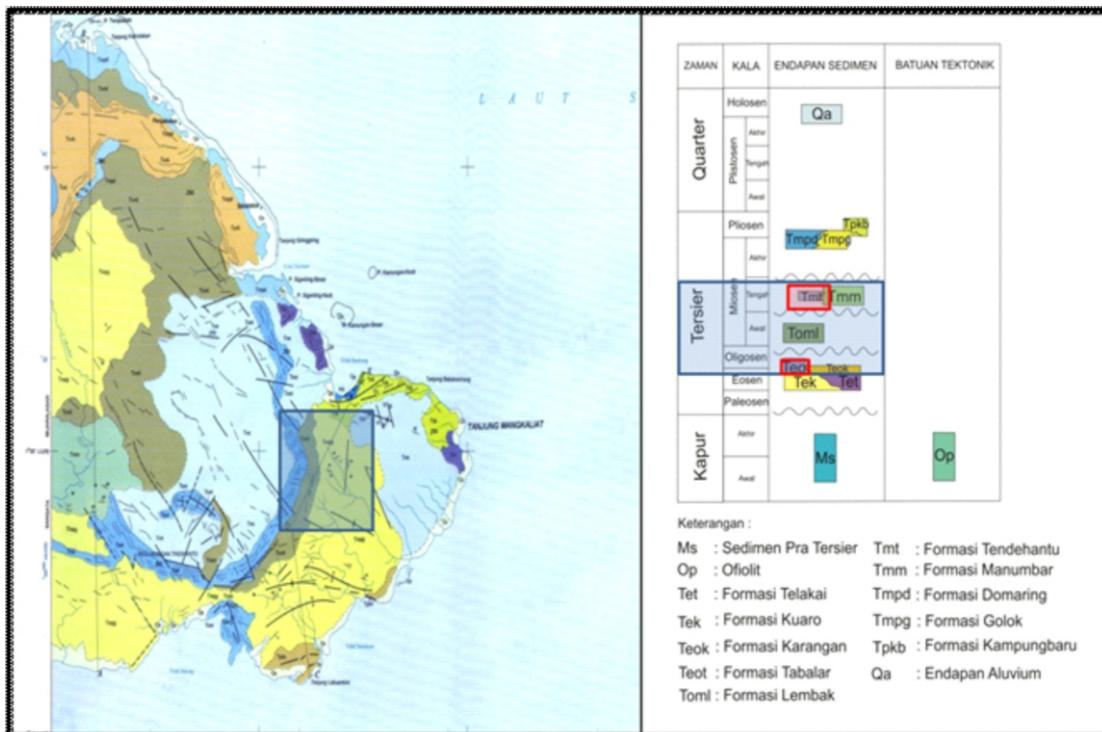


Figure 4 – Regional Geological map and stratigraphical column of research area, (Blue block shows interval of study) (Djamal et al., 1995)

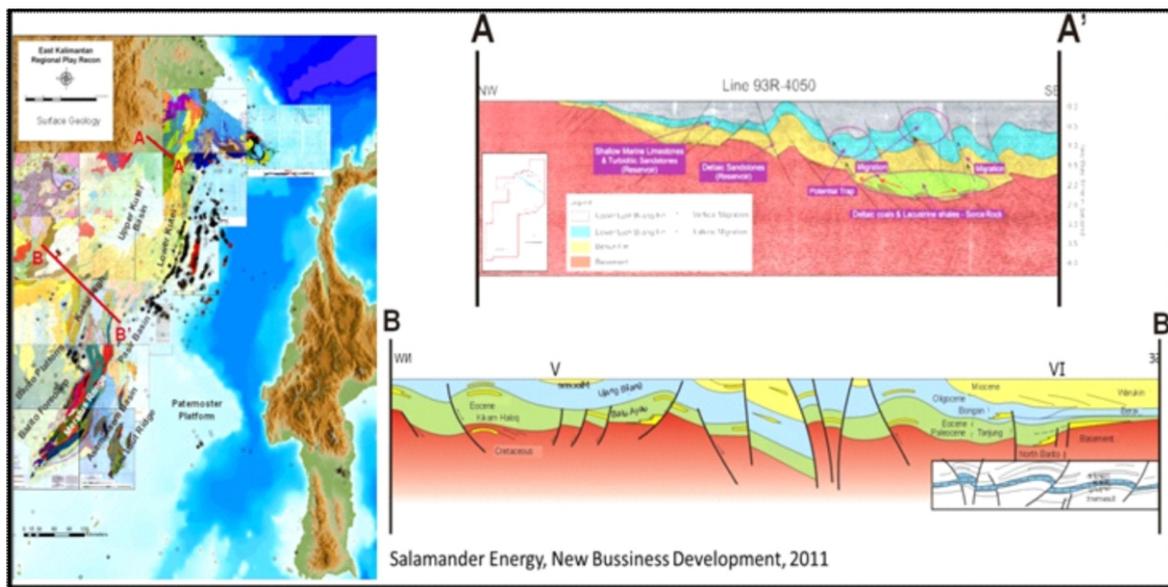


Figure 5 – Play mechanism intersection from regional petroleum system in research area.

with molusca. The focus of stratigraphical segment in this study is in Tendehantu and Tabalar Formations.

**PETROLEUM SYSTEM**

The petroleum system analogue was adopted from comparison with the play mechanism in East Kalimantan (Figure 5 ). The potential source rock is from Paleocene – Eocene segment, consists of deltaic coal and lacustrine of Kutai Basin. The turbidite sandstone and shallow marine deposit also play as reservoir potential in Southern Kutai Basin, that were developed during Eocene – Oligocene. In this study, the Oligocene – Miocene sediments that play as the main target reservoirs are the Tendehantu and Tabalar Formation. The analogue of trapping mechanism in the research area is the present marine segment such as Golok Formation (Figure 4). The migration mechanism can be interpreted by cross section (Figure 5) of an inverted regime during Miocene. This analogue can be reflected in the study area as when Sangkulirang and Maratua Faults were active and developed during Miocene and probably to Recent. The migration mechanism can openly transport the mature hydrocarbon to be trapped in the Eocene – Miocene Reservoir in this study area.

**CARBONATE FACIES ANALYSIS**

Carbonate facies analysis was interpreted based on lithology, texture, composition and fossil content, that observed in field description. Based on that examination Tabalar and Tendehantu Formation were divided into 3 lithofacies. Further analysis, especially for microfacies determination, was interpreted based on thin section texture, composition, fossil content and diagenetic feature.

Tabalar Formation has one lithofacies that can be determined as packstone – wackestone lithofacies (Table 1). This lithofacies is dispersed in the western part of research area (Figure 6), and spreads from North to South trend. The lithofacies has characters of massive body with no bedding feature, white colour, and poor – medium sorted fragment consists of branching and platy coralline as well as containing bivalve shells. The porosity that can be observed is moldic and vuggy as the product of intense dissolution (Figure 11). Petrographical analysis showed that it is generally poorly sorted with grain from 0.2 – 4 mm range, medium abraded with float and point contact. The dominant fragments are bryozoan, larger forams and coralline fragment.

Based on dominant fragment marker, on petrographical analysis, this lithofacies can be divided into 2 microfacies clusters namely the Larger Forams – Coralline Wackestone

and the Bryozoan – Coraline Packestone – Grainstone microfacies.

The Tendehantu Formation is divided into 2 lithofacies namely wackestone – packestone and packstone – grainstone lithofacies.

The wackestone – packestone lithofacies in Tendehantu Formation, has 5 observation stations, which showed poorly sorted with closed packing, the grains mainly from 0.2 – 5 mm range, with moderately abraded and showed point and float contact (Figure 10). Petrographical analysis showed that matrix content is ranging from 26 – 41% and pore visual from 7 – 15%, the dominant grain is larger forams. Further analysis for this lithofacies based on petrographical analysis, showed that it can be clustered into 2 microfacies clusters, those are Larger Forams Packestone and Indetermined Bioclast – Algae Packestone. This microfacies clustering will become a guidance for determining the quality of reservoir candidate.

The packestone – grainstone lithofacies in Tendehantu Formation generally showed a poorly sorted feature in microscopic, with 0.2 – 4 mm grain and moderately abraded, with point and float contact matrix range from 34 – 45% (Figure 10). From further petrographical analysis the lithofacies has 3 microfacieses namely Indetermined Bioclast Packestone, Larger Forams Bryozoan Packestone and Larger Forams Grainstone.

## RESUME OF DIAGENESIS

Based on petrographic analysis, the diagenetic processes observed in Tabalar and Tendehantu Formations include as follows:

### Microbial Micritization

This process was a result of drilling activity in skeletal grain by endolithic algae, fungi and bacteria forming holes and filled with fine sediment or cement. This activity is marked by the presence of micrite envelope. If the hole is not filled up by fine sediment, the hole will be corroded and the moldic porosity formed. Micritization is an important process in both stagnant and active marine phreatic zones (Longman, 1982).

### Dissolution

Dissolution occurred when the diagenetic environment were different, the minerals became unstable and dissolved easily and then transformed into more stable minerals in a new environment. Dissolution intensively happened in several microfacieses in Tabalar Formation, produced secondary porosity as moldic and vuggy (Figure 10 - B). Dissolution occurred as well in freshwater vadose or freshwater phreatic environments (Longman, 1982).

### Cementation

This processes occurred when the pores were fluid supersaturated and there was no kinetic factor hampering the cement precipitation. Based on the analysis in Tabalar and Tendehantu there are three kinds of cement that can be observed: fibrous, blocky and bladed. Bladed and blocky were dominantly observed in Tabalar Formation. Bladed and fibrous cement showed marine phreatic environment, while blocky formed in meteoric phreatic (Figure 11).

### Neomorphism

Neomorphism is a diagenetic product that has larger size inverse micrite recrystallization. The formed crystal showed more clouded colour than spar cement and microspar. Neomorphism occurred in meteoric phreatic environment and present dominantly in both formations.

### Compaction

Mechanical and chemical compaction occur in deep burial environment, caused by pressure and fluid involved. In Tabalar Formation compaction feature showed grain fractures and stylolites. This diagenetic processes gave a huge effect to reduce the pore value.

Based on the processes explained above, it can be summarized that the sequence of diagenetic processes in Tabalar and Tendehantu Formations are:

First stage diagenesis occurred in marine phreatic and fresh water phreatic zone characterized by the occurrence of micritization, fibrous and equant cement.

Second stage is burial environment, shown by mechanical compaction and

Table 1 Data Recapitulation

Tendehantu Formation			Tabalar Formation		
Packestone – Grainstone Lithofacies			Wackestone – Packestone Lithofacies		
Outcrop	TS	Plug	Outcrop	TS	Plug
RA 2-4			RA 13-2		
RA 2-2			RA 13-3		
RA 2-9			RA 13-4		
Wackestone – Packestone Lithofacies			RA 13-5		
RA 16 T –5			RA 13-6		
RA 16T-3			RA 13-8		
RA 2-8			RA 14-1		
RA 2-5			RA 14-2		
RA 7-1			RA 14-5		

chemical compaction. This stage is marked by point and long contact, as well as stylolite forming.

Third stage occurred in meteoric phreatic, shown by blocky cement, neomorphism and dissolution. This stage was dominantly occurred in Tabalar Formation

The tectonic processes that happened to these two research formations caused them to uplift and be located near to the surface position. The diagenetic stage was then changed into meteoric vadose. During this time, when the contact between carbonate formations and meteoric water was intense, vug and other secondary porosity were formed. Tabalar Formation had more intense processes than Tendehantu Formation in this stage.

**CARBONATE RESERVOIR CANDIDATE QUALITY**

The carbonate reservoir quality prediction was taken from microfacies distribution based on the plugs of outcrop samples that were analyzed with routine core analysis method. For Tendehantu Formation there is the Indetermined Bioclast – Bryozoan – Larger Forams in

Packestone – Grainstone microfacies. The quality of this microfacies is 8 -12% for visual porosity and dominated by the moldic, vugs and fracture porosity. The plug outcrop porosity is 7.51 – 10.65% with horizontal permeability value between 0.014 – 15.1 mD. Based on those values this microfacies in general has poor – good quality as a reservoir. The crossplot sample data showed bad correlation between the porosity and the permeability values in this microfacies. Then it can be assumed that diagenesis factor was involved to decrease the microfacies quality, as like tight cementation that reach 5-7%.

The Tabalar Formation has two microfacies clusters. Those are Larger Forams – Coraline Wackestone and Bryozoan – Coraline Packestone – Grainstone.

The Larger Forams – Coraline Wackestone generally can be classified as a good quality reservoir based on the visual porosity which reaches 14%. This porosity is dominated by moldic, intercrystalline and vug (Figure 11). Two plugs of outcrop were analyzed and showed the porosity and permeability values are 16.74 – 17.32 % and 3.985 – 7.278 mD respectively which then classified into fair reservoir classification (Koesoemadinata, 1980). Crossplot diagram from the data showed that the permeability and porosity has relative correlation, which

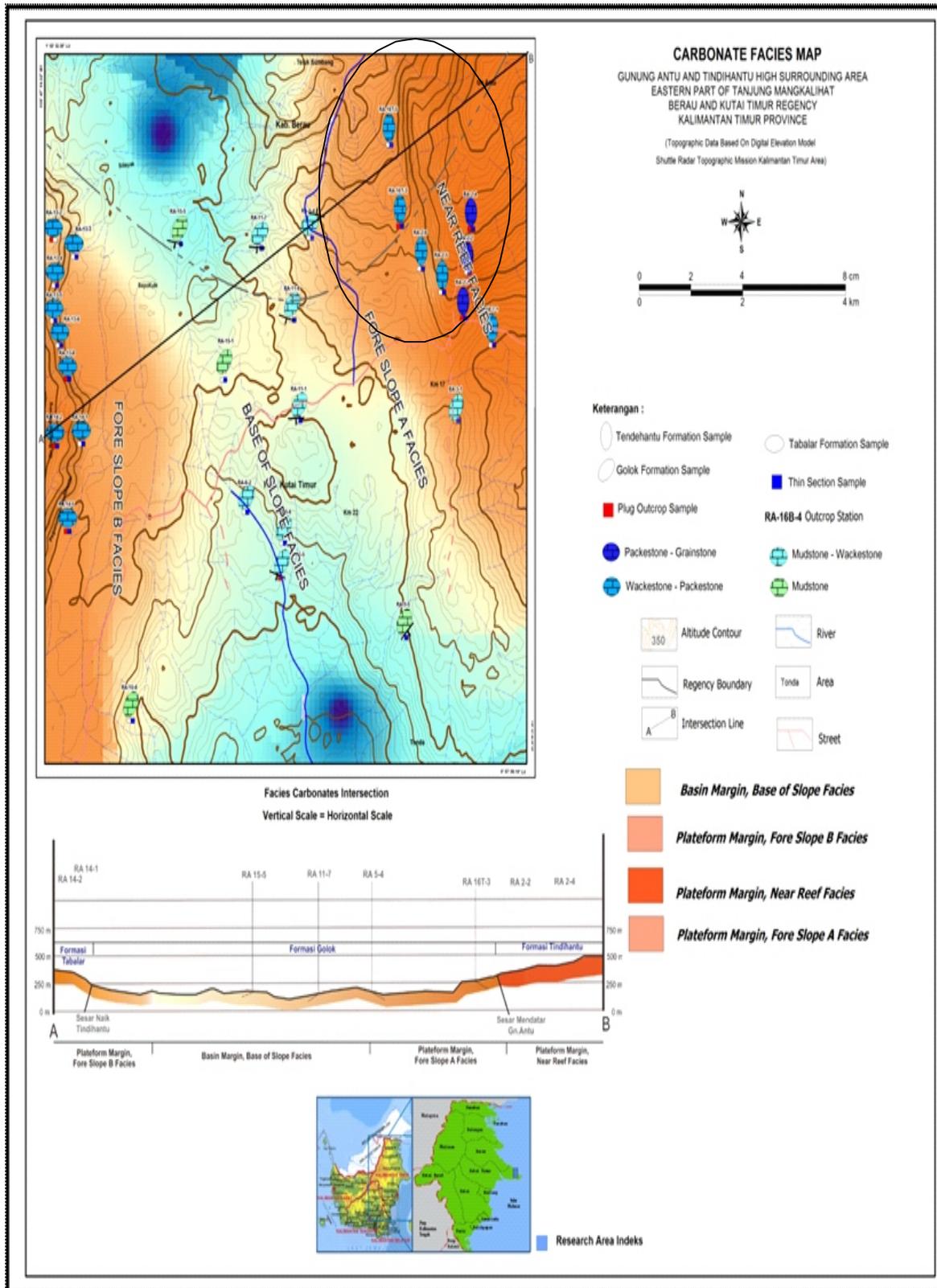


Figure 6 – Carbonates facies map

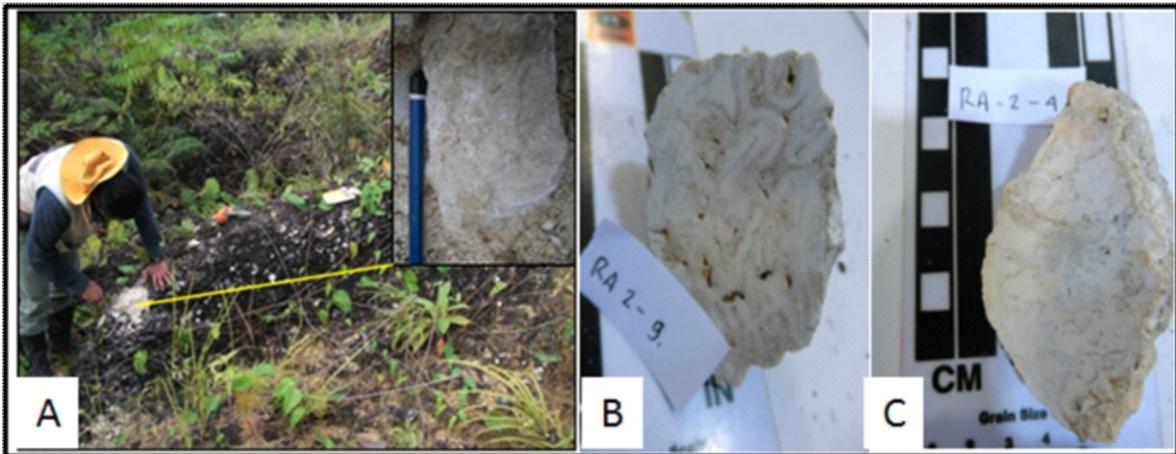


Figure 7. Tendešanu Formation outcrop represents packstone – grainstone lithofacies

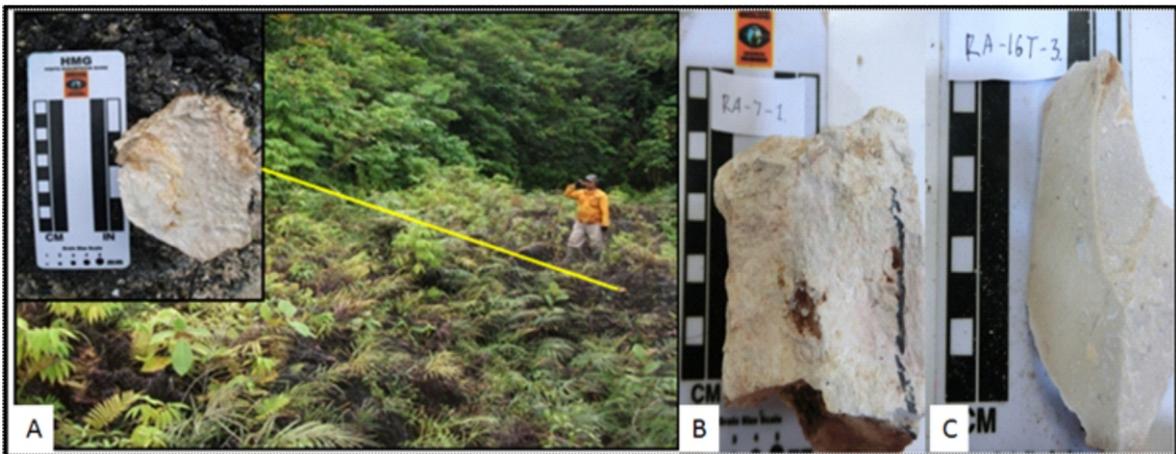


Figure 8 – Wackestone - packstone lithofacies in Tendešanu Formation

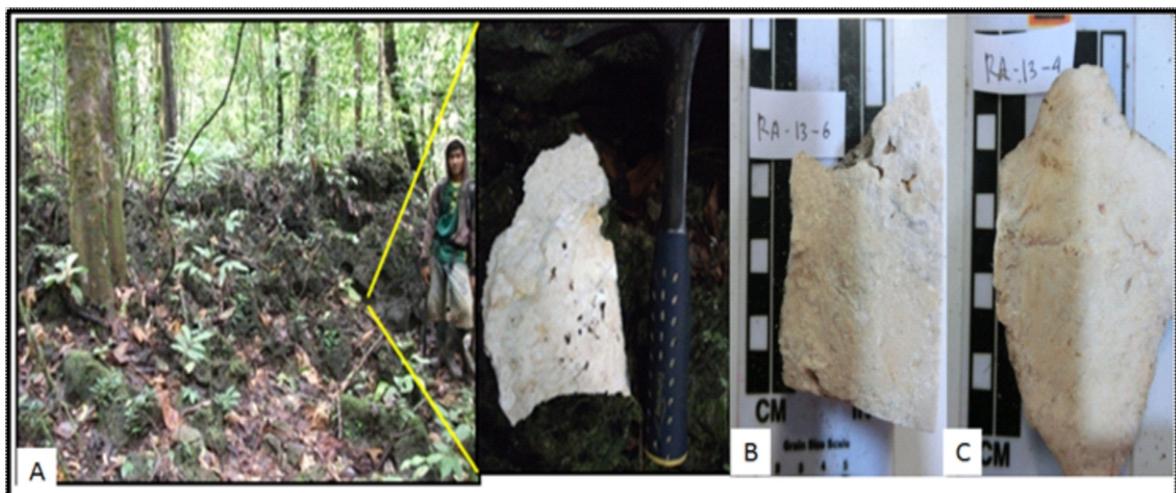


Figure 9. Wackestone – packstone lithofacies in Tabalar Formation

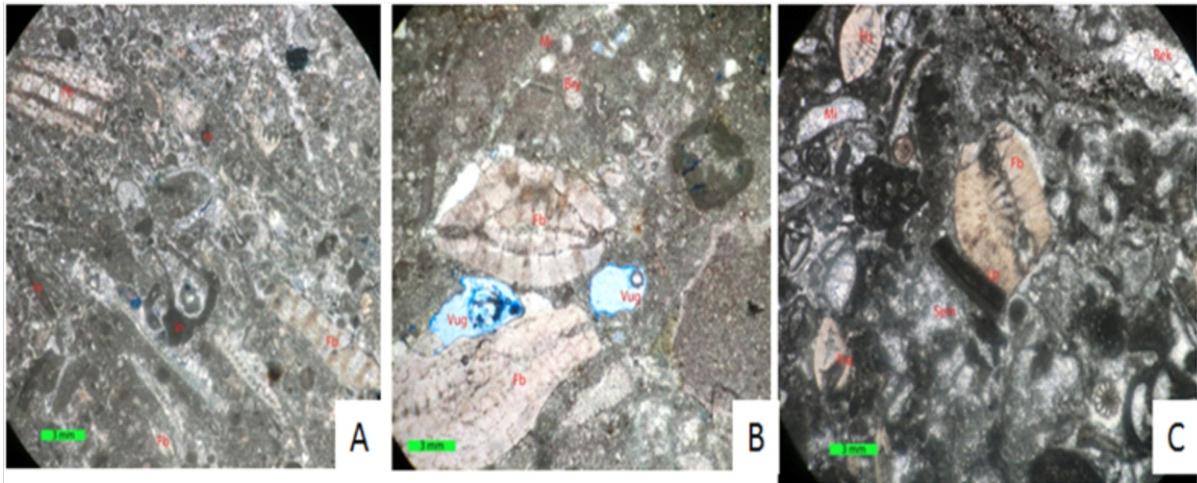


Figure 10 - Three thin section photographs from Tendehantu Formation with 40x lens magnification, RA 24 (A) Cross polarization; Indetermined bioclast packstone RA 2 (B) plane polarization; Larger Forams –Bryozoan Packestone, RA 16 T-3 (C) Cross polarization; Larger Forams Packestone. (Fb : Larger Forams, Lp : Long Contact, Mi: Micritization, Rek: Recrystalization, Fra : Fracture, Bry: Bryozoan, Vug: Vuggy Pore)

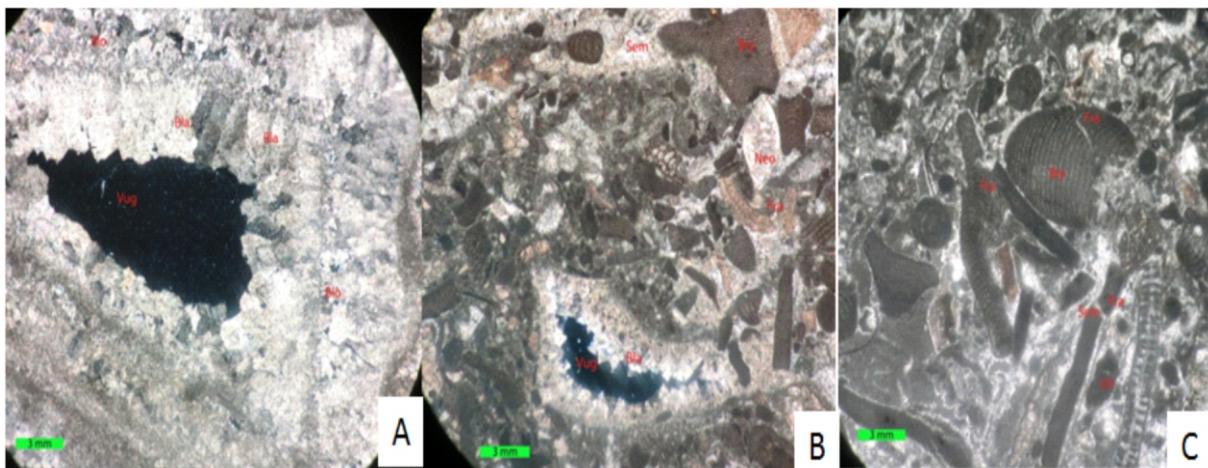


Figure 11 – Three thin section photographs from Tabalar Formation with 40x lens magnification, RA 13 – 3 (A) Cross polarization; Larger Forams Coraline Wackestone, RA 13-6 (B) cross polarization; Bryozoan – Coraline Packestone – Grainstone, RA 13 – 4 (C) Bryozoan – Coraline Packestone – Grainstone. (Red assign : Blo : Blockycement, Bla: Bladed Cement, Vug: Vuggy Pore)

means that the increasing porosity can be followed by the increase of permeability as well. This good relationship between permeability and porosity can be interpreted as the result of dissolution process of diagenesis.

Bryozoan – Coraline Packestone – Grainstone in Tendehantu Formation is the last microfacies cluster. Two outcrop sample plugs RA 14-5 and RA 14-2 were analyzed

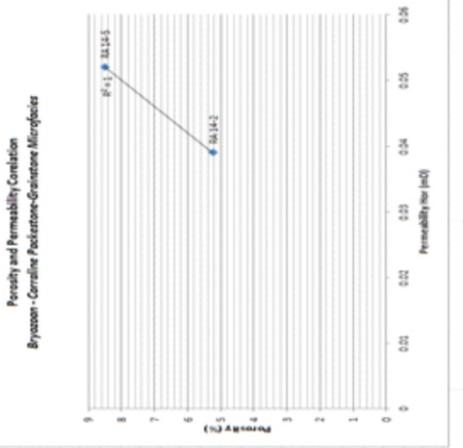
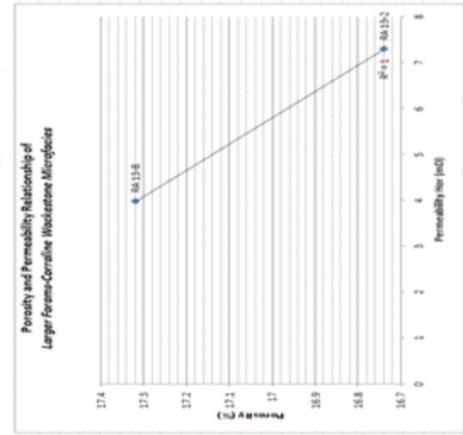
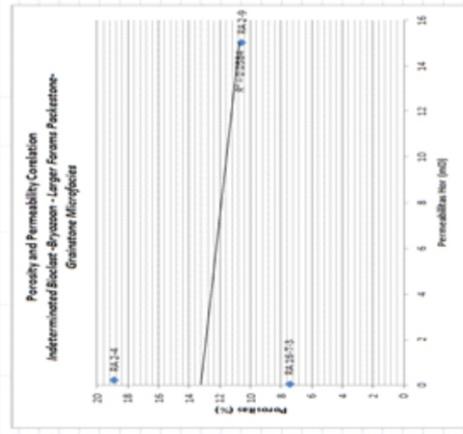
and showed 5.26 – 8.51 % porosity and 0.052 – 0.039 mD for horizontal permeability. The visual porosity value is between 9 – 17%, dominated by moldic, intercrystalline and vug porosity. The permeability and porosity crossplot data showed that the data has relative correlation. Although the porosity and permeability has correlation, the permeability is tight, interpreted as the effect of intense cementation in this microfacies.

Table 2 – Summary of the Diagenetic Analysis for each sample

Station	Formation	Lithofacies	Mikrofacies (Dunham 1962)	Cluster Mikrofasies	Diagenesis					Cement		
					Micritization	Cementation	Recrystallization	Compaction	Dissolution	Bladed	Equant	Fibrous
RA 2-4	Tendehantu	Packestone - Grainstone	Indeterminate Bioclast Packestone	Indeterminate Bioclast - Bryozoa - Lager Foram packestone	0.0	0.0	0.0	0.0	0.0	-	0.0	-
RA 2-2	Tendehantu	Packestone - Grainstone	Larger Foram - Bryozoa Packestone	Indeterminate Bioclast - Bryozoa - Lager Foram packestone	0.0	0.0	0.0	0.0	0.0	-	0.0	-
RA 2-8	Tendehantu	Wackestone - Packestone	Larger Foram Packestone	Indeterminate Bioclast - Bryozoa - Lager Foram packestone	0.0	0.0	0	-	0.0	-	0	-
RA 2-9	Tendehantu	Packestone - Grainstone	Larger Foram Grainstone	Indeterminate Bioclast - Bryozoa - Lager Foram packestone	0.0	0.0	0.0	0.0	0.0	-	0	-
RA 7-1	Tendehantu	Wackestone - Packestone	Larger Foram Packestone	Indeterminate Bioclast - Bryozoa - Lager Foram packestone	0.0	0.0	0.0	0	0.0	0	0	-
RA 2-5	Tendehantu	Wackestone - Packestone	Larger Foram Packestone	Indeterminate Bioclast - Bryozoa - Lager Foram packestone	0.0	0.0	0.0	0.0	0.0	0.0	0	-
RA 16 T-3	Tendehantu	Mudstone - wackestone	Indeterminate Bioclast - Algae Packestone	Indeterminate Bioclast - Bryozoa - Lager Foram packestone	0.0	0.0	0.0	0	-	0.0	0.0	0
RA 16 T-5	Tendehantu	Mudstone - wackestone	Larger Foram Packestone	Indeterminate Bioclast - Bryozoa - Lager Foram packestone	0.0	0.0	0.0	-	0.0	0.0	0	-
RA 13-2	Tabalar	Wackestone - Packestone										
RA 13-3	Tabalar	Wackestone - Packestone	Coral Wackestone	Larger Forams - Coralline Wackestone	0.0	0.0	0.0	0.0	0.0	0.0	0	-
RA 13-8	Tabalar	Wackestone - Packestone	Larger Foram wackestone	Larger Forams - Coralline Wackestone	0.0	0.0	0.0	-	0.0	0	0.0	-
RA 13-4	Tabalar	Wackestone - Packestone	Bryozoa Grainstone	Bryozoa - Coralline Packestone-Grainstone	0.0	0.0	0.0	0.0	0.0	-	0.0	-
RA 13-5	Tabalar	Wackestone - Packestone	Bryozoa Packestone	Bryozoa - Coralline Packestone-Grainstone	0.0	0	0.0	0.0	0.0	0.0	0.0	-
RA 13-6 TS	Tabalar		Bryozoa Grainstone	Bryozoa - Coralline Packestone-Grainstone	0.0	0.0	0.0	0.0	0.0	-	0	-
RA 13-6	Tabalar	Wackestone - Packestone	Bryozoa Packestone	Bryozoa - Coralline Packestone-Grainstone	0.0	0.0	0.0	0.0	0.0	0.0	0	-
RA 14-2	Tabalar	Wackestone - Packestone	Coral Grainstone	Bryozoa - Coralline Packestone-Grainstone	0.0	0.0	0.0	0.0	0.0	0.0	0	-
RA 14-1	Tabalar	Wackestone - Packestone	Coral Grainstone	Bryozoa - Coralline Packestone-Grainstone	0.0	0.0	0.0	0.0	0.0	0.0	0	-
RA 14-5	Tabalar	Wackestone - Packestone	Bryozoa Packestone	Bryozoa - Coralline Packestone-Grainstone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-

Table 3 – Summary of plug outcrop analysis, visual porosity observation and porosity –permeability cross plot in each microfacies cluster .

Station	Formation	Sample This Sec	Outcrop	Plug	Lithofacies	Microfacies (Dunham 1962)	Cluster Microfacies	Pore Visual	Pore Plug Sample (%)	Konoensudrata 1985 Scale	Horizontal Permeability	Konoensudrata 1985 Scale
BA.2.4	Tendeharu				Packstone - Granitstone	Indeterminatef Biotidit - Lager Foram packstone	Indeterminatef Biotidit - Bryoosin - Lager Foram packstone	12	18.96	Good	0.227	Tight
BA.2.2	Tendeharu				Packstone - Granitstone	Larger Foram-Bryoosin Packstone	Indeterminatef Biotidit - Bryoosin - Lager Foram packstone	16		Good		
BA.2.8	Tendeharu				Wackstone - Pakistone	Larger Foram Packstone	Indeterminatef Biotidit - Bryoosin - Lager Foram packstone	7		Poor		
BA.2.9	Tendeharu				Packstone - Granitstone	Larger Foram Granitstone	Indeterminatef Biotidit - Bryoosin - Lager Foram packstone	8	10.85	Fair	15.01	Good
BA.7.1	Tendeharu				Wackstone - Pakistone	Larger Foram Packstone	Indeterminatef Biotidit - Bryoosin - Lager Foram packstone	15		Good		
BA.2.5	Tendeharu				Wackstone - Pakistone	Larger Foram Packstone	Indeterminatef Biotidit - Bryoosin - Lager Foram packstone	9		Poor		
BA.18.13	Tendeharu				Mudstone - wackistone	Indeterminatef Biotidit - Lager Packstone	Indeterminatef Biotidit - Bryoosin - Lager Foram packstone	9	7.51	Poor	0.041	Tight
BA.18.15	Tendeharu				Mudstone - wackistone	Larger Foram Packstone	Indeterminatef Biotidit - Bryoosin - Lager Foram packstone	8		Poor		
BA.13.2	Tibular				Wackstone - Pakistone			16.74		Good	7.278	Fair
BA.13.3	Tibular				Wackstone - Pakistone	Coral Wackstone	Larger Forams - Coralline Wackstone	12		Fair		
BA.13.4	Tibular				Wackstone - Pakistone	Larger Foram wackistone	Larger Forams - Coralline Wackstone	14	17.32	Good	3.958	Fair
BA.13.4	Tibular				Wackstone - Pakistone	Bryoosin Granitstone	Bryoosin - Coralline Packstone-Granitstone	9		Poor		
BA.13.5	Tibular				Wackstone - Pakistone	Bryoosin Granitstone	Bryoosin - Coralline Packstone-Granitstone	14		Fair		
BA.13.6 TS	Tibular				Wackstone - Pakistone	Bryoosin Granitstone	Bryoosin - Coralline Packstone-Granitstone	12		Fair		
BA.13.6	Tibular				Wackstone - Pakistone	Bryoosin Packstone	Bryoosin - Coralline Packstone-Granitstone	17		Good		
BA.14-2	Tibular				Wackstone - Pakistone	Coral Granitstone	Bryoosin - Coralline Packstone-Granitstone	16	5.26	Good	0.039	Tight
BA.14-1	Tibular				Wackstone - Pakistone	Coral Granitstone	Bryoosin - Coralline Packstone-Granitstone	16		Good		
BA.14-5	Tibular				Wackstone - Pakistone	Bryoosin Packstone	Bryoosin - Coralline Packstone-Granitstone	13	4.51	Poor	0.032	Tight



The porosity was reduced by the cementation. Based on that data the Bryozoan – Coraline Packestone – Grainstone microfacies generally has fair quality as a reservoir candidate.

**CONCLUSION**

1. The Tabalar Formation based on field observation can be determined into one lithofacies, which is wackestone – packestone. The Tendehantu Formation has two lithofacies based on field observation. They are wackestone – packestone and packstone – grainstone lithofacies.
2. Petrographical analysis divided the 3 lithofacies into 3 lithofacies clusters. Those are; Indetermined Bioclast – Bryozoan – Larger Forams Packestone – Grainstone Microfacies, Larger Forams – Coraline Wackestone and Bryozoan – Coraline Packestone – Grainstone.
3. The complex diagenetic processes that

happened in the two formations were microbial micritization, dissolution, cementation, and compaction, which happened in four stage.

4. The potential reservoir candidate is Indetermined Bioclast – Bryozoan – Larger Forams Packestone – Grainstone Microfacies from Tendehantu Formation and Larger Forams – Coraline Wackestone from Tabalar Formation with good quality prediction.

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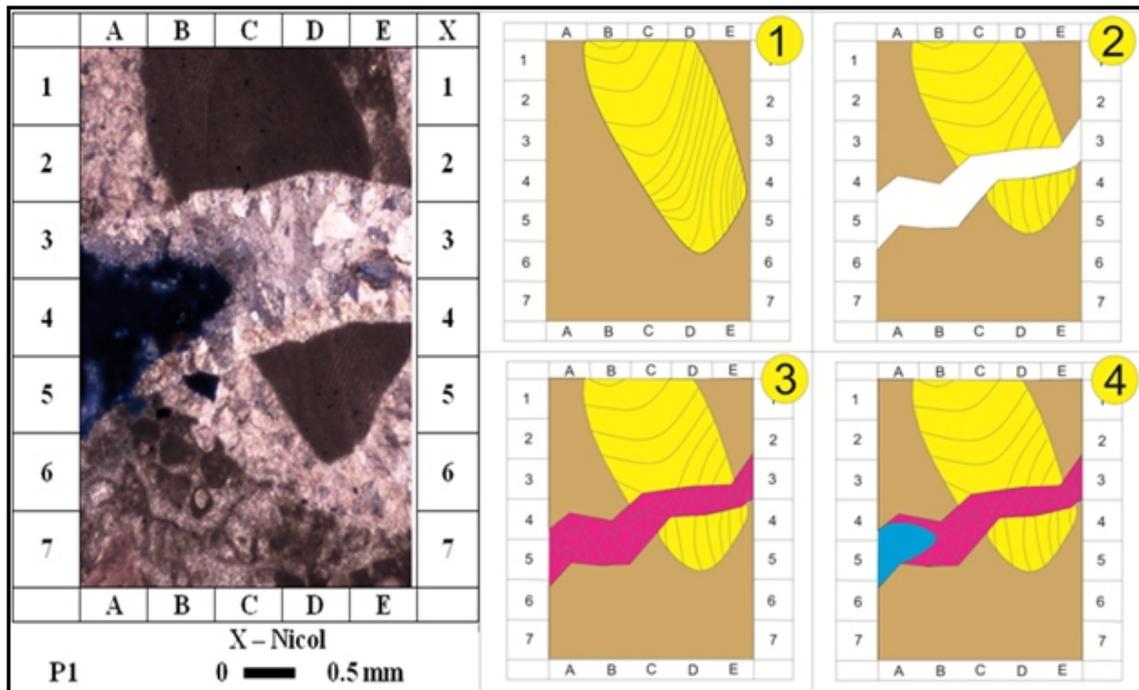


Figure 12 - RA 14-4 Thin section photograph and the diagenetic stage illustration. (1) Microbial Micritization in red algae fragment possibly happened in marine phreatic. (2) Fracturing in algae fragment, possibly caused by burial regime. (3) Blocky and bladed cementation were developed in fracture possibly in meteoric phreatic regime, this phase reduce the fracture pores. (3) The latest diagenesis stages that recorded here is dissolution in cement that formed before, this phase possibly in meteoric vadose.

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