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Limestone Microfacies of Baturaja Formation along Air Rambangnia Traverse, South OKU, South Sumatra

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Abstract - Limestones of the Baturaja Formation occur at Air Rambangnia traverse, South Ogan Komering Ulu, South Sumatra, and they are used as objects for microfacies studies. The microfacies studies are based on a detailed petrographic analysis of thirty four limestone samples, taken from the traverse. Four types of the limestones are identified such as wackestone, packstone, grainstone, and floatstone. At least five microfacies form the limestone succesion of the Baturaja Formation. They are interpreted as sedimentary facies of very restricted bay and pond, back reef local slope, slope and shelf edge, winnowed platform edge sand, and reef flank facies.

Keywords: Baturaja, limestone, petrography, microfacies, sedimentary facies

Introduction

The term microfacies was first put forward by Brown (1943; in Flugel, 1982). It is defined as extensively discrete paleontology and sedimentology aspects, that can be grouped based on the type and number of components in petrographic thin section and polished sample examination. Thereby, microfacies identifies environment of deposition based on petrography data (Maryanto, 2005 and 2008). Based on the type and number of components, Flugel (1982) divides microfacies of limestone into twenty-four types according to the former division of facies zone by Wilson (1975).

Wilson and Rosen (1998) stated that carbonate platform in the western part of Indonesia has appeared since the Late Oligocene. Bishop (2000a) concluded that the Early Miocene of Baturaja Formation consists of carbonate platform sediments having totally thickness of 60 - 120 m. Bishop (2000b) divided Baturaja Formation into two lithostratigraphic units based on deposition, *i.e*. clastic sedimentary facies and limestone or carbonate rock facies.

The researched location was along Air Rambangnia River, in between Baturaja and Muaradua towns, administratively belonging to the area of South Ogan Komering Ulu (OKU) Regency, South Sumatra Province (Figure 1). The carbonate rocks from Baturaja Formation are well found along the Air Rambangnia traverse. This article was written with the aim to study the environment and deposition mechanism of those limestones based on petrography data in relation to the division of limestone microfacies.

Methodology

In order to achieve the study purpose, the research method includes field data collection and laboratory analysis. Field data collection is a systematical rock sampling, which is based on the results obtained by making detailed stratigraphic column along Air Rambangnia traverse. Laboratory work was done by quantitatively petrographic analysis with point-counter for as many as 300 counts (Maryanto, 2007a). Important

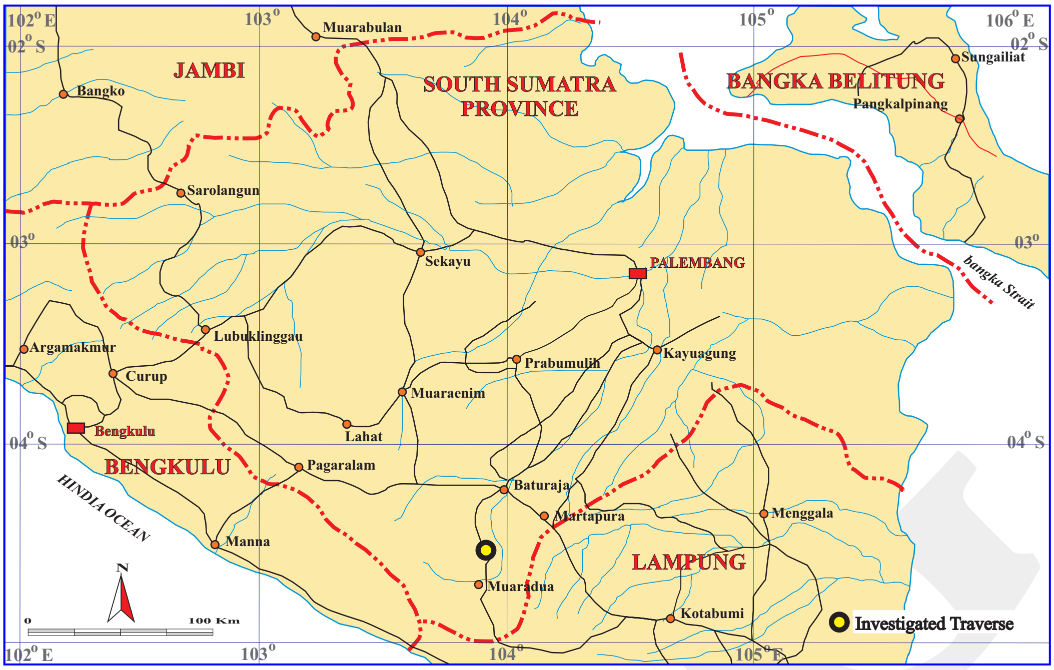

Figure 1. Location map of South Sumatra Province and the investigated traverse at Air Rambangnia River.

aspects of petrography to be identified include:

1. the proportion of major components, such as carbonate grains, terrigenous grains, matrix, neomorphism materials, cement, and rock porosities
2. identification of the characters of each components,
3. texture of rocks that include fabric, sorting, grain size, and shapes. The classification is determined according to Dunham (1962) developed by Embry and Klovan (1971).

Microfacies interpretation of the limestones from the Baturaja Formation along Air Rambangnia traverse is divided according to the standard classification of microfacies from Flugel (1982) and facies zone from Wilson (1975). As a comparison, there are also references from many authors that discuss microfacies and limestone depositional environment, such as Andreeva (2008), Jones and Desrochers (1992), Kindler and Hearty (1996), Read (1985), and Tucker and Wright (1990).

Geological Review

Regional geology in-between Baturaja and Muaradua area is preceded by Pre-Tertiary rocks consisting of granite, andesite-basalt, metasediment, mélange, and metamorphic rocks. Unconformable overlying the basement rocks there are several Tertiary Formations of Kikim, Talangakar, Baturaja, Gumai, Airbenakat, Muaraenim, Ranau, Kasai, and Alluvium (Gafoer *et al*., 1986, 1993; Figure 2). Limestone of the Baturaja Formation in general was deposited in the back-reef environment behind the edge of the basin during the Early Miocene (Maryanto, 2007b). Layered limestone can be observed directly along the Air Rambangnia traverse. The rocks are generally sloping ramps to the east (Figure 3), with the total thickness of about 220 m, measurable reach including carbonate rocks from the Baturaja Formation of 196 m thick.

Volcanic rocks of the Kikim Formation are presented as a basement. It consists of volcanic breccias, volcanic sandstone, mudstone, and conglomeratic sandstone, with andesite lava insertions. The Baturaja Formation limestone unconformably overlies the Kikim Formation (Figure 4).

The lower part of Baturaja Formation was initiated by the presence of grainstone containing some pore-dissolving porosities. Furthermore, the rocks become developed onto layered wackestone-packstone that partially argillaceous with oriented fossils of mollusks (Figure 5) and algae. Several

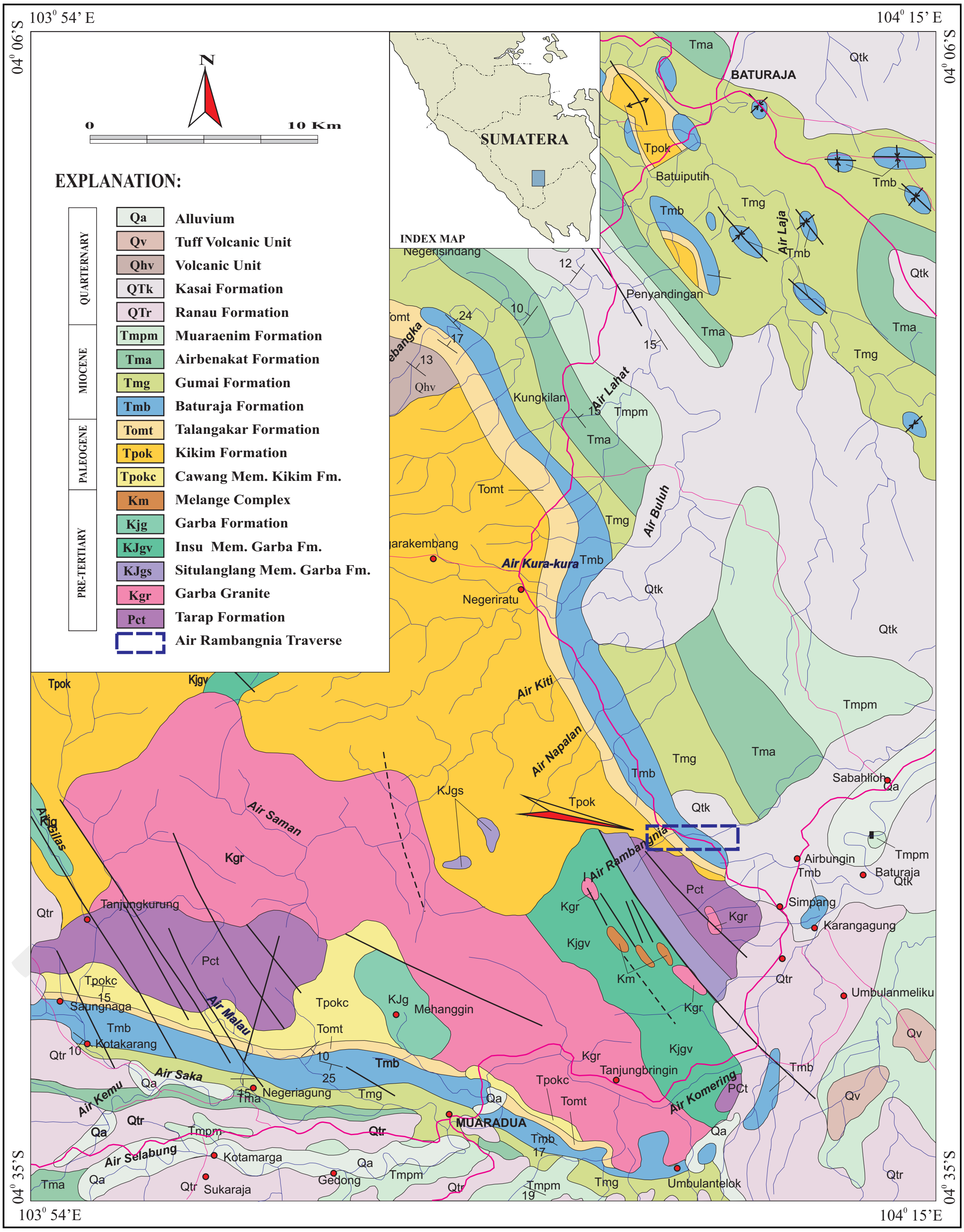

Figure 2. Geological map of Muaradua area, South Sumatra (Gafoer *et al*., 1993) and locations of Air Rambangnia traverse (Maryanto, 2007a and 2008).

floatstone intercalations are found containing some coral skeletons. Stylobed is interlayering between wackestone-packstone with marl ended the deposition of the lower part of Baturaja Formation.

The middle part of Baturaja Formation is composed of floatstone (Figure 6), of which later evolved into argillaceous wackestone. Interlayers between floatstone with wackestone-packstone

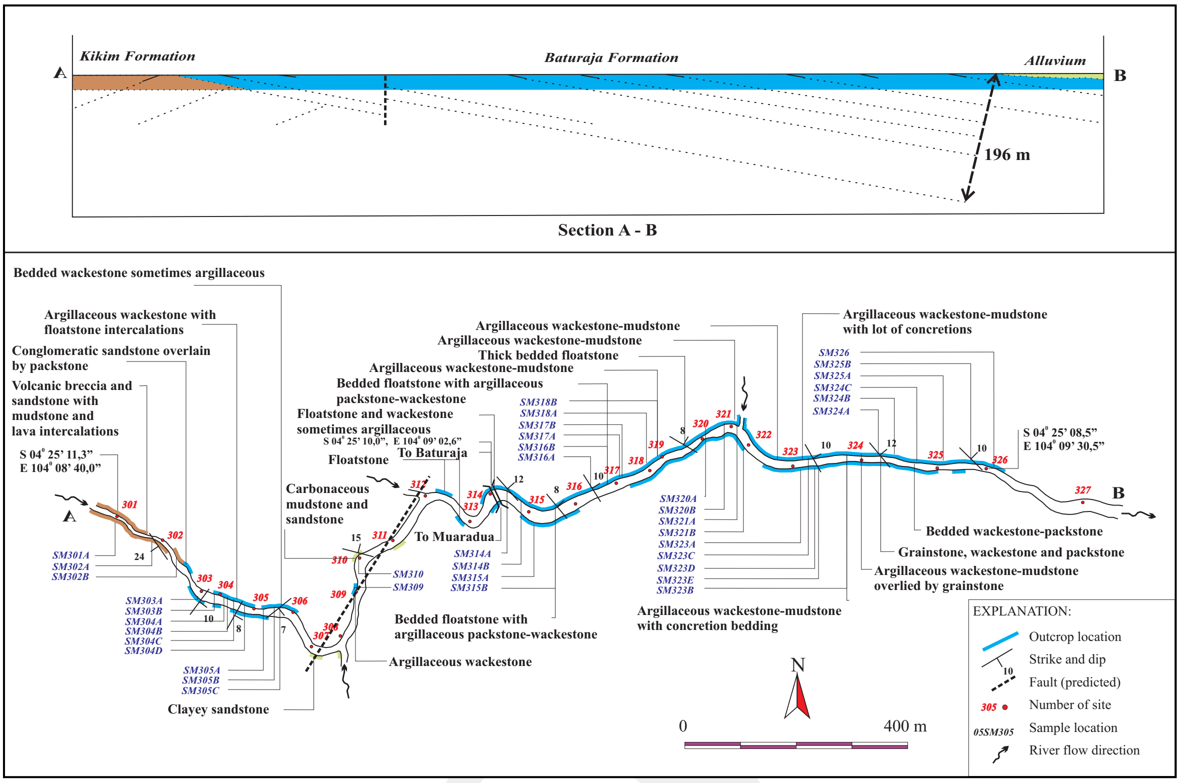

Figure 3. Detailed stratigraphic measured map along Air Rambangnia traverse (Maryanto, 2007a and 2008) and sample locations.

dominated the sequence, which are later fining upward onto sometimes argillaceous wackestone-mudstone. The next lithology is found as floatstone.

The upper part of Baturaja Formation begins with the presence of wackestone-mudstone layers. Stylobedded and or siliceous concretional bedding reaches 80 cm in size are often found in these layers (Figure 7). The concretional bedding sometimes has a parallel direction to the bedding (forming lens) and it shrinks to the upper part. The above concretional beddings are overlain by gradational and planar cross-bedding grainstones (Figure 8). Carbonate rock sequences in this traverse is ended by wackestone-packstone sometimes with dissolving porosities.

The carbonate rocks of Baturaja Formation partially do not crop out along Air Rambangnia traverse, especially between sites 306-213. Among that locations, the clastic sedimentary rocks from Muaraenim Formation are exposed in the form of claystone containing limestone boulders. The sedimentary rocks are preserved due to a tectonic strike-slip fault in N33°E direction.

Petrography

Based on a detailed petrography analysis, the limestone types recognized are wackestone, packstone, sandy packstone, grainstone, and floatstone. Each of these rocks, including the number and type of the rock components would later be used as the basis for microfacies determination (Table 1).

Wackestone

Wackestone group also includes sandy mudstone-wackestone, which is present as an intercalation. The rocks are generally massive with fine-grained fragmental bioclastic texture. Bioclast always occur and comprises diverse type, size, and amount of fossil. Nevertheless, fossil types composing the rock can be identified, such as red algae, mollusks, and foraminifera. Rarely intraclast or extraclast are preserved in the rocks, the same as the presence of pellets. Terrigenous materials are still observed in some rock samples with limited amounts, scatteredly, and uneven. They are composed of quartz, feldspar, volcanic

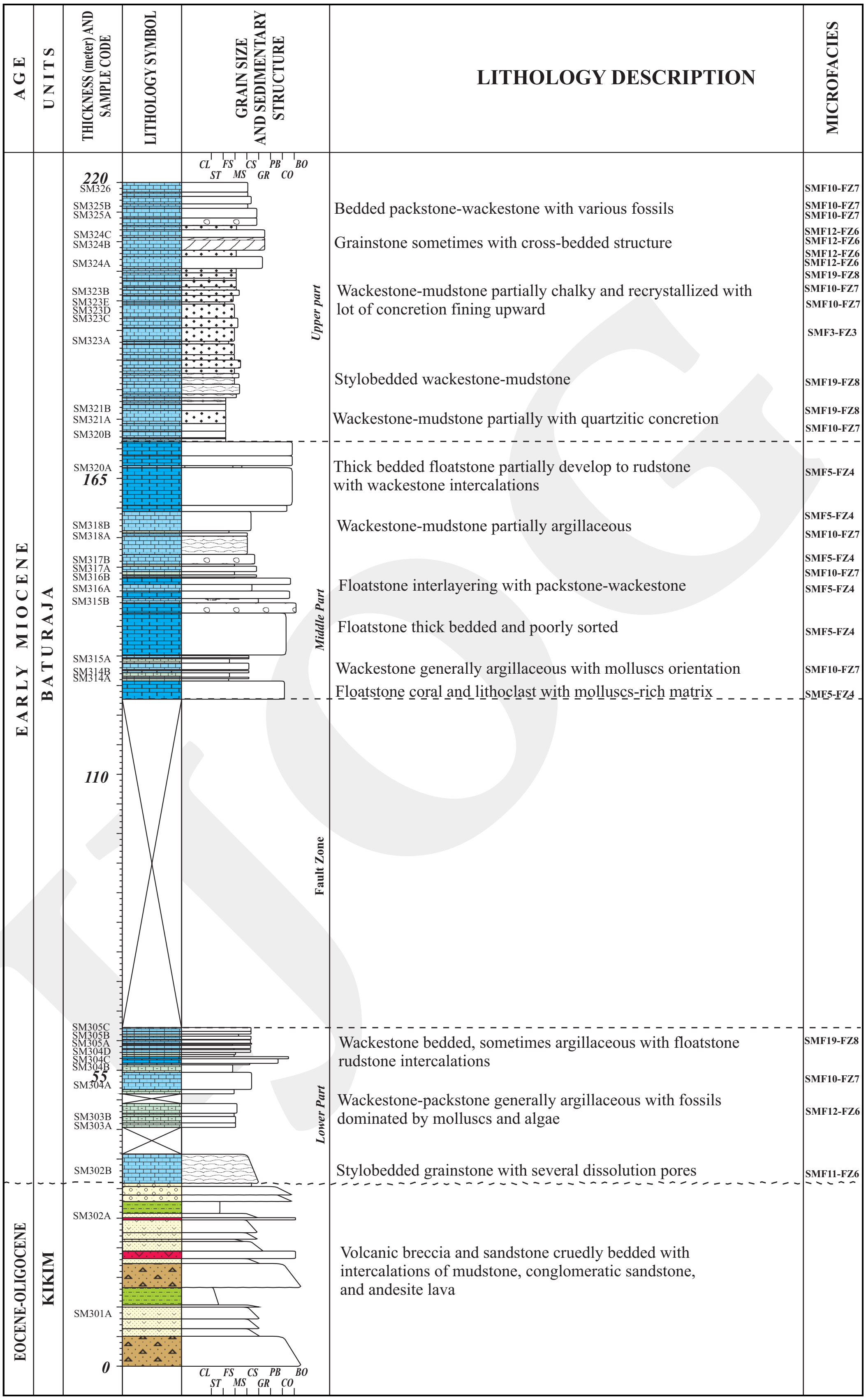

Figure 4. Detailed lithostratigraphy column along Air Rambangnia traverse, OKU Selatan, South Sumatra (Maryanto, 2007a & 2008, with modifications).

Figure 5. Massive marl contains a lot of mollusk mouldics, this point is as the lower part of the Baturaja Formation. Photographed in the 303 site of the Air Rambangnia traverse.

Figure 6. Very poorly sorted floatstone composing of the middle part of Baturaja Formation. Photographed in the 314 site of the Air Rambangnia traverse.

Figure 7. Outcrop of wackestone-mudstone containing siliceous concretions, is a constituent of the upper part of Baturaja Formation. Photographed in the 322 site of Air Rambangnia traverse.

and sedimentary rock fragments, unidentified rock fragments, phosphate, and glauconite. Carbonate mud matrix often have changed into microsparite, some even have recrystallized to form pseudosparite together with carbonate grains.

Figure 8. Grainstone overlying mudstone-wackestone, presents as a constituent of the upper part of Baturaja Formation. Photographed in the 324 site of Air Rambangnia traverse.

Clay mineral matrix in general is inseparable with carbonate mud matrix. The cement material is always present with very limited quantities, particularly as orthosparite, iron oxides, authigenic clay minerals, and silica.

Packstone

Packstone is generally massive with fine- to medium - grained fragmental bioclastic texture. Bioclast is composed of diverse type, size, and amount of fossil, however, it is predominated by red algae, mollusks, and foraminifera. Intraclast or exstraclast is present on the coarser size of limestone fragments, spread unevenly, and consists of coralline, bioclastic, and argillaceous limestones. Less amount of very fine pellet sometimes changes into microsparite. Sparsely, terrrigenous materials are still present sporadically distributed, or sometimes excessively influence the rock name to become sandy. The rock matrix is mainly preserved as carbonate mud, which often changes onto microsparite and/or is recrystallized to form pseudosparite together with carbonate grains. Cement materials are always present in the rocks as various amount of orthosparite calcite, and rarely of iron oxides.

Grainstone

Grainstone is generally massive with medium- to coarse - grained fragmental bioclastic texture. Bioclast is quite dominant consisting of various kind, size, and amount of fossil. Intraclast or extraclast is observed unevenly in some coarse-

Table 1. Petrography Analysis Summary of the Limestones from Baturaja Formation along Air Rambangnia Traverse, South Sumatra (Maryanto, 2007a)

SAMPLE CODE DESCRIPTION	SM 302B	SM 303A	SM 303B	SM 304A	SM 304C	SM 304D	SM 305A	SM 305B	SM 305C	SM 314A	SM 314B	SM 315A	SM 315B
Structure	m	m o	m	m	m	m	m f	m o f	m	m	m	m o	m
Texture	bf	bf	bf	bf	bfc	bfc	bf	bf	bf	bf	bf	bf	bf
Sorting	m	p	p	p	p	p	p	p	p	vp	p	vp	vp
Fabric	c	c	c	o	o	o	o	o	o	o	o	o	o
Av. grain size (mm)	1.80	0.70	1.40	0.30	0.20	0.20	0.20	0.80	0.20	0.80	0.80	1.20	1.80
Grain shape	sr	sr	sr	sr	sr	sr	sr	sr	sr	sr	sr	sr	sa
Grain contacts	p l c	p l c	p l c	f	f	f	f p	f	f	f p	f	f p	f p l
Percentages													
Carbonate Grains													
Green algae	-	10.67	-	-	-	-	-	-	-	-	-	-	-
Red algae	1.67	1.33	1.33	0.33	-	0.33	0.67	-	1.67	0.67	1.67	0.67	2.33
Bryozoans	4.33	-	0.67	-	0.33	-	0.67	1.00	-	0.67	2.33	1.33	1.67
Echinoderms	2.67	4.00	-	1.33	-	-	4.67	1.33	0.67	1.00	1.33	1.33	1.33
Coral	4.67	-	-	-	-	-	-	0.67	-	-	1.33	3.33	8.33
Benthic foraminifera	6.00	3.00	4.00	8.00	0.67	0.67	5.67	7.33	1.67	1.67	0.67	6.33	5.00
Planktonic foraminifera	1.33	-	-	-	-	-	1.00	-	-	-	-	0.67	0.67
Brachiopods	2.00	1.33	-	-	-	-	1.00	0.67	0.67	1.33	1.33	1.33	2.00
Moluscs	15.00	16.33	7.33	5.33	4.00	1.67	4.33	5.67	5.00	6.00	13.00	4.00	4.67
Ostracods	-	-	-	-	-	-	2.67	0.67	0.33	-	1.67	1.67	2.33
Sponge-spicules	-	-	-	-	-	-	-	-	-	-	0.67	0.67	-
Bioturbation	-	-	-	-	-	-	-	-	-	-	-	-	1.00
Unidentified fossils	8.33	6.33	24.67	2.00	9.67	9.67	5.00	3.67	3.33	5.00	5.33	6.00	3.00
Intraclasts / extraclasts	5.33	-	2.67	-	-	-	1.33	1.67	-	-	5.67	3.33	4.33
Pellet / peloids	-	-	0.67	-	-	-	-	-	-	-	-	1.33	1.00
Oolite / oncolite	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrigenous Grains													
Quartz	1.33	4.67	3.33	2.67	1.00	-	0.67	1.00	0.67	3.67	1.00	1.67	0.33
Feldspar	-	0.33	1.33	0.67	-	-	-	0.67	0.33	2.33	0.33	0.33	-
Rock fragments	1.33	6.33	10.33	2.00	1.33	-	3.00	1.67	1.33	2.00	1.33	-	-
Glauconite	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphate	-	-	-	-	-	-	-	0.67	-	1.00	-	-	-
Opaque minerals	0.67	0.67	1.33	-	-	-	0.67	0.67	-	0.67	-	1.33	-
Carbon	-	-	-	-	-	-	-	-	-	0.67	-	-	0.67
Matrix													
Carbonate mud	-	3.33	-	22.00	-	-	50.33	10.33	15.00	6.00	26.67	34.00	39.33
Clay minerals	-	32.33	4.67	-	-	-	3.00	-	-	-	-	6.00	-
Cementing Materials													
Orthosparite	9.67	-	-	0.67	-	2.00	1.67	4.00	3.00	4.00	3.33	8.00	6.33
Iron oxides	2.67	3.00	1.67	0.67	1.00	0.67	3.33	2.33	1.67	1.33	3.67	1.67	1.67
Authigenic clays	-	-	2.00	-	-	2.33	-	0.67	-	1.67	-	-	-
Silica	-	-	-	1.33	-	2.67	0.33	-	-	2.67	-	-	1.00
Neomorphisms													
Microsparite	16.33	-	-	52.33	-	-	5.67	20.33	9.00	17.00	7.33	8.00	5.67
Pseudosparite	6.33	-	26.00	-	21.67	24.00	2.00	5.00	1.00	8.33	3.33	3.00	4.00
Dolomite	7.00	-	6.00	-	59.33	51.67	-	28.00	51.33	28.33	16.00	-	-
Micritized mud	1.33	-	1.00	-	-	-	0.67	-	0.67	2.33	1.00	0.67	1.33
Pyrite	0.67	-	-	-	-	-	-	-	-	-	-	2.67	0.67
Porosities													
Intraparticle	-	-	-	-	-	-	-	-	-	-	-	-	-
Mouldic	-	1.00	-	-	-	-	-	0.67	-	-	-	-	-
Vuggy	1.33	1.67	1.00	0.67	-	4.33	1.00	1.67	2.00	1.67	1.00	0.67	1.33
Intercrystal	-	-	-	-	1.00	-	-	-	-	-	-	-	-
Shelter dan fenestrae	-	2.33	-	-	-	-	-	-	1.67	-	-	-	-
Fracture	-	1.33	-	-	-	-	0.67	0.67	-	-	-	-	-
Rock Name	G	SP	SP	W	W	W	W	W	W	W	W	W	W/F
SMF / FZ	11/6	12/6	12/6	10/7	19/8	19/8	10/7	10/7	19/8	10/7	10/7	10/7	5/4

Table 1. ....continued (Maryanto, 2007a)

SAMPLE CODE DESCRIPTION	SM 316A	SM 316B	SM 317A	SM 317B	SM 318A	SM 318B	SM 320A	SM 320B	SM 321A	SM 321B	SM 323A	SM 323B	SM 323C
Structure	m	m o	m	m	m	m	m f	m	m f	m o	m o	m p	m
Texture	bf	bf	bf	bf	bf	bf	bf	bf	bf	bf	bf	bf	bf
Sorting	vp	p	p	p	p	p	p	p	p	p	p	p	p
Fabric	c	c	c	o	c	o	c	c	o	o	o	c	o
Av. grain size (mm)	1.40	1.45	1.40	0.70	1.60	0.70	1.40	0.40	0.20	0.15	0.15	0.35	0.15
Grain shape	sr	sr	sr	sr	sr	r	sr	sr	r	sr	r	r	r
Grain contacts	p l c	p l c	p l c	f	p l c	f	p l c	p l c	f	f	f p l	p l c	f p l
Percentages													
Carbonate Grains													
Green algae	-	-	4.00	-	2.67	-	0.67	-	-	-	-	-	-
Red algae	2.33	2.33	4.33	1.33	3.67	1.00	5.33	1.67	1.67	1.67	0.67	0.67	0.67
Bryozoans	1.67	1.33	2.33	-	1.33	1.00	5.33	4.33	1.00	-	-	0.67	-
Echinoderms	1.33	1.33	1.33	1.00	1.00	1.33	1.33	1.67	1.33	1.33	5.33	2.33	4.67
Coral	4.67	2.67	5.33	4.00	4.00	2.67	2.67	1.67	-	-	-	0.67	-
Benthic foraminifera	16.33	17.00	7.00	3.33	9.67	1.67	7.67	4.33	4.67	4.00	1.33	1.33	2.33
Planktonic foraminifera	0.33	2.33	0.67	0.67	0.67	-	0.67	2.67	1.00	2.67	16.33	19.67	8.33
Brachiopods	0.67	1.33	1.00	-	2.33	0.67	1.00	2.33	1.67	-	-	4.00	1.67
Moluscs	5.67	13.67	21.67	4.67	19.33	7.67	12.33	9.67	8.00	2.33	7.33	10.33	7.33
Ostracods	0.67	1.67	0.33	-	-	0.33	-	1.00	-	-	-	3.00	2.33
Sponge-spicules	-	-	-	-	-	-	0.33	-	-	-	-	-	-
Bioturbation	1.33	-	1.00	-	0.67	-	1.33	0.67	-	-	-	-	-
Unidentified fossils	4.67	2.00	5.00	3.00	3.00	6.00	6.33	5.00	6.00	6.33	6.00	6.00	6.00
Intraclasts / extraclasts	9.33	1.33	4.00	-	3.00	-	7.33	4.00	-	-	-	2.67	-
Pellet / peloids	0.67	0.67	1.33	-	2.67	1.33	0.67	1.67	-	5.00	-	-	-
Oolite / oncolite	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrigenous Grains													
Quartz	1.33	1.67	1.00	0.67	2.00	0.33	0.67	1.67	-	0.33	1.00	1.33	0.67
Feldspar	0.67	0.67	0.67	-	0.67	-	-	0.67	-	-	0.67	-	0.67
Rock fragments	2.33	1.33	1.67	0.67	1.33	-	-	4.67	1.33	-	-	-	-
Glauconite	-	-	0.33	-	-	-	-	-	-	-	-	-	0.67
Phosphate	0.67	-	-	-	-	-	-	3.00	-	-	1.00	-	-
Opaque minerals	0.67	0.67	0.67	-	0.67	-	-	0.67	-	-	-	0.67	-
Carbon	-	0.67	-	-	-	-	-	-	-	-	-	-	-
Matrix													
Carbonate mud	23.33	13.67	10.67	10.00	9.33	10.00	13.33	9.33	9.33	10.67	5.00	22.33	28.33
Clay minerals	-	-	-	-	-	-	6.00	6.00	4.00	7.00	8.00	-	8.00
Cementing Materials													
Orthosparite	8.00	4.67	5.67	1.67	11.00	3.00	4.33	5.67	4.00	0.67	5.33	4.33	3.00
Iron oxides	1.67	2.67	1.67	0.67	1.67	1.33	1.33	3.33	1.67	1.33	1.33	3.00	1.00
Authigenic clays	0.67	-	-	-	-	0.67	1.00	1.33	-	-	-	-	-
Silica	-	-	-	-	0.67	0.67	0.67	-	-	-	-	-	-
Neomorphisms													
Microsparite	7.33	17.00	7.00	60.33	8.00	56.33	10.67	7.00	20.67	30.67	27.67	5.67	11.33
Pseudosparite	6.00	4.67	3.00	6.67	4.00	-	3.00	5.00	20.67	3.00	5.00	2.00	2.00
Dolomite	4.00	-	4.00	-	-	-	-	6.00	10.67	21.67	5.00	-	9.67
Micritized mud	-	1.33	2.67	0.67	1.00	1.00	0.67	1.67	-	0.67	-	-	-
Pyrite	0.67	-	-	-	-	-	-	-	0.67	-	-	-	0.67
Porosities													
Intraparticle	-	0.67	-	-	-	-	-	-	-	-	0.67	0.67	-
Mouldic	0.67	-	-	-	1.33	0.67	1.33	-	-	-	0.67	-	-
Vuggy	1.33	2.67	1.67	0.67	3.67	2.33	4.33	3.33	1.00	0.67	1.67	8.67	0.67
Intercrystal	-	-	-	-	-	-	-	-	0.67	-	-	-	-
Shelter dan fenestrae	-	-	-	-	0.67	-	-	-	-	-	-	-	-
Fracture	-	-	-	-	-	-	-	-	-	-	-	-	-
Rock Name	P/F	P	P	W	P	W	P	P	W	W	W	P	W
SMF / FZ	5/4	10/7	5/4	10/7	5/4	10/7	5/4	10/7	10/7	19/8	3/3	10/7	10/7

Table 1............continued (Maryanto, 2007a)

SAMPLE CODE / DESCRIPTION	SM 323D	SM 323E	SM 324A	SM 324B	SM 324C	SM 325A	SM 325B	SM 326
Structure	m	m o	m p	m	m	m	m p	m
Texture	bf	bf	bf	bf	bf	bf	bf	bf
Sorting	p	p	m	m	p	p	p	p
Fabric	c	o	c	c	c	c	c	c
Av. grain size (mm)	0.30	0.15	1.20	1.60	1.10	0.80	0.30	0.35
Grain shape	sr	sr	sr	sr	sr	sr	sr	sr
Grain contacts	p l	f p	p l c	p l c	p l c	p l c	p l c	p l c
Percentages								
Carbonate Grains								
Green algae	-	-	-	-	-	-	-	-
Red algae	5.67	4.67	5.33	3.33	4.67	4.67	4.33	2.67
Bryozoans	0.67	-	3.33	2.33	1.67	2.00	1.67	3.33
Echinoderms	4.67	5.00	10.33	9.33	6.67	3.33	2.00	4.67
Coral	-	-	2.67	1.33	3.33	4.00	3.00	3.33
Benthic foraminifera	2.67	0.67	22.00	19.67	14.00	11.33	10.33	29.00
Planktonic foraminifera	7.67	4.00	0.67	1.33	4.67	2.67	5.67	0.67
Brachiopods	2.67	2.67	2.00	1.67	4.00	2.67	2.67	2.00
Moluscs	9.33	6.33	17.00	30.33	23.00	14.00	6.33	11.33
Ostracods	2.67	2.67	-	-	0.67	1.33	1.33	0.67
Sponge-spicules	-	-	-	-	-	-	0.67	-
Bioturbation	-	-	-	-	-	-	-	-
Unidentified fossils	6.33	4.67	-	-	4.33	4.00	6.00	2.67
Intraclasts / extraclasts	4.00	-	3.67	6.00	5.33	2.33	-	3.33
Pellet / peloids	3.33	6.00	0.67	0.67	0.67	0.67	-	1.00
Oolite / oncolite	-	-	-	-	-	-	-	-
Terrigenous Grains								
Quartz	-	1.00	0.67	0.67	1.00	1.33	1.00	0.67
Feldspar	-	-	-	-	-	-	0.33	-
Rock fragments	-	-	-	0.67	1.33	-	-	-
Glauconite	0.67	-	-	1.00	0.67	0.67	-	-
Phosphate	0.67	0.33	-	0.33	-	-	-	0.67
Opaque minerals	-	-	-	-	-	0.67	-	1.33
Carbon	-	-	-	-	-	1.00	-	-
Matrix								
Carbonate mud	9.33	17.33	-	-	-	6.00	12.33	12.67
Clay minerals	5.00	4.00	-	-	-	-	5.00	5.67
Cementing Materials								
Orthosparite	2.67	1.00	14.00	7.67	9.00	4.33	4.67	3.33
Iron oxides	1.33	1.67	1.67	1.33	1.33	1.33	6.00	2.67
Authigenic clays	-	-	1.33	1.00	0.67	1.00	-	-
Silica	13.00	6.67	-	-	-	0.67	-	-
Neomorphisms								
Microsparite	6.00	5.67	-	-	-	15.00	5.33	6.33
Pseudosparite	3.00	3.33	6.00	6.67	3.00	4.00	-	3.00
Dolomite	7.33	14.00	-	-	6.00	8.00	7.67	4.00
Micritized mud	-	-	3.00	1.00	2.00	0.67	2.67	2.67
Pyrite	-	-	-	-	-	-	-	0.67
Porosities								
Intraparticle	-	0.67	-	0.67	0.33	-	0.67	0.67
Mouldic	-	1.67	-	0.67	-	-	-	-
Vuggy	1.33	3.33	5.67	2.33	1.67	2.33	10.33	1.00
Intercrystal	-	-	-	-	-	-	-	-
Shelter dan fenestrae	-	2.67	-	-	-	-	-	-
Fracture	-	-	-	-	-	-	-	-
Rock Name	P	W	G	G	G	P	P	P
SMF / FZ	10/7	19/8	12/6	12/6	12/6	10/7	10/7	10/7

EXPLANATION

Structure:
m = massive
o = with grain orientation
p = with several pores
f = with joints and fractures

Texture:
bf = bioclastic fragmenter
cf = clastic fragmenter
nc = non-clactic
c = crystalline

Sorting:
vw = very well sorted
w = well sorted
m = moderately sorted
p = poorly sorted
vp = very poorly sorted

Fabric:
c = closed
o = opened

Grain shape:
va = very angular
a = angular
sa = sub-angular
sr = sub-rounded
r = rounded
wr = well rounded

Grain contact:
f = floating
p = point
l = long
c = concave-convex
s = sutured

Rock name:
BW = Wackestone
BW/F = Wackestone/floatstone
BP = Packstone
BP/F = Packstone/floatstone
BG = Grainstone
SBP = Sandy packstone

Microfacies:
SMF = Standard microfacies (Flugel, 1982)
FZ = Facies zone (Wilson,1975)

sized rocks, and consists of coralline, bioclastic, and argillaceous limestones. Pellet is very rarely preserved. A less amount of terrigenous materials are present evenly at the upper part of stratigraphic sequences. They are composed of quartz, feldspar, volcanic and argillaceous, metamorphic, and unidentified rock fragments, very rarely glauconite, phosphate, mica, and opaque minerals. Cement materials are always present in the rocks with a diverse number as orthosparite, iron oxides, authigenic clays, and silica. Most orthosparite is present from phreatic meteoric environment, followed by marine and burial environments. Small amount of iron oxides fills cavities and fractures in the rock. Authigenic clay minerals are preserved as pore-cavity filler. Silica in the form of quartz, feldspar, and zeolite are preserved from the phreatic meteoric environment after cementation by the orthosparite calcite.

Floatstone

Floatstone is generally massive with coarse-grained fragmental bioclastic texture, both with closed fabric or opened fabric. Bioclast is made up of diverse type, size, and amount of fossil. Intraclast or extraclast is sporadically distributed in a few samples, and is composed of coralline, bioclastic, and argillaceous limestones. Terrigenous materials are preserved in a limited number and spread out unevenly. Carbonate mud matrix often has changed into microsparite. Cement materials are present limitedly within inter and intra particle pores.

Microfacies Interpretation

Wackestone generally has an inversion texture, *i.e.* coarse grains stuck in carbonate mud matrix, well washed grains, and has various fossils. Such limestone was generally deposited in back reef down-slope (SMF10-FZ7). Limestone facies type resides in this deposition environment including argillaceous-rich limestone to some packstone.

In addition to being in the back reef down-slope, wackestone may also be formed in very restricted bays and ponds (SMF19-FZ8). Special characteristic of the limestone deposited in this depositional environment is the presence of fenestrae porosity type, as a result of a tidal activity (Tucker and Wright, 1990).

Coarse-grained packstone can be deposited in another deposition environment. In some cases, packstone can develop into grainstone with the bioclast composed as well of coated and worn red algae. This rock was usually deposited in slopes and shelf edges (SMF12-FZ6). Abrading and leaching of carbonate grains mark the grainstone was deposited in winnowed platform edge sands (SMF11-FZ6).

Packstone can be interpreted as reef-flank facies (SMF5-FZ4), characterized by the presence of bioclasts mostly derived from the reef dwellers and reef builders, such as coral and bryozoa reefs (Read, 1985). Packstone and sometimes floatstone with large amount of carbonate mud matrix is interpreted as reef-flank deposits.

This microfacies interpretation can be done to each limestone sample petrography tested. The interpretation microfacies result can be used to trace back the development of facies deposition of a limestone formation, in this case is the Baturaja Formation along the Air Rambangnia traverse.

Discussion

Based on petrographic data (Table 1), the character of each sample can be known and traced to order their stratigraphy. The volcanic rocks of Kikim Formation are deposited unconformably on the limestone of Baturaja Formation, while clastic sedimentary rock of Talangakar Formation is not exposed in this traverse (Sukandi *et al.*, 2006). The lowest part of the Baturaja Formation preceded by grainstone was deposited in the winnowed platform carbonates, which is above the wave base (SMF11-FZ6). This area is very close to the beach characterized by the presence of argillaceous material from the transgression phase (Andreeva, 2008), making it into the bay or pond (SMF19-FZ8). The depositional environment of the limestones repeated from very restricted pond and bay (SMF19-FZ8; Figure 9) to back-reef local slope (SMF10-FZ7; Figure 10) is due to regressive and transgressive phases. These depositional environments are characterized by the presence

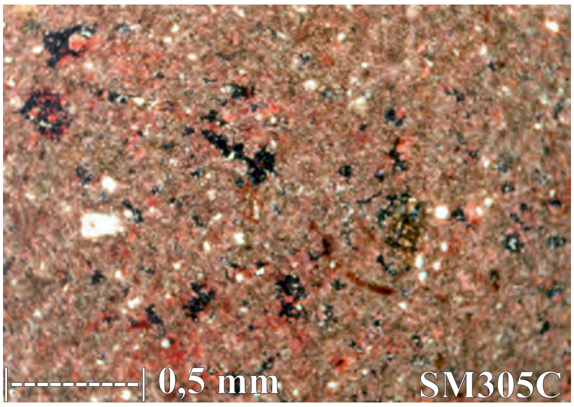

Figure 9. Photomicrograph of wackestone (sample code SM305C) with very fine - grained size, characterizing the SMF19-FZ8 on very restricted bay or pond.

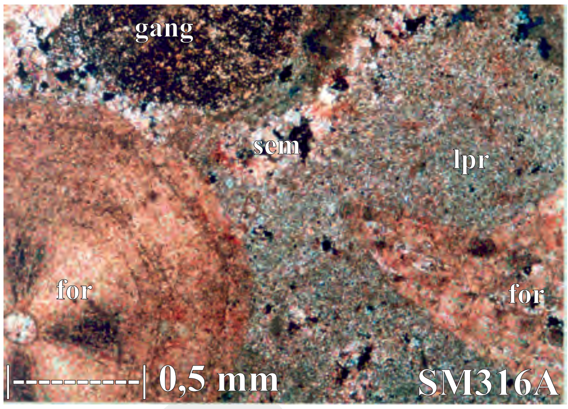

Figure 11. Photomicrograph of packstone/floatstone (sample code SM316A) with various bioclasts of red algae (gang) and large foraminifera (for) distributed in carbonate mud matrix (lpr), typifies the SMF5-FZ4 reef-flank area.

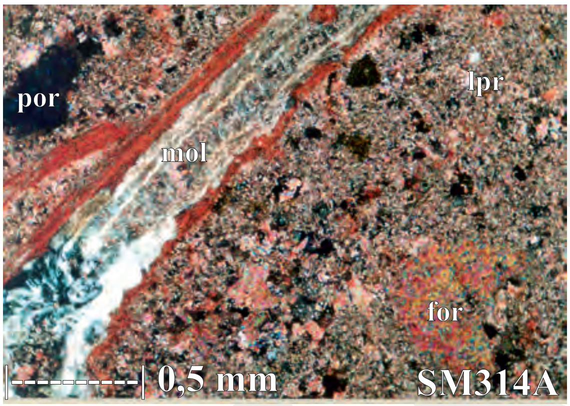

Figure 10. Photomicrograph of wackestone (sample code SM314A) with bioclasts of mollusks (mol) and large foraminifera (for) distributed in carbonate mud matrix (lpr) characterizing the SMF10-FZ7 on back-reef down-slope.

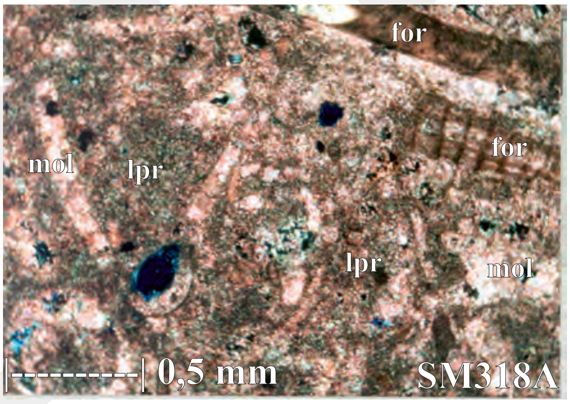

Figure 12. Photomicrograph of packstone (sample code SM318A) with various bioclasts of mollusks (mol) and large foraminifera (for) distributed in carbonate mud matrix (lpr), characterizing the SMF5-FZ4 on reef-flank area.

of wackestone-packstone interlayers some parts of argillaceous and with floatstone intercalation.

Regression process affects sedimentation in the middle part of Baturaja Formation, initiated by floatstone from reef-flank facies (SMF5-FZ4; Figure 11 and 12). The middle part of the Baturaja Formation is dominated by limestones from that depositional environment. The depositional environment repeated alternation with back-reef local slope facies (SMF10-FZ7; Wilson, 1975) and their lithology composed of wackestone-packstone.

The lithology from the back-reef local slope (SMF10-FZ7) continued until the upper part of the formation, and it was preceded by the presence of wackestone-mudstone. Regressive phase led the depositional environment to evolve into the very restricted bay or pond (SMF19-FZ8; Flugel, 1982). Furthermore, transgressive phase led to become the depositional environment of slopes and shelf edges (SMF12-FZ6; Andreeva, 2008; Figure 13) composed of grainstone with graded and planar cross-bedded structures (Bathurst, 1975; Kendall, 2005). Finally, the lithology sequence ended by the presence of wackestone-packstone deposited at back-reef local slope (SMF10-FZ7; Jones and Desrochers, 1992; Figure 14).

Paleogeographically, the reef complex is located in the east of the researched area, thus the highland is being in the west part (Maryanto, 2005). The Baturaja limestones were deposited, with the influence of a regional transgression, on the Late Oligocene age. The development of depositional environment between time forming

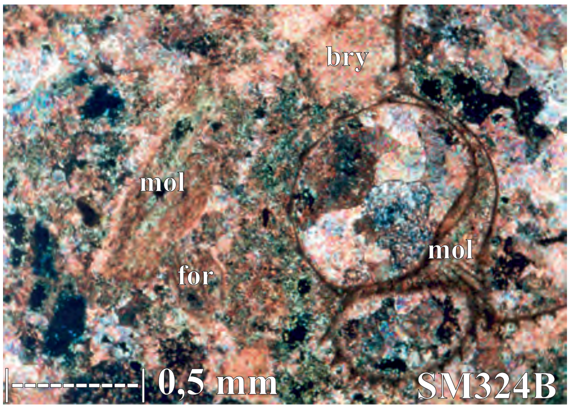

Figure 13. Photomicrograph of grainstone (sample code SM324B) with various bioclasts of mollusks (mol), large foraminifera (for), and bryozoans (bry) in carbonate cement, characterizing the SMF12-FZ6 on slope or shelf edge.

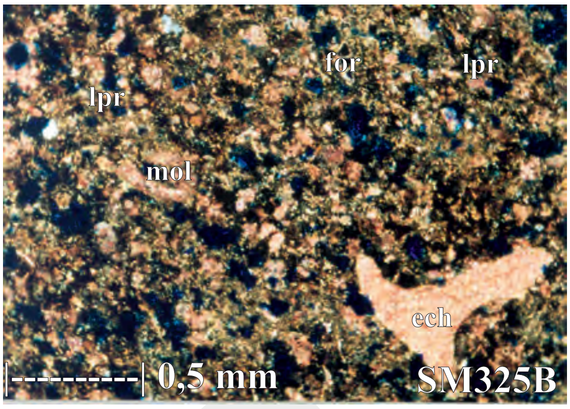

Figure 14. Photomicrograph of packstone (sample code SM325B) with abraded bioclasts of mollusks (mol), large foraminifera (for), and echinoderms (ech) distributed in carbonate mud matrix, characterizing the SMF10-FZ7 on the back-reef down-slope.

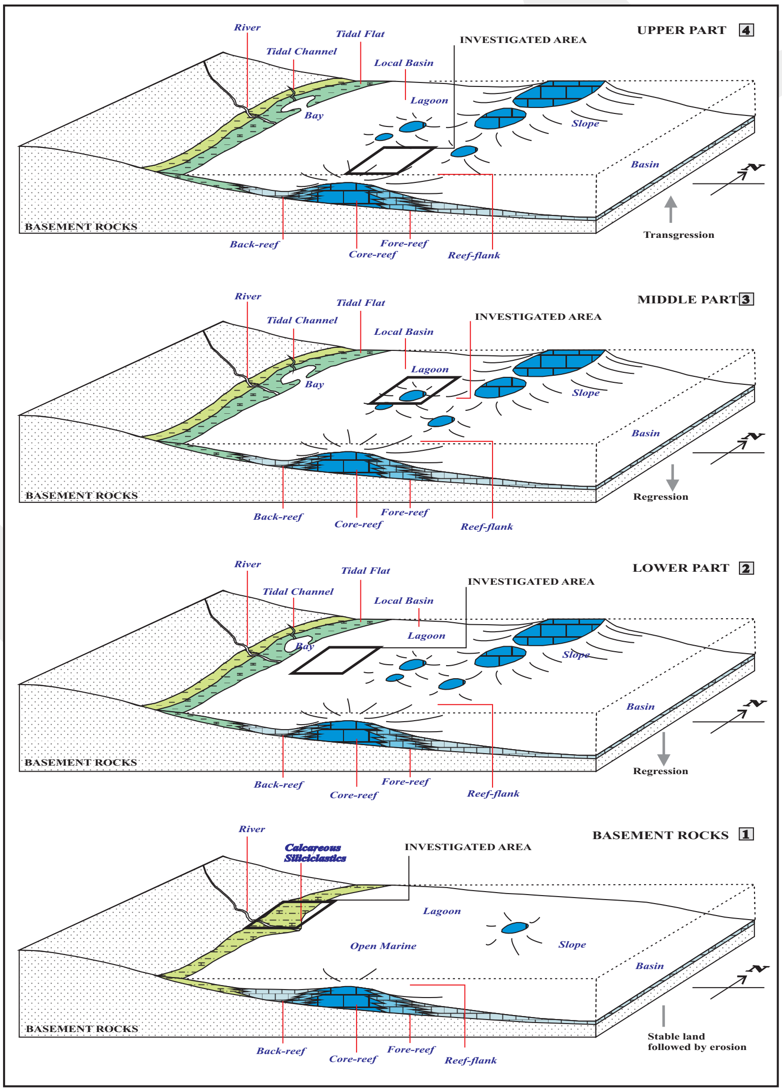

Figure 15. Depositional environment development of the Baturaja limestones along Air Rambangnia traverse, OKU Selatan, South Sumatra.

Baturaja Formation is shown in the Figure 15. Depositional environment of the Baturaja Formation varies from very restricted bay or pond area (SMF19-FZ8), back-reef local slope (SMF10-FZ7), slope and shelf edge (SMF12-FZ6), winnowed platform edge sands (SMF11-FZ6), and reef-flank facies (SMF5-FZ4). In general, the depositional environment is conditioned existence of transgression, characterized by changes in the position of microfacies that increasingly moved away from bay or pond and going onto the reef-flank facies. Depositional phase was still ongoing until the Early Miocene (Maryanto 2007a), which would later be crushed by the Gumai Formation.

Depositional environment forming the Baturaja Formation along Air Rambangnia traverse has never been the deep sea or the fore-reef area. The position of the fore-reef area is predicted to be far away to east-southeast from the researched area. The research area is located at the volcanic back arc basin, at the basin edge bordering the land area, which at that time was occupied by the Pre-Tertiary rocks, now known as Garba Mountains.

Conclusion

Petrographic analysis was carried out upon thirty four limestone samples taken from Air Rambangnia traverse, OKU Selatan, South Sumatera. It shows out that limestones consist of wackestone, packstone, grainstone, and floatstone.

Stratigraphically, each of the rocks studied repeatedly occurs, but generally they developed in a transgressive depositional environment. The depositional environment is diverse ranging from restricted bay or pond, back-reef local slope, slope or shelf edge, winnowed platform edge sand, and reef-flank facies.

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References

Andreeva, P., 2008. Microfacies Analysis of Middle Devonian (Eifelian) Carbonate Rocks from Deep Wells in North-Eastern Bulgaria (Preliminary Results). *Geologie Sedimentologie,* 61 (10), p.1309-1314.

Bathurst, R.G.C., 1975. *Carbonate Sediments and Their Diagenesis, Second Enlarged Edition.* Elsevier Scientific Publishing Company. New York, Amsterdam, Oxford, 658 pp.

Bishop, M.G., 2000a. South Sumatra Basin Province, Indonesia: The Lahat/ Talangakar Cenozoic Total Petroleum System. Open file report 99-50S US Geological Survey. http://geology.cr.usgs.gov/energy/WorldEnergy/OF99-50S/occurrence.html [27/03/2006].

Bishop, M.G., 2000b. Petroleum System of the Northerst Java Province and Offshore Southeast Sumatra, Indonesia. Open file report 99-50R US Geological Survey. http://geology.cr.usgs.gov/energy/World Energy/OF99-50R/index.html > (13/06/2006).

Dunham, R.J., 1962. Classification of Carbonate Rocks According to Depositional Textures. *In*: Ham, W.E. (ed.), Classification of Carbonate Rocks. *American Association of Petroleum Geologists, Memoir* 1, p.108-121.

Embry, A.F. and Klovan, J.E., 1971. A Late Devonian Reef Tract on North-Eastern Banks Island, North West Territory. *Bulletin of Canadian Petroleum Geology,* 19, p. 730-781.

Flugel, E., 1982. *Microfacies Analysis of Limestones*. Springer-Verlag. Berlin, Heidelberg, New York, 633pp.

Gafoer, S., Amin, T.C., and Poernomo, J., 1986. *Geological Map of Lahat Quadrangle, Sumatra, scale 1 : 250.000*. Geological Research and Development Centre, Bandung.

Gafoer, S., Amin, T.C., and Pardede, R., 1993. *Geological Map of Baturaja Quadrangle, Sumatra, Scale 1 : 250.000.* Geological Research and Development Centre, Bandung.

Jones, B. and Desrochers, A., 1992. Shallow Platform Carbonates. *In*: Walker, R.G. and James, N.P. (eds), Facies Models, Response to Sea Level Change. *Geological Association of Canada Bulletin,* p.277 - 301.

Kendall C.G.St.C., 2005. Carbonate Petrology. *In*: Kendall C.G.St.C. and Alnaji, N.S. (developers). *USC Sequence Stratigraphy.*http://strata.geol.sc.edu/ seqstrat.html [27/02/2006].

Kindler, P. and Hearty, P.J., 1996. Carbonate Petrography as an Indicator of Climate and Sea-Level Changes: New Data from Bahamian Quaternary Units. *Sedimentologi,* 43, p.381-399.

Maryanto, S., 2005. Sedimentologi Batuan Karbonat Tersier Formasi Baturaja di Lintasan Air Napalan, Baturaja, Sumatera Selatan. *Jurnal Sumber Daya Geologi,* 15, p.83-101.

Maryanto, S., 2007a. *Keterkaitan Hubungan Antar Variabel Microfacies Batugamping Bioclastic dari Formasi Baturaja di daerah Sekitar Muaradua, Sumatra Selatan*. Tesis S2 Program Pascasarjana Universitas Padjadjaran, Bandung, tidak terbit.

Maryanto, S., 2007b. Petrografi dan Proses Diagenesis Batugamping Formasi Baturaja di Lintasan Air Saka, OKU Selatan, Sumatera Selatan. *Jurnal Sumber Daya Geologi,* 17 (1), p.13-31.

Maryanto, S., 2008. Hubungan Antarkomponen Microfacies Lereng Terumbu dan Cekungan Lokal Terumbu Belakang Batugamping Formasi Baturaja di Daerah sekitar Muaradua, Sumatera Selatan. *Jurnal Sumber Daya Geologi,* 18 (2), p.107-120.

Read, J.F., 1985. Carbonate Platform Facies Models. *American Association of Petroleum Geologists, Bulletin,* 69, p.1-21.

Sukandi, U., Maryanto, S., Amar, Heriyanto, and Krisnawan, D., 2006. Pengambilan Sampel Batuan untuk Pembuatan Material Acuan Standar Petrologi. *Laporan Teknis Intern,* Pusat Survei Geologi, Bandung, tidak terbit, 228pp.

Tucker, M.E. and Wright, V.P., 1990. *Carbonate Sedimentology*. Blackwell Scientific Publications. Oxford, London, Edinburg, Cambridge, 482pp.

Wilson, J.L. 1975. *Carbonate Facies in Geologic History*. Springer-Verlag. New York, Heidelberg, Berlin, 471pp.

Wilson, M.E.J. and Rosen, B.R., 1998. Implications of Paucity of Corals in the Paleogene of SE Asia: Plate Tectonics or Centre of Origin? *In*: Hall, R. and Holloway, J.D. (eds.). *Biogeography and Geological Evolution of SE Asia*, p.165-195.