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Paleotemperature of Middle Eocene Tonasa Limestone based on Foraminifera at Palakka Area South Sulawesi

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ABSTRACT

The research area is located in Palakka area, Barru Regency of South Sulawesi. The aim of this research is to interpret paleotemperature deposition of the Tonasa Limestone especially marl based on small bentonic foraminifera. The reseach method used in this study is measuring section at Palakka River and Pange River and identification and determination of foraminifera species under binoculer microscopic. The research area consists of interbedded mudstone and bioclastic limestone, and based on abundant of foraminifera the depositional environment was Inner Neritic to Middle Neritic of Middle Eocene (P11) and sea water temperature indicate warm water. Sea temperature changes may be affected by sea level change and other activities such as global climate changes, local tectonic, and oceanic current, which impact on the presence and abundance of foraminifera.

Keywords: Palakka area, Paleotemperature, Measuring section, Neritic, Warm water

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1. INTRODUCTION

Study area is located in Palakka area , Barru Regency, South Sulawesi (Figure 1). The area is widely covered by Tonasa Limestone which consists of interbedded limestone and marl. In generally, study on Tonasa Limestone particularly in Barru area has been conducted by many workers such as the regional geology of the area in regional scale (Figure 2) [1]. The evolution and hydrocarbon potential of limestones and marl facies redeposite particularly in the Barru area [2] dan [3]. In addition, the Paleoceanography in Middle Eosen of Tonasa limestone in Barru area from north to the south was most shelf seas to normal marine lagoons [4]. The occurence of Tonasa Limestone is very significant to study about the paleotemperature which provide an important information regarding the global warming as well as tectonic evolution of the island and Indonesian regioan as a whole. However, despite the wide distribution of this formation, no detailed research about paleotemperature of Tonasa Formation in this area. This study report the paleotemperature of Tonasa Limestone based on Foraminifera in marl layer to determine the paleoenvironment condition particulalry depositional environment and temperature of sea water when the rock was formed.

Figure 1. Location map of Barru area

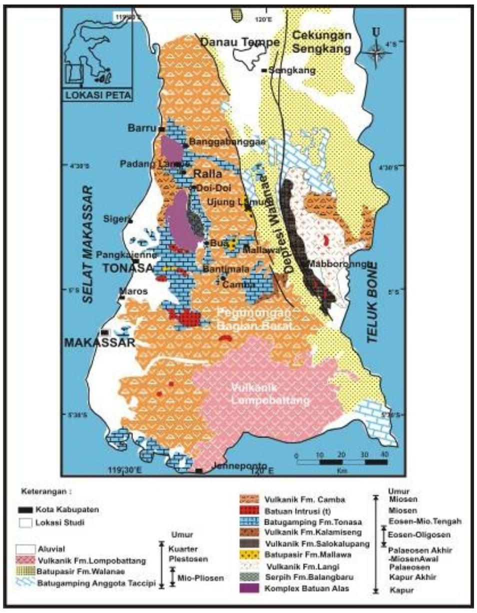

Figure 2. Geological map of Sulawesi (Wilson & Bosence, 1996: modifikasi dari Sukamto, 1982, Sukamto dan Supriatna, 1982)

2. Methods

Research methods are devided into four stages, including; (a) collecting data by using measuring section; (b) sample preparation in Paleontological laboratory by observation of species foraminifera under binocular microscope; (c) Identification and determination of species based on [5] and [6], and (d) Analyzing and interpretation data by using Natland(1933) in [7], [8], and [9].

3. Results

Measuring Section was conducted in two sections, namely Palakka River section and Pange River section.

A. Palakka River Section *:*

Palakka River located in Palakka Village. Length of section is 30.84 meters and strike/dip of bedding is N 355° E / 350° (Figure 3). Benthic foraminifera were found in this section :

Layer 1 – 15 : Cibicides sp., Cibicides lobatus (d’ Orbigny), Ellipsoglandulina labiata (Schwager), Ellipsoglandulina sp., Ellipsoidina abbreviata Seguenza, Nodosarella salmorjraghii Martinotti, Nodosarella subnodosa (Guppy), Bulimina sp., Nodosarella sp., Lagena flintiana Cushman, Lagena trinitatensis Nuttall, Lagena alveolata H.B. Brady, Discorbis sp., Nodogerina sp., Cibicides mantaensis (Galloway and Morray), Textularia sp., Cassidulina sp., and Cassidulina tricamerata Galloway and Heminway.

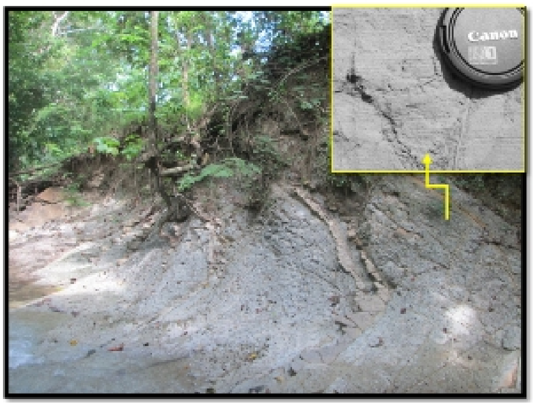

Figure 3. Interbedded marl and thin layers limestone in Palakka River.

Based on benthic foraminifera occurence and compared to the depositional environment classification according to [8] it can be concluded that the layers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 and 15 deposited on the inner neritic to middle neritic with depth 0 to 90 meters, similarly to zones I and II in the classification of Natland (1933) [7] with temperature 0° C – 27° C. Temperature and depth are in *the warm water* condition. While 13 and 14 layers deposited on the middle neritic environment that is at a depth of 30 to 90 meters, analogous to zones I and II in the classification of Natland, 1933 [7] with a temperature of 0°C - 27°C. Temperature is *warm water* condition in the Tropical climate [9].

B. Pange River Section.

The second section located on Pange River around ± 7 km to the east of the Barru city, with a length 27.73 meters and strike/dip of bedding is N 345°E / 300° (Figure 4).

In Pange River section benthic foraminifera were found on layer 1 -12, as follows : *Cibicides* sp., *Ellipsoglandulina labiata* (Schwager), *Nodosarella* sp., *Nodosarella salmorjraghii* Martinotti, *Nodosarella subnodosa* (Guppy), *Lagena flintiana* Cushman, *Nodogerina* sp., *Nodosaria obligua* (Linne), *Cibicides mantaensis* (Galloway and Morrey), *Elphidium* sp.

Figure 4. Interbedded marl and thin layer limestone

Based on presence and abundance of benthic foraminifera which compared to the depositional environment classification [8], it can be concluded that the layers 1, 2, 3, 4, 7 and

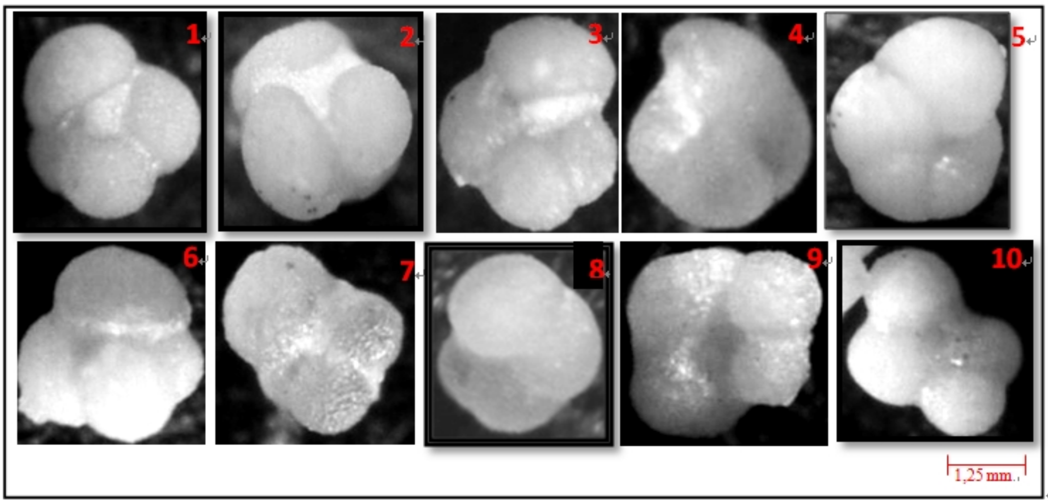

Figure 5. Planktonic foraminifera assemblages in Palakka and Pange Rivers

Table 1. Relative age of marl based on planktonik foraminifera

E O C E N E									NAMA FOSIL
LOWER		MIDDLE				UPPER			
									Globigerapsis kugleri BOLLI, LOEBLICH and TAPPAN
									Globigerina boweri BOLLI
									Globorotalia bullbrooki BOLLI
									Globigerina senni (BECKMANN)
									Globigerapsis index (FINLAY)
									Globigerina yeguaensis WEINZIERL and APPLIN
									Globorotalia centralis CUSHMAN and BERMUDEZ
									Clavigerinella jarvisi (CUSHMAN)
									Globorotalia aragonensis NUTTAL
									Globorotalia bolivariana (PETTERS)
P8	P9	P10	P11	P12	P13	P14	P15	P16	

12 deposited on the inner neritic to middle neritic a depth of 0 to 90 meters, analogous to zone I and II in the classification of Natland, 1933 [7], with a temperature 0°C - 27°C. Temperature and depth are included in the warm water condition.

The layers 5, 6, 8 and 9 deposited on the inner neritic environment that is at a depth of 0 to 30 meters, analogous to zones I and II in the classification of Natland, 1933 [7] with a temperature is 0°C - 27°C. Temperature and depth are included in the warm water condition. The layers 10 and 11 deposited on the middle neritic environment that is at a depth is 30 to 90 meters, analogous to zones I and II in the classification of Natland, 1933 [7] with a temperature is 0°C - 27°C. Temperature and depth are included in the warm water condition.

Globigerina yeguaensis WEINZIER and APPLIN (2) Globigerapsis index (FINLAY) (3) Globorotalia bolivariana (PETTERS) (4) Globorotalia aragoensis NUTTAL (5) Globorotalia centralis CUSHMAN and BERMUDEZ (6) Globigerapsis kugleri BOLLI, LOEBLICH and TAPPAN (7) Globigerina boweri BOLLI (8) Globorotalia bullbrooki BOLLI (9) Globigerina senni (BECKMANN) (10) Clavigerinella jarvisi (CUSHMAN).

Range chart above shows that the age of marl is lower part of Middle Eocene (P1) [5].

4. Discussion

Based on the age determination of foraminifera planktonic in the study area, marl unit was deposited in lower part of Middle Eosen (P11), indicated that the marl is a lower part of Tonasa Formation. Benthic analysis result of carbonate rock of northern part of Tonasa Formation showed that they were deposited in middle – outer neritic or most shelf sea [4]. Meanwhile, the carbonate sediments in the South Barru formed in shallow ocean water conditions are relatively stable, which is known as Tonasa Formation [3]. Therefore, the result of this study show that both northern and southern part of Tonasa Formation in Barru area were developed in shallow marine condition.

This study shows that marl in P11 from Palakka and Pange Rivers was deposited in inner –

middle neritic, indicated that the reasearch area is the most nothern part of carbonate rock in Barru area which was deposited near from continent.

Some of the results of the paleoenvironmental analysis of several layers of marl based on environtmental classification based on foraminifera [8] are as below:

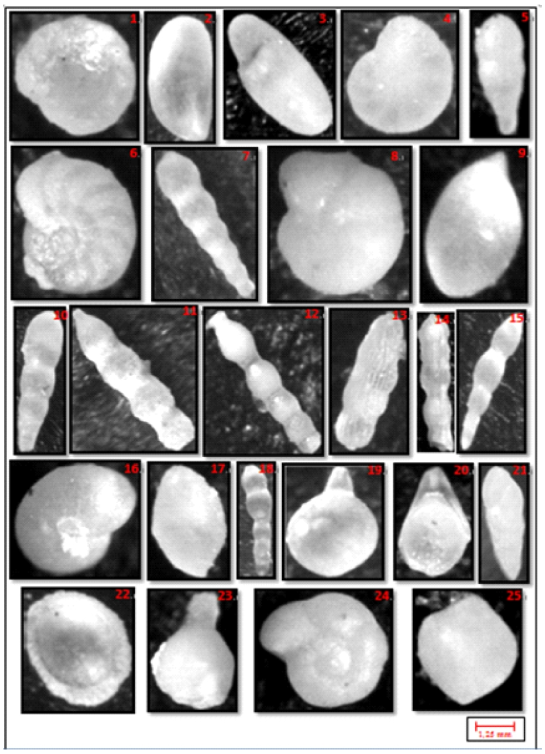

Figure 6. Benthic foraminifera assemblages in Palakka River and Pange River.

5. CONCLUSIONS

The results of field data and laboratory observation of each layer showed that the sea water paleotemperatur of Tonasa Formation particularly marl unit based on identified fossil benthic foraminifera such as *Cibicides* sp., and *Elphidium* sp., were deposited in the Inner zone neritik - Middle neritik, with a depth of 0-90 meters. It was also shown that the foraminifera lived at temperature 0°C - 27°C suggesting warm water condition.

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Tabel 2. Paleoenvironment of benthic foraminifera of Palakka River (layers 1 – 12)

Layer	River	Transition: Marsh	Transition: Marine	Transition: Fluvial	Transition: Beach	Neritic: Inner 0- 30 m	Neritic: Middle 30-91 m	Neritic: Outer 91-183 m	Bathyal: Upper 183-457 m	Bathyal: Middle 457-915 m	Bathyal: Lower 915-1828 m	Abbysal 1828-4876 m	Hadal > 4876 m	Fosil Contents	%
1														*Cibicides* sp.	15
														Ellipsoglandulina labiata (Schwager)	10
														Nodosarella salmorjraghii Martinotti	13
														Nodosarella subnodosa (Guppy)	3
														Ellipsoidina abbreviata Seguenza	3
2														*Cibicides* sp.	3
														Nodosarella salmorjraghii Martinotti	6
														Nodosarella sp.	4
														Nodosarella subnodosa (Guppy)	5
3														*Cibicides* sp.	3
														Ellipsoglandulina labiata (Schwager)	4
														Nodosarella salmorjraghii Martinotti	6
														Discorbis sp.	1
														Nodosarella subnodosa (Guppy)	2
														Lagena flintiana Cushman	2
4														*Cibicides* sp.	9
														Ellipsoglandulina labiata (Schwager)	5
														Nodosarella sp.	2
														Nodosarella subnodosa (Guppy)	2
														Cibicides mantaensis (Galloway and Morray)	2
														Textularia sp.	2
5														*Ellipsoglandulina labiata* (Schwager)	8
														Nodosarella salmorjraghii Martinotti	2
														Cibicides sp.	5
														Ellipsoglandulina sp.	4
														Nodosarella sp.	2
														Nodosarella subnodosa (Guppy)	2
														Cibicides mantaensis (Galloway and Morray)	2
														Textularia sp.	6
														Ellipsoglandulina sp.	2
6														*Nodosarella* sp.	4
														Nodosarella salmorjraghii Martinotti	6
														Ellipsoglandulina labiata (Schwager)	4
														Cibicides sp.	2
														Cibicides s p.	4
7														*Nodosarella* sp.	7
														Cibicides lobatus (d' Orbigny)	2
														Cassidulina sp.	2
														Lagena trinitatensis Nuttall	3
8														*Nodosarella salmorjraghii* Martinotti	4
														Nodosarella sp.	7
														Nodosarella subnodosa (Guppy)	5
														Ellipsoglandulina sp.	2
														Ellipsoglandulina labiata (Schwager)	2
9														*Nodosarella salmorjraghii* Martinotti	2
														Nodosarella sp.	3
														Nodosarella subnodosa (Guppy)	2
														Cibicides sp.	3
10														*Nodosarella* sp.	4
														Nodogerina sp.	3
11														*Cassidulina tricamerata* Galloway and Heminway	2
														Cassidulina sp.	2
														Nodosarella salmorjraghii Martinotti	5
														Nodosarella sp.	11
12														*Ellipsoglandulina labiata* (Schwager)	3
														Cibicides sp.	3
														Nodosarella salmorjraghii Martinotti	2
														Lagena alveolata H.B. Brady	2

Tabel 3. Paleoenvironment of benthic foraminifera of Pange River (layers 1 – 4)

Layer	River	Transition				Neritic			Bathyal			Abbysal	Hadal	Fosil Contents	%
		Marsh	Marine	Fluvial	Beach	Inner	Middle	Outer	Upper	Middle	Lower				
						0 - 30 m	30-91 m	91-183 m	183-457 m	457-915 m	915-1828 m	1828-4876 m	> 4876 m		
1														*Ellipsoglandulina labiata* (Schwager)	7
														Nodosarella salmorjraghii Martinotti	3
														Nodosarella subnodosa (Guppy)	3
2														*Cibicides* sp.	3
														Nodosarella salmorjraghii Martinotti	3
														Nodosarella sp.	5
														Nodosarella subnodosa (Guppy)	4
														Lagena flintiana Cushman	3
3														*Cibicides* sp.	8
														Nodosarella salmorjraghii Martinotti	10
														Nodosarella subnodosa (Guppy)	7
														Nodogerina sp.	5
														Ellipsoglandulina labiata (Schwager)	6
4														*Cibicides* sp.	13
														Nodosarella salmorjraghii Martinotti	15
														Nodosaria obligua (Linne)	3
														Nodosarella sp.	3
														Nodosarella subnodosa (Guppy)	3

Tabel 4. Paleoenvironment of benthic foraminifera of Pange River (layers 8-9)

Layer	River	Transition				Neritic			Bathyal			Abbysal	Hadal	Fosil Contents	%
		Marsh	Marine	Fluvial	Beach	Inner	Middle	Outer	Upper	Middle	Lower				
						0 - 30 m	30-91 m	91-183 m	183-457 m	457-915 m	915-1828 m	1828-4876 m	> 4876 m		
8														*Cibicides* sp.	8
														Elphidium sp.	2
9														*Cibicides* sp.	2
														Nodosarella salmorjraghii Martinotti	2
														Nodosaria obligua (Linne)	2