ALEOBATHYMETRY ANALYSIS OF LIMESTONE IN BONGOMEME REGION BASED ON CONTENT OF BENTHIC FORAMINIFERA FOSSIL, GORONTALO DISTRICT, INDONESIA

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PALEOBATHYMETRY ANALYSIS OF LIMESTONE IN BONGOMEME REGION BASED ON CONTENT OF BENTHIC FORAMINIFERA FOSSIL, GORONTALO DISTRICT, INDONESIA

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ABSTRACT

The location of the study area is surging hills in Bongomene area, Gorontalo, Indonesia. In this study, a geological survey and sampling were taken, then an analysis of the content of benthic foraminifera was performed in each sample. The study aims to discover the species of benthic foraminifera fossils and to determine the paleobathymetry to the studied regions. The results of the analysis contained seven fossils species, namely *Ammomassilina alveoliniformis, Stelligerum astrononion, Haynesia germanica, Nonion fabum, Praeglobobulimina ovata, Rhabdammina discreata* and *Saccorhiza ramosa*. Based on the content of benthic foraminifera fossils, paleobathymetry is determined as Middle Shelf to Outer Shelf in Bongomeme 1, while in Bongomeme 2 and 3 is Middle Shelf.

Keywords: Benthic foraminifera, Bongomeme, Fossils, Limestone, Paleobathymetry.

INTRODUCTION

Limestone is the sediment consists mostly of structured fragments produced by various types of organisms with specific ecological requirements (Meteu-Vicens *et al*., 2008) and commonly occurs and has wide distribution in the carbonate platform. The carbonate platform is characterized by the reestablishment of shallow seawater benthic communities (Berggren and Prothero, 1992; Ivany *et al*., 2000; Prothero, 2003).

Foraminifera has proven useful in reconstructing as is palaeoenvironmental in shallow seawater environments (Mendes *et al*., 2004; Murray, 2006). The most critical control in the distribution of benthic foraminiferal is food availability and dissolved oxygen concentration

(Jorissen *et al*., 1995; De Rijk *et al*., 1999, 2000; Murray, 2001). Analysis of paleobathymetry based on foraminifera assemblages was carried out on Pliocene aged rocks in western Sahal with semi-quantitative reconstruction (Herkat and Ladjal, 2013).

Micropaleontology is a systematic study of microfossils, their morphology, classification and environmental and stratigraphic significance. For practical purposes, microfossils are any fossils, usually small, with the characteristic of which is best studied through a microscope. These include heterogeneous groups of fossils of organisms that are generally microscopic, for instance, foraminifera, ostracoda and radiolaria (Saraswati and Srinavasan, 2016).

Based on the previous study, the study area is included in Reef Limestone Formation (QI), which consists of reef limestone. In addition to this area, the Reef limestone units are also found in Tanjung Kramat region. Petrology analysis of limestone shows the name of the limestone is calcirudite or floatstone (Bachri *et al.,* 1997; Embry and Klovan, 1971; Grabau, 1905; Permana and Eraku, 2017; Permana, 2018).

This research aims to identify the species of benthic foraminifera fossil containing in Bongomeme limestone and to determine the paleobathymetry.

MATERIALS AND METHODS

This research located in Bongomeme Region of Gorontalo District, Indonesia. Western area of Limboto Lake which located at geomorphology of surging hills. The study area divided into three location, that is Bongomeme (1) (00° 35' 29.18" N; 122° 52' 45.82" E), Bongomeme (2) (00° 35' 34.680" N; 122° 52' 50.92" E) and Bongomeme (3) (00° 36' 41.260" N; 122° 50' 44.34" E) (Map 1). The stratigraphic section of this study can be seen in Diagram (1).

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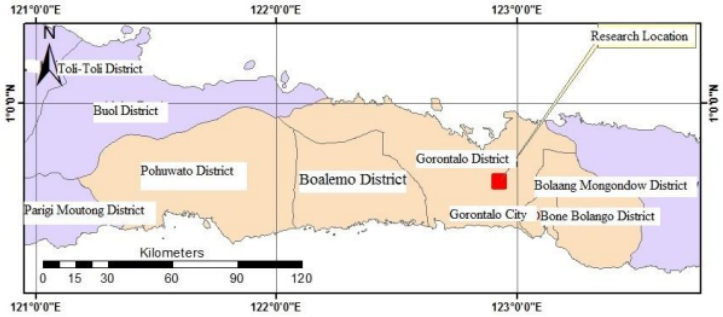


Map (1): Location map to the studied area; that's located in Bongomeme Region, Indonesia.

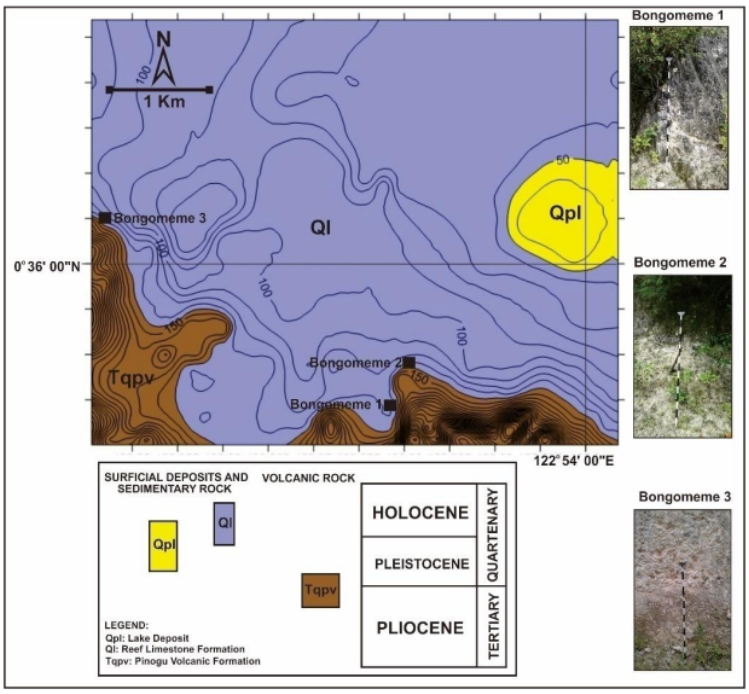


Diagram (1): The stratigraphic sections of this study, divided into three locations that is Bongomeme 1, Bongomeme 2 and Bongomeme 3. The geological map is according to Bachri *et al* (1997).

Material or research materials of samples are limestone containing benthic foraminifera fossils. The research method consisted of two stages, namely field survey and micropaleontological analysis. The field survey carried out is geological survey and determination of samples that were feasible to be analyzed and descriptions of petrology. The micropaleontological analysis was carried out to determine paleobathymetry based on the content of benthic foraminifera fossils (Ghosh and Sarkar, 2013; Martins *et al*., 2015; Roozpeykar and Moghaddam, 2016). Fossils identification is using by the Olympus SZ61 binocular microscope.

In this study, preparations were carried out on samples with a weight of 100gr on each sample. To prepare the benthic foraminifera fossil sample, a solution of 30-50% hydrogen peroxide (H_2O_2), blue methyl solution, 100 mesh sized filter, electric oven sample dryer and digital scales were used (Kadar, 1986).

Identification of benthic foraminifera fossil for the determination of paleobathymetry refers to the classification of Tipsword *et al* (1966) and Jones (1994). Ranking of the determination of paleobathymetry based on the depth of habitat of each benthic foraminifera species. Division of depth based on the environmental intervals of each foraminifera species. Each identified species is calculated for its abundance in each sample. The amount of abundance of one species uses the classification of Kadar (1986).

RESULTS AND DISCUSSION

Geological surveys in the research area indicate that the main constituents are limestone. Based on Hand specimen description, the limestone has white color, medium sorting, floating grains in the matrix (component supported) and bedding structures with an abundance of >2 mm granules of 15%. The compositions are large benthic foraminifera, coral fragments, and opaque minerals as a fragment matrix in the form of micrite. Based on the description of the petrology, the names calcirudite or coralline rudstone. Besides, based on the content of coral fragment, it interpreted that the limestone in the Bongomeme area is a Reefal limestone, which forms around (both near or little far) from the reef build-up. The chart of facies distribution and paleobathymetry of this study can be seen in Diagram (2).

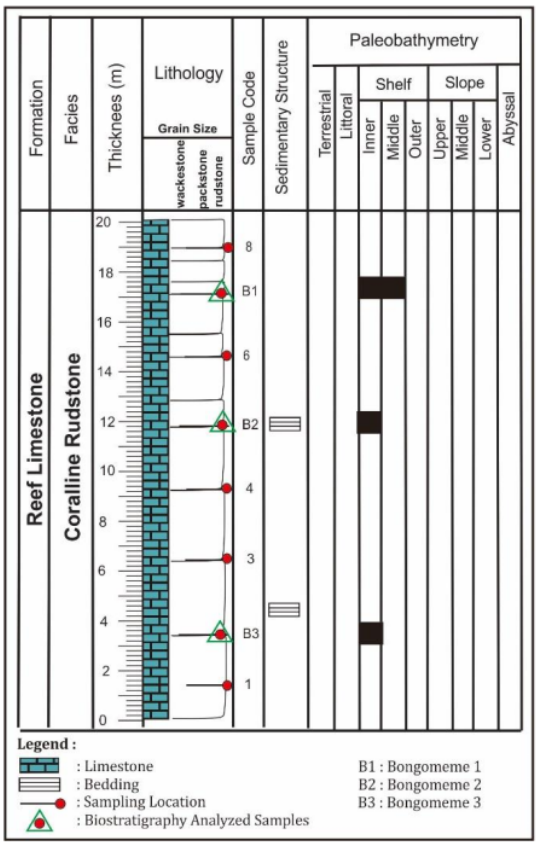


Diagram (2): Chart of facies distribution and paleobathymetry in research location (Bongomeme).

The results of geological survey and Hand specimen description which interpreted that samples of reef limestone contained large fossils of foraminifera, samples were taken for micropaleontological analysis.

The results of micropaleontological analysis shows that the number of benthic foraminifera species is varies. Bongomeme (1) there are three species of benthic foraminifera fossils namely *Haynesia germanica* (Ehrenberg, 1840), *Praeglobobulimina ovata* (d'Orbigny, 1846) and *Rhabdammina discreata* (Brady, 1881). Bongomeme (2) there are six species of benthic

foraminifera fossils namely *Ammomassilina alveoliniformis* (Millett, 1898), *Haynesia germanica* (Ehrenberg, 1840), *Nonion fabum* (Fichtel and Moll, 1798), *Praeglobobulimina ovata* (d'Orbigny, 1846), *Rhabdammina discreata* (Brady, 1881) and *Saccorhiza ramosa* (Brady, 1879). Bongomeme (3) there are four species of benthic foraminifera fossils namely *Ammomassilina alveoliniformis* (Millett, 1898), *Astrononion stelligerum* (d'Orbigny, 1839), *Lamellodiscorbis* (Loeblich and Tappan, 1987) and *Rhabdammina discreata* (Brady, 1881). Seven types of fossil species can be seen in Plate (1).

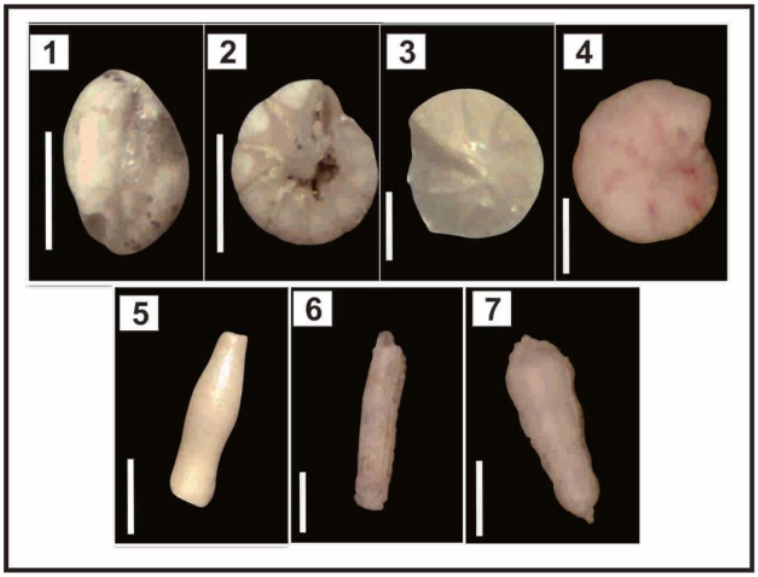


Plate (1): Seven species of benthic foraminifera fossils found in research location; (1) *Ammomassilina alveoliniformis*, (2) *Astrononion stelligerum*, (3) *Haynesia germanica*, (4) *Nonion fabum*, (5) *Praeglobobulimina ovata*, (6) *Rhabdammina discreata*, (7) *Saccorhiza ramosa* (scale size: 100 um).

Complete classification of benthic foraminifera fossils in three different research location can be seen in Table (1)

Table (1): Classification of Foraminifera Benthic Fossil Containment in Bongomeme Region (Hayward *et al.*, 2018 a, b, c, d, e).

Classification	Species 1	Species 2	Species 3	Species 4	Species 5	Species 6	Species 7
Phylum	Foraminifera	Foraminifera	Foraminifera	Foraminifera	Foraminifera	Foraminifera	Foraminifera
Class	Tubothalamea	Globothalamea	Globothalamea	Globothalamea	Globothalamea	Monothalamea	Monothalamea
Order	Miliolida	Rotaliida	Rotaliida	Rotaliida	Rotaliida	Astrorhizida	Astrorhizida
Suborder	Miliolina	Rotaliina	Rotaliina	Rotaliina	Rotaliina	Astrorhizina	Hippocrepinina
Superfamily	Milioloidea	Nonionoidea	Rotalioidea	Nonionoidea	Buliminoidea	Astrorhizoidea	Hippocrepinoidea
Family	Hauerinidae	Nonionidae	Haynesinidae	Nonionidae	Buliminidae	Rhabdamminidae	Hyperamminidae
Subfamily	Siphonapertinae	Astrononioninae		Nonioninae		Rhabdammininae	Saccorhizinae
Genus	*Ammomassilina*	*Astrononion*	*Haynesina*	*Nonion*	*Praeglobobulimina*	*Rhabdammina*	*Saccorhiza*
Species	*alveoliniformis* (Millett, 1898)	*stelligerum* (d'Orbigny, 1839)	*germanica* (Ehrenberg, 1840)	*fabum* (Fichtel and Moll, 1798)	*ovata* (d'Orbigny, 1846)	*discreta* (Brady, 1881)	*ramose* (Brady, 1879)

The total abundance of each fossil species in each location according to (Kadar, 1986) can be seen in Table (2) (Bongomeme 1), Table (3) (Bongomeme 2) and Table (4) (Bongomeme 3).

Table (2): The abundance of each benthic foraminifera fossils species in Bongomeme 1.

Species	Total	Abundance
Haynesia germanica	1	Very Rare (VR)
Praeglobobulimina ovata	2	Rare (R)
Rhabdammina discreta	9	Frequent (F)

Table (3): The abundance of each benthic foraminifera fossils species in Bongomeme 2.

Species	Total	Abundance
Ammomassilina alveoliniformis	2	Rare (R)
Haynesia germanica	1	Very Rare (VR)
Nonion fabum	1	Very Rare (VR)
Praeglobobulimina ovata	3	Rare (R)
Rhabdammina discreata	5	Rare (R)
Saccorhiza ramosa	3	Rare (R)

Table (4): The abundance of each benthic foraminifera fossils species in Bongomeme 3.

Species	Total	Abundance
Ammomassilina alveoliniformis	1	Very Rare (VR)
Astrononion stelligerum	1	Very Rare (VR)
Lamellodiscorbis	1	Very Rare (VR)
Rhabdammina discreta	9	Frequent (F)

Paleobathymetry analysis of limestone in Bongomeme

Table (5): Paleobathymetry Analysis of Bongomeme 1.

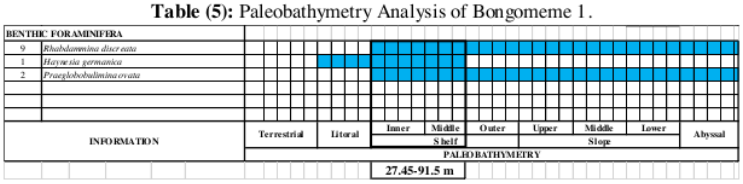


Table (6): Paleobathymetry Analysis of Bongomeme 2.

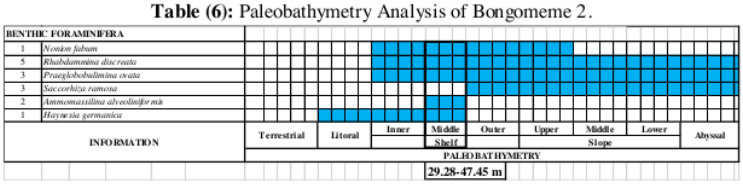
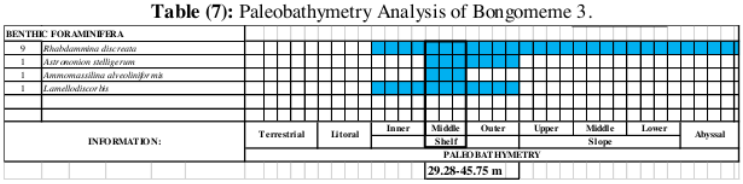


Table (7): Paleobathymetry Analysis of Bongomeme 3.



Based on the research results, there are seven species of benthic foraminifera fossils; therefore, paleobathymetry analysis could be carried out. The analysis was carried out by overlaying the presence of species of benthic foraminifera fossils while it was life. Analysis of paleobathymetry for each location based on Tipsword *et al* (1966) and Jones (1994) can be seen in Table (5) (Bongomeme 1), Table (6) (Bongomeme 2) and Table (7) (Bongomeme 3). The results of the analysis of paleobathymetry shows that paleobathymetry of the limestone Bongomeme 1 area is Middle Shelf - Outer Shelf (27.45-91.5 meters)(Jones, 1994). Paleobathymetry of the limestone Bongomeme 2 area is Middle Shelf (29.28 – 47.45 meters) (Jones, 1994) and paleobathymetry of the limestone in Bongomeme 3 area is Middle Shelf (29.28 – 45.75 meters) (Jones, 1994).

The presence of *Ammomassilina alveoliniformis* species which belongs to the suborder Milliolina indicates the lagoon environment. To prove this, make a comparison of the Rotaliina - Textulariina - Miliolina suborder uses a triangle diagram of Armstrong and Brasier (2005). A comparison of the Rotaliina-Textulariina-Miliolina suborder can be seen in Table (8), and the plotting of triangular diagram of Armstrong and Brasier (2005) can be seen in Diagram (3).

Based on this analysis, it is known that limestone at the location includes hypersaline lagoons, which are formed under hypersaline sea water conditions due to semi-closed water

circulation which is likely caused by a barrier. If we looking at the composition of limestone that composed by coral fragments, it is interpreted that the barrier is reef build-up.

Table (8): Comparison of Rotaliina – Textulariina – Miliolina suborder.

Location	Miliolina		Rotaliina		Textulariina		Total
	Specimen	%	Specimen	%	Specimen	%	
Bongomeme-1	0	0,0	3	100,0	0	0,0	3
Bongomeme-2	2	28,6	5	71,4	0	0,0	7
Bongomeme-3	1	50,0	1	50,0	0	0,0	2

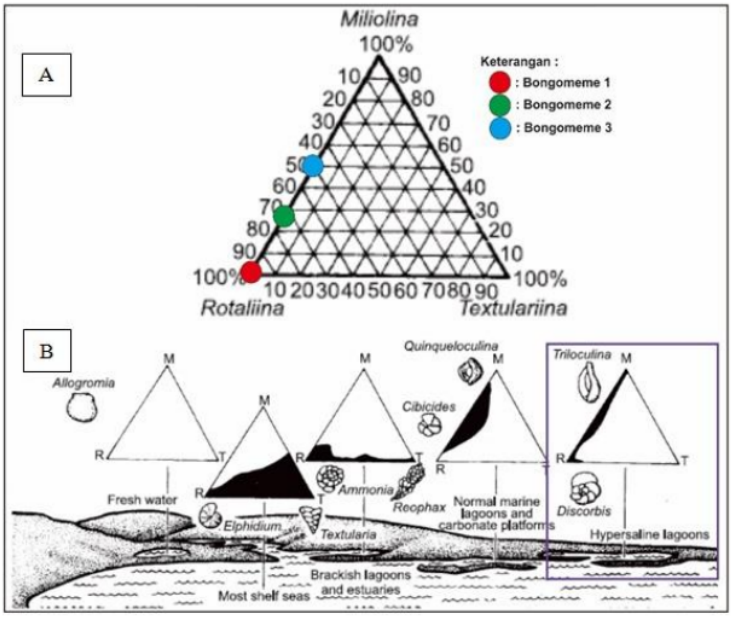


Diagram (3): Comparison of the Rotaliina - Textulariina - Miliolina suborder uses a triangle diagram of Armstrong and Brasier (2005); (A) Plotting of comparison of Rotaliina - Textulariina - Miliolina, suborder, (B) The interpretation of lagoonal condition environment.

Paleobathymetry analysis of the research area at the time of limestone formation was deposited based on the content of benthic foraminifera fossils, finally could answer the research objectives. The Bongomeme area of Gorontalo Regency, which is currently formed by elevations above sea level of 49 meters to hundreds of meters, is based on the history of

limestone formation under the marine. The location of the research was experiencing elevation from the shallow marine Middle Neritic to now land. This fact is strengthened by data on the presence of benthic foraminifera fossils which characterize the marine environment, with hypersaline lagoon condition

CONCLUSION

Based on the results and discussion, some important conclusions can be mentioned. The Bongomeme area of Gorontalo Regency consisting by reefal limestones containing benthic foraminifera fossil and coral fragments.

The results of micropaleontological analysis have showed that there are seven species of benthic foraminifera fossils namely *Ammomassilina alveoliniformis* (Millett, 1898), *Astrononion stelligerum* (d'Orbigny, 1839), *Haynesia germanica* (Ehrenberg, 1840), *Nonion pompilioides* (Fichtel and Moll, 1798), *Praeglobobulimina ovata* (d'Orbigny, 1846), *Rhabdammina discreata* (Brady, 1881) and *Saccorhiza ramosa* (Brady, 1879).

The analysis of paleobathimetry has revealed that the research area was previously a shallow marine environment, which the paleobathymetry of the limestone Bongomeme 1 area. The result of the analysis of paleobathymetry shows that paleobathymetry of the limestone Bongomeme 1 area is Middle Shelf - Outer Shelf (27.45-91.5 meters). Paleobathymetry of the limestone Bongomeme 2 area is Middle Shelf (29.28 – 47.45 meters) and paleobathymetry of the limestone in Bongomeme 3 area is Middle Shelf (29.28 – 45.75 meters).

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تحليل الأحفوريات الحجرية من الحجر الجيري في منطقة بونجوميمي بناء على محتوى إحفوريات المنخريات القاعية ، مقاطعة كورونتالو ، إندونيسيا

آنج بانجي بيرمانا *'**، سباجيو براميوميجويا ** و اكمل الدين**
*قسم الهندسة الجيولوجية، جامعة نيغري كورونتالو ، كورونتالو، إندونيسيا
**قسم الهندسة الجيولوجية، جامعة جادجا مادا، يوجياكارتا، إندونيسيا

تأريخ الاستلام: 2019/07/29، تأريخ القبول: 2019/12/08، تأريخ النشر: 2020/06/24

الخلاصة

تقع منطقة الدراسة في تلال سيرجنج، في منطقة بونجوميمي، كورونتالو، إندونيسيا. في هذه الدراسة، جرت عملية المسح الجيولوجي والنمذجة، وبعد ذلك تم تحليل محتوى المخرمات القاعية في كل نموذج. تهدف الدراسة الى اكتشاف انواع من إحفوريات المخرمات القاعية وتحديد الاعماق القديمة للمناطق المدروسة. بينت نتائج التحليل وجود سبعة انواع إحفوريه، تسمى *Stelligerum astrononion*، *Ammomassilina alveoliniformis*، *Haynesia germanica*، *Nonion fabum*، *Praeglobobulimina ovata*، *Rhabdammina discreata* و *Saccorhiza ramose*.

استناداً الى محتوى إحفوريات المخرمات القاعية، حدد العمق القديم على انه الرف المتوسط الى الخارجي في بونجوميمي 1، بينما في بونجوميمي 2 و 3 هو الرف المتوسط.

ALEOBATHYMETRY ANALYSIS OF LIMESTONE IN BONGOMEME REGION BASED ON CONTENT OF BENTHIC FORAMINIFERA FOSSIL, GORONTALO DISTRICT, INDONESIA

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