UPLIFT RATE OF LIMESTONE GORONTALO INDONESIA BASED ON BIOSTRATIGRAPHY ANALYSIS

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Submission date: 22-Mar-2019 04:04PM (UTC+0700)
Submission ID: 1097785173
File name: proposed_new_journal_ok.pdf (178K)
Word count: 2450
Character count: 13820

PALEONTOLOGY

UPLIFT RATE OF LIMESTONE GORONTALO INDONESIA BASED ON BIOSTRATIGRAPHY ANALYSIS

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ABSTRAK

The uplift rate of Gorontalo limestone is highly dependent on the completeness of age and depth data. All data needed can be obtained based on complete biostratigraphy analysis. The research material used was a 24 meter thick limestone outcrop. The aim of the research was to determine the absolute age of limestone, paleobathimetry and uplift rate of limestone in the research area. The three methods used consisting of the measured section (MS), biostratigraphy analysis and tectonic analysis. Biodatum in the limestone is only one, namely LO *Globoquadrina dehiscens.* Determination of paleobathimetry using two methods. The uplift rate of limestone is 0.0699-0.0724 mm/year.

Keywords : Uplift Rate, Limestone, Gorontalo, Biostratigraphy

INTRODUCTION

The Indonesian archipelago is geologically the center of the meeting of three of world's main active plates, the Indian-Australian Plate which moves north-northeast, the Pacific Ocean Plate moves west-northwest and the Eurasian Continent Plate is almost static [1,2,3,4].

Sulawesi Island, which is located in the central part of the Indonesian Archipelago resembles the letter K. This form is influenced by the movement of the three main plates of the world. Based on regional physiography, Sulawesi Island is divided into South Arm, Middle Part, North Arm, East Arm, Southeast Arm and Neck [4].

Gorontalo which is part of the North Arm of Sulawesi has very complex geological conditions due to tectonic influences. The spread of quarter age limestone in the Gorontalo plains and Pliocene-Plistocene limestone around Lake Limboto are evident. The effect of tectonics is very strong, especially from the position of reef limestone that is quarter age in the Gorontalo region. This reef limestone undergoes a very strong elevation, proven by field data near Gorontalo and the northern coast of Tanjung Daka [4,5,6].

The influence of tectonics on uplift rate limestone in Gorontalo has yet to be known how fast until now. This is inseparable from the data of limestone of Gorontalo that is regionally by dividing it into two large formations without knowing the absolute age and paleobathimetry so that the uplift rate of Gorontalo limestone is unknown. For this reason, based on the background, three main objectives of this research were raised, which are, to find out the absolute age of limestones, to know paleobathimetry and uplift rate of limestone.

MATERIALS AND METHODS

The research location is in Yosonegoro region, Gorontalo Regency, which is the northern part of the Lake Limboto basin with coordinates (00^O 39' 6.7222" North, 122^O 54' 50.0385" East) to (00^O 39' 6.9397" North, 122^O 54' 57.5275" East). 24 meter high limestone outcrop research material. The research method carried out consisting of three methods namely the measured section (MS), biostratigraphy analysis and tectonic analysis. The MS method measures the detail of the coating using a jacob's staff at 1.5 meter intervals by systematic lithology sampling from the oldest to the youngest rocks [7,8]. Biostratigraphy analysis using the Olympus SZ61 binocular microscope to identify the types of fossil planktonic and benthonic foraminifera in determining the age of rocks and paleobathimetry [9,10,11,12,13,14,15,16,17,18,19]. Tectonic analysis to calculate the uplift rate based on absolute age data of limestone, paleobathimetry and current position of elevation [20,21,22].

RESULTS AND DISCUSSION

A. Age

The measured section results at the research location helped to determine the thickness of one stratigraphy pathway and determine the exact position of the sample for biostratigraphy analysis. A total of 10 samples that carried out biostratigraphy analysis based on facies obtained from measured section results. The samples taken certainly contain plangtonic foraminifera fossils and bentonic based on grain size and the content of foraminifera fossils.

Biostratigraphy analysis in 10 limestone samples contained 17 types of planktonic foraminifera fossil . The distribution of 17 types of planktonic foraminifera fossil can be seen in Figure 1. Based on Figure 1, interpretation and analysis of the distribution of the biostratigraphy zone and the position of the biodatum in the stratigraphy pathway can be done. The research location is divided into two biostratigraphy zones, with details as follows:

1. Zone PL2

Definition : The upper boundary of PL2 zone is not found. The lower boundary is LO *Globoquadrina dehiscens.*

Discussion : This zone is *Globoquadrina dehiscens* partial range zone. Zone PL2 (part) is equivalent to the zone PL2 [14] and zone N19 [23]. This zone represents the youngest planktonic foraminifera (top). LO *Globoquadrina dehiscens* [14,24] were found in 3G samples. The contents of fossil association in this zone are *Globigerinoides immaturus* (de Leroy), *Globigerinoides quadrilobatus* (d'Orbigny), *Globigerinoides ruber* (d'Orbigny), *Globigerinoides ruber* (d'Orbigny), *Globigerinoides sacculiferus* (Brady), *Globorotalia humerosa* (Takayanagi and Saito), *Globorotalia plesiotumida* (Blow and Banner), *Pulleniatina pracursor* (Banner and Blow) and *Pulleniatina obliquiloculata* (Parker and Jones). In this sample also found rework fossils in the form of *Globorotalia juanai* (Bermudez and Bolli) and *Globorotalia menardii* (d'Orbigny in Parker, Jones and Brady). The presence of this species is estimated to be reworks originating from older rocks. The thickness of this zone is 13 meters (interval 11-24 meters)

Age : Early Pliocene. ? – 5,80 Ma.

2. Zone PL1

Definition : The upper boundary is LO *Globoquadrina dehiscens*. The lower boundary is not found.

Discussion : This zone is *Globoquadrina dehiscens* partial range zone. Zone PL1 is equivalent to the zone PL1 [14] and zone N18 [23]. The initial datum of this zone is not found. At the end of this zone is LO *Globoquadrina dehiscens* [14,24]. LO

Globoquadrina dehiscens was found in 3G samples. The presence of *Globoquadrina dehiscens* in samples of 3B, 3C, 3D, 3E, 3F and 3G. This species was not found in the samples above, namely 3H, 3I and 3J samples.

The contents of fossil association in this zone are *Globigerinoides immaturus* (de Leroy), *Globigerinoides quadrilobatus* (d'Orbigny), *Globigerinoides quadrilobatus* (deOrbigny), *Globigerinoides ruber* (d'Orbigny), *Globigerinoides sacculiferus* (Brady), *Globigerinoides subquadratus* (Bronnimann), *Globorotalia acostaensis* (Blow), *Globorotalia humerosa* (Takayanagi and Saito), *Globorotalia tumida tumida* (Brady), *Hastigerina aequilateralis* (Brady), and *Pulleniatina pracursor* (Banner and Blow). In this sample also found rework fossil in the form of *Globorotalia continuosa* (Blow) and *Globorotalia juanai* (Bermudez and Bolli). The presence of this species is estimated to be reworks originating from older rocks. The thickness of this zone is 11 meters (interval 1 - 11 meters).

Age : Early Pliocene. 5,80 - ? Ma.

Figure 1. Distribution chart dan biozonation planktonic foraminifera in research area

Based on the division of two biostratigraphy zones, the position of the biodatum of LO *Globoquadrina dehiscens* was found at a thickness of 11 meters, namely the 3G sample. Based on the classification of [13] the absolute age of LO *Globoquadrina dehiscens* was 5.80 Ma. After knowing the absolute age, the interpretation of the position of the elevation location of the study and paleobathimetry were interpreted in the 3G sample.

B. Research Elevation Position

The elevation position of the research location is based on direct measurements using the Global Positioning System (GPS) which is 70 meters.

C. Paleobathimetry

The Paleobathimetry of 3G sample based on biostratigraphy analysis refers to two methods, namely the method of [9] and the combined method of [11,25]. The Paleobathimetry of 3G sample refers to the method of [9] using the calculation of the formula equation $D = e^{(0.0061.P\ +\ 1.25)}$. D value is depth while P is the pelagic ratio. The requirement for using this formula equation is the P value must be known from the comparison of the content of the number of fossils of planktonic and benthic foraminifera. The P value in sample 3G after being calculated is 75% so that the value of D or paleobathimetry can be known 338.661 meters.

The Paleobathimetry of 3G sample refers to the method of [11] based on the overlay of benthic foraminifera fossil content. The fossil content of benthic foraminifera consists of *Fijinonion fijiense* (Cushman and Edwards), *Gyrodinoides soldanii* (d'Orbigny), *Melonis affinis* (Reuss), *Nonion fabum* (Fichtel and Moll), *Pararotalia venusta* (Brady), *Praeglobobulimina ovata* (d'Orbigny), *Rhabdammina discreata* (Brady) and *Saccorhiza ramosa* (Brady). Based on the content of benthic foraminifera fossil, paleobathimetry is obtained in the upper slope zone with a depth of 283.65-366 meters. The Paleobathimetry obtained is still in the range of depth, then the paleobathimetry correction curve [25] was used by looking for the middle value (median) obtained 324.825 meters

D. Uplift Rate

Calculation of the uplift rate in the research area was carried out by comparing the total depth of the limestone since it was formed or deposited until this time divided by the absolute age of the limestone. The total depth value of the limestone summed the thickness of the biodatum position from MS result with the current elevation position and paleobathimetry. Calculation of limestone elevation using two data paleobathimetry namely the method of [9] and the combined method of [11,25]. The results of calculating the limestone uplift can be seen in Table 1.

Table 1. Calculation Comparison of Limestone Uplift Rate

Comparative analysis of the uplift rate of limestone using both methods produces almost the same results. Difference in the ratio of the two uplift rates if rounded 1: 1 or the uplift range 0.0699-0.0724 mm/year.

ACKNOWLEDGE

I would like to thank *Educational Fund Management Agency* (LPDP) for helping me provide the educational scholarships through *Indonesian lecturer main scholarship* (BUDI DN).

CONCLUSION

Biozonation of plangtonic foraminifera in the research area consisted of two, namely PL 1 Zone and PL 2 Zone with biodatum of LO *Globoquadrina dehiscens* (5.80 Ma) equivalent to the Early Pliocene. The depth of limestone was calculated based on the calculation of the total position of the biodatum of MS results with the current elevation position and paleobathimetry. Based on the data of absolute age and limestone depth since it was formed until it was elevated up to its current position, the uplift rate of limestone in the study area ranged from 0.0699-0.0724 mm/year.

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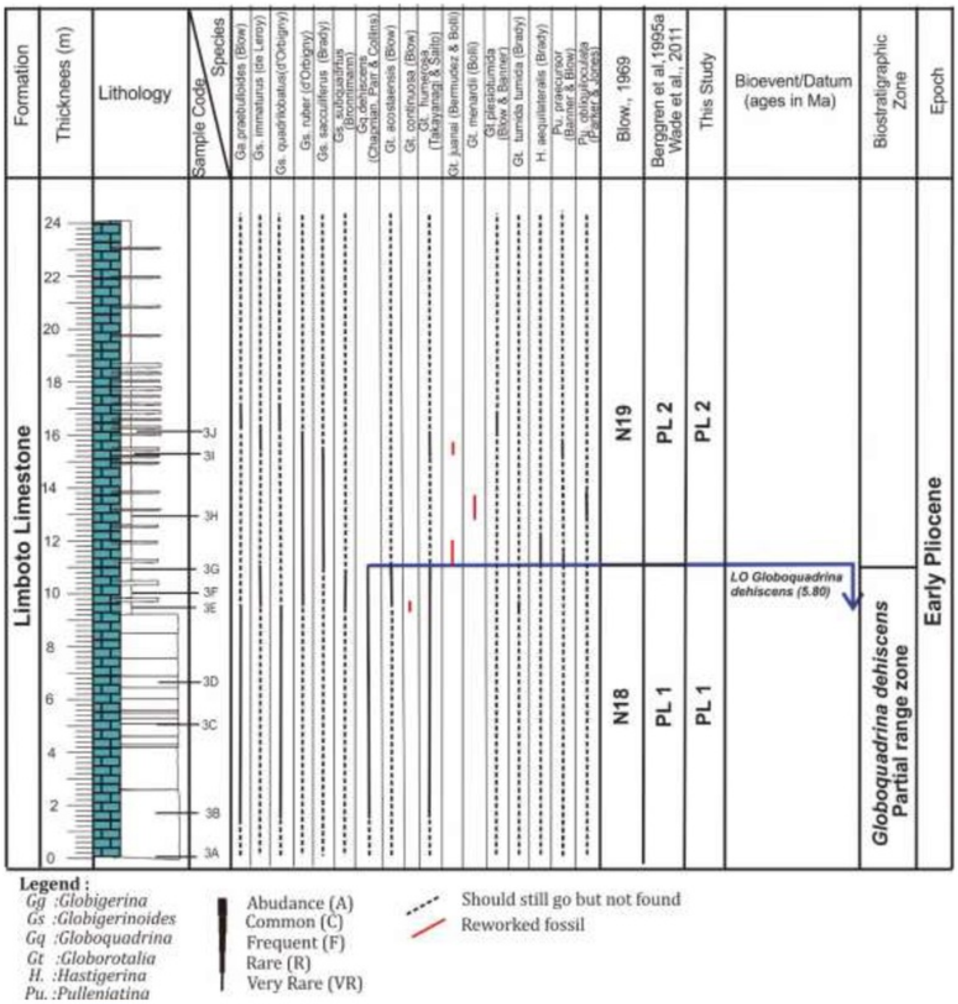

Method	Paleobathimetry (meters)	Elevation (meters)	Biodatum Position (meters)	Uplift Rate (mm/year)	Rate Comparison
[9]	338.661	70	11	0.0724	1 : 1
[11,25]	324.825	70	11	0.0699	1 : 1

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