

A review of biostratigraphic studies in the olistostrome deposits of Karangsambung Formation

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Abstract. Planktonic foraminifera is widely used for marine sediment biostratigraphy. Foraminiferal biostratigraphy of Karangsambung Formation is relatively rare to be investigated by previous researchers. A review of foraminiferal biostratigraphy is expected to be early work to perform a research about the ages of Tertiary rock formations in Karangsambung. The research area is formed by olistostrome process; a sedimentary slide deposit characterized by bodies of harder rock mixed and dispersed in a matrix. Biostratigraphic studies based on foraminifera and nannoplankton in Karangsambung Formation are still qualitative analysis using fossils biomarker. However, the age of this formation is still debatable based on foraminifera and nannofossil analysis. Two explanations of debatable ages in Karangsambung Formation that is possibly developed in Karangsambung area: firstly, Karangsambung Formation is characterized by normal sedimentation in some places and other regions such Kali Welaran and Clebok, Village as a product of olistostrome, and secondly, Karangsambung Formation is olistostrome deposit. However, micropaleontology sampling and analysis in matrix clays from olistostrome were ignored causing biostratigraphical results in those matrix clays occurred in normal sedimentation process and achieving the age of middle Eocene to Oligocene. We suppose previous authors picked samples in matrix of Karangsambung Formation from several river sections, which will make misinterpretation of the age of Karangsambung Formation. The age of middle to late Eocene probably is the dates of the older sediment that was reworked by sliding and sampling process and accumulated in Karangsambung Formation. The date of Karangsambung Fm is in Oligocene period based on a finding of several calcareous nannofossils. Detailed micropaleontological analysis of olistostrome deposits in Karangsambung Formation should be reevaluated for new finding of the accurate dating. Re-evaluation should start from detailed sedimentological mapping of Karangsambung Fm transects based on previous authors especially Kali Welaran, Jatibungkus transect and Clebok section followed by systematic sampling of normal sedimentation process from olistostrome products and matrix clays of olistostrome Karangsambung Formation. Finally, quantitative method of micropaleontological analysis can be applied to identify the age of Karangsambung Formation.

1. Introduction

Planktonic foraminifera has a special character ideally to determine marker fossil for biostratigraphy such as morphologically distinct, diverse, rapidly-evolving, highly abundant, often globally distributed and high preservation potential [1]. The starting point for all biostratigraphy is the recognition of so-called biostratigraphic horizons (biohorizons) that can be thought of as levels that can be correlated between stratigraphic sections where the fossil content changes in some measurable way [1,2]. The biostratigraphic resolution is determined by morphospecies evolution (appearances and disappearances of species) [1]. The zones and subzones allow recognition of fairly broad and easily identifiable intervals of stratigraphy that can be widely and strongly correlated. The practice of naming and/or sequentially



numbering biozones provides the biostratigrapher with easy means of communication [2]. Tropical biostratigraphy of Indonesian region especially Karangsambung area which has been studied since the middle of 19th century will be reevaluated. Karangsambung Formation was studied by previous authors [3-5] who proposed the age of this formation was around the middle Eocene to Oligocene. However, this formation is typical of olistostrome deposit based on its lithological characteristics [6,7] that cannot be easily reconstructed by using normal sedimentary process [8]. Therefore, the age of reconstruction for Karangsambung Formation should consider characteristic of melange deposit and related rock bodies [8] to reduce misinterpretation of Karangsambung Formation biostratigraphy.

Micropaleontological aspects in Karangsambung Formation have been observed by several authors [3-5,9], who studied biostratigraphy of Karangsambung based on foraminifera and calcareous nannofossils. Foraminiferal biostratigraphy [3] demonstrably has obtained the much better age of Karangsambung Formation compared to calcareous nannofossil result [4,5,9] due to minimum existing or disappearances of reworked fossil in foraminiferal micropaleontology study. We analyzed further the detailed section of Karangsambung Formation from previous studies above [3-5] to understand both foraminifera and calcareous nannofossils abundances in those sections. An interesting finding of Oligocene calcareous nannofossils exists in this Formation, which previous authors [4,5] concluded that Karangsambung Formation was deposited started from middle Eocene or Oligocene. Mechanism of younger calcareous nannofossil occurred in Karangsambung Formation is not easily defined. It should be controlled by a process, how to mix that younger fossil in the older formation. In addition, we find foraminiferal biostratigraphy study in Jatibungkus, Karangsambung [3] found shorter ranges of middle to late Eocene foraminifera compared to ranges of middle Eocene to Oligocene calcareous nannofossil assemblages.

Previous authors [3-5,9] used outcrop samples in matrixes and fragments from Karangsambung Formation to identify biostratigraphy of this Formation. Semi-systematic samples procedure was applied by those authors [3-5,9]. A study in Jatibungkus [3] tried to consider the mechanism of olistostrome process to acquire normal sediments for Karangsambung biostratigraphical Formation. Lithological character of clay ironstone and bluish grey marl, as well as lenses of limestone in some parts of Jatibungkus section, was interpreted as a normal succession of Karangsambung Formation [3]. However, other authors [4,6] did not mention the section around Jatibungkus as a normal process. Detailed sedimentology [6] shows that Karangsambung Formation is dominated by scaly clay which associated with various fragments such as claystone, sandstone, conglomerate, and igneous rocks. We suppose Karangsambung Formation was deposited by one process of olistostrome deposition. Debating occurred in determining the age of Karangsambung Formation between previous authors [3-5]. Micropaleontological results [3,4,6] of Karangsambung Formation, both foraminifera and calcareous nannofossil, obtained the age ranging between the middle of Eocene to Oligocene. The aim of this review is to examine a series of sections representing biostratigraphy in the sediment related to olistostrome deposition of Karangsambung Formation. Moreover, detailed analysis of previous foraminiferal biostratigraphy [3-5] would be helpful for the future fieldwork to get micropaleontology samples.

2. Research Area

The research area is located in Karangsambung, Central Java. Karangsambung is characterized by its tectonic of intensified deformation such as ductile and semi-ductile deformation types [10][11]. Geological structure of Karangsambung area was generally deformed in the period of tectonic Late Cretaceous until Paleocene and orogenesis occurring during Eocene until Pliocene [11]. Major penetrative deformation in the Luk Ulo area occurred during the late Eocene to Oligocene [11,12]. The Luk Ulo Melange Complex has been considered to be caused by tectonic mixing during subduction of the Indian oceanic plate under the SE Asia continental plate [13]. However, the updated discovery of middle Eocene block of Larangan and Bulukuning Formation [12] was associated with Karangsambung Formation followed by collision in the late Eocene to early Oligocene [14]. The area around Luk Ulo

researched by previous researchers [3-6] shows that this area consists of olistostrome deposits in which various blocks are embedded in matrix of clays in Karangsambung Formation.

3. Discussion

Karangsambung, Indonesia is located in an area which had active tectonics in the past. Biostratigraphy in Tertiary rock in Karangsambung especially Karangsambung Formation has applied foraminifera and calcareous nannofossils assemblages [3-6]. However, the age of this formation is still debatable (Table 1). We analyzed further the detailed section of Karangsambung Formation from previous studies above [3-5] to understand both foraminifera and calcareous nannofossils abundances in those sections. Our interesting finding is Oligocene calcareous nannofossils exists in this Formation, which previous authors [4,5] concluded Karangsambung Formation was deposited started from the middle of Eocene or Oligocene. In contrast, Karangsambung biostratigraphy based on foraminifera in matrixes scaly clays and limestone fragments shows the age of Karangsambung Formation is between the middle to late Holocene/P12-P14 [3]. Previous authors [4,5] picked samples from several river sections of Karangsambung Formation. However, calcareous nannofossils samples obtained in matrixes of Karangsambung Formation [4,6] were relatively more detailed using semi-systematic sampling than other [5]. If we see Jatibungkus section as parts of Karangsambung Formation [3] which assumed normal sedimentation from, olistostrome process will be questionable. Mechanism of Jatibungkus limestone as reefal shallow water dispersed in the olistostrome deposit has never been explained. The Eocene formation including Karangsambung Formation has undergone deformational event after deposition [10,11], characterized by various rocks embedded in a sheared shale matrix [12]. Moreover, the study of this formation around Jatibungkus [6,10] did not mention Jatibungkus limestone as a normal process of reefal shallow marine. However, biostratigraphy of foraminifera and calcareous nannofossil applied qualitative method to identify microorganism. Foraminiferal assemblages in Jatibungkus section [3] consist of limited number of foraminiferal content in ~ 50 samples. This analysis is questionable whether the author only put the assemblage which was suitable in the age of middle to late Eocene or Karangsambung Formation has minimal content of foraminifera.

Calcareous nannofossils biostratigraphy was obtained from matrix of Karangsambung Formation in several river sections [4,5]. Karangsambung Fm in Kali Welaran [4] and around Clebok Village [5] consists of Oligocene calcareous nannofossils such as *Sphenolithus distentus*, *Sphenolithus capricornicus*, and *Sphenolithus praedistentus*. These calcareous nannofossils are dated in Oligocene period or NP23-NN21 [15]. These younger nannofossils cannot be explained easily in matrix clays during normal sedimentation. These should be controlled by another process that was not described by previous researchers [4,5]. If we see further definition of olistostrome, a sedimentary slide deposit characterized by bodies of harder rock mixed and dispersed in a matrix [16], we suppose middle Eocene probably is not the date of the age of Karangsambung Formation started from. Olistostrome process proposed by former researchers [6,10-12] could transport matrix of scaly clays in Karangsambung Formation. This process can be used to reconstruct evidence of several calcareous nannofossils: *Sphenolithus distentus*, *Sphenolithus capricornicus*, and *Sphenolithus praedistentus*, associated with middle to late Eocene nannofossil assemblages in Karangsambung Formation. Therefore, these younger nannofossils might be the key to normal sedimentation process in the olistostrome product.

Table 1. Debatable age dating of Karangsambung Formation based on foraminiferal and calcareous nanofossils biostratigraphy.

References	Age
[3] Paltrinieri et al., 1976	Middle-Upper Eocene
[4][6] Kapid & Harsolumakso, 1996; Harsolumakso et al., 1995	Upper Eocene
[5] Hadiwisastra & Kumai, 2000	Middle Eocene - Oligocene

Characteristics of melange/olistostrome rock bodies lie within a continuum unit of normal depositional process and chaotic masses of rock that lack of continuity of internal stratigraphy; detailed unit of type α until unit of δ to identify intensity of deformation process [8]. In this review, previous authors [4-6] obtained the micropaleontology samples in matrix of Karangsambung Formation. We assume the age determination in matrix of Karangsambung Formation was based on calcareous nannofossils [4-6] which only considered normal sedimentation process. Therefore, a limited number of Oligocene calcareous nannofossils in Kali Welaran and Clebok Village is not identified clearly as products of olistostrome process. Foraminiferal biostratigraphy around Jatibungkus section [3] confirms the age between middle to late Eocene in the similar section based on calcareous nannofossils [4-6]. However, a minimum number of foraminiferal content in ~ 50 samples in Jatibungkus section [3] still need to be checked whether foraminiferal assemblages have a minimum number in Karangsambung Formation. Foraminiferal biostratigraphy [3] looks promising in determining the age of Karangsambung Formation in Jatibungkus region. In addition, Jatibungkus limestone is an open question related to its existence during middle to late Eocene in complex tectonic activity [11,12] whether its normal reef formation [3] or olistolith [8] entered the matrix of Karangsambung Formation. We suppose the age of middle to late Eocene probably is the dates of the older sediment that was reworked by sliding and sampling process and accumulated in Karangsambung Formation. The date of Karangsambung Fm is Oligocene period based on the findings of several of these calcareous nannofossils.

Two explanations of debatable ages in Karangsambung Formation that is possibly developed in Karangsambung area. Firstly, Karangsambung Formation is characterized by normal sedimentation in unit of α [8] in some places as hypothesized by former researcher [3], and as a product of olistostrome in unit of γ or δ [8] in other regions such Kali Welaran and Clebok Village. Secondly, Karangsambung Formation is olistostrome deposit. However, micropaleontological sampling and analysis in matrix clays from olistostrome were ignored causing biostratigraphical results [3-5] in those matrix clays occurred in normal sedimentation process. Detailed micropaleontology analysis of olistostrome deposits in Karangsambung Formation should be reevaluated for new finding of the accurate dating. Re-evaluation should start from detailed sedimentological mapping of Karangsambung Fm transects based on previous authors [3-6] especially Kali Welaran, Jatibungkus transect and Clebok section followed by systematic sampling of normal sedimentation process from olistostrome products and matrix clays of olistostrome Karangsambung Formation. Finally, quantitative method of micropaleontological analysis can be applied to identify the age of Karangsambung Formation.

4. Conclusions

A review of foraminiferal biostratigraphy of Karangsambung formation come across some issues that should be resolved. Foraminiferal biostratigraphy demonstrably has a much better age of Karangsambung Formation compared to nannoplankton result due to minimum existing or disappearances of reworked fossil in foraminiferal content. The age of this formation is still debatable based on foraminifera and calcareous nannofossil analysis. Two explanations of debatable ages in Karangsambung Formation that is possibly developed in Karangsambung area. Firstly, Karangsambung Formation is characterized by normal sedimentation in some places and as a product of olistostrome in other regions such Kali Welaran and Clebok Village. Secondly, Karangsambung Formation is olistostrome deposit. However, micropaleontology sampling and analysis in matrix clays from olistostrome were ignored causing biostratigraphical results in those matrix clays occurred in normal sedimentation process and achieving the age of middle Eocene to Oligocene. We suppose previous authors picked samples in matrix of Karangsambung Formation from several river sections, which will make misinterpretation of the age of Karangsambung Formation. The age of middle to late Eocene probably is the dates of the older sediment that was reworked by sliding and sampling process and accumulated in Karangsambung Formation. The date of Karangsambung Fm is in Oligocene period based on findings of several calcareous nannofossils. Therefore, reevaluation for the new finding of the accurate dating in the olistostrome deposit in Karangsambung should be further explored. Detailed micropaleontological analysis of olistostrome deposit in Karangsambung, especially to reevaluate Kali

Welaran and its surroundings and document foraminiferal content of Karangsambung Formation, will be representative to acquire high-resolution micropaleontological analysis in this area.

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