Diatom as an alternative for biostratigraphy research in Karangsambung

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Abstract. Paleogene stratigraphy of Karangsambung consists of Karangsambung and Totogan olistostrome deposit. The previous biostratigraphy research for those formations used the olistostrome matrix as the main sample. In fact, the olistostrome matrix is also a mixed material that might consist of the mixed material of the older and young sediment, making this sample unrepresentative for biostratigraphy analysis. The previous biostratigraphy research based on the matrix sample should be evaluated and should also consider new criteria for the representative sample. The most suitable biostratigraphy analysis sample from the olistostrome deposit is soft fraction sediment and laminated sediment which represent the suspension deposition phase in the part of olistostrome depositional process. On the other hand, diatom biostratigraphy could be applied in the representative sample related to the diatom living strategy in deep marine as lamination form and also their progressive spreading in Cenozoic. However, the application of diatom biostratigraphy in olistostrome deposit is still new and it lacks of reference, especially for diatom research in Indonesia. Though the application would be difficult to realize, it might open the chance for new research and discovery in Karangsambung biostratigraphy.

1. Introduction

Stratigraphy of Karangsambung consists of PreTertiary and Tertiary groups. PreTertiary Formation is Lok Ulo Melanges Complex which consists of tectonic blocks of various rocks embedded in a sheared shale matrix. The blocks comprise sandstone, greywacke, chert, limestone, pillow basalt, ultramafics, rhyolite, marble, phyllite and schist [1]. Some of the sandstone blocks are interbedded with shale, while cherts are in close association with limestones (calcilutites) and pillow basalts. Long axis of the blocks has general trend of ENE-WSW [1,2]. Wakita [3] in his review suggests the main part of the Luk Ulo Complex is a typical accretionary wedge formed by oceanic plate accretion in the Cretaceous. Unconformably, this melange complex is overlain by Tertiary sediments, the Karangsambung, Totogan, Waturanda, and Penosogan, and Halang Formations [3,4]. These formations have been recognized as Cenozoic cover sequence, which cover all the accretionary – collision complexes of the Cretaceous suture zone [3]. Karangsambung and Totogan Formations are olistostrome deposits consisting of sedimentary mixture of rocks fragments and blocks (olistoliths) such as sandstone, conglomerate, fossiliferous (Nummulites) limestone in clay matrix [5]. These two formations have later lateral gradual changes [5]. Later, two discoveries of new type of Eocene rocks in the Bulukuning and Larangan areas have reported and separated from Lok Ulo Melange Complex [6]. Overlying unconformable on these olistostromal deposits is the Waturanda Formation that consists of volcanic breccias and sandstones, which over lain conformably by Penosogan Formation consisting of alternation of calcareous sandstone and marl. There are two major structural trends in Karangsambung [6].
PreTertiary biostratigraphy of Karangsambung was built based on Foraminifera and radiolarian as two of three microfossils that are commonly used in Paleozoic-Mesozoic biostratigraphy [7]. Tertiary biostratigraphy studies have more significant progress with more variation of index fossil (shown in Table 1).

Table 1. Several tertiary biostratigraphy studies in Karangsambung Area.

| Author                | fossil index     | Age, Formation                                                                 |
|-----------------------|------------------|---------------------------------------------------------------------------------|
| Asikin [4]            | Foraminifera     | Lower-Middle Cretaceous block and Paleocene matrix of Lok Ulo Melange Complex   |
| Wakita et al [2]      | Radiolarian      | Early -Late Cretaceous age, early Paleocene                                    |
| Hadiwisastra and Kumai [8] | Nannoplankton    | Cretaceous and Eocene Mixed (Eocene), Karangsambung Formation                  |
| Morgenroth et al [9]  | Dinoflagellate   | Karangsambung Formation                                                        |
| Prasetyadi [6]        | larger benthic foraminifera | Eocene, previously part of Lok ulo Melange Complex                             |
| Polhaupessy [10]      | Pollen           | Eocene-Oligocene, Karangsambung and Totogan Formation.                         |
| Accordi et al [11]    | foraminifera, schelactinian, calcareous algae | Thanetian Jatibungkus block, Fm.Karangsambung                                |

This review will highlight the Paleogene biostratigraphy of Karangsambung which consists of olistostrome deposit of Karangsambung and Totogan Formation. The main reason is the chaotic sedimentation of olistostrome deposition that should be a mix between the older and younger sediment. Hadiwisastra and Kumai [8] reported the mixed association of nannofossil assemblages in the olistostrome matrix of Karangsambung. According to the result of nannoplankton study, the author assumed that the matrix component of the olistostrome deposit is also the part of the chaotic mass and might contain the older sediment component. The olistostrome matrix could not be the representative sample for biostratigraphy analysis. The previous result of biostratigraphy research which commonly used the matrix sample must be evaluated. The author suggests that the most suitable sample is soft and laminated sediment which represents the suspension depositional part of olistostrome depositional process, even the sample with this criterion would be difficult to find.

2. Diatom as an Alternative Biostratigraphy: Opportunity and Challenge

Diatoms are widely spread in the ocean’s photic zone (water depth typically 100 meters) and they are also required for growth an availability of light, silicic acid, nitrate, phosphate, and carbon as nutrients [12]. Most of the research reported that the earliest diatoms were marine, even the discovered fossil deposits in Korea show that episodes of terrestrial colonization may have occurred in the Mesozoic [13,14]. Like the other siliceous microfossil, diatom have over calcareous microfossil groups that are affected neither by carbonate dissolution nor oxidation [15]. They are primary producers that diverse and widespread strongly as a reflective response to environmental forcing, particularly changes in
nutrient supply, making them excellent paleoceanographic indicators [16]. All marine diatoms are sensitive to water-mass distribution and both surface and vertical oceanic circulation [17].

Even the diatoms are one of three major phytoplankton groups that emerge in Mesozoic [16], diatoms widespread progressively in the Cenozoic era. Eocene diatoms in deep-sea sediments have been obtained from high latitude and equatorial regions [18,19] as well as a number of well-known outcrops for example shales in California [20].

Related to the author’s suggestion about soft and laminated sediment deposit as the representative sample, diatom could be an alternative microfossil for Karangsambung biostratigraphy. Some diatoms have the living strategy to create lamination form in deep marine, which grows slowly at depth in “deep chlorophyll maximum” [21]. This living strategy has to spread the possibilities of diatom to apply in the deep marine sediment of Karangsambung Formation stratigraphy. Their existence in the photic zone also make diatoms a good optional biostratigraphy to the sublittoral compound in the upper part of Karangsambung and Totogan Formation that was reported by palynology research [10]. Diatom biostratigraphy might confirm the upwardly changes of Karangsambung Formation sedimentation facies from the deep marine to the shallow marine environment which was reported by nannoplankton research [8].

The challenge of diatom application in Paleogene biostratigraphy comes from the geographic condition of Indonesia as a tropical region. Radiolarian is dominated by biosiliceous microfossil in the tropical ocean, which can compete for the diatom to absorb silica and affect their preservation [22]. Indonesian diatom biostratigraphy study lacks of reference, especially for Paleogene deposit. Ling and Samuel [23] reported the existence of diatomites in Nias that is associated with the Miocene sedimentary deposit but absence in Oligocene age deposit. Burckle [24] studying the marine diatom for Njepung Section, reported the diatom zonation for Middle Miocene (Nitzschia jousea zone) to Late Miocene-Pliocene (Thalassiosira convexa zone). Related to the olistostrome deposit of Karangsambung and Totogan Formation, the diatom biostratigraphy would be difficult to apply, because, until this time, there is no application report of diatom biostratigraphy in olistostrome sediment. The high intensity of tectonic deformation in the sediment should decrease the frustule preservation. The difficulties are also similar to how to collect the representative sample for biostratigraphy analysis.

However, there is a wide open chance for the first research for diatom biostratigraphy application in Karangsambung. To begin with, some reports of deep ocean drilling project (DSDP) for diatom biostratigraphy in eastern equatorial Pacific (Eocene-Oligocene diatom) [25], eastern tropical Pacific [26], low equatorial region (Eocene-Oligocene planktonic diatom) [27], equatorial Indian Ocean [28] and eastern Indian ocean (Paleocene-Eocene diatom) [18] could be the main reference although they have not been applied to olistostrome deposit.

3. Conclusions
The previous biostratigraphy in Karangsambung olistostrome deposit based on matrix sample should be evaluated. The author suggests that the representative sample in olistostrome deposit is soft and laminated sediment which represents the low regime part of olistostrome depositional process. Diatom biostratigraphy might be suitable for the sample with those characters as the alternative biostratigraphy for olistostrome Karangsambung and Totogan Formation. Even the application of diatom biostratigraphy in the olistostrome deposit is difficult, there is still a chance for new research and discovery for Karangsambung biostratigraphy.

Acknowledgments
Thanks to the chairman of Research Center for Geotechnology, and also Karangsambung research team for all the support and motivation. Special thanks to Dr. Munasri and Dr. M M Mukti for their support and for sharing some precious information and references to encourage this work. I acknowledged comments and suggestions from the reviewer and editor of GCGE2017.
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