ABSTRAK


Kata Kunci: rekaman polen, perem, sedimen laut, Timor Barat.

ABSTRACT

This is the first publication to present palynological study on the Permian marine sediments of West Timor. This is aimed to evaluate its palynomorph content. Similar studies have been performed on the Permian sediments which mostly focus on non-marine sediments. 15 surface samples were collected from Lilana river outcrop which comprises the alternation of calcareous shale and sandstone. This outcrop is assumed to represent some parts of Bisane Formation. Standard preparation methods were employed to extract palynomorphs including acid maceration and oxidation. This study applies quantitative method which requires counting of palynomorphs in each sample. This study provides low to moderate pollen recovery which mostly consists of striate and non-striate bisaccates as well as trilete monosaccates. The age restricted taxa appearing in the non-marine sediments also present in the studied samples to mark Permian age such as Protohaploxypinus samoilocvichi, Lunatisporites pellucidus, Falcisporites australis, Plicatipollenites malabarensis and Cannanoropollis janakii. On the other hand, common occurrence of marine dinoflagellates of Dapsilidium langii and Veryhachim reductum combined with abundant macrofossil of chrinoids confirm a shallow marine paleoenvironment. Common green algae of Tasmanites sp. is a firmed evidence for the appearance of potential source rock of hydrocarbon within the Permian shallow marine sediments of West Timor.

Keywords: pollen record, permian, marine sediment, West Timor.
I. INTRODUCTION

As a distal part of Australian continental plate, Timor is dominated by shallow to deep marine sediments from Paleozoic to Cenozoic (Charlton and Gandara 2012). In addition, Perm is well known to deposit marine sequence which able to preserve marine fossils such as crinoids, molluscs, brachiopods, corals and trilobits (van Gorsel 2014). However, latest works by Lelono et al. (2016a) prove that Permian formation exposed on West Timor is composed of non-marine (lacustrine) and marine sediments. While the non-marine sediments receive major attention due to its potentiality as a source of hydrocarbon, the marine sediments have never been properly explored. Meanwhile, in other areas where Perm is non-marine successions, palynomorphs were proved to occur considerably. The flora of almost all Permian Gondwanan continents between 40° to 90° paleolatitude is dominated by glossopterids (McLoughlin 2001). Although Gondwana was a large supercontinent which was presumably supported by homogenous vegetation, some intra-Gondwanan floristic provinces can be recognised as indicated by distinct regional palynomorph compositions. Recent study by Barbolini et al. (2016) on the Permian sediments from Australia and South Africa shows that index pollen appear diachronously in the two countries or they are absent in one of the countries. On the other hand, palynological study on the Late Permian coal of the Bowen Basin, Australia defines pollen zone of Protohaploxypinus sp. as partly indicated by the presence of Protohaploxypinus sp., Plicatipollenites densus, Falcisporites australis, Striatopodocarpites fusus (van de Wetering, 2013). The Late Permian sediments from Godavari Graben, India is characterised by abundant striate bisaccates which derived from Glossopterids. The paleovegetation studies depict the dominance of arborescent vegetation along with the low percentage of algal and pteridophytic spores which support the occurrence of warm, humid tropical forests. However, the occasional bloom in algal and pteridophytic spores represents the flooding environment (Mishra et al. 2015).

The area of study is located in Nusa Tenggara Timur of West Timor (Figure 1). The island of Timor is interpreted as a young product of the collision between Banda volcanic arc and Australian continent which has occurred since late Neogene (Chamalaun and Grady 1978; Hamilton 1979 and Harris 1991). Regional stratigraphy of West Timor proposed by Rosidi et al. (1979) and combined with Sawyer et al. (1993); Charlton (2001) and Harris (2011) covers pre-Permian to Quaternary successions representing tectonic events during this.

Ages (Figure 2). The research provided in this paper is a palynological study on the Permian marine sediment which is a part of Bisane Formation. In the regional stratigraphy of Timor, the Bisane Formation is assumed to equal to Atahoc Formation or Cribas Formation. The result of this study combined with the previous research on lacustrine sediment by Lelono et al. (2017) will complete inventarisation of palynomorphs from Permian West Timor. Having the above situation, this study is aimed to access palynological content of the Permian shallow marine sediments for understanding the Late Paleozoic stratigraphy and its possibility to be the source rock.

II. METHODOLOGY

For sampling purpose, it is selected a section along the Lilana river which provides sufficient outcrops for sample collection. It is employed a method of measured section to build a lithology column allowing systematic sampling (Figures 1 and 3). 15 samples with fine grain lithology (such as shale, clay, silt) were selected from about 50 meters thick of outcrop, namely LIL-0A to LIL-13. This outcrop is lithologically characterised by the alternation of calcareous sandstone and shale. Sandstones range from 0.3 to 5 meters, light grey colour, calcareous, fine to medium with angular to sub-angular grains, fining upward, cross bedding and hummocky. They contain abundant mica and some marine macrofossil of chrinoid. Mean while, shales show dark grey and calcareous.

All samples were processed in the LEMIGAS Stratigraphy laboratory using standard preparation techniques such as HCl, HF and HNO₃ macerations which were followed by the alkali treatment using 10% KOH to clear up the residue. Sieving with 5 microns sieve was performed to collect more palynomorphs by separating them from debris materials. Finally, residue was mounted on the slides using polyvinyl alcohol and canada balsam (Lelono 2001).

Pollen identification heavily refers to the publications of Permian palynology especially those concerning Timor as written by Lelono et al. (2016b and 2017). Accurate identification determines reliable age and paleoenvironmental interpretations.
3. Pollen Record of the Permain Marine Sediments from West Timor

(Eko Budi Lelono)

Figure 1: Map shows the area of study and the outcrop of Permain marine succession.
More over, the author refers to other publications which relate to the Permian palynology for analysing age and paleoenvironment such as Traverse (1988), Brugman et al. (1985), Feng et al. (2008), Jan (2014) and Jha et al. (2014).

III. RESULT AND DISCUSSION

All samples generally show low to moderate pollen recovery (Figure 4). Only twenty nine species are recorded which mostly consist of miospore and bisaccate pollen. Most species are also found in the Permian non-marine (lacustrine) sediments of West Timor such as Protohaploxypinus samoilovichi, Lunatisporites pellucidus ( striate bissacate), Falcisporites australis, Pinuspollenites globascus, Staurosaccites quadrasus, Platsaccus spp. ( non striate bissacate), Plicatipollenites malabarensis, Cannanoropollis janakii (monosaccate), Osmundacidites senectus and Ceratosporites helidonensis (miospore) (Lelono et al. 2016b and
Although, palynomorphs are rare, some key taxa appear to allow zonal reconstruction and age analysis including striate bisaccates and trilete monosaccates (Figure 5). In addition, this research provides the evidence for dinoflagellate occurrence which supports marine paleoenvironment. In fact, some palynomorphs from studied area are reported to appear in Australia (Kemp et al. 1977), Africa (Ruckwied et al. 2014), India (Tewari et al. 2015) and South America (Beri et al. 2010 and Boardman et al. 2012). Further more, this study discovers significant appearance of green algae *Tasmanites* sp. in the lower section (Figures 4 and 5). *Tasmanites* sp. is a major element in the Permian lacustrine sediments of West Timor which dominates more than 80% of pollen assemblages. In addition, it is proved to be the source of hydrocarbon (Lelono et al. 2017).

The age restricted taxa of bisaccate pollen appearing in the measured section characterises...
Figure 4
Pollen diagram of the Permian shallow marine samples (Lilana river of West Timor).

Figure 5. Pollen Record of the Permain Marine Sediments from West Timor (Eko Budi Lelono)
Permo-Triassic age including Protohaploxypinus samoilovichii, Lunatisporites pellucidus (striate bissacates), Falcispores australis (non striate bissacate). Referring to Mesozoic pollen zonation of Australia, these palynomorphs indicate Falcispores superzone which ranges from Late Permian to Late Triassic (Helby et al. 1987). The presence of index spore of trilete monosaccates of Plicatipollenites malabarensis and Cannanoropollis janakii suggests the age of Carboniferous-Permian age (Brugman et al. 1985). Meanwhile, the appearance of chrinoid within the calcareous sandstones may indicate Permian age (Lelono, 2016b). After all, it can be inferred that the studied sediments are assigned to Permian age.

Pollen assemblage of the studied section is characterized by significant occurrence of marine dinoflagellates including Dapsilidium langii and Veryhachim reductum. This indicates the appearance of marine environment. In addition, the calcareous sandstone with rich of chrinoids defining shallow marine environment.

Having this data, it is interpreted that the studied sediments must have been deposited in the shallow marine environment. The occurrence of green algae Tasmanites sp. is an interesting part of this study as this algae is found abundantly in the Permian lacustrine black shale of West Timor. It is proved to be the source of hydrocarbon by the discovery of tricyclic terpenoids compound which is proved by the presence of tricyclic terpenoids compound. As the enrichment of this algae relates to algal blooms in areas supplied with meltwater from surrounding glaciers, it is inferred that Timor Island was geographically situated far south in the temperate region during Permian.

Common occurrence of green algae of Tasmanites sp. demonstrates the potentiality of the Permian marine sediment as a major source for hydrocarbon which is proved by the presence of tryciclic terpenoids compound. As the enrichment of this algae relates to algal blooms in areas supplied with meltwater from surrounding glaciers, it is inferred that Timor Island was geographically situated far south in the temperate region during Permian.

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REFERENCES


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