Late Oligocene and Early Miocene planktic foraminifera from the Temburong Formation, Tenom, Sabah

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Abstract: Recently, some planktic foraminifera were successfully retrieved from the shale unit of the Temburong Formation at the Paal River in the Tenom district, southwest Sabah. The area is underlain by the Crocker and Temburong Formations and overlain by alluvial deposits. The Temburong Formation is mainly composed of fine-grained flysch deposits, characterized by rhythmic repetitions of siltstone and shale. Two samples of shale were collected for micropaleontological analysis. The samples were processed according to standard micropaleontological method for foraminifera. A total of eleven species of planktic foraminifera have been identified. The planktic foraminifera comprise Catapsydrax dissimilis, Catapsydrax unicus, Globigerina ciperoensis, Globigerina connecta, Globigerina eamesi, Globigerina praebulloides, Globigerinoides primordius, Globigerinoides triloba, Globoquadrina venezuelana, Globorotalia bella and Praeorbulina sicana. The planktic foraminifera can be divided into two assemblages representing two biozones namely the Globorotalia ciperoensis Zone (Zone P22) of Chattian age (Late Oligocene) and the Catapsydrax dissimilis-Praeorbulina sicana Zone (N7) of late Burdigalian (Late Early Miocene). The Temburong Formation was deposited at a distal part of a deep-sea fan.

INTRODUCTION

The Temburong Formation was first introduced by Brondijk (1962) and then was revised by Wilson (1964). This formation is dominantly argillaceous, characterized by rhythmic repetition of siltstone and shale. The Formation is remarkably uniform in lithology, consisting mainly of a flysch deposit, with common intercalations of slightly calcareous pelagic shale (Hutchison, 2005). Wilson (1964) has described turbidite sedimentary structures for the siltstones, such as graded bedding and flute and groove casts which can be seen in eastern Brunei and south of Beaufort, Sabah. Several studies have been conducted on the Temburong Formation and it was considered that the formation was deposited in a deep marine environment by weak turbidity currents (Wilson, 1964; Tate, 1994; Mazlan, 1997). The age of the formation ranges from Oligocene to Lower Miocene based on planktic foraminiferal assemblages (Wilson, 1964). Since then there have been no significant paleontological studies conducted. Hence, it is essential to conduct a research and revise the micropaleontological studies of the Temburong Formation.

Planktic foraminifers were recovered from an outcrop of the Temburong Formation exposed at Paal River, Tenom, southwest Sabah. The outcrop consists of dominantly thick shale and interbeds with thin siltstone. This rock unit is interpreted to be deposited on a distal part of a deep-sea fan. The objective of this research is to identify the species of planktic foraminifera and their importance in age determination.

GEOLOGICAL SETTING

The North West Sabah Basin was a part of the main Tertiary depocentre in Northwest Borneo and two distinct periods of basin filling are recorded (Leong, 1999; Madon 1999). The first period (Paleocene-Eocene) was related to the deposition of deep-sea sediments, the Rajang-Embaluh Group. Second was deposition of the Late Eocene to Early Miocene West Crocker and Temburong Formations. The
formations were deposited in an arc-related basin (Stauffer, 1967; Hutchison, 1996). The study area is underlain by the Crocker and Temburong Formations which have interfingering relationship (Wilson, 1964) and overlain by younger alluvial deposits. These two formations were part of turbidite deposits in the Crocker basin sensu lato. The distribution of the rock units in the study area is shown in Figure 1.

The Crocker Formation was deposited by turbidity currents during the Upper Eocene to Middle Miocene (Basir et al., 1991; Rangin et al., 1990; Sanudin & Baba, 2007). The Crocker Formation is composed of a few lithological units, such as thick sandstone unit, interbedded sandstone and shale unit, interbedded siltstone and shale unit and thick shale unit. The dominant north-south strike of the Crocker Formation gives rise to a series of parallel elongated ridges (Wilson, 1964). The major structural pattern in this area is dominated by thrust faults trending northeast-southeast with minor folds plunging to the northeast.

The Temburong Formation was deposited during the Oligocene to Upper Miocene (Wilson, 1964). The Temburong Formation is slightly different from the Crocker Formation by its lithological units. It is composed of interbedded siltstone and shale unit and thick shale unit. The first order large-scale folds have never been observed due to lack of large-scale outcrops. Nevertheless, the aerial photo and satellite lineament patterns and measurement of strike directions in the field show that there are regular fold patterns. A photograph of an outcrop-scale anticline in the Tenom Gorge is shown in Wilson (1964) and Hutchison, (2005) described it as a tight upright fold.

DESCRIPTION OF OUTCROP

The outcrop is exposed at a cliff along the Paal River at the Sipitang-Tenom road. The outcrop consists of interbedded siltstone and thick shale. The shale is dominant, buff grey to black in colour and almost laminated (Figure 2). Exposure of this outcrop is more than 8 meters high and about 20 meters long. Some rare thin siltstone bed about 1 cm thick are present in the shale layers. The siltstone and the shale show typical fine-grained turbidite sequence Td and Te. Two samples of shale (TF0101 and TF0102) were collected (Figure 3).

MATERIAL AND METHOD

The samples were crushed into small (1-2 cm) fragments and then boiled with sodium bicarbonate (Na₂CO₃) solution for several hours. After that the samples were washed and sieved and then dried. Foraminifera were pick and analysed using a binocular microscope following procedure by Armstrong and Brasier (2005). Well-preserved specimens of planktic foraminifera were photographed by scanning electron microscope (SEM).

RESULTS AND DISCUSSION

Biostratigraphy

The shale samples yielded poorly preserved foraminifera. However, some are identifiable. The classification and stratigraphic distribution of foraminiferal species are based on Stainforth et al. (1975), Kennett and Srinivasan (1983), and Bolli and Saunders (1985). A total of eleven planktic foraminifera species have been identified from the two
samples. Distribution of foraminifera species in the samples are recorded in Table 1. The foraminiferal assemblage in sample TF0101 and TF0102 are listed in alphabetic order as follow:-

- **Catapsydrax dissimilis** Cushman and Bermudez, (Plate 1; 1a-b)
- **Catapsydrax unicavus** Bolli, (Plate 1; 2a-b)
- **Globigerina ciperoensis** Bolli, (Plate 1; 3a-b)
- **Globigerina connecta** Jenkins, (Plate 1; 4a-b)
- **Globigerinella eamesi** Blow, (Plate 1; 5a-b)
- **Globigerinoides praebulloides** Blow, (Plate 1; 6a-b)
- **Globigerinoides primordius** Blow (Plate 1; 7a-b)
- **Globigerinoides triloba** (Reuss), (Plate 1; 8a-b)
- **Globoquadrina venezuelana** (Hedberg), (Plate 2; 9a-b)
- **Globorotalia bella** Jenkins, (Plate 2; 10a-b)
- **Praeorbulina sicana** (De Stefani), (Plate 2; 11a-b)

Sample TF0101 contains **Catapsydrax dissimilis** Cushman and Bermudez, **Globigerina ciperoensis** Bolli, **Globigerinella eamesi** Blow, **Globigerinoides praebulloides** Blow, **Globigerinoides primordius** Blow and **Globoquadrina venezuelana** (Hedberg) (Table 1). The occurrence of zonal marker **Globigerina ciperoensis** in the sample indicates that the assemblage belongs to the **Globigerina ciperoensis** Zone (P22) Chattian, Late Oligocene (Figure 3).

Sample TF0102 yielded **Catapsydrax dissimilis** Cushman and Bermudez, **Catapsydrax unicavus** Bolli, **Globigerina ciperoensis** Bolli, **Globigerinella eamesi** Blow, **Globigerinoides praebulloides** Blow, **Globigerinoides primordius** Blow and **Globoquadrina venezuelana** (Hedberg) (Table 1). The occurrence of **Praeorbulina sicana** and **Globorotalia bella** Jenkins and **Praeorbulina sicana** Zone (N7) of Berggren (1995) (Figure 3).

The planktic foraminiferal assemblage from the two samples TF0101 and TF0102 are comparable to planktic foraminifera zones by Berggren et al. (1995). Two assemblage zone have been identified. The older assemblage is the **Globigerina ciperoensis** Zone of Late Oligocene and the younger assemblage represents **Catapsydrax dissimilis-Praeorbulina sicana** Zone (N7) of late Early Miocene. Its show that the age of shale unit of Temburong Formation range from Chattian of late Upper Oligocene (P22-**Globigerina ciperoensis** Zone) to Burdigalian of late Lower Miocene (M4-**Catapsydrax dissimilis-Praeorbulina sicana** Zone) (Figure 3). The age of lower boundary of shale unit is characterized by the first occurrence of **Globigerinoides primordius**. The upper boundary is indicated by the last appearance of **Globigerina connecta**.

## Deposition environment

The Temburong and the Crocker Formations are of the same age but in different parts of a deep water environment as lateral variations. The Crocker Formation consists of medium to coarse grained turbidite while the Temburong Formation is dominated by fine-grained turbidites. Howell and Normark (1982) reported that the fine grained sediments represent pelagic and hemipelagic detritus. The siltstone was transported by weak turbidity currents and followed by deposition of hemipelagic mudstone. The sequence represents the fine-grained turbidite, which comprises Td and Te of the Bouma sequence. The rock association at the Paal River section was deposited in a basin or a distal deep-sea fan which was influenced by weak turbidity currents.

## CONCLUSIONS

The shale unit of Temburong Formation from the Paal River Tenom contains two planktic foraminiferal assemblages. The older assemblage is the **Globigerina ciperoensis** Zone of Late Oligocene and the younger assemblage represents **Catapsydrax dissimilis-Praeorbulina**
Figure 3: Lithology of a measured section at L1 (referred to Figure 1) and the stratigraphic distribution of some selected planktic foraminifera.

Plate 1: Illustration of selected planktic foraminifera; 1(a-b) = Catapsydrax dissimilis Cushman and Bermudez, 2(a-b) = Catapsydrax unicavus Bolli, 3(a-b) = Globigerina ciperoensis Bolli, 4(a-b) = Globigerina connecta Jenkins, 5(a-b) = Globigerina eamesi Blow, 6(a-b) = Globigerina praebulloides Blow, 7(a-b) = Globigerinoides primordius Blow, 8(a-b) = Globigerinoides triloba (Reuss).
sicana Zone (N7) of late Early Miocene. This rock unit has been deposited at a distal part of a deep-sea fan on a basin plain under the influence of weak turbidity currents during Chattian (Late Oligocene) to Burdigalian (late Early Miocene).

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Plate 2: Illustration of selected planktic foraminifera; 9(a-b) = Globoquadrina venezuelana (Hedberg), 10(a-b) = Globorotalia bella Jenkins, 11(a-b) = Praeorbulina sicana (De Stefani), (Plate 2; 11a-b).