Lower Miocene planktic foraminifera from the Temburong Formation in Menumbok, Klias Peninsula, Sabah

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Abstract: Lower Miocene sedimentary rocks of the Temburong Formation exposed at Kg. Assam, Menumbok, Klias Peninsula were examined for planktic foraminifera analysis. Four shale samples were collected and processes were done based on the standard micropaleontological method. This assemblage allows two local biozones to be recognized, namely the *Globigerinoides primordius* Zone (N4 zone) and the second assemblage belongs to the *Globoquadrina dehiscens-Globoquadrina praedehiscens* Zone (N5 zone). This study also indicates that the shale unit of the Temburong Formation from Kg. Assam was deposited in a distal part of a deep-sea fan environment during upper Oligocene–lower Miocene (upper Chattian–Aquitanian).

Keywords: Early Miocene, planktic foraminifera, Temburong Formation, Menumbok, Klias Peninsula

INTRODUCTION

Klias Peninsula comprises five lithostratigraphic units i.e. the Temburong, West Crocker, Setap shale, Belait and Liang formations (Wilson, 1964). The rock sequence exhibits complex structures and it is very difficult to map. There are problems regarding the lithostratigraphy of Sabah and it urgently needs to be revised especially the Temburong, West Crocker and the Setap Shale. This paper focus on the planktic foraminifera from the Temburong Formation. Mazlan Madon (1994) recognized two lithostratigraphic lithostratigraphic units in Labuan namely the Temburong and the Belait formations. The Setap Shale is the most problematic lithostratigraphic unit. Mazlan Madon (1994, 1997) states that the "Setap Shale" and "West Crocker" formation in Labuan are included in the Temburong Formation. The similar lithology was observed in Klias Peninsula. Therefore, they belong to the Temburong Formation. The late Early Miocene planktic foraminifera reported by Basir Jasin et al. (1993) and Basir Jasin (2002) was in fact probably from the Temburong Formation.

The Temburong Formation in Klias Peninsula is more argillaceous and have thin turbiditic sandstone compared to the proper West Crocker Formation of Kota Kinabalu area (Tate, 1994; Zakaria *et al.*, 2013). The Temburong Formation is lateral variation of the West Crocker Formation. The Crocker Formation dominated by the thick turbiditic sandstone is deposited in a proximal deep-sea fan complex (Zakaria *et al.*, 2013) whereas the Temburong Formation is more argillaceous an is deposited in the distal part of the fan. The boundary of the two formations cannot properly be drawn. Hutchison (2005) includes the Temburong Formation in the West Crocker Formation.

GEOLOGICAL SETTING

Klias Peninsula comprises three important lithostratigraphic units i.e. the Temburong, Belait, and Liang formations. The deep-water Oligocene-Early Miocene Temburong Formation is unconformably overlain by the Middle Miocene shallow marine, the Belait Formation. The Belait Formation is unconformably overlain by the Plio-Pleistocene Liang Formation.

The Temburong Formation in Klias Peninsula shows some variations in lithology. At Batu Linting the thinly bedded turbidite sand is more dominant. At Menumbok and Batu Luang the argillaceous rocks are more dominant with isolated limestone lenticular beds. Some of the turbidite exhibits Bouma sequence from Tb to Te but mostly shows Tc to Te sequence. Thinly bedded sandstone is rarely observed in the shale dominated sequence. Junaidi *et al.* (2015) reported some planktonic foraminifera in the Temburong Formation at the Tenom Area. This assemblage suggests an age ranges from Late Oligocene to late Early Miocene.

The outcrop of the Temburong Formation is exposed at Kg. Assam, in the district of Kuala Penyu, Klias Peninsula (Figure 1). The exposure shows thick grey shale with



Figure 1: Location of study area and the Geological Map modified from Wilson (1964).

intercalations of thin bedded, fine-grained turbidite which consists of Tc-Te Bouma sequence (Figure 2). The rock sequence at Kg. Assam is interpreted as distal deep-sea fan influenced by low density turbidity currents. The shale yields several well-preserved planktic foraminifera. The aim of this paper is to highlight the discovery of planktic foraminifera and to locate the stratigraphic significance of the Temburong Formation.

MATERIAL AND METHOD

Four samples (M101 to M104) were collected along the Menumbok road at Kg. Assam, Menumbok, Klias Peninsula (Figure 1). The outcrop consists of dominantly thin bedded shale interbedded with thin bedded of moderate to fine grain sandstone. The shale is buff grey to black in colour and laminated. The outcrop is 5m in vertical section. The samples were crushed into small size (1-2 cm) and then boiled in the sodium bicarbonate (Na₂CO₃) solution for several hours. The samples were then washed, sieved and then dried. Foraminifera were picked and analysed by binocular microscope (Armstrong & Brasier, 2005). Well-preserved specimens of planktonic foraminifera were photographed by scanning electron microscope (SEM).

RESULTS AND DISCUSSIONS

A total of eleven planktic foraminiferal species were identified from four samples (Kg. Assam). The foraminifera species are; *Catapsydrax dissimilis, Catapsydrax unicavus, Dentoglobigerina altispira altispira, Dentoglobigerina altispira globosa, Globigerinella obesa, Globigerinoides primordius, Globoquadrina baroemoenensis, Globoquadrina binaiensis, Globoquadrina dehiscens, Globoquadrina praedehiscens* and *Globoquadrina venezuelana*. The illustration of planktic forminifera species are portrayed in Figures 3 and 4. Their stratigraphic distribution is shown in Figure 5.

The classification and stratigraphic distribution of the foraminiferal species are based on Stainforth *et al.* (1975), Kennett & Srinivasan (1983), and Bolli & Saunders (1985). The foraminifera assemblages are also compared to foraminiferal zones established by Blow (1969) and Wade *et al.* (2011). Two Foraminifera assemblages were identified from Kg. Assam, Menumbok (Figure 6). The lower assemblage is characterised by the appearance of zonal maker *Globigerinoides primordius*. Beside the aforementioned species, this assemblage includes the *Catapsydrax dissimilis*, *Globoquadrina binaiensis*, and *Globoquadrina venezuelana*. This assemblage is indicative of N4 zone (*Globigerinodes primordius/Globorotalia kugleri*) of late Upper Oligocene-early Lower Miocene of Blow (1969). This zone is synonym with the *Globigerinoides primordius* Zone (Bolli & Saundres, 1985). The assemblage is recorded from shale sample M101.



Figure 3: Planktic Foraminifera; S = dorsal view, U = ventral view: 1) *Catapsydrax dissimilis*, 2) *Catapsydrax unicavus*, 3) *Dentoglobigerina altispira altispira*, 4) *Dentoglobigerina altispira globosa*, 5) *Globoquadrina binaiensis*, 6-7) *Globigerinoides primordius*, 8) *Globoquadrina baroemoenensis*.



Figure 2: Photograph showing the outcrop of the study area.



Figure 4: Planktic Foraminifera; S = dorsal view, U = ventral view: 1) *Globoquadrina praedehiscens*, 2) *Globigerinella obesa*, 3) *Globoquadrina dehiscens*, 4) *Globoquadrina venezuelana*.

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Figure 5: Lithologic sequence of Temburong Formation at Kg. Assam and the distribution of planktic foraminifera.

The upper assemblage comprises *Catapsydrax dissimilis*, *Catapsydrax unicavus, Dentoglobigerina altispira altispira, Dentoglobigerina altispira globosa, Globigerinella obesa, Globoquadrina baroemoenensis, Globoquadrina dehiscens, Globoquadrina praedehiscens* and *Globoquadrina venezuelana.* The occurrence of zonal marker *Globoquadrina dehiscens* and *Globoquadrina praedehiscens* indicates N5 zone of Lower Miocene (Blow, 1969). This zone is synonym with the *Catapsydrax dissimilis* Zone of Bolli & Saundres (1985). This assemblage is retrieved from the shale samples of M102, M103, and M104 (Figure 6).

Based on the analysis of planktic foraminifera from the four samples (M101-M104) of Kg. Assam, Menumbok, we conclude that the Temburong Formation at this locality ranges from late Upper Oligocene to Lower Miocene (N4-N5 zone of upper Chattian-Aquitanian) (Figure 6). This is the first report on the planktic foraminifera assemblage at the Menumbok, Klias Peninsula.

Wilson (1964) suggests the Oligocene to Lower Miocene (Tcd-Te₅) for the Temburong Formation based on planktic foraminifera from Padas Valley (Tenom-Sipitang Area). The planktonic foraminifera species that found in the Padas Valley area namely *Globigerina* spp., *Globigerina* binaiensis, *Globigerina cf. ciperoensis*, *Globigerina* dissimilis, *Globigerina cf. increbescens*, *Globigerinoides* spp., *Globigerinoides index*, *Globigerinoides* 'rubra group',

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Planktonic Foraminifera Zone							SUV	nilis	edehiscens	ısis	mordius	Itispira globosa	iiscens	sa	oemoenensis	Itisnira altisnira
Age (Ma)	Period	Epoch	Stage	Blow zone	Wade et al. (2011)	PLANKTONIC FC	Catapsydrax unica	Catapsydrax dissin	Globoquadrina pra	Globigerina binaier	Globigerinoides pri	Dentoglobigerina a	Globoquadrina deł	Globigerinella obe:	Globoquadrina bar	Dentodohiaerina a
-	PALEOGENE NEOGENE	N	Serra.	N11/ 12	M8							1	Î	ſ	Î	1
			"b	N10 N9	M7 M6								L			
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			Aqu	N4	M1											
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		O	upelia	P19	02											
			R	P18	01											

Figure 6: Stratigraphic distribution of planktic foraminifera from the Temburong Formation at Kg. Assam.

Globigerinoides semi-involuta, Globigerinoides 'triloba group', Globoquadrina sp., Globoquadrina venezuelana, Globorotalia centralis, Globorotalia meyeri, and Hantkenina alabamensis. The present of Globigerina ciperoensis and Globigerina dissimilis or Catapsydrax dissimilis in Wilson (1964) is indicative of P22/N3 and N5 zone (Bolli & Saunders, 1985; Blow, 1969). The N4 zone is not reported in Wilson (1964) but the planktonic foraminifera from the Klias Peninsula yield N4 zone index fossil. Adam in Wilson (1964) suggested an age of the Late Oligocene (Td) or Early Miocene $(Te_{1,4})$ based on larger benthic foraminifera from the limestone at Ulu Lakutan, Melikut River and Padas Valley. Junaidi et al. (2015) report P22/N3 zone of planktic foraminifera from the Temburong Formation at Tenom area by the presence of *Globigerina ciperoensis*. Previous researcher consistently shows that the age of the Temburong Formation ranges from Oligocene to Early Miocene. The Temburong Formation in the Klias Peninsula which is younger, range from late upper Oligocene to lower Miocene (N4 and N5 of Blow Zone) compared to the age

of the Temburong Formation sequence at Padas Valley area (Tenom-Sipitang).

CONCLUSIONS

Eleven planktic foraminiferal species were identified from four samples at the Kg. Assam Menumbok, Klias Peninsula. The foraminifera species are; Catapsydrax dissimilis, Catapsydrax unicavus, Dentoglobigerina altispira altispira, Dentoglobigerina altispira globosa, Globigerinella obesa, Globigerinoides primordius, Globoquadrina baroemoenensis, Globoquadrina binaiensis, Globoquadrina dehiscens, Globoquadrina praedehiscens and Globoquadrina venezuelana. Two planktic foraminifera assemblages were identified. The first assemblage is characterized by the presence of Globigerinoides primordius of N4 (Globigerinoides primordius) zone and the second assemblage is represented by Globoquadrina dehiscens and Globoquadrina praedehiscens of N5 (Globoquadrina dehiscens-Globoquadrina praedehiscens) zone.

The Temburong Formation in the Klias Peninsula which is younger, range from late upper Oligocene to lower Miocene (N4 and N5 of Blow Zone) compared to the age of the Temburong Formation sequence at Padas Valley area (Tenom-Sipitang). The exposure shows thick grey shale with intercalations of thin bedded, fine-grained turbidite that consists of Tc-Te of the Bouma sequence. The shale unit of the Temburong Formation from Kg. Assam is interpreted as a distal part of deep-sea fan deposited during the Upper Oligocene to Lower Miocene (Upper Chattian to Aquitanian).

Both biozone (N4 & N5) confirmed the stratigraphic position of the Temburong Formation in the Sabah Tertiary stratigraphy. This argillaceous facies is part of a large submarine sequence occupying the distal fan during Upper Oligocene to Lower Miocene of the Crocker basin *sensu lato*.

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