Bulletin of the Geological Society of Malaysia, Volume 61, December 2015, pp. 43 – 47

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 micropaleontology method for foraminifera. A total of eleven species of planktic foraminifera have been identified. The planktic foraminifera comprise *Catapsydrax dissimilis*, *Catapsydrax unicavus*, *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-Preaorbulina sicana Zone (N7) of late Burdigalian (Late Early Miocene). The Temburong Formation was deposited at a distal part of a deep-sea fan.

Abstrak: Mutakhir ini beberapa foraminifera plantik telah berjaya diperolehi daripada unit syal Formasi Temburong yang terletak di Sungai Paal di daerah Tenom, baratdaya Sabah. Kawasan kajian didasari oleh Formasi Crocker dan Formasi Temburong dan ditindih oleh endapan aluvium. Formasi Temburong merupakan endapan 'flysch'berbutir halus yang dicirikan oleh perulangan secara berirama oleh batu lodak dan syal. Objektif kajian ini adalah untuk mengenal pasti foraminifera dan usia himpunan foraminifera plantik. Dua sampel syal diambil untuk analisis mikropaleontologi. Sampel sampel tersebut diproses mengikut kaedah mikropaleontologi yang sah untuk foraminifera. Sejumlah sebelas spesies foraminifera plantik telah dikenal pasti. Foraminifera planktik tersebut terdiri daripada *Catapsydrax dissimilis*, *Catapsydrax unicavus*, *Globigerina ciperoensis*, *Globigerina connecta*, *Globigerina eamesi*, *Globigerina praebulloides*, *Globigerinoides primordius*, *Globigerinoides triloba*, *Globoquadrina venezuelana*, *Globorotalia bella* dan *Praeorbulina sicana*. Foraminifera palnktik ini boleh dibahagikan kepada dua himpunan mewakili dua biozon iaitu Zon Globorotalia ciperoensis (Zon P22) berusia Chattian (Oligosen Akhir) dan Zon Catapsydrax dissimilis- Praeorbulina sicana (Zon N7) berusia akhir Burdigalian (akhir Miosen Awal). Formasi Temburong dienapkan pada sekitaran hujung kipas laut dalam.

Keywords: Oligocene, Miocene, planktic foraminifera, Temburong Formation, Tenom

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

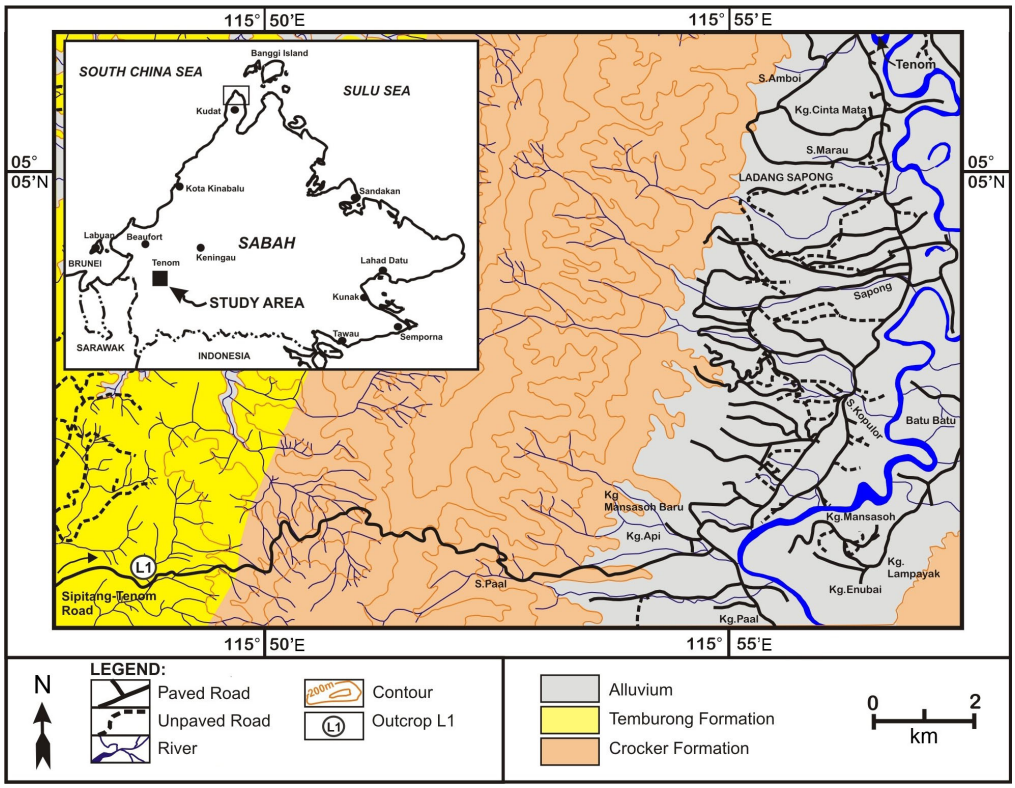

Figure 1: Maps showing the location in the study area and Geological Map of Tenom Area (modified after Wilson and Wong, 1964).

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 (Na_2CO_3) 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 Amrstrong 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

Figure 2: Photograph shows the outcrop of the study area. The light colour bed is siltstone and the gray colour bed is shale.

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)
Globigerina eamesi Blow, (Plate 1; 5a-b)
Globigerina 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)

Sampel TF0101 contains *Catapsydrax dissimilis* Cushman and Bermudez, *Globigerina ciperoensis* Bolli, *Globigerina eamesi* Blow, *Globigerina 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, Loeblich, and Tappan, *Globigerina connecta* Jenkins, *Globigerina eamesi* Blow, *Globigerina praebulloides* Blow, *Globigerinoides primordius* Blow, *Globigerinoides triloba* (Reuss), *Globoquadrina venezuelana* (Hedberg), *Globorotalia bella* Jenkins and *Praeorbulina sicana* (De Stefani) (Table 1). The occurrence of *Praeorbulina sicana and Globorotalia bella* suggests that the assemblage belongs to *Praeorbulina sicana* and *Catapsydrax dissimilis* Zone (N7) of Berggren *et al*. (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*.

	Planktonic Foraminifera Species	TF0101	TF0102
1	*Catapsydrax dismisslis*	●	●
2	*Catapsydrax unicavus*		●
3	*Globigerina ciperoensis*	●	
4	*Globigerina connecta*		●
5	*Globigerina eamesi*	●	●
6	*Globigerina praebulloides*	●	●
7	*Globigerinoides primordius*	●	●
8	*Globigerinoides triloba*		●
9	*Globoquadrina venezuelana*	●	●
10	*Globorotalia bella*		●
11	*Praeorbulina sicana*		●

Table 1: Distribution of planktic foraminifera species in the samples TF0101 and TF0102 in section L1.

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 thr 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*

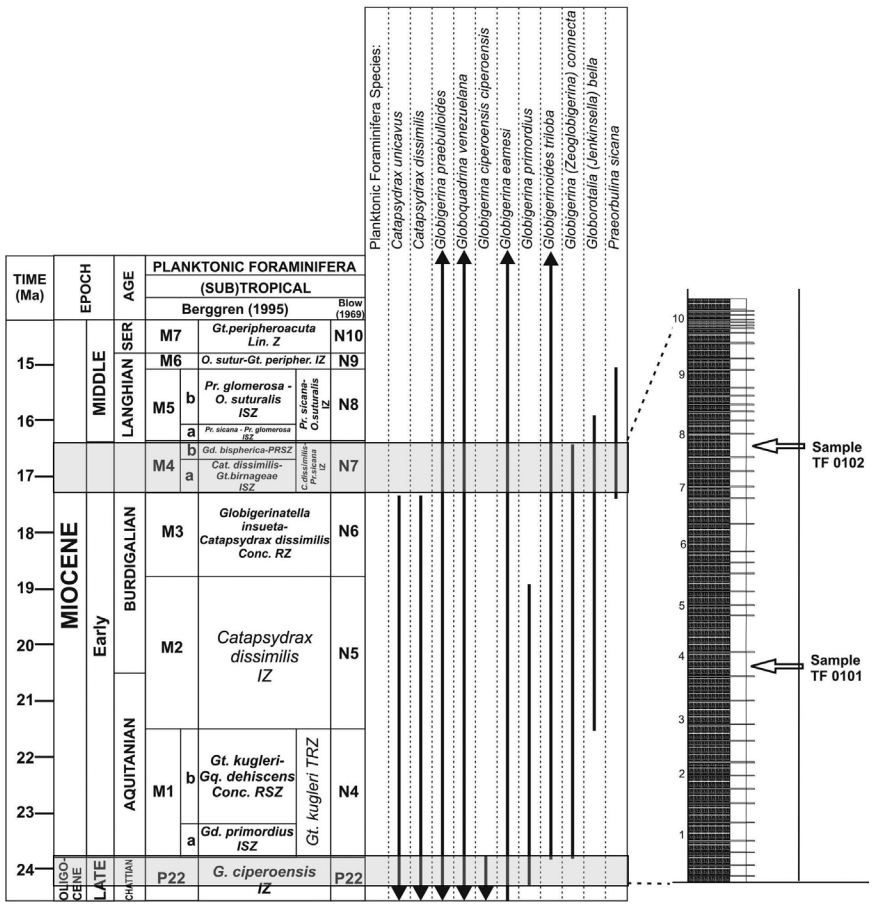

Figure 3: Lithology of a measured section at L1 (referred to Figure 1) and the stratigraphic distribution of some selected planktic forminifera.

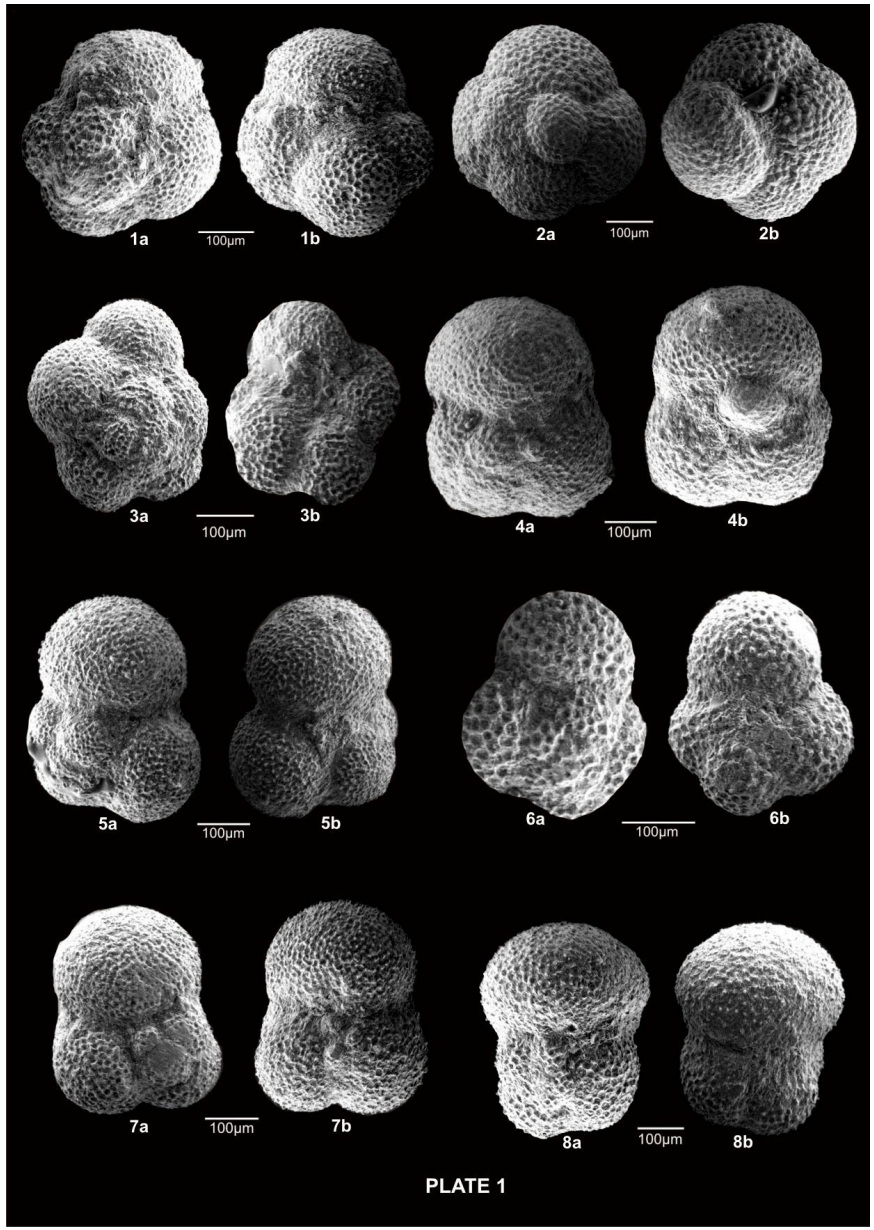

Plate 1: Ilustration of selected planktic foraminifera; 1(a-b) = *Catapsydrax dissimilis* Cushman and Bermudez, 2(a-b) = *Catapsydrax unicavus* Bolli, 3(a-b) = *Globigerina ciperoensis* Bolli, 4(a-b) = *Globigerina connecta* Jenkins, 5(a-b) = *Globigerina eamesi* Blow, 6(a-b) = *Globigerina praebulloides* Blow, 7(a-b) = *Globigerinoides primordius* Blow, 8(a-b) = *Globigerinoides triloba* (Reuss), (Plate 1; 8a-b).

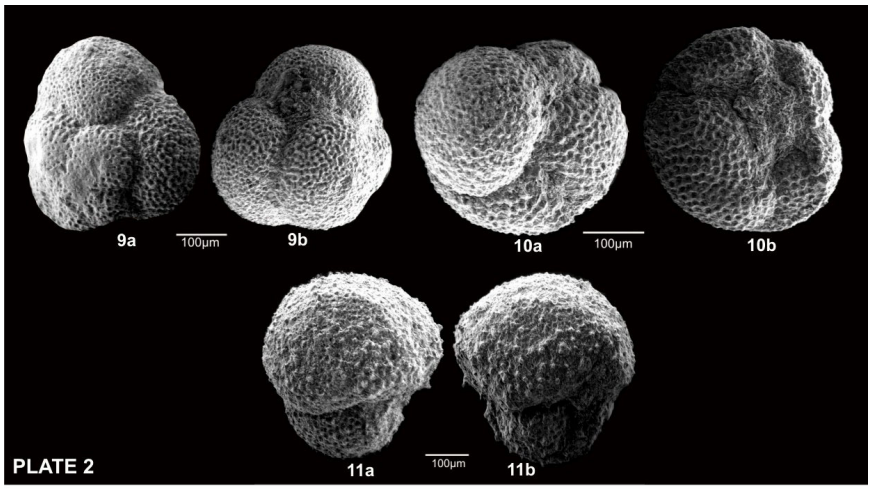

Plate 2: Ilustration of selected planktic foraminifera; 9(a-b) = *Globoquadrina venezuelana* (Hedberg), 10(a-b) = *Globorotalia bella* Jenkins, 11(a-b) = *Praeorbulina sicana* (De Stefani), (Plate 2; 11a-b).

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).

ACKNOWLEDGEMENTS

The first author would like to thank to Dr. Lee Chai Peng for critically reviewed the manuscript. Thanks to Mrs. Mala Karim for preparing the SEM photomicrograph for this research. The first author also wants to thank Universiti Malaysia Sabah for providing facilities and material for this research.

REFERENCES

Armstrong H.A. & Brasier M.D., 2005. Microfossils. 2nd edition. United Kingdom. Blackwell Publishing.

Basir Jasin, Sanudin Hj. Tahir & Tating, F. F., 1991. Late Eocene Planktonic Foraminifera from the Crocker Formation, Pun Batu, Sabah. Warta Geologi 17 (4), 187-191.

Berggren, W.A., Kent, D.V., Swisher III, C.C., Aubry, M.-P., 1995. A revised Cenozoic geochronology and chronostratigraphy In: Berggren, W.A., Kent, D.V., Aubry, M.-P., Hardenbol, J. (Eds.), Geochronology, Time Scales and Global Stratigraphic Correlation: A United Temporal Framework for an Historical Geology: SEPM Spec. Publ. 54. 129-212.

Brondijk, J.E., 1962. Reclassification of part of the Setap Shale Formation as Temburong Formation. British Borneo Geological Survey Annual Report for 1962. 56-60.

Bolli, H. M. & Saunders, J. B., 1985. Oligocene to Holocene low latitude planktic foraminifera, In: Bolli, H. M., Saunders, J. B., and Perch-Nilsen, K., eds., Plankton Stratigraphy. Cambridge. Cambridge University Press. 155-262.

Howell, D. G., & Normark, W. R., 1982, Sedimentology of submarine fans, In: Scholle, P. A., and Spearing, D. R. (eds.) Sandstone depositional environments, 31 of AAPG Memoirs: Tulsa, OK, AAPG, p. 365-404.

Hutchison, C.S., 1996. The 'Rajang accretionary prism' and 'Lupar Line' problem of Borneo. In: Hall, R. & Blundell, D. (Eds.), Tectonic Evolution of Southeast Asia. Geol Soc. of London Special Publication 106, 247-261.

Hutchison, C.S., 2005. Geology of North-West Borneo (Sarawak, Brunei and Sabah). Amsterdam. Elsevier.

Kennett, J. P. & Srinivasan, M., 1983. Neogene Planktonic Foraminifera: A Phylogenetic Atlas. Stroudsburg. Hutchinson Ross Publishing Co. p 265

Leong, K.M., 1999. Geological setting of Sabah. The Petroleum Geology and Resources of Malaysia. Petroleum Nasional Berhad (PETRONAS), Kuala Lumpur, chapter 21, pp. 475-497.

Mazlan Madon, 1997. Sedimentological aspects of the Temburong and Belait Formations, Labuan (offshore west Sabah, Malaysia). Geol. Soc. Malay. Bull. 41, 61-84.

Mazlan Madon, 1999. North Luconia Province. The Petroleum Geology and Resources of Malaysia, chapter 19, Petroliam Nasional Berhad (PETRONAS), Kuala Lumpur, pp. 443-454.

Normark, W.R. 1978. Fan valleys, channels, and depositional lobes on submarine fans: characters for recognition of sandy turbidite environments. AAPG Bull. 62, 912-931.

Rangin, C, Bellon, H., Benard, P., Letouzey, J., Muller, C. & Sanudin, T., 1990. Neogene arc-continent collision in Sabah, Northern Borneo (Malaysia). Tectonophysics, 183, 305-319.

Sanudin Hj. Tahir & Baba Musta, 2007. Pengenalan Kepada Stratigrafi. Penerbit Universiti Malaysia Sabah. Kota Kinabalu.

Stainforth, R. M., Lamb, J. L., Luterbacher, H., Beard, J. H., & Jeffords, R. M., 1975. Cenozoic planktonic foraminifera zonation and characteristics of index forms. Lawrence. University of Kansas Paleontological Contributions. 62. p. 1-425

Stauffer, PH., 1967. Studies in the Crocker Formation, Sabah. Borneo Reg. Malay. Geol Surv. Bull, 8, 1-13.

Tate, R. B. ,1994. The sedimentology and tectonics of the Temburong Formation – deformation of early Cenozoic deltaic sequence in NW Borneo. Geol. Soc. Malay. Bull. 35, 97-112.

Wilson, R.A.M., 1964. The geology and mineral resources of the Labuan and Padas Valley area, Sabah, Malaysia. Geological Survey of the Borneo Region of Malaysia, Memoir 17.

Manuscript received 27 January 2015
Revised manuscript received 10 September 2015