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Some Triassic Radiolarians from the Kodiang Limestone, northwest Peninsular Malaysia

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Abstract: The clastic and radiolarian chert sequence at the base of Bukit Kechil, is the only clastic interval in the Kodiang Limestone. The chert yielded eleven taxa of radiolarians i.e. *Entactinosphaera chiakensis, Entactinosphaera* sp,. *Entactinia nikorni, Thaisphaera minuta, Cenosphaera andoi, Cenosphaera* sp., *Pantanellium ? virgeum, Pantanellium* sp., *Acanthosphaera* sp A, *Acanthosphaera* sp B, and *Acanthosphaera* sp C. This assemblage is indicative of late Spathian age, Early Triassic. The sequence was deposited in a deeper environment compared to the limestone. The Kodiang Limestone was deposited on an unstable shelf environment.

Abstrak: Jujukan klastik dan rijang beradiolaria pada bahagian dasar Bukit Kechil, merupakan satu-satunya jujukan klastik yang terdapat pada Batu Kapur Kodiang. Rijang menghasilkan sebelas taksa radiolaria iaitu *Entactinosphaera chiakensis, Entactinosphaera* sp., *Entactinia nikorni, Thaisphaera minuta, Cenosphaera andoi, Cenosphaera* sp., *Pantanellium? virgeum, Pantanellium* sp., *Acanthosphaera* sp A, *Acanthosphaera* sp B, dan *Acanthosphaera* sp C. Himpunan ini menunjukkan usia Spathian akhir, Trias Awal. Jujukan ini diendapkan pada sekitaran lebih dalam berbanding dengan batu kapur. Batu Kapur Kodiang diendapkan dalam sekitaran pentas yang tak stabil.

INTRODUCTION

The Kodiang limestone was informally used by Burton (1973) to describe the occurrence of limestone hills in the Kodiang area. The Kodiang Limestone was formalised as a new lithostratigraphic unit by de Coo and Smit (1975) based on the the composite type section exposed at Bukit Kechil and Bukit Kalong. Gazdzicki and Smit (1977) described some Middle to Late Triassic foraminifera from the type section. Ishii and Nagomi (1966), Nagomi (1968), Koike (1973, 1982), Tamura *et al.* (1975), Metcalfe (1990, 1992) reported the occurrence of Triassic conodonts from the Kodiang Limestone. Basir Jasin *et al.* (1995) described some late Triassic radiolarian faunas from Bukit Kodiang. However, the age of the limestone changed after Metcalfe (1984) discovered the Late Permian and Early Triassic conodonts from Bukit Hantu.

Occurrence of chert in the Kodiang Limestone has been reported by de Coo and Smit (1975) and Kamal Roslan Mohamed *et al.* (1993). The radiolarian chert from Bukit Kodiang has been studied by Basir Jasin *et al.* (1995). Recently, we collected two chert samples from the clastic interval exposed at the base of Bukit Kechil. We managed to retrieve some fairly well-preserved radiolarian faunas.

GEOLOGICAL SETTING

The Kodiang Limestone is exposed at six isolated mogotes which rise steeply from flat-lying alluvium covered by rice-field in the vicinity of Kodiang town. The hills are Bukit Hantu, Bukit Kechil, Bukit Kalong, Bukit Kodiang, Bukit Mulong and Bukit Kepelu (Fig. 1). The limestone is gently dipping (20^0 -30^0) towards northeast. The lower part of the limestone is located at Bukit Hantu where Metcalfe (1984) discovered the Late Permian conodonts. The limestone is younging towards northeast and the top part is located at Bukit Mulong and Bukit Kepelu where the late Carnian to middle Norian conodonts were retrieved (Metcalfe, 1992). The lower boundary of the limestone is not exposed and the relationship with the underlying strata in not known.

de Coo (1975) recognised five rock types in the Kodiang Limestone; laminated limestone, intraformational breccias, black nodular mudstones, graded clastic limestone and limestone conglomerate. The laminated limestone was deposited in shallow marine shelf and the other rocks were deposited in alternating unstable and stable deeper marine environments (de Coo and Smit, 1975). Kamal Roslan *et al.* (1993) recognised ten limestone facies in the Kodiang Limestone, i.e. thinly bedded limestone-chert, biosparite limestone, micritic limestone, limestone breccia, black limestone, wavy laminated limestone, interbedded mudstone and calcareous sandstone, conglomeritic limestone, slump unit and dolomite facies. They concluded that the limestone was deposited in a shallow marine environment.

DISTRIBUTION OF CHERT IN THE KODIANG LIMESTONE

The chert is found as thinly bedded chert and chert nodules. The bedded chert is located at the base of Bukit Kechil and at Bukit Kodiang. Chert nodules are found in Bukit Hantu, Bukit Kechil, Bukit Kalong, Bukit Kodiang, and Bukit Kepelu. Some Late Triassic radiolarians were

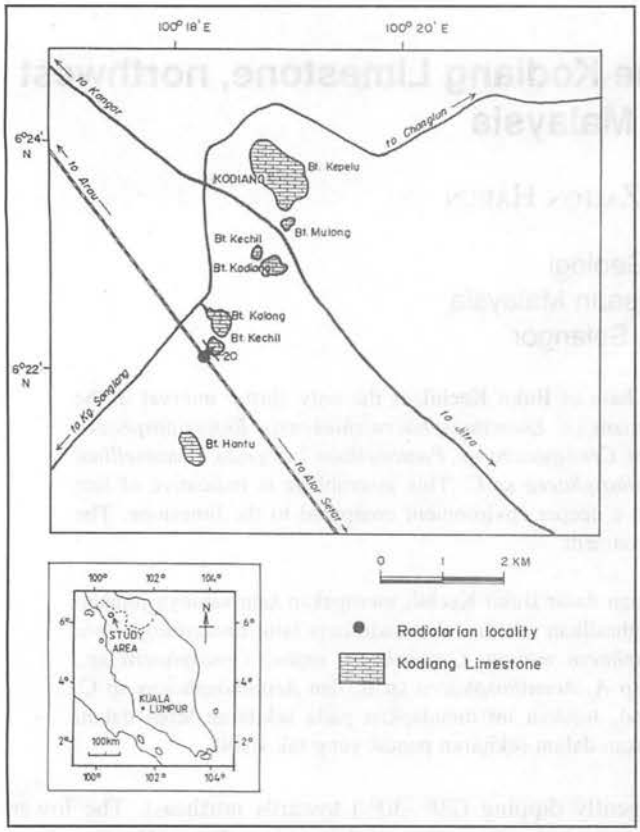

Figure 1. Map showing radiolarian chert locality.

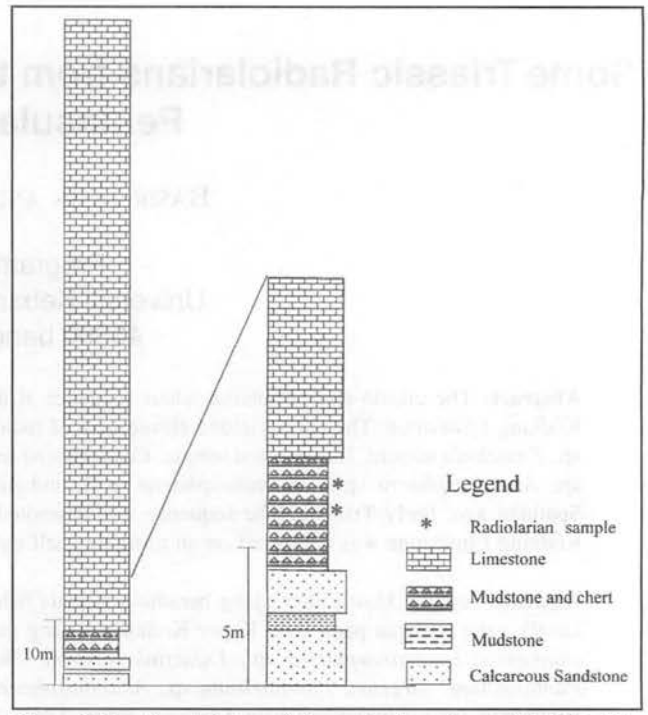

Figure 2. Stratigraphic log of the studied section at Bukit Kechil.

described by Basir Jasin *et al.* (1995) from Bukit Kodiang. No radiolarians were found from Bukit Hantu, Bukit Kalong, and Bukit Kepelu.

OCCURRENCE OF CHERT AT BUKIT KECHIL

Bukit Kechil is a small hill located south of Bukit Kalong. The limestone of Bukit Kechil is exposed at an abandoned quarry. The sequence consists of siliciclastic mudstone, flat to wavy laminated limestone, black lime mudstone with chert nodule, brecciated limestone, and massive limestone (de Coo and Smit, 1975; Kamal Roslan *et al.*, 1993). Bedded chert is found in siliciclastic mudstone sequence at the base of Bukit Kechil (Fig. 2). This is the only clastic interval observed in the Kodiang Formation. The sequence consists of thickly bedded calcareous sandstone interbeds with thin mudstone at the base and thinly bedded calcareous mudstone and sandstone interbeds with bedded chert at the top (Fig. 3).

The thickness of the individual bedded chert varies from 1 cm to 3 cm. The chert is hard and gray in colour. Two chert samples were collected from the outcrop.

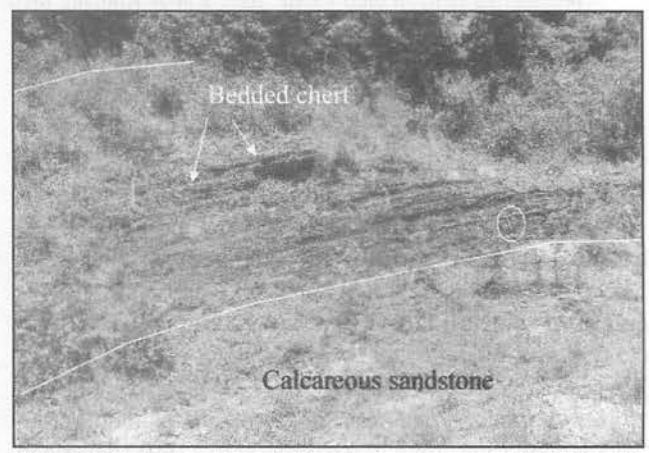

Figure 3. Outcrop of the clastic-chert sequence at Bukit Kechil. (Hammer in white circle as scale)

RADIOLARIAN FAUNAS AND GEOLOGICAL AGE

The two chert samples yielded several fairly well-preserved taxa of radiolarians. All the radiolarians belong to Suborder Spumellaria. The fauna is mainly of "Paleozoic type" (Sugiyama, 1992). The identified faunas are composed of:-

Entactinia nikorni Sashida & Igo (Pl. 1, figs. 1, 2)
Entactinosphaera chiakensis Sashida & Igo (Pl. 1, fig. 3)
Entactinosphaera sp. (Pl.1, fig. 4)
Thaisphaera minuta Sashida & Igo (Pl. 1, figs. 5, 6)
Pantanellium ? *virgeum* Sashida (Pl 2, fig. 1)
Pantanellium sp. (Pl. 2, fig. 2)
Cenosphaera andoi Sugiyama (Pl. 2, fig. 3)
Cenosphaera sp. (Pl. 2, fig. 4)
Acanthosphaera sp A (Pl. 2, fig. 5)
Acanthosphaera sp B (Pl. 2, fig. 6)
Acanthosphaera sp C (Pl. 2, fig. 7)

There are some new forms, which cannot be identified. They are probably new taxa.

Early Triassic radiolarians are very rare. Most of them have been recorded from Japan (Sashida, 1983; 1991; Sugiyama, 1992; Nagai and Mizutani, 1993; Kamata, 1999) and Thailand (Sashida and Igo, 1992). *Entactinia chiakensis*. *Entactinia nikorni*, and *Thaisphaera minuta* were first described by Sashida and Igo (1992) from a limestone hill at Khao Chiak near Patthalung, southern Thailand. They suggested the age of the limestone is latest Spathian to earliest Anisian based on the co-occurrence of some well-preserved conodonts *Neospathodus homeri* (Bender), *Neospathodus timorensis* (Nagomi) and *Neohindeodella aequiramosa* Kozur and Mostler. Sashida (1991) described *Pantanellium? virguem* from the Ogamata Formation, central Japan. The co-occurrence of *Pantanellium? virguem* and *Neospathodus* cf. *homer* (Bender) indicates an age of late Spathian, Early Triassic.

In central Japan, *Pantanellium? virgeum* and *Cenosphaera andoi* were reported from the *Parentactinia nakatsugawaensis* Assemblage Zone, late Spathian of Mt Kinkazan (Sugiyama,1992). Kamata (1999) discovered *Entactinosphaera chiakensis* and *Pantanellium? virgeum* from the *Parentactinia nakatsugawaensis* Assemblage Zone, late Spathian of the Kuzu area. All the Early Triassic radiolarians so far discovered, belongs to the *Parentactinia nakatsugawaensis* Assemblage Zone.

The occurrence of *Entactinia chiakensis*, *Entactinia nikorni*, *Thaisphaera minuta*, *Cenosphaera andoi* and *Pantanellium? virgeum* in the present material suggests that the assemblage represents the *Parentactinia nakatsugawaensis* Assemblage Zone. The zonal marker *Parentactinia nakatsugawaensis* is not found in the present in spite of careful examination of the samples. The other Early Triassic genera such as *Archaeosemantis* and *Cryptostephanidium* are also absent in the present material.

This is the first recorded Early Triassic radiolarians from the Peninsular Malaysia. Middle Triassic radiolarians were reported from the Semanggol Formation (Basir Jasin, 1997), and the Late Triassic fauna was reported from Bukit Kodiang. Early Triassic radiolarians are very rare and the diversity is also very low. The Palaeozoic radiolarians were wiped out by the Permo-Triassic catastrophic event. The emergence of new radiolarian taxa was very slow during the Early Triassic. Diversity of radiolarians increased during Middle and Late Triassic.

The overlying limestone at Bukit Kechil yielded some conodont elements; *Epigondolella mungoensis* (Diebel), *Glandigondolella tethydis* (Huckriede), *Paragondolella polygnathiformis* (Budurov and Stefanov) *Gondolella navicula* Huckriede which indicate late Ladinian or early Carnian (Koike, 1973; Tamura *et al.* 1975). Gazdzicki and Smit (1977) recorded some foraminifera from the top limestone unit of Bukit Kechil i.e. *Glomospira densa* (Pantic), *Glomospira gemerica* (Salaj), *Agathammina austroalpina* Kristan, Tollmann and Tollmann, *Ophthalmidium* sp., *Tolypammina gregaria* Wendt, *Endothyranella lombardi* Zaninetti and Bronnimann, *Endothyra kueperi* Oberhauser, *Involutina communis* (Kristan), and *Involutina gaschei* Koehn-Zaninetti and Bronnimann. This assemblage represents an age of early Anisian to Ladinian. It is evident that the age of Bukit Kechil ranges from late Spathian to Ladinian.

DEPOSIONAL ENVIRONMENT OF THE CHERT

At the base of Bukit Kechil, the clastic sequence comprises thinly bedded chert interbedded with mudstone and calcareous sandstone. The sequence is overlain by laminated limestone. The lithologic association of chert, carbonate and clastics is usually found in marginal basin. The chert – clastic sequence was deposited in a deeper environment and the limestone was deposited in shallow marine. The association of chert and shallow marine limestone indicates the inter-platform basin (Karl, 1989). This suggest that this area was unstable during the Triassic (de Coo, 1975).

CONCLUSION

The Radiolarian assemblage indicates that the age of the chert is late Spathian, Early Triassic. The chert was deposited in an inter-platform basin during the high siliceous productivity cause by the upwelling of nutrient rich deep water mass. The assemblage discovered at the base of Bukit Kechil was deposited in a deeper marine environment. A vertical succession from deep-water radiolarian chert and clastic upward to shallow laminated limestone, indicates a change in sea-level. This was related to lowering of sea level caused by tectonic uplift of the area.

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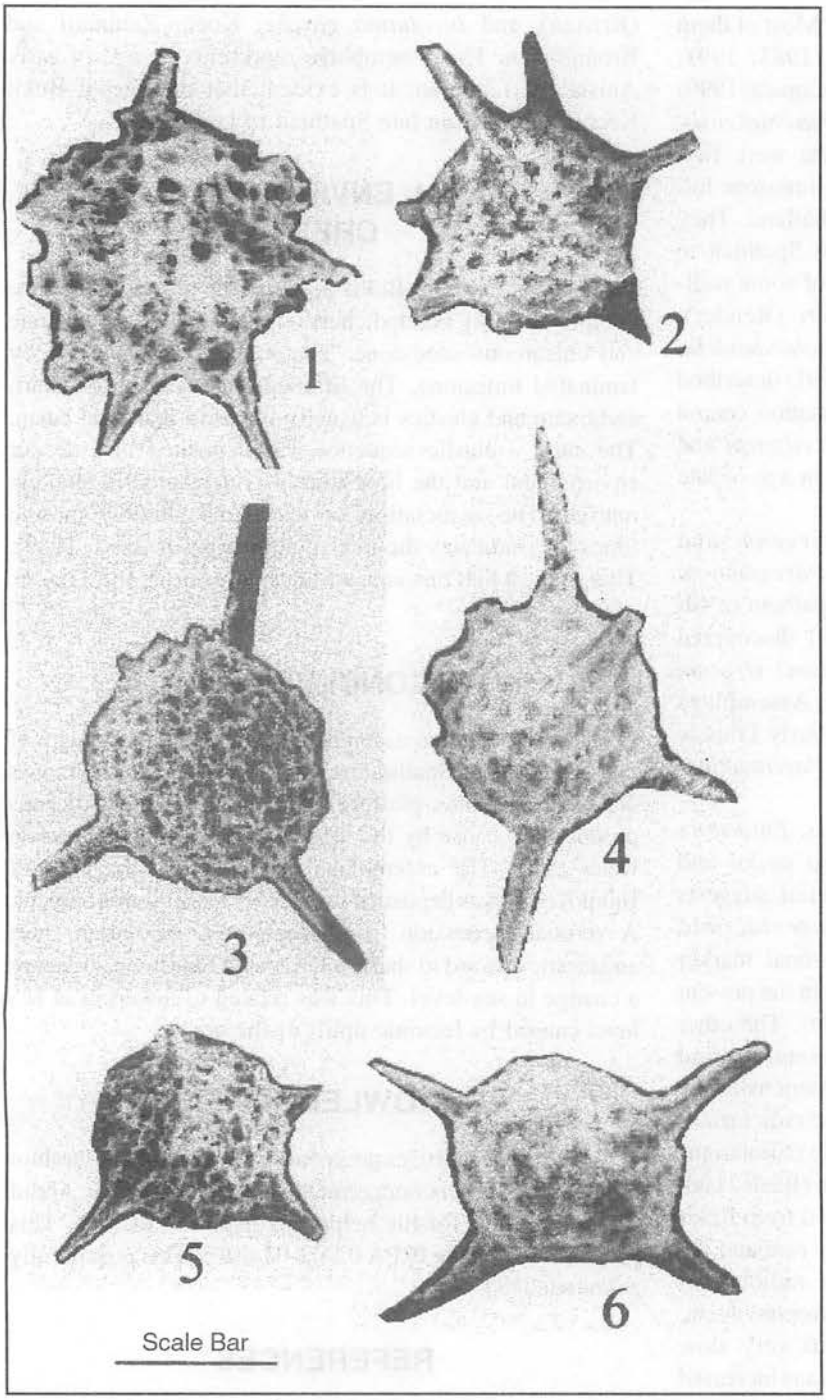

Plate 1. Radiolarians from the clastic-chert sequence. 1, 2. *Entactinia nikorni* Sashida & Igo (50μm); 3. *Entactinosphaera chiakensis* Sashida & Igo (100μm); 4. *Entactinosphaera* sp.(59μm); 5, 6. *Thaisphaera minuta* Sashida & Igo (100μm and 59μm respectively) (Scale bar in μm is indicated in the parenthesis).

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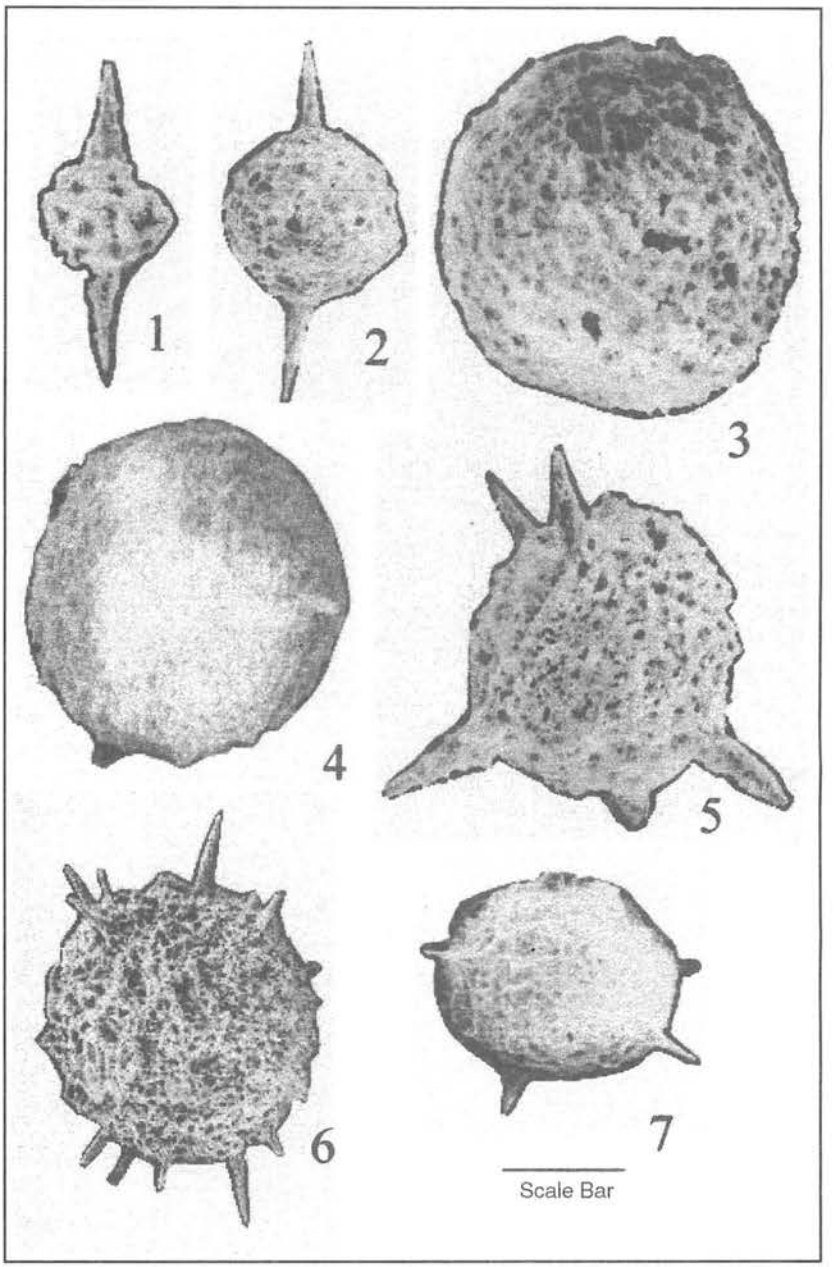

Plate 2. 1. *Pantanellium ? virgeum* Sashida (100μm); 2. *Pantanellium* sp. (111μm); 3. *Cenosphaera andoi* Sugiyama (80μm); 4. *Cenosphaera* sp. (100μm); 5. *Acanthosphaera* sp. A (67μm); 6. *Acanthosphaera* sp. B (133μm); and 7. *Acanthosphaera* sp. C (100μm) (Scale bar in μm is indicated in the parenthesis)

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