# Discovery of some Early Carboniferous Radiolarians from North Perak and their significance

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**Abstrak:** Dua puluh taksa radiolaria telah dikenal pasti daripada sampel yang diambil daripada singkapan rijang yang terdapat dalam batuan Paleozoik Atas di Utara Perak. Ini merupakan suatu penemuan baru fosil radiolaria di kawasan tersebut. Himpunan fosil radiolaria ini mewakili Zon Himpunan *Albaillella deflandrei* yang menunjukkan usia awal Tournaisian, Karbon Awal. Radiolaria yang berusia Tournaisian ini didapati daripada banyak lokasi di Semenanjung Malaysia dan juga di seluruh dunia. Pembentukan rijang beradiolaria pada masa Tournaisian berlaku secara global dan dikenali sebagai period hipersilika Tournaisian. Himpunan radiolaria ini mengisi wilayah paleobiogeografi dalam lautan Paleo-Tethys.

**Abstract:** Twenty radiolarian taxa were identified from a chert sample collected from an outcrop of Upper Paleozoic rocks in North Perak. This is a new discovery of radiolarians in the area. The radiolarian assemblage represents the *Albaillella deflandrei* Assemblage Zone that indicates an age of Tournaisian, Early Carboniferous. Tournaisian radiolarians were found in many localities in Peninsular Malaysia and worldwide. Development of radiolarian chert during the Tournaisian was a worldwide event and is known as a hypersiliceous period. The radiolarian assemblage occupied paleobiogeographic province in the Paleo-Tethys ocean.

## INTRODUCTION

Radiolarian cherts are found in several rock formations in Peninsular Malaysia. The cherts occur as minor parts of the Setul Formation, the Mahang Formation, the Baling Group, the Kubang Pasu Formation, the Kati Beds, the Semanggol Formation, and the Kodiang Limestone. Elsewhere, bedded chert are informally known as the Langkap chert unit, Pos Blau chert unit, and Genting Serampang chert unit (Basir Jasin *et al*., 1995a,1995b; Basir Jasin and Che Aziz Ali, 1977a; 1977b). Chert blocks are also common in the Bentong-Raub suture zone.

The age of the cherts from the Setul and the Mahang Formations is Early Silurian based on the occurrence of graptolites (Jones, 1981; Burton, 1988). The oldest radiolaria identified are from the Late Devonian chert of the Bentong-Raub Suture Zone (Spiller & Metcalfe, 1995; Spiller, 1996; Spiller 2002; Basir Jasin *et al*., 2004). Early Carboniferous radiolarian cherts were reported from the Langkap chert unit (Spiller & Metcalfe, 1995; Spiller, 1996; Spiller 2002; Basir Jasin & Che Aziz Ali, 1997b), the Kubang Pasu Formation (Basir Jasin, 1995: Basir Jasin and Zaiton Harun 2001b) the Kenny Hill Formation (Zaiton Harun & Basir Jasin, 2003) and some chert blocks from the Bentong-Raub suture zone (Spiller & Metcalfe, 1995; Spiller, 1996; Spiller 2002). Permian and Triassic cherts are found in the Semanggol Formation, the Pos Blau chert, and the Genting Serampang chert and the Kodiang Limestone ( Basir Jasin, 1994; Sashida *et al*., 1993; Spiller, 1996; Spiller, 2002; Basir Jasin *et al*. 1995: Basir Jasin, 1997; Basir Jasin & Zaiton Harun 2001a).

Recently, 15 chert samples were collected from bedded chert exposed at several outcrops along the Malaysian-Thai border road at Hulu Perak. The lithostratigraphy of the rocks has not been properly described and the rocks have not been properly dated. Several well-preserved radiolarians were retrieved from one chert sample collected from Kilometer 19 of the border road. The aim of the paper is to highlight the new discovery of radiolarians in the chert and to determine the age of the rock formation.

## GEOLOGICAL SETTING

The study area is located in the Pengkalan Hulu District, north Perak (Figure 1). The area consists of the Early Ordovician-Early Devonian Kroh Formation, the Upper Paleozoic rocks and the Tertiary Nenering beds.

The Kroh Formation is a part of the Baling Group consisting of sandstone, shale, chert, siltstone and limestone. The rocks are highly deformed and folded (Burton, 1986). This formation is equivalent to the Mahang Formation in Kedah. The Kroh Formation is overlain by the Upper Paleozoic rocks. The Upper Paleozoic rocks were considered as an extension of the Kati Formation (Teh & Azhar Hussin, 1994), which was first described as the Kati beds by Foo (1990) from the Kuala Kangsar-Taiping area. The rock sequence consists of bedded chert and intraformational chert conglomerate at the bottom followed by interbedded mudstone and sandstone and massive sandstone. It is difficult to assign the rock sequence to any of the established Carboniferous-Permian rock formations such as the Kubang Pasu and Kati Formations. The Kati beds are in many ways, very similar to the Kubang Pasu Formation (Wong, 1991). This rock sequence needs a detailed lithostratigraphic study because the rocks were deposited in a different sedimentary basin from that of the Kubang Pasu and the Kati Formations. It is better to assign these rocks to a new formation. The Kati Formation is underlain by the Kinta Limestone and the Kubang Pasu

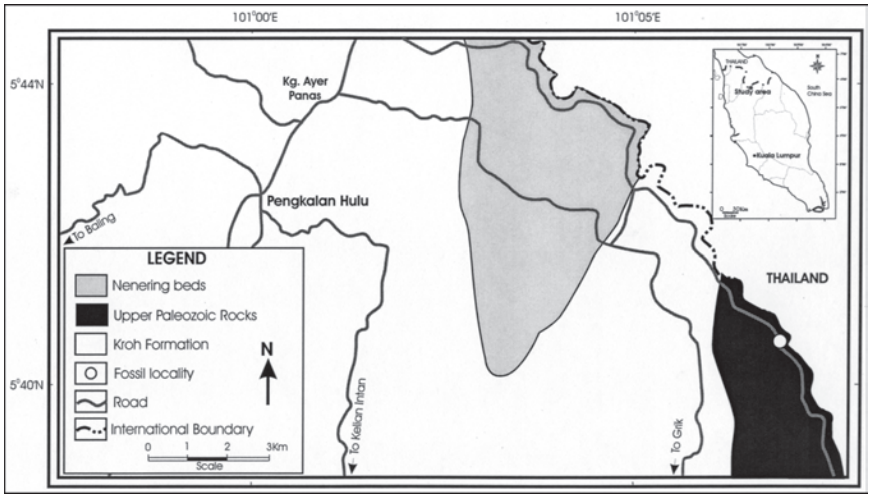


**Figure 1.** Geological map of North Perak showing the study area.

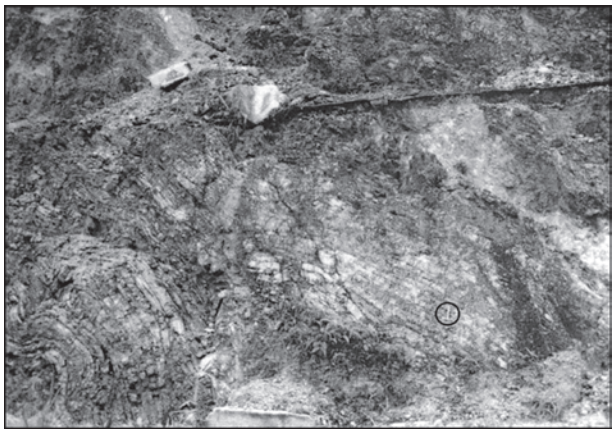

**Figure 2.** Photograph of the studied section showing bedded chert. (Hammer as a scale)

Formation in Kedah and in Perlis is underlain by the Mahang and the Setul Formations respectively. The Tertiary Nenering beds unconformably overlie the Upper Paleozoic rocks.

All the rock formations are well exposed along the Malaysian-Thai border road. The Upper Paleozoic sequence generally dips towards east. A chert sequence was found at two localities; near the army post (N 005° 40.59', E 101° 6.75') and at kilometer 19 (N 005° 40.47', E 101° 6.85') along the border road. Both chert sequences are actually of the same age. The top one was brought up by a series of thrust faults.

## DISTRIBUTION OF THE UPPER PALEOZOIC CHERT

The chert at the army post (km 18.9) consists of bedded chert at the bottom and is overlain by the intraformational chert conglomerate. The chert clasts in the conglomerate are elongated and parallel to the bedding. Ten samples were collected from this outcrop and radiolarians obtained are poorly preserved and cannot be identified.

The second outcrop at the kilometer 19 exposes an approximately 10 meters thick chert sequence. The chert is thinly bedded and interbeds with siliceous shale. The sequence is highly folded (Figure 2). There is a thrust fault zone just below the chert. Seventeen samples were collected from this locality.

## MATERIAL AND METHOD

A total of 27 samples were collected; 10 samples from the chert exposure near the army post (N 05° 40.59', E 101° 6.75') and 17 samples from kilometer 19 (N 05° 40.47', E 101° 6.85'). The samples were crushed into approximately 0.5 cm fragments. Each sample was soaked in dilute hydrofluoric acid to release radiolarians from the siliceous matrix. The residue was washed over a 45 mm aperture sieve and dried. The radiolarians were picked by using paint-brush and sorted on grid slide. The specimens were photographed by using scanning electron microscope.

## RESULT AND DISCUSSION

Most of the specimens found in the samples are crystallized and cannot be identified. Only one sample yielded exceptionally well-preserved specimens. Some specimens in the sample are also crystallized and very few are well preserved. Twenty radiolarian taxa are identified as follow: (Plates 1 and 2)

*Albaillella* cf. *perforata* s.l. Won (Pl. 1, fig 1)
*Archocyrtium lagabriellei* Gourmelon (Pl. 1, fig. 2)
*Archocyrtium pulchrum* Braun (Pl. 1, fig. 3)
*Archocyrtium venustum* Cheng (Pl. 1, fig. 4)
*Astroentactinia biaciculata* Nazarov (Pl. 1, figs.5, 6)
*Astroentactinia digitosa* Braun (Pl. 1, figs. 7, 8)
*Astroentactinia mirousi* Gourmelon (Pl. 1, figs. 9, 10)
*Astroentactinia multispinosa* Won (Pl. 1, figs.11, 12)
*Astroentactinia stellaesimilis* Won (Pl. 1. fig. 13)
*Belowea hexaculeata* Won (Pl. 1, fig. 14)
*Belowea variabilis* Ormiston & Lane (Pl. 2, fig.1)
*Ceratoikiscum berggreni* Gourmelon (Pl. 2, fig. 2)
*Palaeoscenidium cladophorum* Deflandre (Pl. 2, fig. 3)
*Pylentonema antiqua* Deflandre (Pl. 2, fig. 4)
*Stigmosphaerostylus brilonensis* (Won) (Pl. 2, fig. 5)

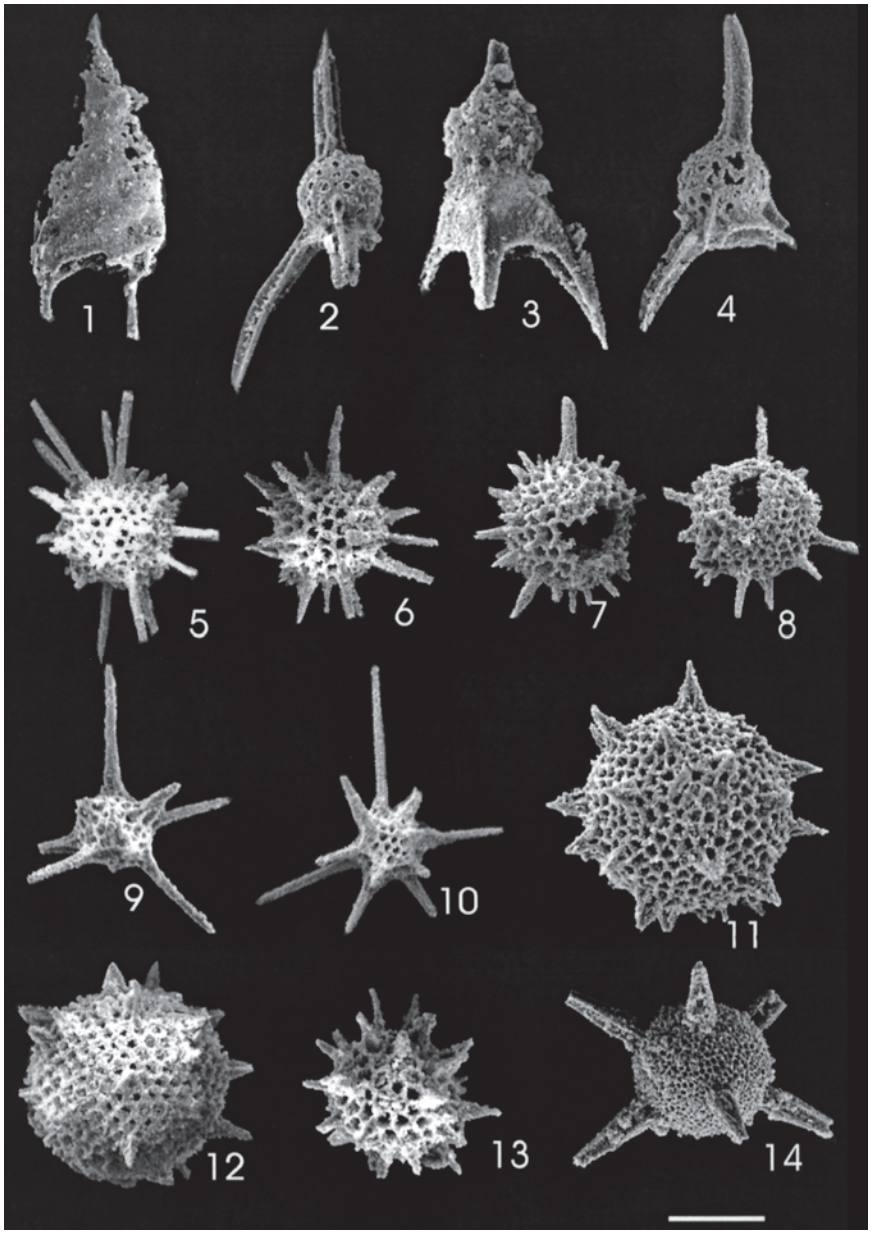


**Plate 1.** Scale bar in μm is indicated in the parentheses.

1. *Albaillella* cf. *perforata* s.l. Won (100 μm)
2. *Archocyrtium lagabriellei* Gourmelon (100 μm)
3. *Archocyrtium pulchrum* Braun (50 μm)
4. *Archocyrtium venustum* Cheng (100 μm)
5, 6. *Astroentactinia biaciculata* Nazarov (100 μm and 75 μm respectively)
7, 8. *Astroentactinia digitosa* Braun (100 μm)
9, 10. *Astroentactinia mirousi* Gourmelon (100 μm)
11, 12 *Astroentactinia multispinosa* Won (75mm and 80 μm respectively)
13. *Astroentactinia stellaesimilis* Won (75 μm)
14. *Belowea hexaculeata* Won (125 μm)

*Stigmosphaerostylus tortispina* (Ormiston & Lane) (Pl. 2, fig. 6, 7)
*Stigmosphaerostylus variospina* (Won) (Pl. 2, figs. 8, 9)
*Stigmosphaerostylus vulgaris* (Won) (Pl. 2, figs. 10, 11)
*Trilonche altasulcata* (Won) (Pl. 2, fig. 12)
*Triaenosphaera* sp. (Pl. 2, fig. 13)

The radiolarian assemblage is very much similar to those described from the Early Carboniferous of Germany (Won, 1983; Braun, 1990), France (Gourmelon, 1987) and Spain (O'Dogherty *et al*., 2000) with the exception that the present material lacks the zonal marker *Albaillella deflandrei* which is widely used in the radiolarian biostratigraphy. The only *Albaillella* found in the present material is a poorly preserved specimen of *Albaillella* cf. *perforata* s.l. Won. The variations in specific diversity of the taxa may be due to the state of preservation. The spherical spumellarians are more resistant compared to the delicate albaillellarians. *Astroentactinia* and *Stigmosphaerostylus* are the most common genera in the present material.

The age of the assemblage is determined by looking at the stratigraphic distribution of some selected taxa from the studies of Won (1983), Braun (1990), Braun & Schmidt-Effing (1993), and Gourmelon (1987). The absence of zonal markers such as *Albaillella paradoxa*, *Albaillella deflandrei* and *Albaillella indensis* does not allow a proper age determination.

The distribution of some selected species (Figure 3) gives some clues about the age of the present assemblage. The assemblage belongs to *Albaillella deflandrei* Assemblage Zone of Braun and Schmidt-Effing (1993), which is late Tournaisian, Tn3 Early Carboniferous.

Early Carboniferous cherts in Peninsular Malaysia are found in the Langkap chert (Spiller & Metcalfe, 1995; Spiller 1996; Spiller 2002; Basir Jasin and Che Aziz Ali, 1997b), the Kubang Pasu Formation (Basir Jasin, 1995:

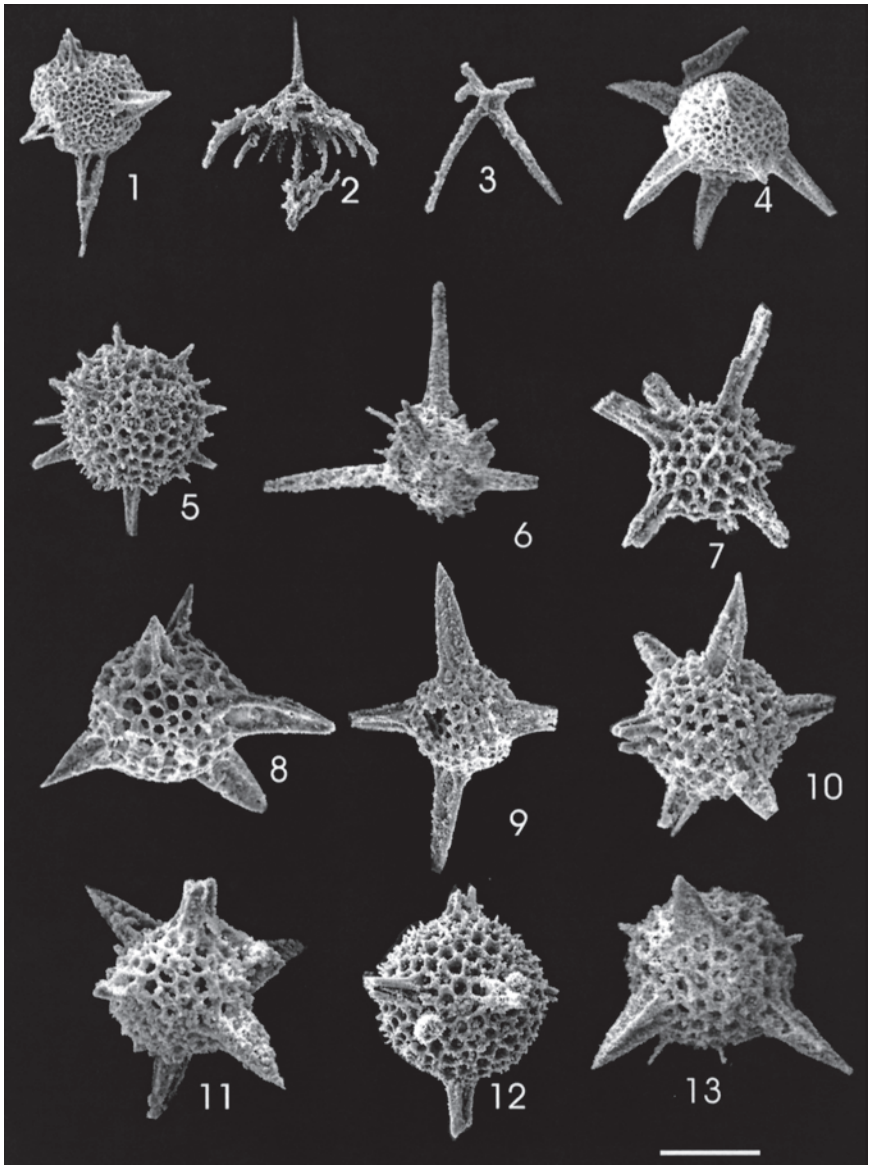


**Plate 2.** Scale bar in μm is indicated in the parentheses.

1. *Belowea variabilis* Ormiston & Lane (100 μm)
2. *Ceratoikiscum berggreni* Gourmelon (100 μm)
3. *Palaeoscenidium cladophorum* Deflandre (50 μm)
4. *Pylentonema antiqua* Deflandre (100 μm)
5. *Stigmosphaerostylus brilonensis* (Won) (100 μm)

6,7. *Stigmosphaerostylus tortispina* (Ormiston & Lane) (75 μm)

8, 9. *Stigmosphaerostylus variospina* (Won) (75 μm and 100 μm respectively)

10, 11. *Stigmosphaerostylus vulgaris* (Won) (75 μm)

12. *Trilonche altasulcata* (Won) (100 μm)
13. *Triaenosphaera* sp. (75 μm)

Basir Jasin & Zaiton Harun 2001b) the Kenny Hill Formation (Zaiton Harun & Basir Jasin, 2003) and some chert blocks from the Bentong-Raub suture zone (Spiller & Metcalfe, 1995; Spiller, 1996; Spiller 2002). Most of the cherts are mainly associated with clastic sediments such as mudstone and shale. This rock association is known as a chert shale association (Karl, 1989) or continental chert association (Jones & Murchey, 1986). This rock association indicates that the depositional environment was located in a basin very close to the continental margin, which episodically supplied the clastic material. The absence of volcanic material suggests that the basin was close to a passive margin.

Early Carboniferous radiolarian chert deposits have been reported from southwestern China (Wu *et al*., 1994), Thailand (Sashida *et al.*, 2002), eastern Australia (Aitchison & Flood, 1990), Germany (Won, 1983; Braun 1990; Braun, & Schmidt-Effing 1993), France (Gourmelon 1987), Spain (O'Dogherty *et al*., 2000), Turkey (Holdworth, 1973), and southern North America (Cheng, 1986, Schwartzapfel & Holdworth, 1996). Most of the Early Carboniferous chert localities worldwide are located at the low latitude regions. Racki & Cordey (2000) have recognized Tournaisian as one of the main hypersiliceous periods. This period coincides with a cool interval. The worldwide occurrence of radiolarian chert deposits of that age indicates higher radiolarian productivity, which is usually tied to the increase of nutrient supply during the Early Carboniferous. The productivity was probably related to upwelling of nutrient rich cold deep-water mass coming from the north-polar region, which developed during the cool interval.

The composition of Early Carboniferous radiolarians from the Asian region, are closely similar to those of the western Europe and slightly different from those of North America. This similarity in radiolarian composition of Asian and western Europe suggests that the radiolarians were occupied the same palaeobiogeographic province in the Palaeo-Tethys ocean (Figure 4). The south North

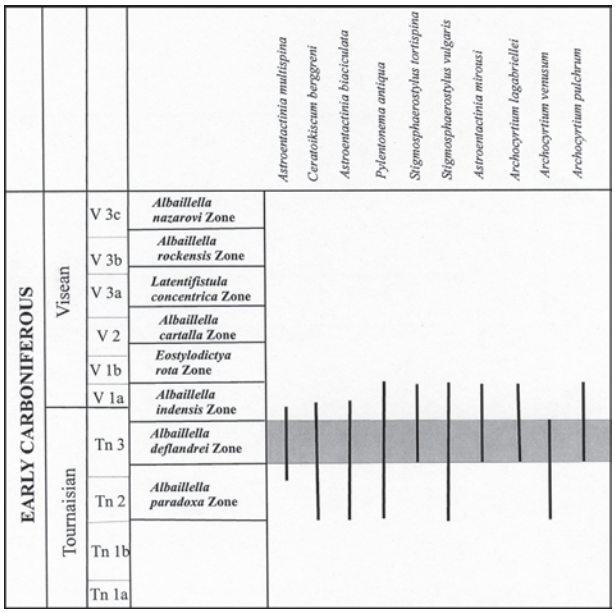


**Figure 3.** Stratigraphic distribution of selected taxa based on the biostratigraphic scheme of Braun & Schmidt-Effing (1993).

American paleobiogeographic province was partially isolated from the Palaeo-Tethys.

## CONCLUSIONS

The Upper Paleozoic chert-siliciclastic rocks in North Perak were deposited in a different sedimentary basin from the Kubang Pasu and Kati Formations. These rocks need to be properly described and mapped. The chert sequence yielded twenty taxa of radiolarians, which are very well-preserved. The radiolarian assemblage belongs to *Albaillella deflandrei* Assemblage Zone, Tournaisian, Early Carboniferous. The chert sequence was deposited in a basin on a passive continental margin. The chert sequence was deposited during the Tournaisian hypersiliceous period, which coincides with a cool interval. The worldwide occurrence of chert could be related to the increase of nutrients, which triggered the high productivity of radiolarians. There were two paleobiogeographic provinces developed during the Tournaisian; the Palaeo-Tethys and the south North America palaeobiogeographic provinces. The radiolarians in this study belong to the Palaeo-Tethys province.

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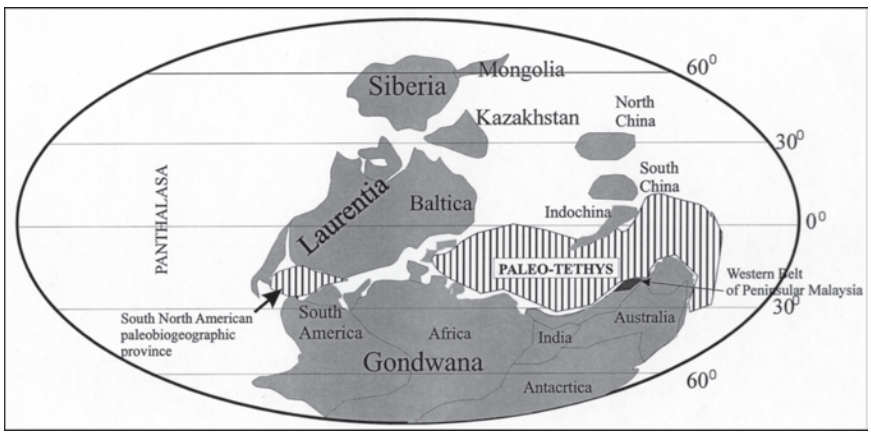


**Figure 4.** Paleogeographic map showing the radiolarian palaeo-geographic province during Tournaisian (Modified after Metcalfe, 1996).

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