

Research paper

Late Permian and Early to Middle Triassic radiolarians from the Hat Yai area, southern peninsular Thailand: Implications for the tectonic setting of the eastern margin of the Sibumasu Continental Block and closure timing of the Paleo-Tethys



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ABSTRACT

The fine clastic and siliceous sedimentary successions distributed in the Hat Yai area, southeastern peninsular Thailand were examined using radiolarian biostratigraphy, lithology, and stratigraphy. The studied succession was essentially divided into two kinds of fine-grained sedimentary rock units: the lower shale unit and the upper chert unit. The lower shale unit and the upper chert unit yielded late Middle to early Late Permian and Early to Middle Triassic radiolarians, respectively. We clarified that the sedimentary rocks distributed in the study area are not entirely Carboniferous, but contain some sediments from the Permian and Triassic. This age determination suggests that the clastic–chert succession distributed in the study area should be distinguished from the Carboniferous Yaha Formation and correlated with the Permian to Triassic Semanggol Formation. Lithological change with increasing siliceous composition was observed in the uppermost part of the lower shale unit, and the geological age based on the radiolarians indicates a nearly conformable stratigraphic relationship for the lower shale unit and the upper chert unit. The stratigraphy and lithology of the Permian to Triassic succession in the study area, together with geological correlation around southernmost Thailand and northern Malaysia, suggest that the Triassic chert should be interpreted as continental slope sediments overlying Permian clastic and/or calcareous facies, rather than typical pelagic deep-water sediments formed on an abyssal plain. The depositional environment of the chert in this area was likely restricted to the vicinity of a continental slope. Considering with the wide distribution of Triassic platform carbonates over southeastern peninsular Thailand, the continental margin of the Sibumasu along the Paleo-Tethys was represented by a stable passive margin during the Middle–early Late Triassic time. On the basis of the sedimentary setting and stratigraphy in the Permian and Triassic, it is suggested that the closure of the Paleo-Tethys between the Sibumasu and Indochina continental blocks took place at least after the Middle Triassic in southeastern peninsular Thailand.

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1. Introduction

In order to understand the geotectonic history of Thailand, several models of tectonic subdivisions have been proposed (e.g. Bunopas, 1981; Metcalfe, 1988, 1999; Barr and Macdonald, 1991; Ueno, 1999, 2002; Charusiri et al., 2002; Sone and Metcalfe, 2008; Ueno and Charoentitirat, 2011) based on Paleozoic and Mesozoic stratigraphy and micropaleontology, represented by foraminiferal and radiolarian biostratigraphy, paleobiogeography, the tectonic settings of granitoids,

ultramafic rocks indicative of suture lines, and paleomagnetic data (Fig. 1A). These geotectonic interpretations and tectonic subdivisions in mainland Thailand have been refined by studies from northern Thailand, where Paleozoic to Mesozoic basement rocks of the Sibumasu Continental Block and oceanic rocks, such as radiolarian bedded chert and seamount-type carbonate rocks, are widely distributed.

The geological map produced by the Department of Mineral Resources (DMR) of Thailand indicates that peninsular Thailand, which is south of the Three Pagodas Fault Zone, is occupied by Pre-Cambrian and Paleozoic to Mesozoic basement rocks. Furthermore, most of the peninsula lies within the Sibumasu Continental Block, except for the southeastern tip east of the Bentong–Raub Suture that is the boundary

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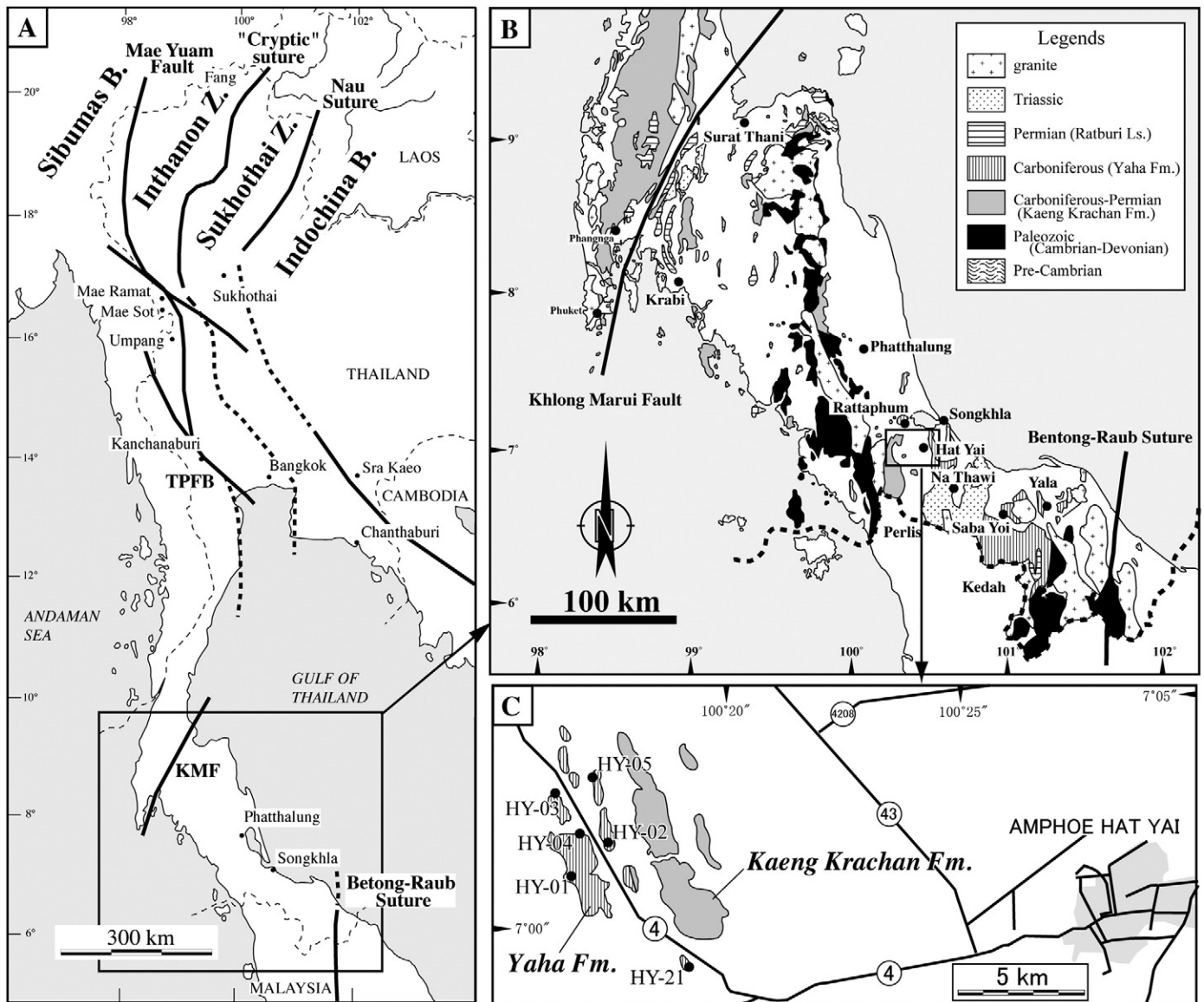


Fig. 1. (A) Outline map showing the tectonic subdivision of mainland and peninsular Thailand, (B) outline geological map of peninsular Thailand indicating the location of the study area, and (C) index map of Hat Yai, Songkhla Province, showing the distribution of the Yaha and Kaeng Krachan formations and the location of the study sections.

between the Sibumasu and Indochina continental blocks (Fig. 1B). Recently, Paleozoic strata in peninsular Thailand were well documented and summarized by Hansén and Wemmer (2011), Ridd (2009, 2011), and Ueno and Charoentitirat (2011). According to these studies, Carboniferous–Permian strata are widely distributed in the upper peninsula, which is north and west of the Khlong Marui Fault, but are less widespread in the lower peninsula southeast of the Khlong Marui Fault (Fig. 1B). The stratigraphy, lithology, and sedimentary environments of the Carboniferous–Permian Khuan Klang Formation, Kaeng Krachan Group, and Permian Ratburi Limestone were documented and discussed in these studies. These Carboniferous–Permian successions possess gross tectono-stratigraphic and faunal similarities to the basins of NW Australia and strongly suggest that the origin of the Sibumasu Block was off the northwestern Australian continental margin of Gondwanaland (e.g., Metcalfe, 1988; Ridd, 2009). They have also discussed about the sedimentary environments of the Paleozoic sediments. For example, the Kaeng Krachan Group represents rift-filling sediments under a developing extensional fault system during the separation of Sibumasu from Gondwana (Ridd, 2009, 2011), and the

Ratburi Limestone was ubiquitously deposited on the Sibumasu Block to form a wide carbonate platform in the late Early to Late Permian (Ueno and Charoentitirat, 2011).

In contrast, geological information (e.g. stratigraphy and lithology) is scarce regarding the relatively deeper fine clastic and siliceous rocks that are mainly distributed in the southeastern part of the lower peninsula from Hat Yai in Changwat Songkhla to the Bentong–Raub Suture (Fig. 1B). Carboniferous, Permian, and Triassic radiolarians were reported from bedded chert and siliceous rocks (Sashida et al., 2000, 2002; Kamata et al., 2008, 2009); however, the stratigraphy and depositional environment have not been fully established. In particular, the Triassic succession distributed in this area is crucial for correlation with the Permo-Triassic Semanggol Formation, which is widely distributed in northern peninsular Malaysia, and to understand the tectonic setting of the eastern margin of the Sibumasu Continental Block and the collision and closure time of the Sibumasu and Indochina continental blocks.

In the course of mapping the 1:50,000 Hat Yai Quadrangle (Sardud and Saengsrirachan, 2002), directed by the Geological Survey Division, Department of Mineral Resources (DMR), Thailand, late Middle Permian

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