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Middle–Late Devonian radiolarians from Klaeng District, Rayong Province, southeastern Thailand: Geotectonic significance of the Rayong area as a continental margin of the Sibumasu Block

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ABSTRACT

A fine clastics–siliceous succession exposed at Laem Krabang Phet, approximately 20 km southwest of Klaeng, Rayong area, southeastern Thailand was examined based on lithology, radiolarian biostratigraphy, and geological correlation. In the study section, thinly bedded chert layers are intercalated with black carbonaceous shale, light-colored tuffaceous shale, brown glassy tuff, and quartz-rich sandstone layers. A horizon of the chert in the section yielded poorly preserved radiolarians, however, several forms including *Palaeoscenidium cladophorum* Deflandre, *Stigmosphaerostylus* cf. *pusilla* (Hinde), and Entactiniidae gen. et spp. indet. were identified. This fauna is probably referable to the Middle–Late Devonian. The study section had been assigned to various stratigraphic units, such as Silurian–Devonian or Carboniferous–Permian, due to a poor fossil occurrence. However, the occurrence of the Devonian radiolarians in this study provides concrete evidence for the sedimentary age of the succession, and supports assignment to the Silurian–Devonian. Although the study succession exposed at Laem Krabang Phet is coeval with the Devonian part of the Fang chert, northern Thailand, the lithological assemblage is dissimilar, and the post-Devonian radiolarian chert is absent. These lithological, chronological, and stratigraphic results indicate that the depositional environment of the study section was close to the continental margin, such as a continental slope or rise.

1. Introduction

Since first introduced the use of plate tectonics to interpret the geological evolution of Thailand (e.g., Mitchell, 1977; Bunopas, 1981), several models have been proposed to elucidate the geotectonic subdivision of this country and adjacent areas such as western Yunnan and Malaysia (e.g., Metcalfe, 1988, 1999; Barr and Macdonald, 1991; Ueno, 1999, 2002; Ueno and Hisada, 1999; Charusiri et al., 2002; Sone and Metcalfe, 2008; Sone et al., 2012). Some initial models proposed the simple scenario that mainland Thailand consists of two principal continental blocks: the Sibumasu in the west of the Nan Suture and Indochina in the east of the Nan Suture. The Nan Suture was interpreted as a closed remnant of the Paleo-Tethys Ocean that once existed between the two continental blocks. Recent advances in foraminiferal and radiolarian biostratigraphy, Paleozoic and Mesozoic stratigraphy, the tectonic settings of granitoids, and the geotectonic origin of ultramafic rocks that are distinctive of suture lines have made it possible to establish a new geotectonic subdivision in Thailand. Ueno (2002) and Ueno and Charoentitirat (2011) proposed a new tectonic scheme for mainland Thailand, dividing it into three geotectonic units. From west to east, these include the Sibumasu Block, the Sukhothai Zone, and the Indochina Block, which are separated by the Chiang Rai Tectonic Line and the Nan-Uttaradit Suture, respectively (Fig. 1). In addition, the peculiar Inthanon Zone is recognized in the eastern part of the Sibumasu Block in northern Thailand, where Paleo-Tethyan oceanic rocks are widely distributed as tectonic slices. This geological peculiarity in northern Thailand is represented by the existence of oceanic materials of

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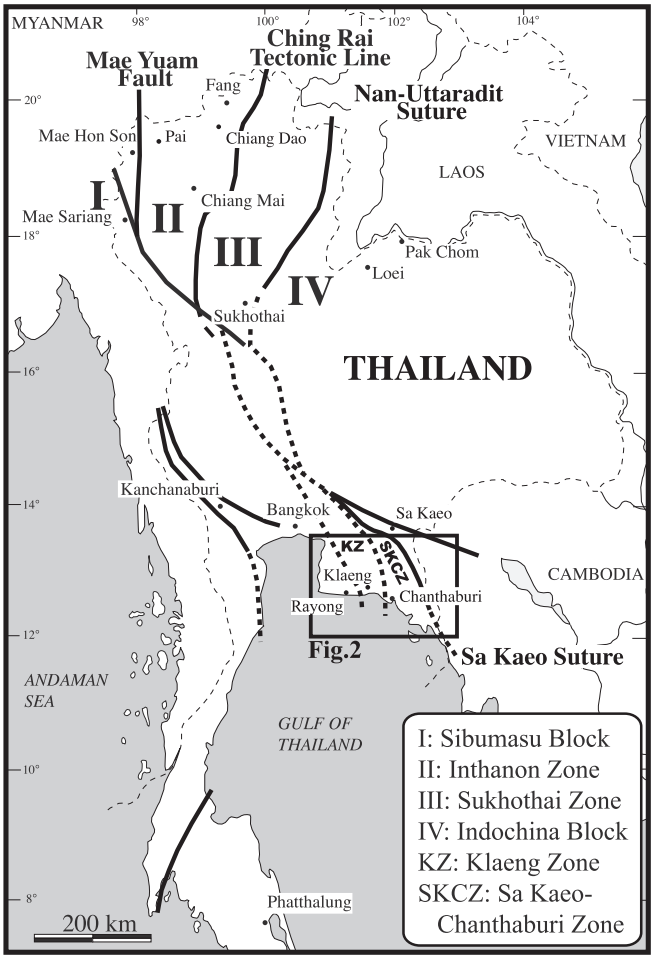

Fig. 1. Tectonic division of mainland Thailand (after Ueno and Charoentitirat, 2011), showing the study area of Rayong–Klaeng–Chanthaburi, southeastern Thailand.

seamount-type limestones and pelagic radiolarian cherts accompanied by oceanic basaltic rocks; all thrust over the basement rocks of the Sibumasu Block (e.g., Caridroit et al., 1992; Ueno, 2002).

Recently, geological features and kinematics of the tectonic mélange that resulted from oceanic plate subduction have been clarified in northern Thailand (Hara et al., 2009). The distribution and broad correlation of the accreted oceanic materials as an accretionary complex are important for understanding the development of the continental margin during the subduction of the oceanic plate. As mentioned above, the geotectonic subdivisions in northern Thailand are now better understood. However, the tectonic subdivisions of central and southeastern Thailand are still poorly documented, except some recent studies (Ueno et al., 2012; Sone et al., 2012), due mainly to extensive coverage of the basement rocks by younger deposits and disruption of them by major NW-SE strike-slip faults (Morley et al., 2011; Ridd, 2012). Moreover, unlike in northern Thailand, there is no true oceanic rock of Paleo-Tethys origin in these regions (Ueno and Charoentitirat, 2011; Ueno et al., 2012). In addition to the geotectonic divisions, the origin and geotectonic significance of the rocks in the area such as depositional environment, deformation features, and emplacement processes are not yet fully understood.

We examined Paleozoic and Mesozoic stratigraphy, lithology, and radiolarian ages from siliceous rocks distributed in southeastern Thailand to clarify the geotectonic associations of this area as well as the southern extensions of the geotectonic units of northern Thailand (Figs. 1 and 2). Middle–Late Devonian radiolarians were recovered from well-bedded siliceous rocks distributed in the southwest of Klaeng, Rayong Province. In this study, we report the lithology and age of the Radiolaria-bearing rocks and discuss regional stratigraphy and geotectonic significance of the Rayong region.

2. Geological outline of southeastern Thailand

Rocks distributed in southeastern Thailand (Fig. 2) were divided into fundamental geotectonic units from west to east (Ueno and Charoentitirat, 2011): the Sibumasu Block, the Klaeng Zone, the Sa Kaeo-Chanthaburi Zone, and the Indochina Block. A similar geotectonic division that consisting of six N-S tectono-stratigraphic belts (I–VI belts from west to east) was proposed by Ridd (2012). Hereinafter, the outlines explain according to the division of Ueno and Charoentitirat (2011).

The Indochina Block (Indochina domain), which is known as a Cathaysian continental block, is separated from the Sa Kaeo-Chanthaburi Zone by the Sa Kaeo Suture (Fig. 2). The Sa Kaeo-Chanthaburi Zone is characterized by the distribution of Triassic siliceous to fine siliciclastics (the Noen Po and Pong Nam Ron formations) and the Sa Kaeo-Chanthaburi Accretionary Complex (Chutakositkanon and Hisada, 2008), which corresponds to the Thung Kabin Mélange described by Hada et al. (1999). The Klaeng Zone is primarily characterized by the distribution of Permian to Triassic shallow marine siliciclastic and carbonate strata. Ueno and Charoentitirat (2011) stated that the Klaeng Zone is equivalent to the Sukhothai Zone based on these lithological and faunal similarities. Sone and Metcalfe (2008) and Sone et al. (2012) united the Klaeng Zone and the Sa Kaeo-Chanthaburi Zone into the Chanthaburi Terrane, but the terrane has clearly shown composite features in this case, mixing several geological units that are disparate in view of tectono-stratigraphic origin.

The Sibumasu Block (Sibumasu domain) is separated from the Klaeng Zone (Sukhothai Arc domain) by the cryptic Klaeng Fault, and is equivalent to the area west of the Klaeng Tectonic Line described by Sone and Metcalfe (2008) and Sone et al. (2012). Paleozoic and Mesozoic sedimentary rocks and Triassic granitoids have been assigned as some of primary basement rocks of the Rayong area (Fig. 2). Mapping by Nakinbodee et al. (1984) and the Department of Mineral Resources (DMR) (1999) previously determined that the geology of the basement rocks in this region consists of Precambrian gneiss, the Silurian–Carboniferous Kaeng Krachang and Kanchanaburi formations, Carboniferous–Permian siliciclastics and carbonates, and Permo-Triassic volcanogenic clastics. Stratigraphic relationships, ages, and the structural contacts of these geological units, however, have not been fully documented due to insufficient study of the detailed local geology. The geological age and stratigraphic position of some of these lithological units were recently reinterpreted (Geard, 2008; Ridd, 2011; Ueno and Charoentitirat, 2011). The DMR (1999) shows the wide distribution of a Carboniferous-Permian succession consisting of limestone and siliciclastics over the western, coastal, part of the region. Recently, Ridd (2011, 2012) named the former the Ko Sichang Limestone and the latter the Sattahip Formation, contending that all of these strata are Lower Paleozoic. In the southeast portion of the Sibumasu Block, Vimuktanandana and Munchai (2008) established the Permian–Triassic Khao Wang Chik Formation (Fig. 2). They assigned the rocks of the study section to this formation.

3. Study section

3.1. Lithology of the study section

Radiolaria-bearing bedded fine clastics–siliceous strata are exposed along the coast at Laem Krabang Phet (12°37′55″N,