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An Early Permian fusuline fauna from southernmost Peninsular Thailand: Discovery of Early Permian warming spikes in the peri-Gondwanan Sibumasu Block

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ABSTRACT

An Early Permian fusuline fauna is reported from the Tarn To Formation of the Yala area in southernmost Peninsular Thailand, which geotectonically belongs to the peri-Gondwanan Sibumasu Block. The fauna consists of *Pseudofusulina* and *Praeskinnerella*? species, including forms closely resembling Tethyan and Panthalassan *Pseudofusulina fusiformis* and *Pseudofusulina* ex gr. *kraffti*. A Yakhtashian–Bolorian age is estimated for this fauna. In Sibumasu, shallow-marine biotas showing similar Tethyan affinities, such as the fusulines *Misellina* and alatoconchid bivalves, also occur in the Early Permian succession of the Kinta Valley area in western Peninsular Malaysia. These unusual Tethyan faunas within Early Permian peri-Gondwanan fossil records suggest episodic influences from paleo-tropical Tethyan biotas. They are here interpreted as showing short-term warming spikes during the late Yakhtashian–Bolorian transgression, which would facilitate sporadic migration and temporal inhabitation of warm-water dwellers into the eastern Cimmerian areas. The Yala and Kinta Valley fusuline and other invertebrate faunas would give us a new insight for the Permian geohistory and environmental change of the peri-Gondwanan Sibumasu Block.

1. Introduction

The Permian succession of the peri-Gondwanan Sibumasu Block (Metcalfe, 1984, 1988) is composed essentially of two successive units with highly contrasting lithostratigraphic features. The lower unit, the broadly Early Permian Kaeng Krachan Group, consists entirely of siliciclastics, characteristically yielding glaciogene sediments in some levels (Stauffer and Mantajit, 1981; Ampaiwan et al., 2009). This group is also marked by the occurrence of "cool-water" and/or antitropical brachiopod faunas that show affinities in varying degrees with those from the Gondwana region (e.g., Shi and Archbold, 1998). Conformably overlying is the latest Early–Late Permian Ratburi Limestone, which exhibits extensive platform-type carbonate deposition on the Sibumasu Block during that time interval (Ueno and Charoentitirat, 2011). In spite of prevailing shallow-marine carbonate environments, its marine faunas (fusulines and brachiopods in particular) are essentially different from coeval ones found in the paleo-tropical Tethys region. They are known to form a unique paleobiogeographical domain called the Sibumasu province (Shi and Archbold, 1998) or Gondwanan Cimmerian subprovince (Ueno, 2003), which shows intermediate features between the cool-water Gondwana region and the paleo-tropical Tethys region. In the Permian fusuline fauna of Sibumasu, which paleogeographically is included in the eastern Cimmerian continent, Ueno (2003) recognized two major characteristics. One is consistent low taxonomic (generic) diversity throughout the Permian, compared with coeval faunas in the western Cimmerian continent (such as South Pamirs, South Afghanistan, and Iran) and the paleoequatorial Tethys–Panthalassa region. The other is the total absence or high scarcity of verbeekinids and neoschwagerinids in the Middle Permian, although later investigation suggested that Ueno (2003) overestimated the paucity of these Tethyan fusulines with large and complicated shells (Ueno and Charoentitirat, 2011). In spite of increasing information on its fusuline fauna, however, Early Permian fusulines from the Sibumasu Block are still poorly documented, except for the sporadic occurrence of the antitropical *Monodiexodina* fauna from the basal part of the Ratburi Limestone and its correlatives.

In Peninsular Thailand, spectacular cliff-forming limestone is one of the outstanding geological features of the Paleozoic–Mesozoic

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bedrock (Ridd et al., 2011). Many of the cliffs consist of the Permian Ratburi Limestone although Ordovician and Triassic limestones also form a similar topography in some areas. The Permian age for this thick carbonate succession is substantiated by the documentation of shallow-marine fossils (mainly foraminifers, corals, brachiopods, and bryozoans) from many localities on the peninsula since the 1960s (see Ueno and Charoentitirat, 2011 for details). The Ratburi Limestone is widely distributed in Western Thailand, upper Peninsular Thailand, and the upper part of lower Peninsular Thailand, which constitute parts of the Sibumasu Block (e.g., Metcalfe, 1999).

In the Yala area, the southernmost (or lower) part of lower Peninsular Thailand (Fig. 1), occurs the Tarn To Formation, consisting mainly of recrystallized limestone (Muenlek et al., 1985). It has been considered Permian and provisionally correlated to the Ratburi Limestone (Ueno and Charoentitirat, 2011), but this correlation lacked concrete fossil evidence. We recently carried out a field survey in the Yala area and found poorly preserved but clearly Permian fusulines from the formation. They are somewhat unusual compared to other well-known fusulines of the Sibumasu Block. The age of this fusuline fauna, moreover, is possibly one of the oldest ever found in the Permian of the peri-Gondwanan, eastern Cimmerian continent. In this paper, we prove for the first time that the Tarn To Formation is Permian based on the fusuline assemblage. We also discuss the geological implications of this fusuline fauna for the overall geohistory of the Sibumasu Block by comparing it with fossil information from western Peninsular Malaysia. All the thin-section specimens used for this study are registered in the Micropaleontological Collection of the National Museum of Nature and Science, Tsukuba, Japan, with prefix MPC.

2. Geological outline of the Yala area

In the main part of the Malay Peninsula, the Bentong–Raub Suture in Malaysia denotes the major geological boundary separating the eastern Indochina/East Malaya Block and the western Sibumasu Block (Metcalfe, 1999, 2000, 2013). Although its location becomes vague to the north beyond the Malaysia–Thailand border, the suture is thought to extend into southeasternmost Peninsular Thailand (Ridd et al., 2011; Ueno and Charoentitirat, 2011). Ridd (2013) recently correlated metamorphosed and deformed clastic rocks, distributed in the Yala area to the Lower Paleozoic Satun and Tarutao groups in Sibumasu, although we consider that his geotectonic interpretation of southernmost Peninsular Thailand is largely hypothetical. Moreover, Kamata et al. (2014) clarified that Permian–Triassic, shallow shelf to deeper continental slope sediments of the Sibumasu Block widely underlie southernmost Peninsular Thailand. Thus, in view of the geotectonic subdivision, the Yala area, studied herein, is supposedly located just west of the Bentong–Raub Suture and belongs to the eastern part of the Sibumasu Block.

In Yala and the surrounding areas, basic geological information is provided only by geologic maps produced by the Department of Mineral Resources (DMR), Thailand. Of these, the 1:250,000 scale geological map of Changwat Narathiwat and Amphoe Takbai (Muenlek et al., 1985) and the 1:1 million scale geological map of Thailand (DMR, 1999) are the major source of geological information, which shows that seven different types of rock units are distributed in this area (Fig. 1).

The Ban To Formation (Muenlek et al., 1985) comprising the oldest strata consists of mica-schist, phyllite, quartzite, and

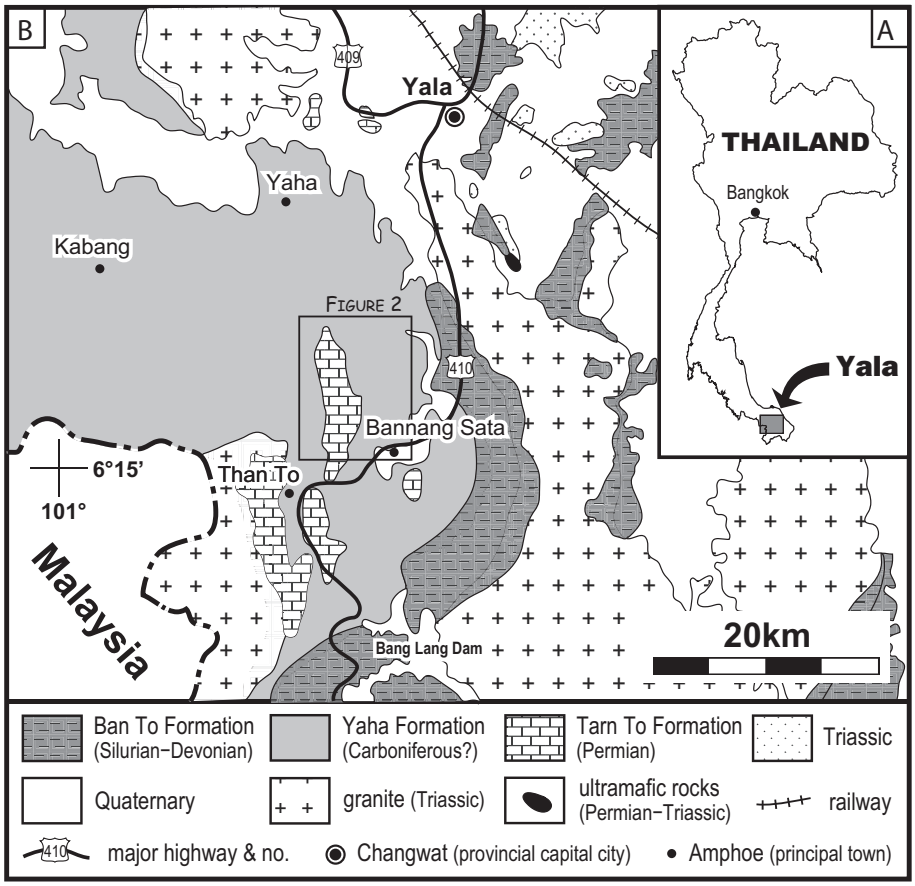

Fig. 1. Index and geological maps of the Yala area. (A) Index map of the Yala area in southernmost Peninsular Thailand. (B) Geological map of Yala and the surrounding areas, adopted from the DMR (1999) with modification based on data from Muenlek et al. (1985).