

## Oldest Fusulinid of Khao Khad Formation, Saraburi Province

Sutharat Sirot<sup>1, 2, \*</sup>, Thasinee Charoentitirat<sup>1</sup>

1. Department of Geology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

2. Department of Mineral Resources, 75/10 Rama VI Rd., Ratchathewi, Bangkok 10400, Thailand

\*Corresponding author email: sutharatsirot@gmail.com

### Abstract

The study area is located at Khao Makok, in Khao Khad Formation, Saraburi province. It consists of limestone with a lot of fossils such as fusulinid, crinoid, coral, bivalves, etc. These collected limestone samples were prepared as thin sections for petrographic study. The fusulinid is an index fossil used to indicate the age in Carboniferous - Permian. Most of fusulinids in previous studies determined middle Middle Permian - late Middle Permian. However, *Robustoschwagerina* in this study determined Early Permian (Sakmarian-Yakhtashian). It is the oldest fusulinid of Khao Khad Formation representing that Khao Khad Formation was developed in Early Permian. In petrographic study, the rock is bioclastic rudstone. The most bioclastic grains are fusulinids that show high diversity. It indicates that the study area was deposited in outer shelf environment.

**Keywords:** Fusulinid, Khao Khad Formation, Saraburi, Carbonate petrography.

### 1. Introduction

Saraburi Group is the significant Upper Paleozoic rock of Thailand and widely distributed in Saraburi province and adjacent areas (Figure 1). It consists of 6 formations in ascending order: Phu Phe, Khao Khwang, Nong Pong, Pang Asok, Khao Khad, and Sup Bon. The total thickness is about 5,000 meters (Hinthong, 1981 and Hinthong et al., 1985).

Khao Khad Formation mainly consists of thin-to very thick-bedded limestone with chert nodules and interbedded with shale, siltstone, sandstone, and conglomerate in some parts. Its thickness is up to 1,800 m (Hinthong, 1981). Fusulinids of Khao Khad Formation were determined as Early to Middle Permian (Toriyama and Kanmera, 1979 and (Toriyama et al., 1974). This Formation was deposited in shallow-marine carbonate-platform environment (Dawson and Racey, 1993 and Toriyama et al., 1974 and Ueno and Charoentitirat, 2011).

Structural geology of Saraburi Group is very complicated. There are many faults and folds and maybe stratigraphic repetition (Dew et al., 2018 and Morley et al., 2013). Therefore, the sequence of this group may be too thick and may not be simple superposition. Only lithostratigraphic study may not be effective to estimate the thickness.

According to numerous previous studies, fusulinids of Khao Khad Formation were determined as Early – Middle Permian. The detailed study on oldest fusulinids, however, is limited in this formation. Therefore, this study focuses on oldest fusulinids of Khao Khad Formation, Saraburi Province.

### 2. General Geology

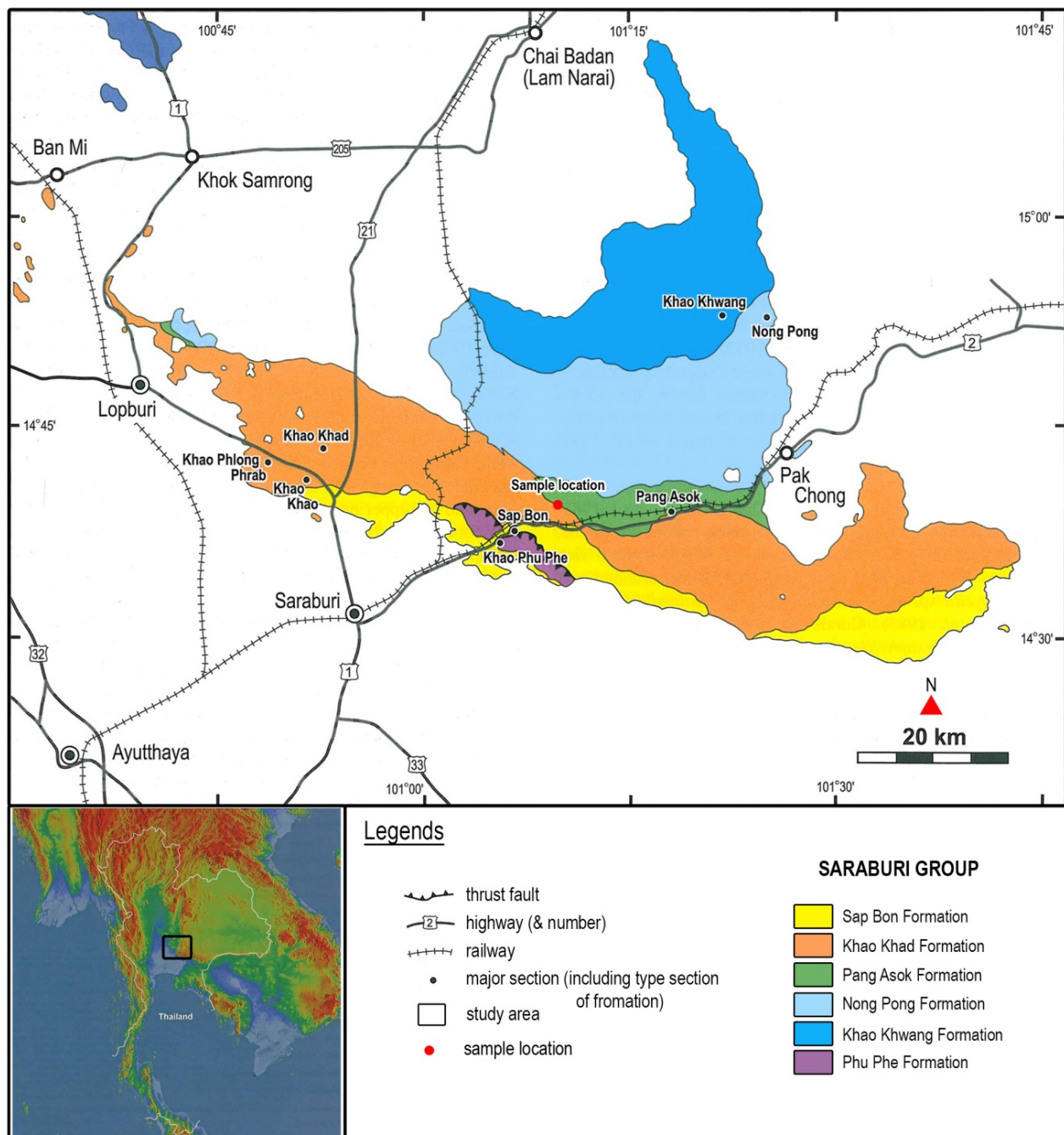
According to Hinthong (1981), Khao Khad Formation is predominantly composed of thick bedded to massive, medium to dark gray and occasionally recrystalline limestones and dolomites. Generally, gray to brownish-gray bedded and nodular cherts are usually intercalated. However, the interbedded light brown to yellowish-brown sandy cherts, shales, siltstones and sandstones are less abundant. Locally, the rocks are marbles, calc-silicates and hornfelses. Many biostratigraphic studies reported that Khao Khad Formation range is between Early to Middle Permian. The largely bioclastic limestone lithology indicated shallow-marine deposition in a carbonate-platform environment.

Fusulinids of Khao Khad Formation in the previous studies indicated middle Middle – late Middle Permian age. Toriyama and Kanmera (1979) and Toriyama et al. (1974) studied and made standard fusulinid biostratigraphy of Khao Phlong Phrab and Khao Khao. It indicated upper

Lower to middle Middle Permian for Khao Phlong Phrab and middle Middle Permian for Khao Khao.

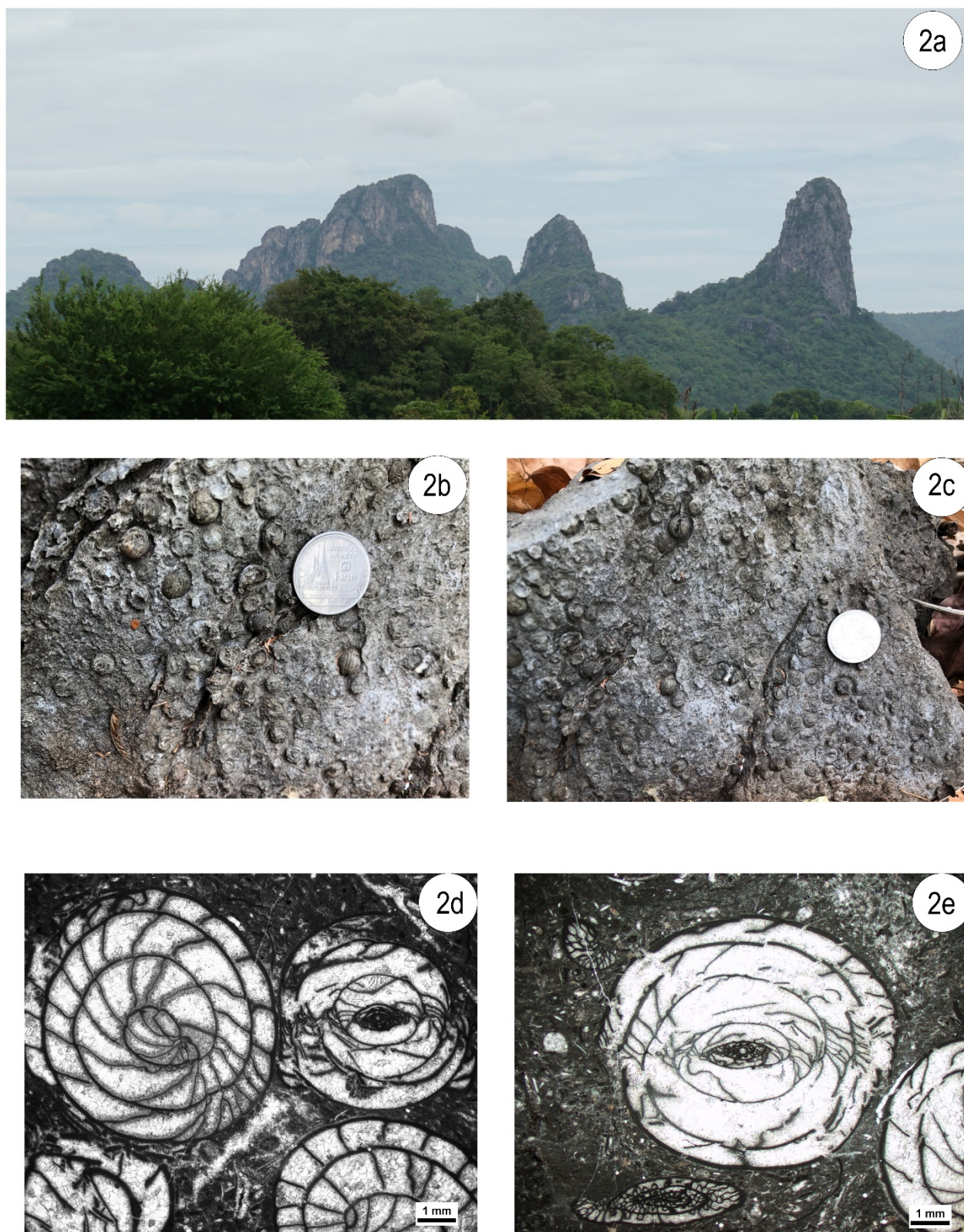
Dew et al. (2018) and Morley et al. (2013) studied the structural geology and deformation of Khao Khad Formation. There are many folds

and faults in Saraburi Group especially in Khao Khad Formation. This may cause a stratigraphic repetition. As a result, the apparent thickness of the sequence may be thicker than the true thickness.



**Figure 1.** A geologic map of Saraburi Group and sample location (modified from Ueno and Charoentitirat, 2011). The sample location is near Khao Makok, NE of cement factory, Saraburi province.





**Figure 2.** (2a) Karst topography of Khao Khad Formation. (2b and 2c) In hand specimen, Limestone with fusulinids. (2d and 2e) In thin-section, bioclastic rudstone with *Robustoschwagerina*.

### 3. Methodology

Literature review on previous works was conducted to plan for field works. In field work, we collected limestone samples especially, limestone with a lot of fusulinids. These samples were prepared for petrographic study as thin-section samples. Carbonate petrography and systematic paleontology was conducted by using microscope.

### 4. Result

#### Carbonate petrography

Khao Khad limestone in the study area exposed at steep hill and plain area. Karst topography is usually a form of limestone in Saraburi province (Figure 2a).

The outcrop consists of thin- to medium-bedded, light grey limestone with a lot of fossils with WNW-ESE bedding plane dipping to SW. The bottom of outcrop contacts with sandstone. In hand specimen, limestone with abundant fusulinids can be clearly observed (Figure 2b and 2c). In microscopy, bioclastic rudstone yields abundant fusulinids (*Robustoschwagerina* and *Parafusulina*) in micrite (Figure 2d and 2e). Most bioclastic grains contained 5-7 mm size of *Robustoschwagerina* and some *Parafusulina*.

Well preserved *Robustoschwagerina* can be used for systematic paleontology study. Representatives of *Robustoschwagerina* are presented in Figure 3-5.

#### Systematic paleontology

Family *Schwagerinidae* Dunbar and Henbest, 1930

Subfamily *Pseudoschwagerininae* L. H. Chang, 1963

Genus *Robustoschwagerina* A.D. Miklukho-Maklay, 1959

*Robustoschwagerina* Leoblich and Tappan, 1988

*Robustoschwagerina* A. D. Miklukho-Maklay, 1959, p. 160.

*Robustoschwagerina* A. D. Miklukho-Maklay, 1956, p. 1154 (name not available, ICZN Art. 13 (a)(i), no description).

*Pseudoschwagerina* (*Robustoschwagerina*) Igo, 1964, p. 287 (nom. transl).

**Description:** The large test is in subspherical shape with a strongly umbilicate.

Mature from 3 specimens in axial sections and 1 specimen in tangential section are 5.56 to 6.02 mm in length and 5.04 to 6.20 mm in width, giving a form ratio of 0.97 to 1.10. Small proloculus is 0.06 to 0.08 mm in diameter.

**Age:** Sakmarian – Yakhtashian

For this work, the *Robustoschwagerina* was discovered with other fossil assemblages which is considered to Sakmarian-Yakhtashian.

### 5. Discussion

Previous studies have no detailed report about *Robustoschwagerina* in Khao Khad Formation. We studied in detail of *Robustoschwagerina*. According to Alfred et al., (1988), it indicate to Asselian but in this study, indicate to Sakmarian - Yakhtashian because it was discovered with *Parafusulina* which is a wide-range fusulinid. Therefore, this study is added data from the previous works which discovered only fusulinids of middle Middle Permian to late Middle Permian (Toriyama and Kanmera, 1979 and Toriyama et al., 1974). This information presented that Khao Khad Formation was developed at the Early Permian age (Sakmarian-Yakhtashian).

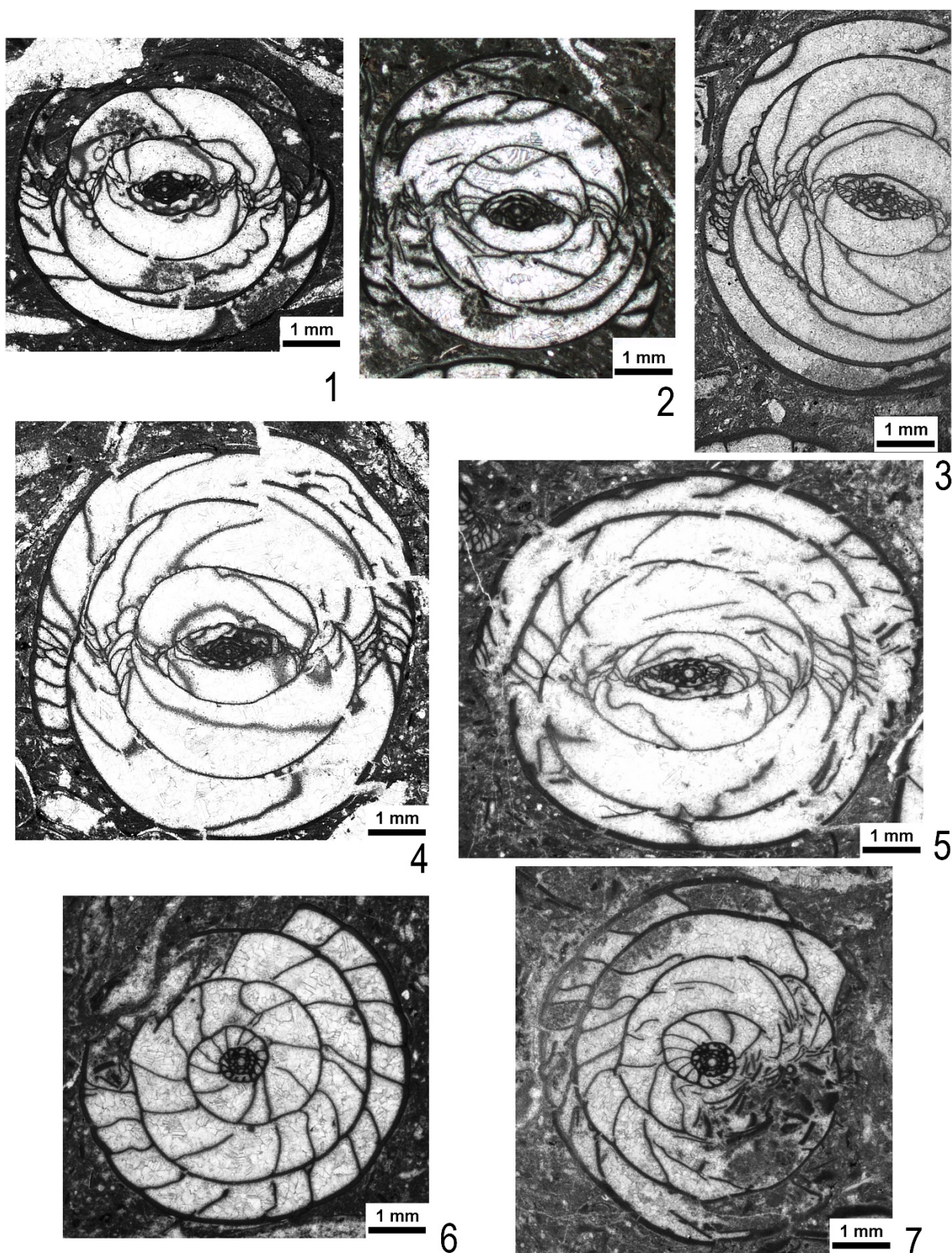
In carbonate petrography study, many fossils including fusulinids and crinoid fragments were found. They presented high diversity. Therefore, this area was deposited in outer shelf environment (Figure 6).

In conclusion, the Khao Khad Formation was developed in Sakmarian-Yakhtashian age at open-marine outer shelf environment.

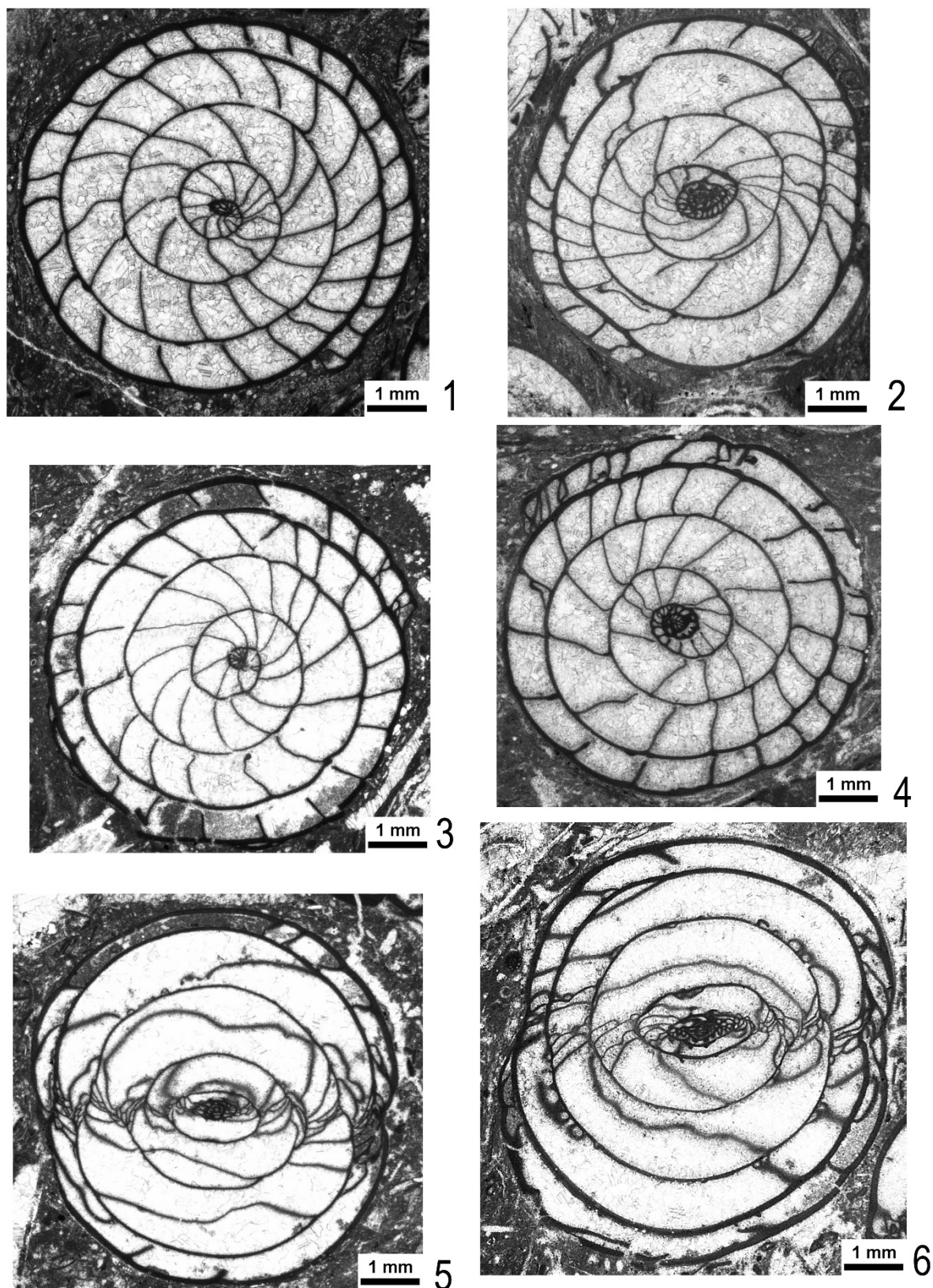
### 6. Conclusion

The study area consists of limestone which mostly contains fusulinids. Microscopically, the rock is bioclastic rudstone. Most of bioclastic grains are *Robustoschwagerina* indicating Sakmarian - Yakhtashian age. It is the oldest fusulinid indicating that Khao Khad Formation was developed in this age. Depositional environment of study area is outer shelf due to high-diversity of bioclastic rudstone.



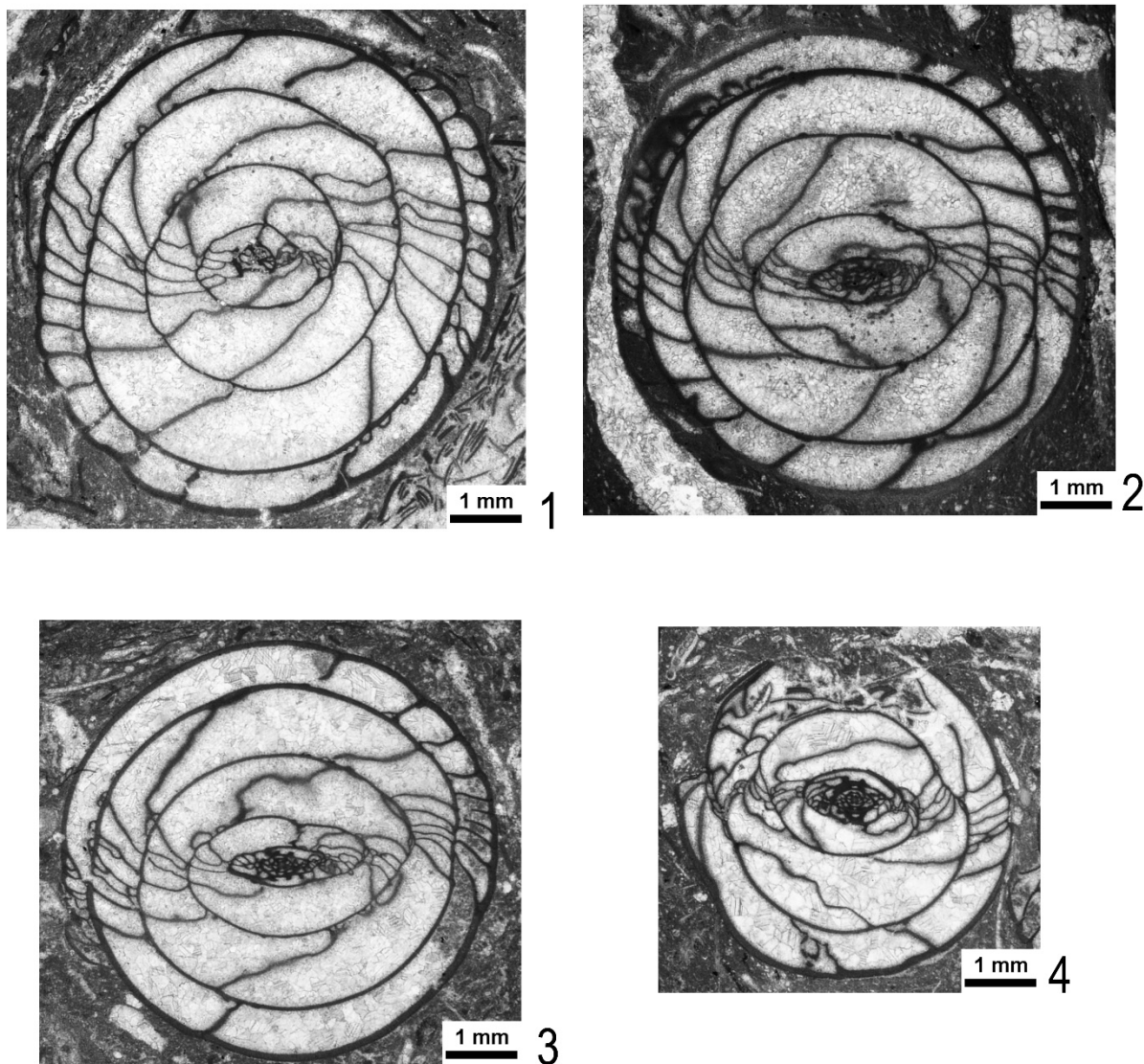


**Figure 3.** *Robustoschwagerina* from Khao Khad Formation, Saraburi province, part 1. (1-5) Axial section of *Robustoschwagerina*, (6-7) Sagittal section of *Robustoschwagerina*.

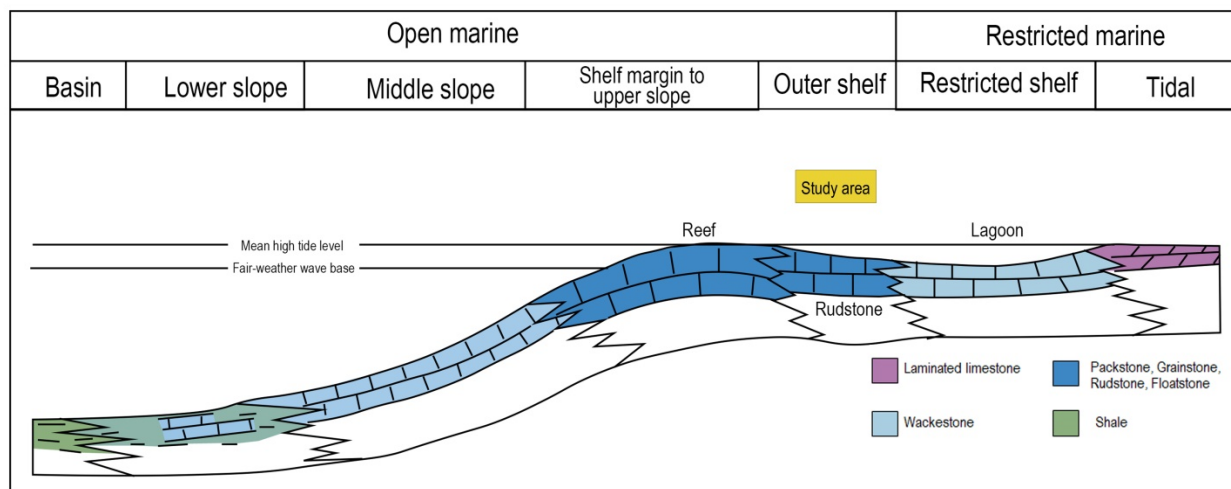


**Figure 4** *Robustoschwagerina* from Khao Khad Formation, Saraburi province, part 2.  
(1-6) Oblique section of *Robustoschwagerina*.





**Figure 5.** *Robustoschwagerina* from Khao Khad Formation, Saraburi province, part 3.  
(1-4) Oblique section of *Robustoschwagerina*.



**Figure 6.** The depositional environment model of study area showing position of outer shelf environment in Early Permian (Sakmarian-Yakhtashian) (modified from Flugel, 2010).

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