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# Stratigraphic Distribution of Permian Gastropods from Tak Fa Formation in Southern Part of Nakhon Sawan Province, Thailand

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## Abstract

The Permian carbonate succession in Tak Fa and Takhli district areas of southern Nakhon Sawan province were grouped in the Tak Fa formation of Saraburi group. The rocks comprise limestones, argillaceous limestones with nodular cherts and intercatalation of shale, which yield several species of gastropods including many invertebrate fossils such as fusulinids, sponges, bivalves, calcareous algae, corals, and bryozoans. The section reaches a thickness of 40 meters. The samples of stratified sampling were collected from Khao Noi and Khao Chai Thong measured sections for petrographic determination. Textures of carbonate rocks consist of bioclastic wackestone to packstone. The gastropod assemblage is dominated by typical Late Palaeozoic cosmopolitan genera with bellerophontoids and pleurotomariines. The distribution of these gastropods suggests the presence of three assemblages zones within distinctive lithofacies: *Bellerophon* sp. – *Glabrocingulum* sp. zone, *Stegocoelia* sp. and Gastropod barren zone. This study indicates that the depositional environment was on shelf lagoon within the carbonate platform varying from back reef to deep of carbonate platform.

**Keywords**: Tak Fa limestone, Stratigraphy, Nakhon Sawan, Permian

## 1. Introduction

Permian gastropods from Thailand are scarcely known. There are only few investigations have been reported, such as in Grant (1976) and Waterhouse (1982) from southern Thailand and Sone (2010) from the Guadalupian (Middle Permian) of East Thailand. The Permian gastropod fauna of the Tak Fa limestone has previously been recorded in a preliminarily report of Ketwetsuriya *et al.* (2014). They found on silicified shells weathering out at the surface of carbonate rocks, which was described and treated the species in open nomenclature representing twenty species. The fauna represented one of the riches gastropods from Thailand.

This paper presents the stratigraphic distribution of Permian gastropods recovered from Khao Noi and Khao Chai Thong section that are the part of Tak Fa formation. This fauna is very abundant and widely distributed through the studied section. Additionally, the study of these assemblages in combination with the study of carbonate facies is also given palaeoenvironment.

## 2. Geology of the study area and age

Khao Noi and Khao Chai Thong, where the section was established and the samples were collected, are located 80 km south of Nakhon Sawan City or about 8 km northeast of Takhli district along Highway 1 (Figure 1), extending 3 kilometers in the east-west direction and about 6 kilometers in the north-south direction. They are surrounded by unconsolidated soil with the average elevation of 300 meters above mean sea level. Paleogeographically, these limestones are the part of the Khao Khwang Platform (Wielchowsky and Young, 1985) during Middle Permian that covered Phetchabun Province, Lop Buri Province and Nakhon Sawan Province on the western margin of the Indochina Block (Metcalfe and Sone, 2008).

The Khao Noi and Khao Chai Thong section belong to the Tak Fa Formation, Saraburi Group (Nakornsri, 1976, 1981), and was previously Early Permain in age. However, Napradit (2005) studied the fusulinoidean limestones of the Tak Fa Limestone in Takhli district, where are near Khao Chai Thong,

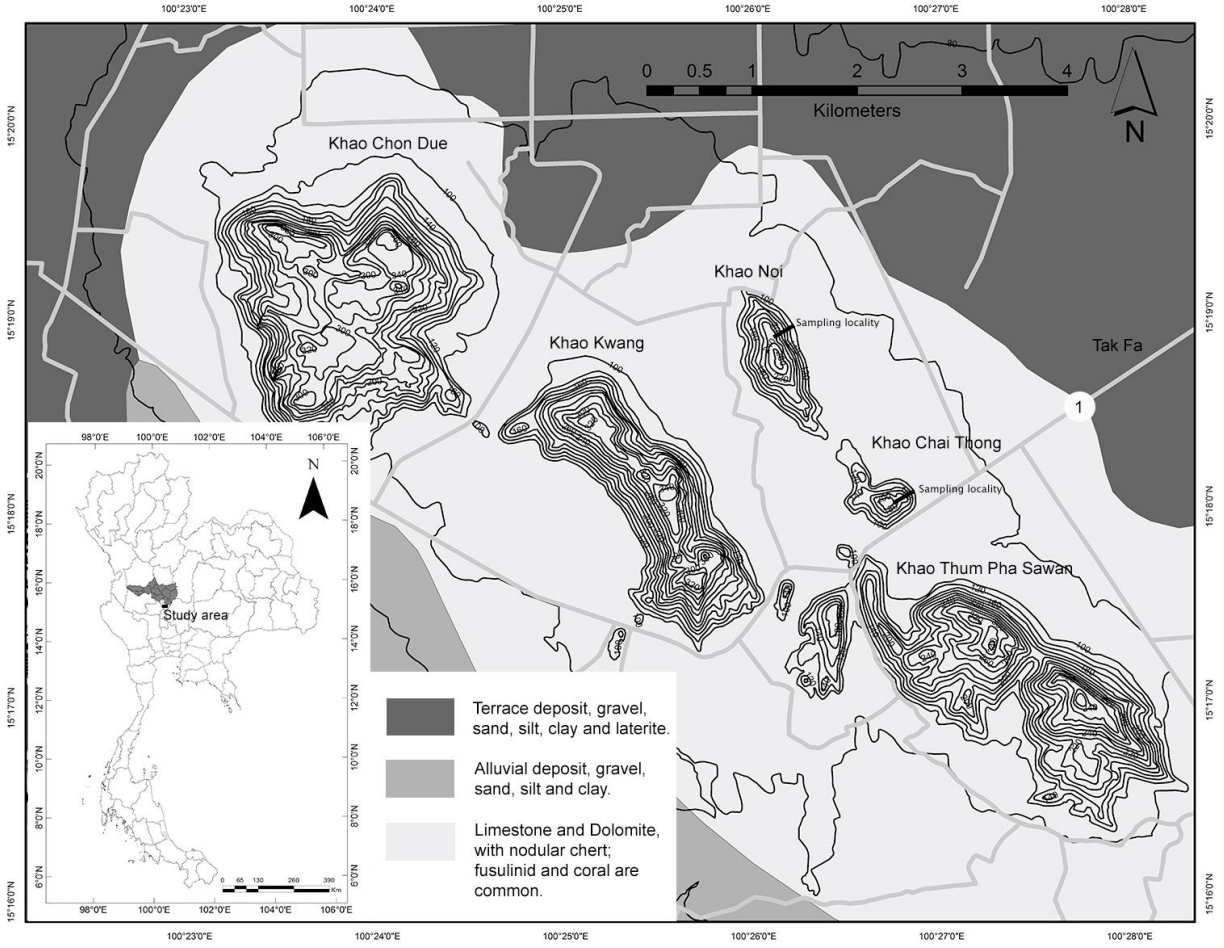


**Figure 1.** Geologic map and the gastropod sampling locality at Khao Noi and Khao Chai Thong.

which indicates the Murgabian or Wordian. Moreover, Jaiboon (2001) established biostratigraphy of Tak Fa formation in Lop Buri province, approximately 40 km northeast of the study area with reference to fusulinids that assigned the Wordian age.

The Permian rocks that exposed in the study area (Figure 3) consist of thin to very-thick bedded limestones, with nodular cherts and intercatalation of shale. Carbonate rocks are light grey to dark grey bioclastic wackestone to packstone and yield several marine invertebrate fossils such as sponges, bivalves, calcareous algae, corals and bryozoans; especially gastropods are highly diverse and widely distributed. The section has a thickness of approximately 40 meters, which is divided into three parts. The lower part of sequence is dominated by thick-bedded micritic limestone with dark gray. The fauna are commonly found. The middle part of the section is composed of thick to very thick-bedded wackestone with black chert nodules. In this part of sequence, gastropods and fusulinids are abundant. The upper part of the section consists of thin to very-thick bedded, gray to dark gray limestone and locally interbeded with laminated dark grey shale, which contains few fauna.

## 3. Methods

The gastropod samples were collected and lithostratigraphic sections were arranged from two localities in southern Nakhon Sawan city are near each other. Khao Noi (15º 18’ 50” N, 100º 26’ 18” E) is accessible via a concrete road from Highway 1 for approximately 2 kilometers to north wing Khao Noi, and Khao Chai Thong (15º 17’ 59” N, 100º 26’ 51” E), where is situated beside Wat Khao Chai Thong Wararam temple that can be accessed by the

Highway no.1 in the north-eastern direction, east of the hill. Attitude of bedding are mainly 180 º and dipping 30 º to the west direction (Khao Noi) and a general strike 135º to 150º and dipping 35 º to the southwest direction (Khao Chai Thong). The materials are poorly to moderately preservation. Most of the fossils are silicified. The samples were documented with microphotography. These images were used for identification. The specimens were sorted according to species based on a comparison with literature data. Thin sections were made for micro-facies analyses.

## 4. Results and Discussions

### 4.1 Community of gastropod fauna

Twenty species of gastropods were previously known from Khao Noi area (Ketwetsuriya *et al.*, 2014). Additionally, according to field investigations were performed at Khao Noi and Khao Chai Thong in Tak Fa district and Takhli district, Nakhon Sawan province. The gastropod specimens were studied; they belong to *Bellerophon* sp., *Warthia* sp., *Glabrocingulum* sp., *Discotropis* sp. *Trachydomia* sp. *Naticopsis* sp., *Cambodgia* sp., *Palaeostylus* sp. *Meekospira* sp., *Stegocoelia* sp., *Baylea*? sp. *Goniasma* sp. Anomphalus sp. and *Streptacis* sp. in association with fusulinids, sponges, bivalve, bryozoans, calcareous algae and corals.

### 4.2 Stratigraphic distribution of gastropods

Gastropod fauna are abundant in the studied sections with several species are recovered, they are grouped as *Bellerophon* sp. – *Glabrocingulum* sp. zone, which is the most diverse biozone of two study areas at the middle part of stratigraphic section while *Stegocoelia* sp. becomes the second diverse biozone in the lower part. The upper part of Khao Chai Thong sections contains rarely fragments and fusulinids. The range chart of gastropods at the study area (Figure 2) shows that the distribution of gastropods of Tak Fa limestone in Nakhon Sawan city that is subdivided into three biozones. The followings are biozones of the study.

| | |
|---|---|
| Upper | Gastropod barren zone |
| Middle | *Bellerophon* sp. – *Glabrocingulum* sp. zone |
| Lower*?* | *Stegocoelia* sp. zone |

#### 4.1.1 *Stegocoelia* sp. zone

Lithofacies: Biomicrite (wackestone)
Locality: Khao Noi, Khao Chai Thong
Characteristic species: *Stegocoelia* sp.
Associated species: *Bellerophon* sp., *Goniasma* sp., *Streptacis* sp and *Meekospira* sp.
Size distribution: small to moderate size
Associated fauna: fusulinids, bivalves, corals and sponges
Bounded: This zone is bounded along the interval between the lowest and highest occurrence of the *Stegocoelia* sp.
Remark: This fauna is restricted to the lower part of the section (Figure 3A), which consists of biomicrite (wackestone) about 10 m thick with *Streptacis* sp. and *Meekospira* sp. occur in the lower bed of this zone.

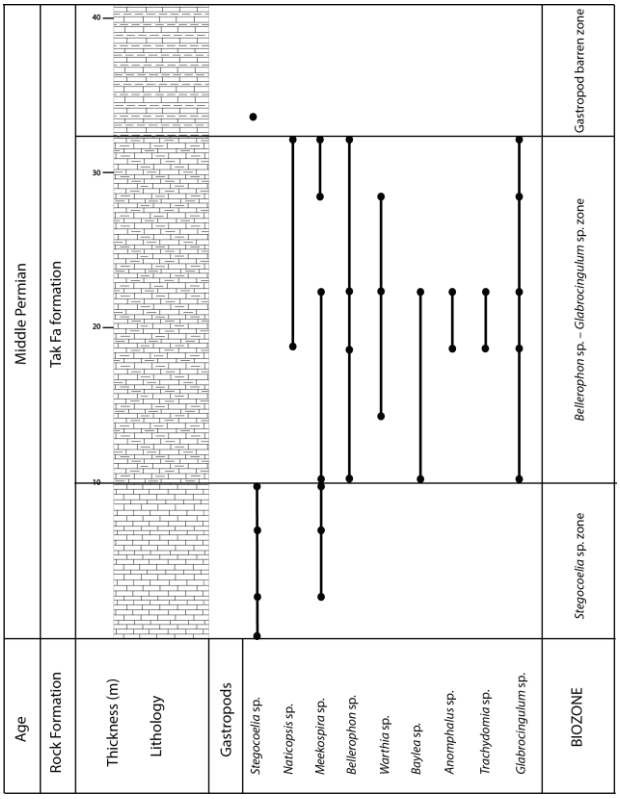


**Figure 2.** Stratigraphic distribution of Permian gastropods from the study area (Khao Noi and Khao Chai Thong) showing range of three biozones.

#### 4.1.2 *Bellerophon* sp. – *Glabrocingulum* sp. zone

Lithofacies: Biomicrite (wackestone to packstone)
Locality: Khao Noi, Khao Chai Thong
Characteristic species: *Bellerophon* sp. and *Glabrocingulum* sp.
Associated species: *Bellerophon* sp., *Warthia* sp., *Glabrocingulum* sp., *Discotropis* sp. *Trachydomia* sp. *Naticopsis* sp., *Cambodgia* sp., *Palaeostylus* sp. *Meekospira* sp., *Stegocoelia* sp., *Baylea*? sp. *Goniasma* sp. Anomphalus sp. and *Streptacis* sp.
Size distribution: Various stages
Associated fauna: fusulinids, pelecypod, gastropod, coral, sponge, algae and bryozoan were discovered in this zone.
Bounded: This zone is bounded along the interval between the lowest and highest occurrence of the *Bellerophon* sp. and also *Glabrocingulum* sp.
Remark: This assemblage is recorded from the middle part of the section (Figure 3B). This zone is approximately 22 m thick. *Naticopsis* sp. occurs at the lower part of this zone. Althought the characteristic species occurs commonly along this zone, but they abundantly appear in the middle part, which is the most diverse.

#### 4.1.3 Gastropod barren zone

Lithofacies: Mudstone to wackestone
Locality: This zone covered the upper part of these section; Khao Chai Thong. There is only fusulinid distributed throughout the zone.
Remark: This zone usually occurs at the upper part of the section (Figure 3C).

### 4.3 Paleoenvironment

The study area is situated on the Khao Khwang Platform, which is represented by shallow marine cabonates (Wielchowsky and Young, 1985). The Permian rocks of Tak Fa limestone in the studied section exhibit two lithofacies: wackestone and packstone with whole fossils facies and carbonate mudstone with little faunal diversity facies. Wackestone and packstone with whole fossils facies represented by the lower to middle part of the section. *Stegocoelia* sp. zone and *Bellerophon* sp. – *Glabrocingulum* sp. are the part of this lithofacies. The fossil association together with its microfacies investigation indicates a shelf-lagoon environment at back reef with low-energy. Carbonate mudstone with little faunal diversity facies represents deep lagoon environment with low-energy. Gastropod barren zone is included here in the upper part of the section.


**Figure 3.** Outcrop photographs of several carbonate successions; belong to the Tak Fa formation in southern part of Nakhon Sawan, central Thailand. See also Fig. 1 for location of outcrops revealed here. (A) Medium-bedded limestone exposed at lower part, northeastern side of Khao Noi (coordinates: 15° 18’ 50” N, 100° 26’ 18” E), this rock represents *Stegocoelia* sp. zone. (B) The middle part of the studied section illustrates thick-bedded fossiliferous limestones yielding the major studied gastropods, northeastern side of Khao Noi, which represents *Bellerophon* sp. - also *Glabrocingulum* sp. zone. (C) The upper part of the section consists of bedded limestone and locally interbeded with laminated dark grey shale, which contains few fauna, eastern side of Khao Chai Thong (coordinates: 15° 17’ 59” N, 100° 26’ 51” E), represents gastropod barren zone.

## 5. Conclusions

Gastropods have been observed from Middle Permian Tak Fa limestone in southern Nakhon Sawan Province, central Thailand. They comprise at least twenty species. The gastropod assemblages distribute along the studied section that is subdivided into three biozones; *Stegocoelia* sp. zone is situated at the lower part, *Bellerophon* sp. – *Glabrocingulum* sp. zone is found at the middle part and represents the most diverse species, gastropod barren zone is located at the upper of the section. *Stegocoelia* sp. zone and *Bellerophon* sp. – *Glabrocingulum* sp. deposited in shelf lagoon at back reef with low-energy environment and gastropod barren zone indicated deep lagoon environment with low-energy environment.

## 6. Acknowledgements

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