CHAPTER 5

CONCLUSION

5.1 CONCLUSION

5.1.1 The Khao Tham Pong quarry section

From the petrographic study, the carbonate rocks at Khao Tham Pong quarry section are oosparite microfacies, pelsparite microfacies, cortoidsparite microfacies, and intrasparite microfacies. The oosparite microfacies is dominant and the cortoidsparite microfacies is rare. The measured section has three cycles.

The first cycle is an oosparite microfacies 9.3 meters thick, then a 3.6-meter cortoidsparite microfacies, then this followed by a 0.9-meter pelsparite microfacies at the top. The second cycle is an ooparite microfacies 8.4 meters thick that changes upward to a 3.6-meter pelsparite microfacies. The third cycle is a 6-meter oosparite microfacies that has a 0.9-meter intrasparite microfacies at its top.

The depositional environments in this section were interpreted as shallowing upward shallow marine sequences. The second cycle is similar to the first cycle in that both start as tidal ooid bars or tidal ooid channels and change to lagoonal deposits. The third cycle is initially a tidal ooid bar, then changes to tidal flat environments. The foraminifera in the Khao Tham Pong quarry section suggest the section is Moscovian in age (Table 5.1). Figure 5.1 shows the symbols for all tables.

Table 5.1 The Khao Tham Pong quarry section showing its thickness, types of microfacies, depositional environments, and faunas.

Thickness	Column	Microfacies Types	Interpretation	Fauna
0.6 meter	⊙ ⊙ A ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ A ⊙	Oosparite microfacies	Tidal bar and Tidal channel or Tidal inlet environment	*Fusulinella pseudobocki* *Beedeina elegans* Middle Carboniferous
0.9 meter	△ △ △ A △ △ △ △ △	Intrasparite microfacies	Tidal flat; intertidal environment	
6 meters	⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ A ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ A ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙	Oosparite microfacies	Tidal bar and tidal channel or tidal inlet environment	
3.6 meters	····· ····· ····· ····· A	Pelsparite microfacies	Lagoon environment	
8.4 meters	⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ A ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙	Oosparite microfacies	Tidal bar and tidal channel or tidal inlet environment	

	⊙ ⊙ A ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙			
0.9 meter	····· ····· ·····A	Pelsparite microfacies	Lagoon environment	
5.7 meters	⊙ ⊙ ⊙ ⊙ A ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ A ⊙ ⊙	Oosparite microfacies	Tidal bar and tidal channel or tidal inlet environment	
0.3 meter	••••••• ••A••••	Cortoidsparite microfacies	Tidal bar environment	
3.6 meters	⊙ ⊙ ⊙ A ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ ⊙ A	Oosparite microfacies	Tidal bar and tidal channel or tidal inlet environment	

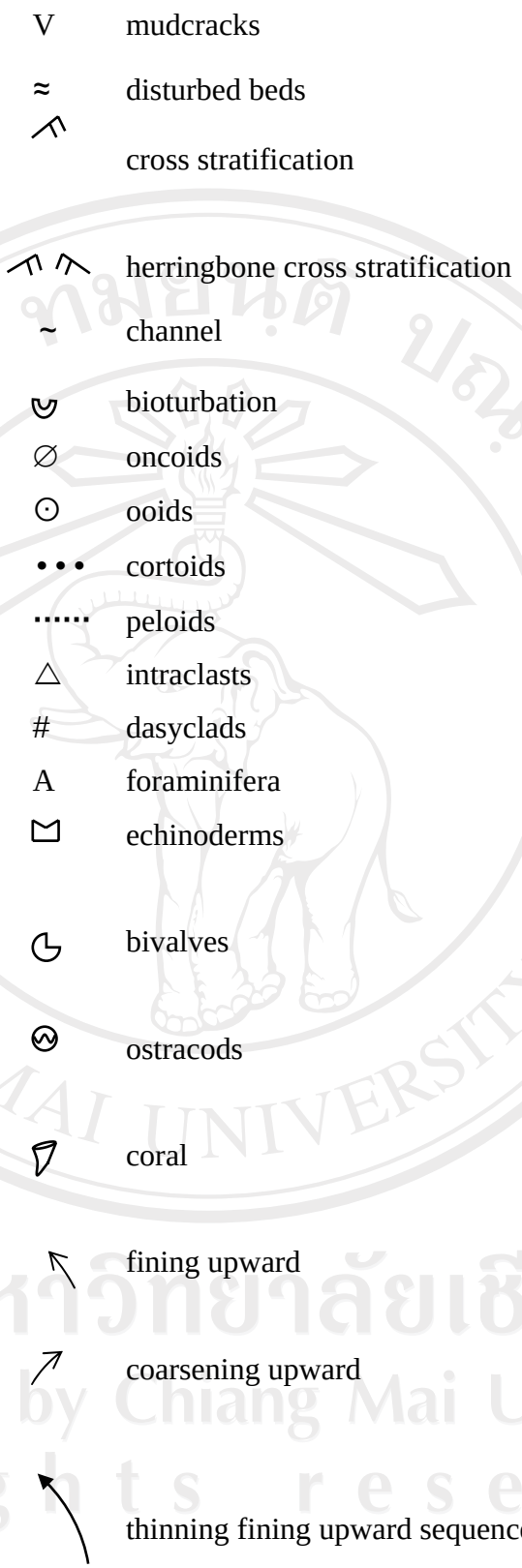

Figure 5.1 Symbols for all columns of Table 5.1-5.7

5.1.2 The CD 92 outcrop section

The carbonate rocks at CD 92 outcrop section are biosparite microfacies and biomicrite microfacies. The bioclasts of these microfacies are dasyclads and small foraminifera. This 15-meter thick section has two units. The lower unit is a high energy biosparite microfacies that has abundant dasyclads. This unit is 10 meters thick. Overlying this biosparite microfacies is a 5-meter thick low energy biomicrite microfacies. The CD 92 section is interpreted as tidal bars and tidal channels of lagoons and as subtidal deposits. The section's foraminifera suggest a Late Carboniferous age (Table 5.2).

Thickness	**Column**	**Microfacies Types**	**Interpretation**	**Fauna**
5 meters	· · · · · · # # # # · · · · · · # # # #	Biomicrite microfacies	Tidal flat; subtidal environment	Green algae; dasyclads and small foraminifera
10 meters	A # # # # A # # # # A # # # # A A # # # #	Biosparite microfacies	Tidal channels of lagoon environment	Green algae; dasyclads and small foraminifera

	A A			

Table 5.2 The CD 92 outcrop section showing thickness, microfacies types, depositional environment, and faunas.

5.1.3 The CD 4 outcrop section

The carbonate rocks at CD 4 outcrop section are biomicrite microfacies. The bioclasts are dasyclads, ostracods, and small foraminifera. This 25-meter thick section is a low energy sub-tidal deposit. Its foraminifera suggest a Late Carboniferous to Permian age (Table 5.3).

Table 5.3 The CD 4 outcrop section showing thickness, microfacies types, depositional environment, and faunas.

5.1.4 The CD 93 outcrop section

The carbonate rocks at CD 93 outcrop section are biosparite microfacies. The bioclasts are small foraminifera. This 15-meter section is interpreted as tidal bar and

Thickness	Column	Microfacies Types	Interpretation	Fauna
25 meters	····· ···#····· ····· ····· ····· ····· ·····#····· ····· A····· ····· ·····	Biomicrite microfacies	Tidal flat, subtidal environment	Green algae; dasyclads, phylliods, ostracods, and small foraminifera

channel bar deposits in lagoon environments. Its foraminifera suggest a Late Carboniferous age (Table 5.4).

Table 5.4 The CD 93 outcrop section showing thickness, microfacies types, depositional environment, and faunas.

15 meters	A A A A	Biosparite microfacies	Tidal bar and tidal channel of lagoon environment	Small foraminifera *Eolasiodiscus* sp. *Endothyranopsis* sp. *Biseriella parva*

Thickness	**Column**	**Microfacies Types**	**Interpretation**	**Fauna**

5.1.5 The CD 93.1 outcrop section

Most of the carbonate rocks at CD 93.1 outcrop section are oncoidsparite microfacies. This 6-meter thick section is interpreted as an inter-tidal deposit of a tidal flat environment. Its foraminifera suggest a Late Carboniferous to Permian age (Table 5.5).

Table 5.5 The CD 93.1 outcrop section showing thickness, microfacies types, depositional environment, and faunas.

6 meters	∅ ∅ ∅ ∅ A ∅ ∅ ∅ ∅ ∅ ∅ ∅ ∅ ∅ ∅ ∅ ∅ A ∅ ∅ ∅ ∅ ∅ ∅ A ∅ ∅ ∅ ∅ ∅	Oncoidsparite microfacies	Tidal flat; intertidal environment	Small foraminifera *Pamirina (P.) darvasica* (late Early Permian, Ueno and Igo, 1997)

Thickness	**Column**	**Microfacies Types**	**Interpretation**	**Fauna**

5.1.6 The CD 1 outcrop section

The limestone at CD 1 outcrop section is biosparite. The bioclasts in this biosparite are small foraminifera. This biosparite sequence is interpreted as tidal bar and channel deposits of lagoon environments. Its foraminifera suggest a Late Carboniferous age (Table 5.6).

Table 5.6 The CD 1 outcrop section showing thickness, microfacies types, depositional environment, and faunas.

15 meters	A A A A	Biosparite microfacies	Tidal bar and tidal channel of lagoon environment	Small foraminifera *Globivalvulina* sp. *Eoschubertella* sp.

5.1.7 The CD 3 outcrop section.

The carbonate rocks in the CD 3 outcrop section are biosparite microfacies and the bioclasts are small foraminifera and coral fragments. This 10-meter section is interpreted as tidal bar and channel deposits of lagoon environments. Its small foraminifera are *Globivalvulina* sp., *Climacammina* sp., *and Tetrataxix* sp. Its fusulinids are *Pseudoschwagerina* sp., and *Triticites* sp. *Pseudoschwagerina* sp. suggests early Early Permian Asselian age and *Triticites* sp. indicates the Gzhelian of the late Late Carboniferous. These two foraminifera suggest the Carboniferous-Permian boundary occurs within the CD 3 section (Table 5.7).

Table 5.7 The CD 3 outcrop section showing thickness, microfacies types, depositional environment, and faunas.

5.1.8 The depositional model

The carbonate rocks in this study were deposited in tidal flat environments. Particularly in tidal bar, tidal channel, tidal inlet, intertidal, lagoonal, and subtidal environments (Figure 5.2).

Thickness	**Column**	**Microfacies Types**	**Interpretation**	**Fauna**
10 meters	A A A A	Biosparite microfacies	Tidal bar and tidal channel of lagoon environment	Coral fragments and fusulinids *Pseudoschwagerina* sp. *Triticites* sp.

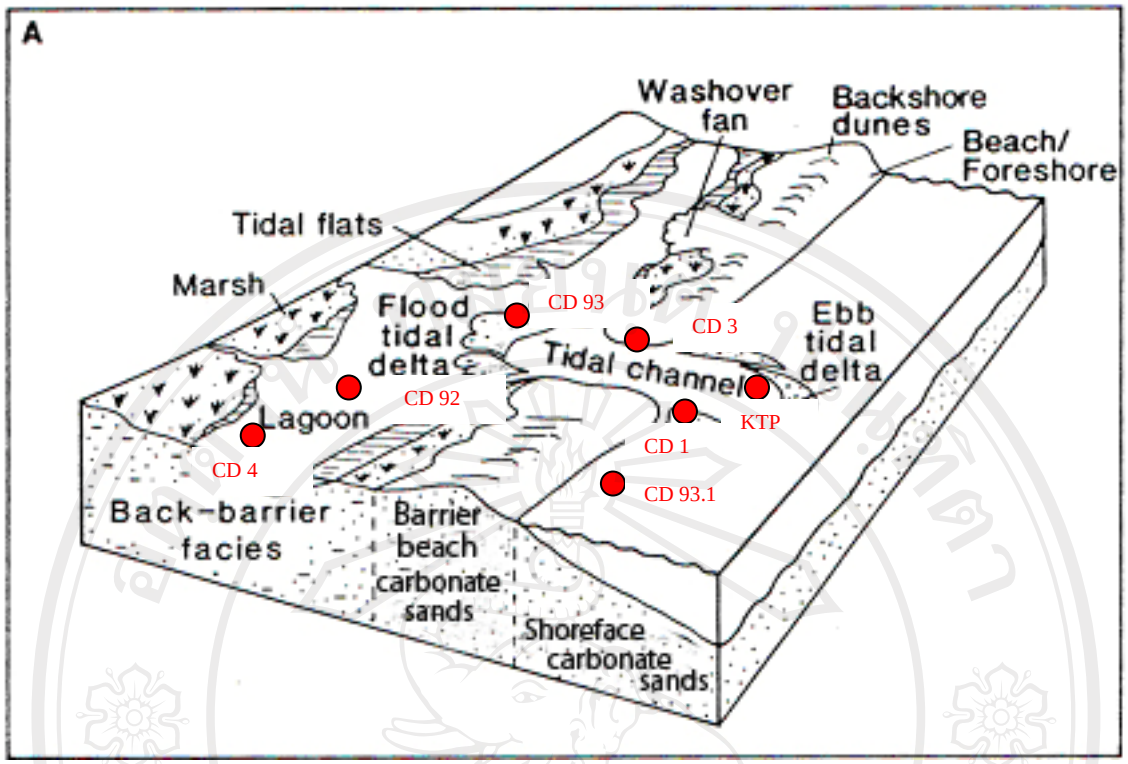

Figure 5.2 Depositional model of this study showing location of measured outcrop sections (modified from Tucker et al., 1994).

5.2 DISCUSSION

5.2.1 Age

The Carboniferous-Permian boundary is likely within the CD 3 outcrop section behind the Pong Tong temple. Two index foraminifera, *Triticites* sp. and

Pseudoschwagerina sp., found within this section indicate the late Late Carboniferous Gzhelian and the early Early Permian Asselian, respectively.

5.2.2 Ooid grains

Most of the ooid grains in the oosparite microfacies are bimodal ooids. This means that the depositional environment of this microfacies was not just a beach environment because, if so, a beach environment would have only unimodal ooids. Bimodal ooids are dominant in a tidal inlet environment that is affected by long shore currents. These currents cause a mixing of varities of ooid grains with peloids and intraclasts. The nuclei of the ooid grains are carbonate mud and bioclasts. None of the nuclei are detrital quartz or feldspar. Consequently, the ooids would have originated far from continental coastal areas. This origin supports the seamount model for this area of Thailand during the Carboniferous and Permian.

5.2.3 Depositional environments

The worm tube structures in the pelsparite microfacies suggest a low energy depositional environment. The small gastropod fossils in the intrasparite microfacies indicate that these bioclasts were deposited in a very shallow water environment, such as supratidal and intertidal areas of tidal flat environments. The geological data in the Chiang Dao area and the results of this study suggest that the Carboniferous-Permian carbonate rocks in the Chiang Dao area developed as carbonate caps on top of seamounts. This conclusion is based on the character of ooid nuclei. The depositional environments could have been bank depositional environments affected by long shore currents.

5.2.4 Tectonic evolution

During Middle Carboniferous to Early Permian time, the carbonate rocks in the Chiang Dao area would have been deposited in a tropical zone. This interpretation

is different from the interpretation for the same age Shan-Thai terrane rocks in peninsular Thailand. Those peninsular Thailand rocks are pebbly mudstone glacio-marine deposits, the Kaeng Krachan Group. Following deposition of the Kaeng Krachan rocks, carbonate rocks were deposited during the Middle Permian, the Ratburi Group (Chaodamrong et al., 2004). Thus, the carbonate rocks in the Chiang Dao area are different from the Shan-Thai terrane rocks in peninsular Thailand but are closely similar to the carbonate rocks in the Indochina terrane in northeast Thailand. The carbonate rocks in the study area could be located in the Chiang Mai-Chiang Dao suture of the Metcalfe model (Metcalfe, 2002).

5.2.5 Fauna evidence

The faunas of the carbonate rocks in this study are similar to the faunas from the Indochina terrane but are different from the faunas of the Shan-Thai terrane in peninsular Thailand.