

# Việt Nam Cát Bà Island Carboniferous Visean stage reef depositional facies analysis

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**Abstract:** Việt Nam Cát Bà island is area developed Carboniferous Visean stage reef on the world rare in neonatal animal of framework reef, the coral reef of main part by group rugose coral *Donophyllum* sp. and *Thysanophyllum* sp. etc. built, make up the framework corals similar but all by fasciculate and corniform two types developed forms. Reef continuous developed, did not form a distinct gap and period characteristics, reef distribution has certain evolution trend; and within the layers of coral but without the development of evolution characteristics, identify three consecutive biological stage, i.e. plexiform *Donophyllum* sp. developmental stages, the columnar *Donophyllum* sp. development stage and columnar *Thysanophyllum* sp. developmental stages, of reef rock profile micro phase characteristics of that divide out the mud bioclastic packstone and coral lattice frame barrier product rocks, bioclastic grainstone and can identify the three types of sedimentary facies. In the development process of the reef, the reef facies, reef and shoal facies are experienced by the open platform, reef platform, and shallow platform.

**Keywords:** Cat Ba Island; Guangxi; Carboniferous; reef; comparison

## 1. Introduction

The Carboniferous period was considered to be a progressive rehabilitation phase in the process of the historical evolution of reef organisms (West, 1988; Webb, 1994; Chevalier et al., 2005; Rodríguez et al., 2012), During the early Carboniferous period, the structure of reef organism lacked breakwater reefs, and were instead characterized by the development of the lime mud mound Waulsortian (Wood, 2001; Riding, 2002; Gong Enpu, 2007).

While populations of microorganisms play an important role in... during the Visean period, rugose corals were responsible for constructing the grid on which multicellular reef animals were able to reside. Many reef organism developed during the Visean are solid, formed by rugose coral (Rodríguez et al., 2012). This can be seen in areas of the UK, Ireland, Belgium, France, Spain, Ukraine, Algeria, Morocco, Australia, Japan, China, Kazakhstan, Russia and Turkey- I am not sure what is trying to be said with this list of countries, please make sure it was interpreted correctly. However, a full comprehensive is still unclear on the structure and of the Visean reef. After the first discovery of coral reefs during the Carboniferous period the Visean reefs were found in the southern area of Cat Ba Island Vietnam Northeast region (citation needed). Here, we used descriptive analysis of reef platform limestones to identify methods of tectonic and sedimentary characteristics of the North Vietnam. Also, comparing and summarizing reef in the Visean period in Lang Ping Guangxi China, we demonstrate characteristics of reef development during the Visean period Carbon century in South Basin Jiang Hai. As a result, our research provides a more comprehensive awareness about the true development of multicellular animals on reefs in the Visean period.

Cat Ba Island, the largest island in Halong Bay is in Cat Hai district, Hai Phong city the central city, Vietnam (Figure 1). The southern island of Cat Ba is a sedimentary basin in Quang Ninh Northeast Asia of the Bac Bo Basin (Tran Van Tri, et al., 2001). Here, the stratigraphic record Devon-Permian period continued

laying sediments, which Carboniferous stratigraphic developed the Pho Han Formation and the Bac Son Formaiton(Figure 2). The Pho Han Formation is reef platform sediment or slope sediment, consisting mainly of limestone including thick floors, thin layer of igneous rock, silica and chert limestone. The Pho Han Formation contains samples from the Famennian period to the Carboniferous period (Tran Van Tri, 2008). The Bac Son Formation, formed in a stable environment for long periods, consisting of mostly gray or light gray, thick or lumped limestone floors of sediments. The Bac Son Formation contains a large amount of organisms debris, such as foraminifera, corals, brachiopods etc ...(Tong-Dzuy Thanh, 2005). Nguyen Van Liem pursuant aged the foraminifera from Visean of early Carboniferous to Capitanian stage of Middle Permian period (Nguyen Van Liem, 1985). Han Lo and Bac Son group showed the interactions- of between each other?. The coral reefs used in this study are found adjacent to the Khe Sau road from South of Cat Ba island to Cat Ba town, about 500 meters from the village of Khe Sau (Figure 2). Reefs were from the Visean stage of the early Carboniferous period.

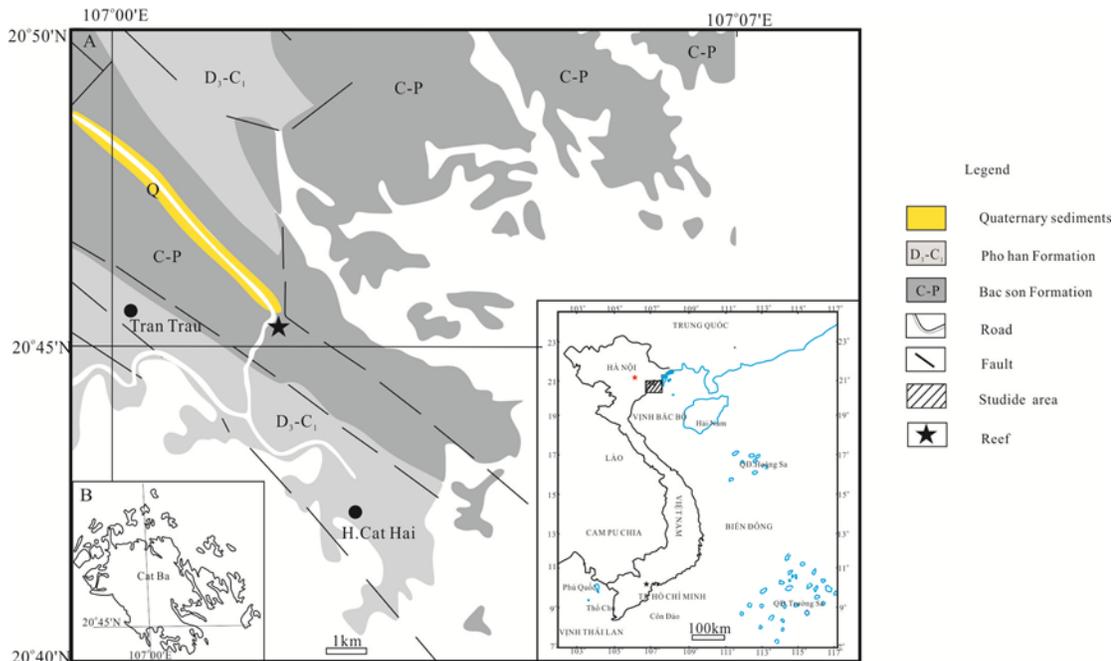


Fig.1: Geological research area and location of reef

System	Series	Stage	Cat Ba	Reef
Permian			Bac Son Formation	
Carboniferous	Pennsylvanian	Gzhelian		
		Kasimovian		
		Moscovian		
		Bashkirian		
	Mississippian	Serpukhovian		
		Visean		★
		Tournaisian		Pho Han Formation
Devonian		Famennian		

Fig.2. Schematic stratigraphic of research area

Cat Ba Island Reef (20°45'14.1 N, 107°01'50.4 E) is an overflow reef running SE-NW and is approximately 6m high, with the exception of the last 12 meters. The main group of reef-building organisms found in reef cores were rigose corals *Donophyllum* sp. and *Thysanophyllum* sp. *Donophyllum* sp. The corals show two growth types, a cluster form and a corner tower form. The dense barrier forming waves created these two forms. In a section of the reef, *Thysanophyllum* sp. grows in the form of cylindrical mesh angle. Additionally, the sporadic growth of *Caninia* sp. is on the bottom. The reef organisms were relatively monotonous, with crinoid, hand-rolled algae, foraminifera, gastropods, hard-shelled species and some solitary corals (see Figure 3). Approximately 10 m thick the reef benthos was composed of the corals *Donophyllum* sp., *Syringopora* sp., *Caninia* sp., *Caninophyllum* sp., this trend continued for 10m away from the reef.

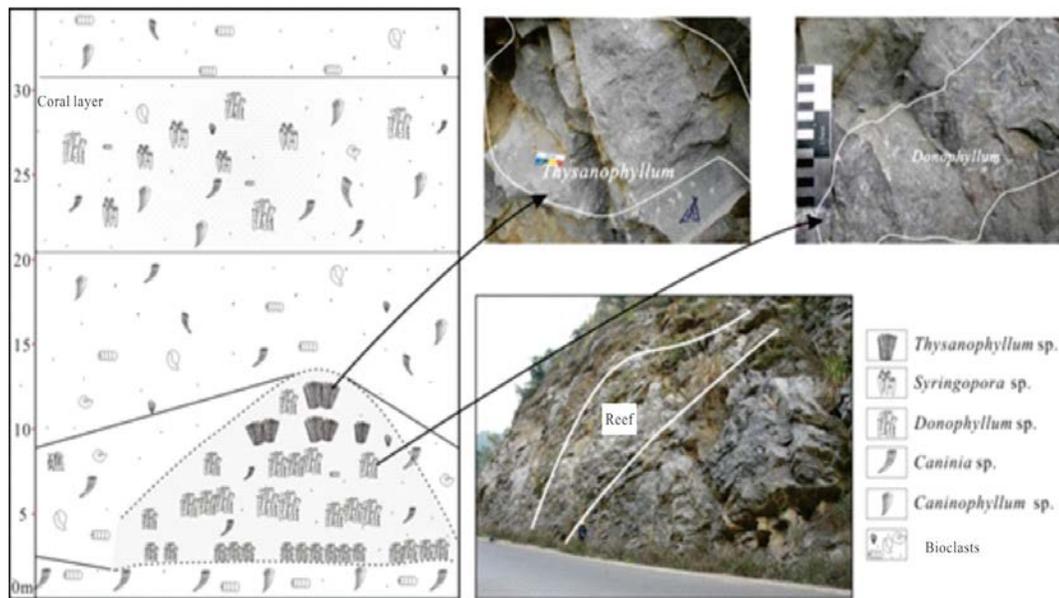


Fig.3 Structure diagram of reef

### 3. Materials and methods

Sedimentary microfacies analysis features tremendous significance for the grasping of Sedimentary environment model in the geological time and the lithofacies-paleo-Geography. Influenced by the F/Fbiota extinction event and the global climate change, the Carboniferous Period was considered a stage of gradual restoration in the process of biological evolutionary process (Chevalier and Aretz, 2005; Rodríguez et al., 2012; Wood, 2001; Webb, 1994). Although many scientists have introduced their own interpretations it is gradually realized that if we can define depositional environment, which is closely linked to the biota extinction sea level change then the mechanism of the biota extinction can be solved.

By using this approach, thirty six samples have been collected from the stratigraphic sections of the coral reef in the Cat Ba Island for microfacies analysis. Under the microscope, the biotypes, degrees of abrasion, rock compositions and the grain parameters in the thin section were examined.

Microfacies have been for long time suggested to be a good indication of sedimentary environment, and are closely associated with sea level change. Therefore, microfacies types are also an important parameters for studying the sea level variation in the past.

#### 4. Microfacies classification and characteristics of the coral reef profiles

##### 4.1 Features reef sedimentary section

Visean reef sections from the carbon period in Vietnam's Cat Ba Island have pure carbonate sediments that are contained in a thick dark gray floor. The classification study found strong heterogeneity in minster lava of reef limestone (Zhang Yuan Yuan at al. 2009) Visean coral reef of Cat Ba Island is also relatively consistent, based on the general classification method of Dunham and Cuffey (YEAR). The change in organism debris indicates the process of sedimentary forces acting on reef sections. Visean reef sections of Cat Ba Island were divided from the bottom to the top in three categories: packstone stones, bead limestone and coral grid bafflestone stones. (Figure 4).

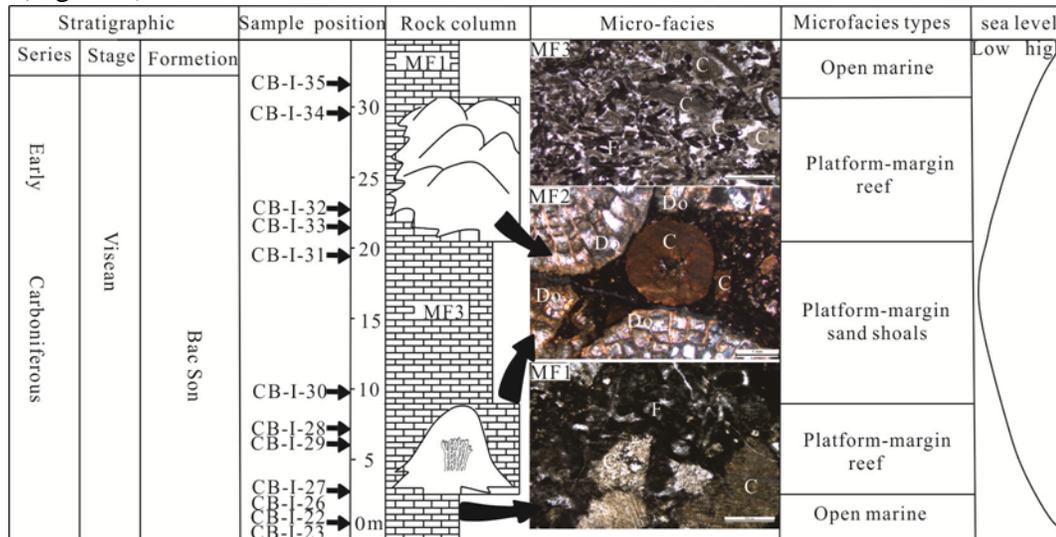


Fig.4 Axial diagram of Cat Ba island reefs and evolutionary diagram

MF1: Organism debris packstone stone (Figure 4A)

This small platform is generally located at the bottom of the reef and the covered floor of coral floors. Organism debris mainly consisted of crinoids and foraminifera, fragments algae and spherical particles- I would list the most common elements, best to not use and so on during a paper The majority of these organisms are characterized by a plaster shell, calcified mud, or intergranular mud for linked support. This small platform demonstrates the corrosion chips or sheath layers of sediment in small platformicles. Results indicate no access from the reef to the outside and no marine debris interacting with a continental source. Seawater circulation level during this period was adequate, however whole water momentum conditions were relatively weak near the bottom of the waves or below. Therefore, organism debris normally appears in the open shelf environment with open water circulation patterns (FZ7) (Ma Yong Sheng, 2004).

MF2: coral grid battlestone

This small platform mainly occurred in the reef and the coral floor. Battlestone is formed by a group of rugose coral grow in place with thickly or clusters that hinder organism debris. Coral reef nets usually develop with a typically dense layout, however between individual coral small organism debris can be found (Figure 4). This leads to stiffer frame for breakwater. The coral grid in the coral reef is often scattered and small-scale This small platform primarily appeared in reef environment (FZ5) (Ma Yong Sheng, 2004).

MF3: organism debris limestone particles

Organisms debris limestone particles is a small platform that primarily appeared in the covered floor of the reef and the bottom of coral floor (Ma Yong Sheng, 2004). Thorns and foraminifera are common and lead to small quantities of spherical particles and algae debris. Debris from other creatures are rare. The majority of the foraminifera were found in the lime mud. Limestone particles also have small organism debris between interconnected particles. This small platform is similar to the standard platform SMF11, representing the sedimentary environment on the bottom which is affected by waves and usually appear in the shallow shelf boundaries (FZ6) (Ma Yong Sheng, 2004).

#### Summary analysis of limestone

The Visean reef sedimentary section environment of Visean period in Carboniferous of Cat Ba Island is open shelf environment. Three distinct sedimentary platforms can be identified: the open platform, the reef platform, and the shallow platform.

The order of the Visean reef sedimentary section environment of Visean period in Carboniferous of Cat Ba Island represents a relatively clear process of continuous change between the sea surface and sedimentary environment of corresponding platforms. Beginning the open platform at bottom of the reef, facing up to the coral reef platform, reef covered floor to grow into shallow platform, and then, coral floor once again entered the coral reef platform, finally appears open platform again- I think this would be best described with a figure. The ordering of this platform has shown the development process of Visean reef sections in Carboniferous of Cat Ba Island which has undergone the low - rise evolution time of sea level.

#### **4.2 Typical characteristics of reefs**

All biological organisms were identified to the genus level. The diversity of coral reef species of Visean period in Carboniferous of Cat Ba Island was relatively low. Reef organisms consisted mainly of clusters and corner tower forms of *Donophyllum* sp. and corner tower forms of *Thysanophyllum* sp. The species diversity of coral reefs in this time frame is relatively high, not only includes clusters and corner tower form of *Donophyllum* sp. to create coral reefs, but also including a sheet of *Syringopora* sp. coral and single *Caninia* sp. and *Caninophyllum* sp. When considered from the perspective of macro-evolutionary development beyond natural reefs, coral reefs grow continuously, without interruption of characteristic formulation. However, in terms of the distribution of the development of coral reefs an evolutionary trend can be found. The corals grow framing a scattered are with side boundaries that are not clear, therefore the front provided the coral reef, and the latter consisted of the coral floor

The shape of coral reef and species characteristics indicate the development of coral reefs in Visean period in Carboniferous of Cat Ba Island experienced 3 consecutive stages of development: 1) the development of clusters of *Donophyllum* sp., 2) the development of corner tower form *Donophyllum* sp. and, 3) the development stages of corner tower form of *Thysanophyllum* sp. with *Donophyllum* sp. developing clusters at the bottom of the reef. These processes are the pioneering elements of reef development, along with the gradual lowering of the sea. As a result of the decreasing sea level, and increasing water energy, the population of the cluster form of *Donophyllum* sp. gradually transitioned into populations of the corner tower form. The corner tower form *Donophyllum* sp. has constituted the core of the reef. Due to the impact of geological scale and the influence outside appearance, we cannot assess clusters and corner tower form *Donophyllum* to species. However, based on ancient ecology, and the disturbance in water, the subgenus cluster form small-developed colonies, causing the majority of the population to develop into the lump form (J. Robert Dodd, 1989; Yang Shi Pu, 1993). The transition from the cluster form *Dodophyllum* sp. to the corner tower form *Dnophyllum* sp.

reflects the lower sea level and increased water energy. In the process of reef degradation, the upper part of the reef had the population corner tower form *Donophyllum* sp. replaced by *Thysanophyllum* sp. The cluster part of the *Thysanophyllum* sp. population was relatively small, and could withstand the impact of the increased water energy. Our research area then transitioned into the terrestrial environment, the strength of water disturbance was no longer suitable for the growth of coral, and caused the development of single forms of corals. Along with the gradual increase of the sea surface, and reducing water energy, the water environment was suitable for the growth and development of framing coral, *Donophyllum* sp., *Syringopora* sp., *Caninia* sp. and *Caninophyllum* sp. These framing corals became part of the main floor devoted coral reefs and it is not clear the time period in which they formed.

### 4.3 Discussion

Coral reefs in Visean period of the Carboniferous system of Cat Ba Island, Vietnam were produced in the shelf of Bac Bo Basin (Tran Van Tri et al., 2001), while coral reefs in Visean period in Lanh Binh Guangxi, China were produced in the shelf of Nam Ban Giang basin (Chen et al. 2013). These reefs are in the "Sea of Nam Ban Giang" (Ruo Wu Hao, 2003), located at the top of Paleo Tethys, Panthalassa connecting the area with the east. We conducted a comparative description of the Visean period reef in Carboniferous of Cat Ba Island, Vietnam and coral reefs in Visean period in Lang Ping Guangxi, China, with the purpose of showing the characteristics of coral reefs in Visean period in the "Sea of Nam Ban Giang

Organism in the reefs of Cat Ba Island-Vietnam, and Lang Ping Guangxi-China, though not the same about the basin, scale reef, reef-building organism populations, reef section platform, are the same age, reef environment and had the similar sea surface conditions. Coral reefs in Visean period in Carboniferous of Cat Ba Island, Vietnam were produced in the shelf of the Bac Bo basin (Tran Van Tri et al., 2001), while coral reefs in Visean period in Lang Ping Guangxi, China were produced in the shelf of "Nan jiang" basin (Chen et al. 2013). The difference in overall appearance of the reefs are large, for example the Cat Ba Island-Vietnam exposed approximately 6 m high, and 12 m long. However, Lang Ping Guangxi-China raised approximately 50 m high, and was 260 m long. Although, the same type of reef, the reef of Cat Ba Island-Vietnam had a relatively monotonous reef-type, framed and covered by a limited number of corals and invertebrate species. Lang Ping Guangxi-China was relatively rich in species diversity, including: framed creatures, covered creation, frame, prevent, and adhesion creatures. The framed creatures of two regions were mainly corals. The framing coral of Cat Ba Island-Vietnam is relatively monotonous, only 1-2 types: *Donophyllum*, *Thysanophyllum* sp. The framing coral Ha Dong Lang Binh Guangxi-China were relatively rich in diversity with *Diphyphyllum*, *Siphonodendron*, *Lithostrotion* and *Syringopora* sp. making up the main components of the reef. Cat Ba Island-Vietnam and Lang Ping Guangxi-China had different areas, the organisms that covered them were relatively similar. This is mainly a result of these sedimentary independent growth type of *Syringopora* sp. coral. These corals created the framing creatures breakwater of Cat Ba Island-Vietnam and Lang Ping Guangxi-China. In the framing-breakwater reef, there was only 1 type *Thysanophyllum* sp. in Cat Ba Island-Vietnam, but there were more than one type of coral reefs found in Xiadong Lang Ping Guangxi-China, including *Paralithostrotion* and *Palaeostraea*, coral bones, with grid that prevented particles of organism debris and lime mud. The reef in Cat Ba Island-Vietnam was not a cohesive organism, but in Xiadong Lang Ping Guangxi, China reefs were mainly the microorganisms lava shell with microorganisms. Through identification of natural stone, rock specimen identification and an analysis of creatures small sedimentary mineral in the lab, the physical environment of Cat Ba Island-Vietnam area and Lang Ping Guangxi - China are relatively ideal for reef development (such as temperature, water quality, sun levels, food, and oxygen). The environmental conditions of the two regions

were not entirely homologous, these differences caused differences in reef organisms to form. The type of reef in Cat Ba Island-Vietnam is fairly monotonous, simple sedimentary environment, the differences very small, small platform of morphological types are also reduced. The lack of diversity of organisms in the study area is relatively low. Comparatively, the organism diversity of the Lang Ping Guangxi-China region was a rich, complex environment with much larger reef. Although, both Cat Ba Island -Vietnam and Lang Ping Guangxi-China are developed on a carbonate shelf, the different locations demonstrate a difference in scale, and sediment.

	Cat Ba Island, VietNam	Lang Ping Guangxi, China
Reef-building organism	<i>Donophyllum</i> <i>Thysanophyllum</i>	<i>Diphyphyllum</i> <i>Siphonodendron</i> <i>Lithostrotion</i> <i>Syringopora</i> <i>Paralithostrotion</i> <i>Palastraea</i> <i>Microform rock</i>
Scale reef	Raised about 6m, side lasted about 12m	About 50m high, lateral stretching about 260m
Development an devionment of coral reef	Table	Table
Microfacies types	The open platform, reef platform and shallow platform	The water of open platform relatively deep/shallow, coral reef platform, slope platform in shelf shallow platform in shelf
Sea level	Lower sea surface	Lower sea surface

## 5. Conclusions

The development of coral reefs in Visean period in Carboniferous of Cat Ba Island, Vietnam is very typical, reefs formed the similarly to the with reefs that developed within the Visean period in Lang Ping, Guangxi, China. Here, we present a detailed analysis and discussion about the creatures of the coral reefs in Visean period in Carboniferous of Cat Ba Island, Vietnam, describing the ecological characteristics, population, growth and development process of the reef. These can be summarized by:

- (1) The type of living organisms in coral reefs in Visean period in Carboniferous of Cat Ba Island, Vietnam was relatively low, framing creatures is monotonous. This phenomenon shows that the population during the Visean period in Carboniferous was influenced by biological extinction in late Devonian remained in the recovery process.
- (2) Based on the type and combination of reef-creating organisms, coral reef growth Visean period Carboniferous of Cat Ba Island, Vietnam underwent three stages of continuous development.
- (3) During the developmental process, Carboniferous of Cat Ba Island, Vietnam has undergone an open shelf platform, a coral reef platform and a shallow platform due to the lowering sea level and increased water energy.
- (4) By comparing the Visean coral reef in Carboniferous of Cat Ba Island, Vietnam and Visean coral reef in Lang Ping Guangxi, China it is clear that differences occurred and the time period was complex.

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