DIATOM ASSEMBLAGES RESPONSE TO SEDIMENT FACIES CHANGE DURING THE LAST 3000 YEARS IN TV1 CORE, MEKONG RIVER DELTA

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(Manuscript received on August 14, 2005; revised manuscript received on october 19, 2005)

ABSTRACT: Diatom data from the boring core TV1, located at Duyen Hai district, Tra Vinh province in the Mekong River Delta is one of good tools to research on sediment facies change in Holocene. There are five diatom ecological groups: marine plankton, marine-brackish, brackish, fresh-brackish and fresh water groups. The stratigraphical change of these groups is divided into four diatom divisions, namely D1, D2, D3 and D4. Each diatom divisions is closely related to the sedimentary environment caused by Holocene sea-level change. Deltaic sediment is characterized by marine plankton and brackish water groups.

The six depositional facies were recognized in ascending order: Late Pleistocene deposits, regressive lag deposit, prodelta mud, delta front sandy silt, sub-to intertidal flat silty sand, subaerial delta plain sand and sandy silt facies. There is not any evidence of marine facies from this core. The sedimentary succession of sea-level regression suggests that the Mekong River Delta has prograded to the site since 2,719 yr. BP.

1. INTRODUCTION

Diatoms can be used as indicators of past and present environmental conditions [1,2,8]. Together with lithological features, sedimentary structure and absolute 14C age, the change of diatom assemblages contributes considerably to study sedimentary environments in relation to Late Pleistocene-Holocene relative sea-level change [3, 6, 7]. This paper presents a detailed Holocene sediment facies with diatom assemblage changes from TV1 core at Duyen Hai-Tra Vinh province (Fig.1).

The authors express their gratitude to Dr. Y. Saito, Geological Survey of Japan for helping with analyses of ^{14}C ages; Prof. M. Tateishi and Prof. I. Kobayashi, Niigata University for kind comments on our manuscript. We would thank the reviewers for their critical reviews to improve this manuscript. This work was supported by the Natural Science Council of Vietnam. This was part of a collaborative project between the Sub-Institute of Geography, Vietnamese Academy of Science and Technology, and the Department of Geology, Niigata University Japan.

2. METHODS

The core samples were split out and described. Total 24 diatom samples were analysed by Kashima method (1990). Diatoms were identified and counted under optical microscope. In this paper, we describe the Holocene facies on the basis of diatom analysis results compiling lithological data and accelerator mass spectrometry (AMS) ^{14}C dates from previously described TV1 core [5].

2.1. Characteristic species and ecological group of diatom

On the basis of the ecological spectra, these diatoms are grouped into five ecological groups, namely marine plankton, marine-brackish, brackish, fresh-brackish and fresh water.

Marine planktonic species are represented by *Coscinodiscus radiatus, C. nodulifer, C. rothii, Thalassionema nitzschioides, Thalassiosira excentrica* and *Actinocyclus ehrenbergii,*

Marine-brackish species are represented by *Diploneis bombus, Nitzschia sigma, N. cocconeisformis, Grammatophora oceanica* and *Achnanthes brevipes,*

Brackish-water species are representative of *Paralia sulcata, Cyclotella caspia, C. styrolum* and *Coscinodiscus lacustris.*

Fresh-brackish water species are representative of *Cocconeis placentula, Nitzschia vitrea* and *Rhopalodia gibberula.*

Fresh water species are represented by *Aulacoseira granulata, Synedra affinis, Cymbella* spp., *Gomphonema* spp., *Pinnularia* spp. and *Stephanodiscus astrea.*

2.2. Stratigraphical changes of diatom flora in TV1 core

Stratigraphical changes of diatom flora in TV1 core can be divided into four diatom divisions, labeled D1, D2, D3 and D4 in ascending order. The relatively abundant genera and species in the core are shown in Fig. 2.

Division D1 (-20.06 to -13.48 m) shows that marine plankton species obviously increase. However, the change of marine plankton species, brackish water and fresh water species are not monotonous, they rhythmically change in vertical. This division can be divided two sub-division D1a and D1b.

Sub-division D1a (-20.06 to -19.0 m) is mainly composed of 40.0 % marine plankton, 20.0-30.5 % brackish water and 23.5-17.2 % fresh water. *Sub-division D1b* (-19.0 to -13.48 m) has 48.3-67.0 % marine plankton, 8.5-20.3 % brackish water and 7.0-16.0 % fresh water.

Marine plankton species such as *Coscinodiscus radiatus, C. nodulifer, Thalassiosira excentrica* and *Cyclotella caspia, C. styrolum, Cocconeis placentula* and *Synedra affinis* are common. They indicate a shallow-marine habitat is predominant upwards but there is a clear supplement of brackish and fresh water.

Division D2 (-13.48 to -10.5 m) presents the obvious decrease of marine plankton species and the increase of brackish species as well as fresh water species. It is composed of 54.8-41.2 % marine plankton, 17.3-22.6 % brackish water and 17.7-24.9 % fresh water. *Coscinodiscus radiatus, C. nodulifer* are still abundant but markedly decrease in individual. *Thalassiosira excentrica, Thalassionema nitzschioides* present in low frequency. *Cyclotella caspia, C. styrolum,* and *Paralia sulcata* are common and gradually increase upward. *Synedra affinis* and *Cocconeis placentula* are common. This indicates an increasing in influence of fresh water.

Division D3 (-6.8 to -1.4 m) Marine plankton obviously decrease upward while brackish water species increase. It is composed of 17.6-38.0 % marine plankton, 29.4-40.5 % brackish water and 15.0-35.3 % fresh water. Fresh-water species such as *Synedra affinis, Aulacoseira granulata* and fresh-brackish water such as *Cocconeis placentula* are common. Brackish water species such as *Cyclotella caspia, C. styrolum* increase in individual upward. This indicates a brackish water habitat with influence of marine water.

Division D4 (-1.4 to +0.8 m) shows the complicate intermixture of marine plankton, brackish and fresh water diatom species. Fresh-water species obviously increase in the

lower then decrease upward. Marine plankton and brackish water species are abundant. It is composed of 21.7-39.0 % marine plankton, 27.3-38.1% brackish water and 15.2-33.0 % fresh water. Fresh-water and fresh-brackish water species such as *Synedra affinis, Aulacoseira granulata* and *Cocconeis placentula* are common but decrease in individual upward. Marine plankton and brackish water species such as *Coscinodiscus radiatus, C. nodulifer, Thalassiosira excentrica* are common and increase in individual upward. This indicates a rhythm change of marine brackish and fresh water environments.

2.3. Late Pleistocene-Holocene sedimentary facies

On the basis of combining lithological characteristics, divisions of diatom and ^{14}C ages, the sedimentary facies of the TV1 core are interpreted as follows (Fig.3):

Undifferentiated Late Pleistocene sandy silt facies

This facies consists of slightly oxidized, mottled yellowish grey stiff sandy silt, silty sand and fine-medium sand bearing scattered ferralic pebbles. Colors of sediments show the deposition is effected by oxidized and weathered conditions. In the upper part, it is composed of sandy silt without marine shells suggesting fresh-water environment. However, shallow-marine shell fragments scattered in the lower part with sand content obtained to 70%. Thus, before being weathered, the sediments of TV1 core were deposited in marine environments then non-marine environment respectively. A shell fragment from around -25.0 m indicates an age of 43,420 cal yr BP.

Sandy lag facies

It mainly consists of poorly sorted pebbly sand with marine shell fragments and ferralic pebbles an a fining-upward succession. Shell fragments are abundant. This facies is correlated to the diatom division D1a characterized by the intermixture of marine plankton, brackish and fresh-water species group. Marine plankton species such as *Coscinodiscus radiatus, C. nodulifer, Thalassiosira excentrica,* brackish water species such as *Cyclotella caspia, C. styrolum,* fresh water *Cocconeis placentula* and *Synedra affinis* are common. In lithology, this facies is similar to the transgressive sandy lag like VL1 core [4], however, marine transgressive diatom assemblage is not found, moreover, a shell fragment gave an age of 2,719 cal yr BP. Therefore, the deposit is formed after Holocene transgression and it is suggested regressive sandy lag facies.

Pro-delta mud facies

In lithology, it represents a coarsening-upward succession of dark grey, greenish grey silt, sandy silt and fine sand. It is characterized by discontinuous laminae, parallel laminae and wavy bedding. Burrows and bioturbations are scattered. The bioturbated silty clay in the lower part suggests that sediments were deposited under relatively quiet hydrodynamic conditions. The coarsening-upward succession indicates deltaic sediments effect to the depositional process. This facies corresponds to diatom division D1b characterized by the obvious increase in marine plankton species. Brackish-water and fresh-water species rhythmically change in vertical. *Coscinodiscus radiatus, C. nodulifer* and *Thalassiosira excentrica* are abundant. *Cyclotella caspia, C. striata, Cocconeis placentula* and *Synedra affinis* are common. They indicate a shallow marine habitat is predominant but there is a clear supplement of brackish and fresh water, the marine environment gradually is effected by terrigenous flux upwards. The combined analyses

suggest this facies as a pro-delta mud facies. This facies was dated 1,962 cal yr BP from shell fragments.

Delta front sandy silt facies

It mainly consists of greenish grey sandy silt and fine-medium sand in a coarsening-upward succession. Well-sorted medium sand suggests that the deposit was formed in the long transport and high-energy condition of wave- dominant zone. Sedimentary structures are various such as wavy bedding, parallel laminae, current ripples and lenticular bedding. Shell fragments, bioturbation and organic matter are scattered throughout the facies. This facies is correlated to the diatom division D2. *Coscinodiscus radiatus, C. nodulifer, Cyclotella caspia, C. striata,* and *Cocconeis placentula* are abundant. *Paralia sulcata* and *Synedra affinis* are common. This indicates an increasing in influence of brackish and fresh-water habitat. The coarsening-upward succesion implies the increase of river influx associated with deltaic progradation. The facies is interpreted as delta front sandy silt facies. The shell fragments indicate ages of 1,826 cal yr BP.

Sub- to intertidal flat sandy silt facies

This facies consists of silty sand and fine-medium sand in a coarsening-upward succession. The sediment is composed of intercalated silt and fine-medium sand with wavy bedding, lenticular bedding, parallel laminae, current ripples. Coarsening-upward succession with well-sorted fine-medium sand indicate the sediment deposited under wave actions. Organic matter increases upward, shell fragments and bioturbation are scattered all the facies. This facies corresponds to the lower part of diatom division D3 representing the obvious increase of brackish-water species and the gradual decrease of marine plankton species. *Cyclotella caspia, C. striata* and *Coscinodiscus radiatus* are abundant. *Coscinodiscus nodulifer* and *Cocconeis placentula* are common. This indicates marine-brackish water habitat changes to brackish-water habitat with influence of fresh water. This facies is interpreted sub- to intertidal flat sandy silt facies. Shell fragments indicate ages of 1,001 cal yr BP.

Subaerial delta plain facies (marsh and beach ridge)

This facies consists of sand and clay alternating. Well-sorted fine-medium yellowish grey sand is in the lower part. Dark grey silt is in the uppermost part. Sand content reached to 85-90% in the middle and lower parts. Shell fragment gave an age of 721 cal yr BP. This facies corresponds to the diatom division D4 showing a complicate intermixture of marine plankton, brackish-water and fresh-water diatom species. *Cyclotella caspia, C. striata, Cocconeis placentula* and *Aulacoseira granulata* are abundant. *Coscinodiscus radiatus, C. nodulifer* are common. *Synedra affinis* and *paralia sulcata* occur in low frequency. Moreover, marine plankton and brackish water species including *Coscinodiscus radiatus, C. nodulifer, Thalassiosira excentrica* and *Cyclotella striata* are increased in individual upward. This indicates a fresh-brackish water habitat changes to brackish-marine habitat. It suggests that the change of environment is not monotonous and simple. Brackish-water and fresh-water influences become predominant but marine factors still exist. This facies is interpreted as a subaerial delta plain facies with the silty clay marsh and sand beach ridge succession. In particular, the change of diatom species indicate marine influence gradually increases on the top, this implies the salt-water intrusion is occurring in the coastal zone of Mekong River Delta.

3. CONCLUSION

– Results of diatom study (46 genera and 38 species) combined with lithological features, sedimentary structures and C14 ages from TV1 borehole contribute considerably to clarify sediment facies in relation to Holocene relative sea-level change in Travinh area. The delta has prograded to the site since 2,719 yr. BP.

– Diatom assemblage indicating to Holocene marine transgression is not found in this site.

– Diatom assemblage indicating to pro-delta facies is *Coscinodiscus radiatus, C. nodulifer, Thalassiosira excentrica, Cyclotella caspia, C. styrolum.*

– Diatom assemblage indicating to delta front facies is *Coscinodiscus radiatus, C. nodulifer, Cyclotella caspia, C. styrolum, Cocconeis placentula, Synedra affinis.*

– Diatom assemblage indicating to sub- to intertidal flat is *Cyclotella caspia, C. styrolum, Coscinodiscus radiatus.*

CÁC PHỨC HỆ DIATOM TƯƠNG ỨNG VỚI THAY ĐỔI TƯỚNG TRẦM TÍCH TỪ 3000 NĂM CÁCH NAY TRONG LỖ KHOAN TV1, ĐỒNG BẰNG SÔNG CỬU LONG

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TÓM TẮT: *ài liệu tảo silic từ lỗ khoan TV1 ở huyện Duyên Hải tỉnh Trà Vinh là một trong những công cụ hữu hiệu để nghiên cứu thay đổi tướng trầm tích trong thời Holocen. Năm nhóm sinh thái tảo silic được tìm thấy: biển phù du, mặn-lợ, nước lợ, lợ-ngọt và nhóm nước ngọt. Sự thay đổi của các nhóm này từ dưới lên trên được chia thành bốn phức hệ tảo silic là D1, D2, D3 và D4. Mỗi phức hệ tảo liên quan chặt chẽ tới môi trường trầm tích do thay đổi mực nước biển trong Holocen. Trầm tích tam giác châu được đặc trưng bởi nhóm nước mặn phù du và nước lợ. Sáu tướng trầm tích được xác định theo thứ tự là: trầm tích Pleistocen muộn, trầm tích vụn biển lùi, bột pro-delta, bột-cát delta front, bột-cát bãi triều và bột-cát tam giác châu trên cạn. Loạt trầm tích biển lùi cho thấy tam giác châu phát triển ở vị trí này từ khoảng 2.719 năm trước hiện tại.*

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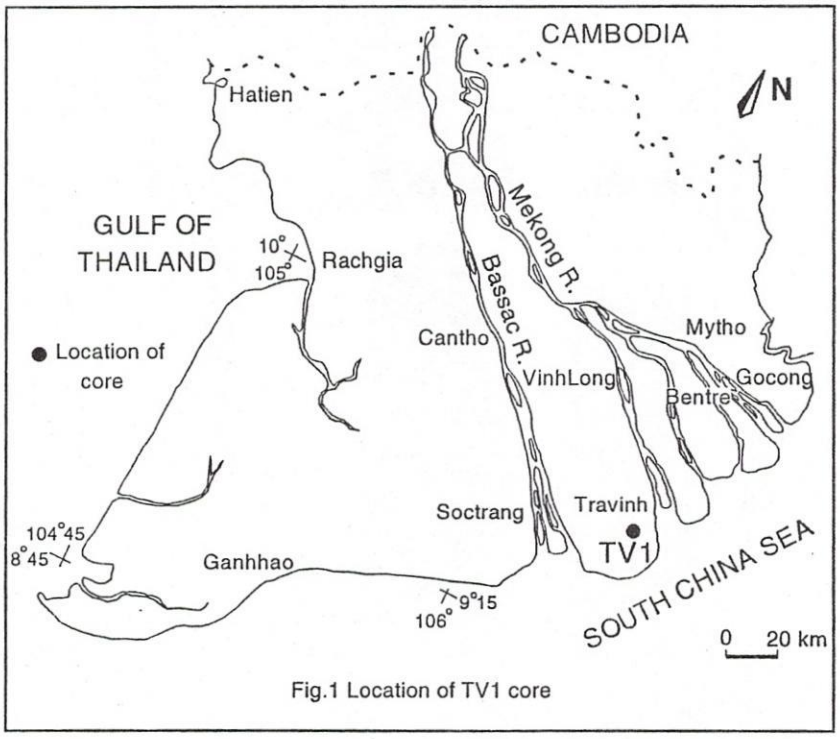

Fig.1 Location of TV1 core

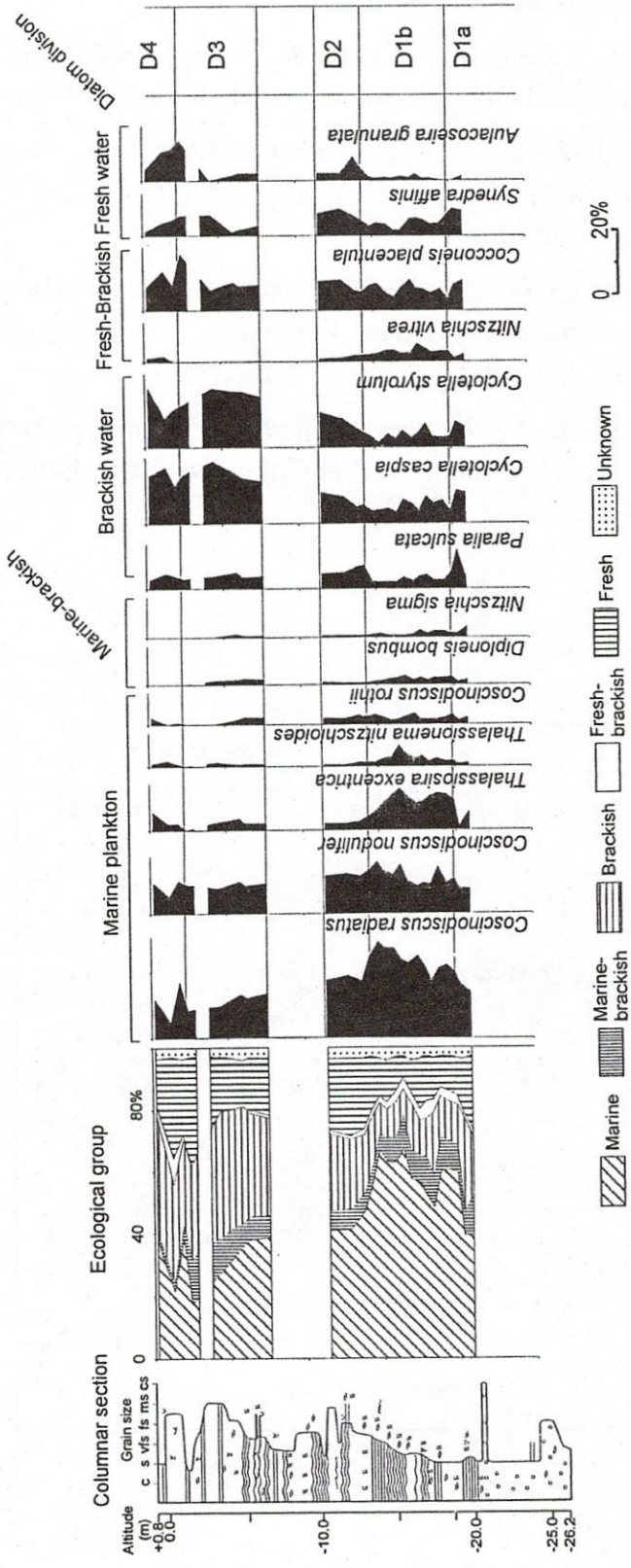

Fig. 2. Diatom division of TV1 core

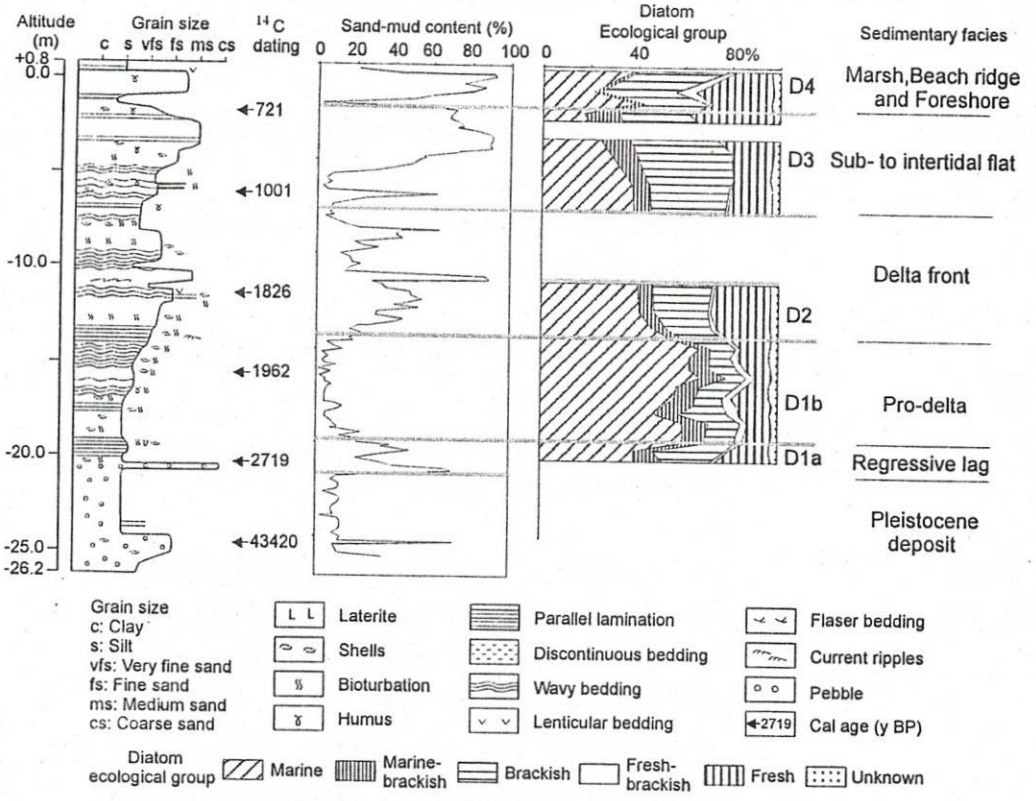

Fig. 3. Sedimentary facies of TV1 core