HOLOCENE SEDIMENTARY FACIES CHANGE IN TV1 CORE MEKONG RIVER DELTA

Nguyen Van Lap, Ta Thi Kim Oanh
Sub-Institute of Geography, Vietnamese Academy of Science and Technology
(Bài nhận ngày 25 tháng 06 năm 2005, hoàn chỉnh sửa chữa ngày 02 tháng 08 năm 2005)

ABSTRACT: *The TV1 boring site is a typical section at coastal part of the Mekong River Delta (MRD) and has 20.8m in thickness of the Holocene deltaic sediments. Holocene marine transgressive deposit is not found here. Holocene deltaic sediments unconformably covered late Pleistocene sediments and characterized by 20,8 m in thickness of the coarsening-upward succession including pro-delta, delta front, sub- to intertidal flat and beach ridge sediments. This typical section has been dated since 3 ky. BP. It is a typical tide- and wave- dominated delta succession of the MRD.*

Introduction

Sedimentary facies and deltaic evolution of the MRD have been studied recently [1,2]. Detail studies by using borehole samples and high-resolution ^{14}C dating are important to spculate the changes of sedimentary facies related to sea-level changes [3,4]. A 27 m long core located at TraVinh province (Fig.1) gives a good opportunity to study deltaic progradaion in the esatern coast of the MRD.

This paper presents a detailed description of sediment facies and ^{14}C ages, and discusses the relationship between these facies and the latest Pleistocence-Holocence sea-level changes.

The authors express their gratitude to Dr. Y. Saito, Geological Survey of Japan for helping analyses of ^{14}C ages; Prof. M. Tateishi and Prof. I. Kobayashi, Niigata University for kind comments on our manuscript. This work 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. This work was supported by the Natural Science Council of Vietnam.

Methods

The core samples were split out and described. Slab samples (5 x 25 x 1cm) were collected from whole cores. These slab samples were photographed, X-radiographed, and described in detail in terms of lithology, granulometry, and sedimentary structures. Sand and mud contents were measured every 20cm throughout the core. Sand samples were 5 cm thick and mud samples were 2cm thick. After organic materials were removed with 10% H_2O_2, sands were separated on a 63-μm sieve under pored water. After measuring the dry weight of sand portion, sand contents were calculated. Six ^{14}C ages were measured on plant fragments and molluscan shells by accelerator mass spectrometry (AMS) at Beta Analytic Inc. Calendar ages were calculated by the INCAL98 calibration curve.

RESEARCH RESULT

1. Lithological units

On the basis of sedimentary characteristics and ^{14}C ages, the TV1 core can be divided into six lithological units (Fig.2) as follows:

Unit 1 (-26.2 to -20.8 m) consists of stiff, slightly oxidized, mottled yellowish grey silt, silty sand and fine-medium sand bearing scattered ferralic pebbles. Shell fragments scattered in the lower part and sand content is 10-15% excepting 70% in -24.5 m. Fine to medium sand and shell fragments were trapped in sand pipes. In the upper part, sand portion is 3-10 % and shell fragments are not found.

Unit 2 (-20.8 to -19.4m) generally consists of medium-coarse sand with marine shell fragments and ferralic pebbles. Sand content is 20-70%. Shell fragments and microfossils such as foraminifera and sponge spicules are abundant.

Unit 3 (-19.4 to -15.0 m) is composed of dark grey sandy silt and silty clay in a fining-upward succession. Sand content is 4-20 %. It is characterized by discontinuous laminae and parallel laminae. Laminae are generally composed of sandy silt with very thin dimension only about 1 mm in thickness. Spotted burrows and bioturbations are scattered in the sandy silt. Small shell fragments and very fine to fine sand are trapped inside the burrows.

Unit 4 (-15.0 to -8.10 m) mainly consists of greenish grey sandy silt and fine-medium sand in a coarsening- upward succession. Sand content is 2-60% excepting 85-88% from -10.8 to -11.8 m. Wavy bedding is common all this unit. Parallel laminae are in the lower part, current ripples and lenticular bedding occurred in the middle part. Yellowish grey clay spots containing calcareous incipients or nodules occurred in the middle to lower parts. Shell fragments, bioturbation and organic matter are scattered throughout the unit.

Unit 5 (-8.10 to -1.25m) consists of dark grey silty sand to fine-medium sand in a coarsening- upward succession. Sand content is 10-90%. In the lower part, intercalated silt and fine -medium sand with wavy bedding, lenticular bedding and contorted structures are common. In the upper part, parallel laminae and current ripples occurred. Shell fragments, organic matter and bioturbation are common in this unit.

Unit 6 (-1.25 to +0.8 m) consists of alternating beds of sand and clay with dark grey silt in the uppermost part and well-sorted fine- medium yellowish brown and gray sand in the lower one. Sand content reached to 85-90% in the middle and lower parts. Flaser and lenticular beddings are in the lower part. Organic matters commonly exist in the upper part.

2. Sedimentary facies

In the TV1 core, six sedimentary facies are interpreted (Fig.2) as follows:

Undifferentiated Late Pleistocene sandy silt facies

In lithology, it coincides to unit 1 and generally 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. Although the sediment appears to be undifferentiaed Late Pleistocene facies of the VL1 core [3], it has some differences of distribution of grain size texture and microfossils, in particular, of foraminifera species. In the upper part, similar to the VL1 core, it is composed of sandy silt and the absence of shell fragments and foraminifer species is noticed. It suggests that environment is effected by fresh-water factors. On the contrary, shell fragments scattered in the lower part of unit and sand content obtained to 70% and a few shallow marine foraminifer species. The common presence of *Ammonia* spp., *Asterorotalia multispinosa, Elphidium* sp., *Hanzawaia* sp., indicate a coastal shallow-marine habitat. Thus, in the TV1 site, before being exposed on a supra-tidal and weathered

zone, the sediments were deposited respectively in marine environments then non-marine environment respectively. A shell fragment sample from -25.0 m indicates an age of 43,420 cal. kyBP.

Sandy lag facies

This facies coincides to unit 2, mainly consists of poorly sorted pebbly sand with marine shell fragments and laterite pebbles (Fig.3A) and a fining-upward succession. Shell fragments and microfossils such as foraminifera and sponge spicules are abundant. Although this facies is similar to the transgressive sandy lag in lithology like VL1 core [3], a shell fragment gave an age of 2,719 cal yr BP. Therefore, the deposit is formed after an Holocene transgression and it is suggested regressive sandy lag facies.

Pro-delta mud facies

This facies coincides with unit 7 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. Spotted burrows and bioturbations are scattered in the sandy silt (Fig.3B). Small shell fragments and very fine to fine sand are trapped inside the burrows. 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. 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

This facies coincides with unit 8 and the lowest part of unit 9. It mainly consists of greenish grey sandy silt and fine-medium sand in a coarsening-upward succession. Sand content is usually 2-60% excepting the interval of -10.8 to -11.8m to be 85-88%. Well-sorted medium sand suggests that the deposit was formed in the long transport and high-energy condition of wave-dominant zone. Various sedimentary structures typically exist on this facies such as wavy bedding, parallel laminae, current ripples and flaser bedding (Fig.3C). Shell fragments, bioturbation and organic matter are scattered throughout the facies. The coarsening- upward succesion implies the increase of river influx associated with deltaic progradation. The facies is interpreted as a delta front sandy silt facies. The microfossil data also support this interpretion. The shell fragments indicate ages of 1,826 cal yr BP from the lower to upper parts of this facies.

Sub- to intertidal flat sandy silt facies

This facies coincides with the middle of unit 9 consisting of dark grey silty sand and fine-medium sand in a coarsening- upward succession. The sand content in the upper part is over 90%. The sediment is composed of intercalated silt and fine- medium sand with wavy bedding, lenticular bedding, parallel laminae and current ripples. Wavy and lenticular bedding suggest the tide influence [6]. Current ripples may indicate the effect of tidal currents. Coarsening- upward succession with well- sorted fine- medium sand indicates the sediment deposited under wave actions. Organic matters increase upward, shell fragments and bioturbation are scattered all the facies (Fig.3D). This facies is interpreted as a sub- to intertidal flat sandy silt facies (Fig.3E). Shell fragments indicate ages of 1,001 cal yr BP.

Subaerial delta plain facies (marsh and beach ridge)

This facies coincides with the uppermost parts of unit 9 and 10, consists of alternating beds of sand and clay. 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 (Fig.3F). Parallel laminae and organic matter are common. Shell fragment gave an age of 721 cal yr BP. This facies is interpreted as subaerial delta plain facies with the silty clay marsh and sand beach ridge succession.

3. Sea level change and sediment facies

The Holocene sediment successions were controlled by the changes in late Pleistocene topography, sea level and sediment supply. The Holocene trangressive incised-valley filling succession consists of estuarine channel/tidal river sandy silt, estuarine marine sand and finally open bay mud facies and dated 13.0 to 5.3 cal. Ky. BP. [5,6]. This indicates that after Last Glacial Maximum at around 18-20 ky.BP, due to sea-level rising sedimentation filled the incised valleys meanwhile erosive process occurred on interfluves. Holocene maximum transgression occurred here at 5.0-5.5 ky. BP, and coastline was in the north part of the Mekong River Delta [2]. Away from the incised valley, a progradational deltaic succession with a thickness of about 20.8 m has developed especially during the last 2-3 ky. During the highstand and subsequent periods of slightly falling sea-level, due to a large sediment load from the river the deltaic sediments prograded and overlay bay mud facies at the lower part [3,5] then covered the late Pleistocen sediment at the higher part such as locality of the TV1 site. The coarsening- upward succession from pro-delta, delta front and sub- to intertidal flat facies suggests that the delta sediments formed after the occurrence of maximum Holocen transgression and a big gap of around 40 ky without deposition and/ or erosive processes. In the lower deltaplain with its beach-ridge system, the upper part of the sub- to intertidal flat consists of a coarsening-upward succession, including in its uppermost part foreshore/dune sediments. This indicates a wave-and tide-dominated delta succession. Moreover the facies succession change coincides with the surficial morphology of the present lower deltaplain.

4. Relationship between accumulation rate and sediment facies

The accumulation rate and sediment facies are closely related. At the TV1 site, accumulation rates were high at 10.6 mm y^{-1} in the delta front from 1 to 1.8 ky and to be lower at 6.6mm y^{-1} in the prodelta from 1.9 to 2.7 ky. That indicates a low accumulation rate in the prodelta facies and a high accumulation rate in the delta front facies.

CONCLUSION

This paper provides a detailed description of sedimentary characters, sedimentary structures and ^{14}C ages obtained from the TV1 core in lower deltaplain of the MRD. Based on these analyses, seven sediment facies were recognized in relation to sea-level changes since the latest Pleistocene. The late Pleistocene sediments dated 43 ca. ky. BP were unconformably covered by Holocene deltaic sediments. It indicates that the late Pleistocene sediments are subjected by erosive proccesses for a long interval of 35-40 ky. Due to a high topography of the locality an open bay mud facies that indicated maximum Holocene transgression are absent here. The subsequent regression of sea level appears as an upward shallowing sedimentary succession ranging from prodelta, through delta front,

and sub- to inter-tidal flat to floodplain in the core. ^{14}C ages from the core indicate that the accumulation rates were closely related to the sediment facies: low rate for prodelta facies, high rate for delta-front facies.

THAY ĐỔI TƯỚNG TRẦM TÍCH TRONG LỖ KHOAN TV1 ĐỒNG BẰNG SÔNG CỬU LONG

Nguyễn Văn Lập, Tạ Thị Kim Oanh
Phân Viện Địa lý tại Tp. HCM, Viện Khoa Học Và Công Nghệ Việt Nam

TÓM TẮT: *Lỗ khoan TV1 trình bày mặt cắt điển hình ở ven biển đồng bằng sông Cửu Long với 20,8 m trầm tích Holocene. Trầm tích biển tràn Holocen không tìm thấy ở đây. Trầm tích châu thổ tuổi Holocen phủ bất chỉnh hợp trên trầm tích Pleistocen muộn và đặc trưng bởi 20,8 m dầy của loạt trầm tích thô dần lên trên gồm pro-delta, delta front, trầm tích bãi triều và giồng cát. Mặt cắt điển hình nầy được thành tạo từ 3.000 năm cách nay. Đó là loạt trầm tích tam giác châu điển hình chịu tác động ưu thế bởi triều - sóng ở đồng bằng sông Cửu Long.*

REFERENCES

[1] Nguyễn Ngọc Hoa (chủ biên), *Bản đồ địa chất và khóang sản Việt Nam 1/200.000. lọat tờ đồng bằng Nam bộ*. Cục Địa chất, VN, Hà Nội, (1995)

[2] Nguyen, V.L., Ta, T.K.O., Tateishi, M., Late *Holocene depositional environments and coastal evolution of the Mekong River Delta, Southern Vietnam.* Journal of Asian Earth Science **18**, 427-439, (2000)

[3] Nguyen Van Lap, Ta Thi Kim Oanh, *Sediment facies and evidence of middle Holocene trangression in the VL1 core, Mekong River Delta.* Tạp chí Phát triển Khoa học và Công nghệ **6**, 45-53, (12/2003)

[4] Nguyễn Văn Lập, Tạ Thị kim Oanh, *Môi trường trầm tích và tuổi tuyệt đối C14 lỗ khoan CM vùng Cà Mau.* Tạp chí Phát triển Khoa học và Công nghệ **7**, 50-55, (11/2004)

[5] Tạ Thị Kim Oanh, Nguyễn Văn Lập, *Diatom- chỉ thị môi trường trầm tích và dao động mực nước biển trong Pleistocene muộn- Holocene.* Tạp chí Các Khoa học về Trái Đất, **22**(3), 226-233, (2000)

[6] Tạ Thị Kim Oanh, Nguyễn Văn Lập, *Trầm tích Pleistocene muộn- Holocene và sự phát triển của tam giác châu sông Cửu Long ở Bến Tre.* Tạp chí Các Khoa học về Trái Đất, **24**(2), 103-110, (2002)

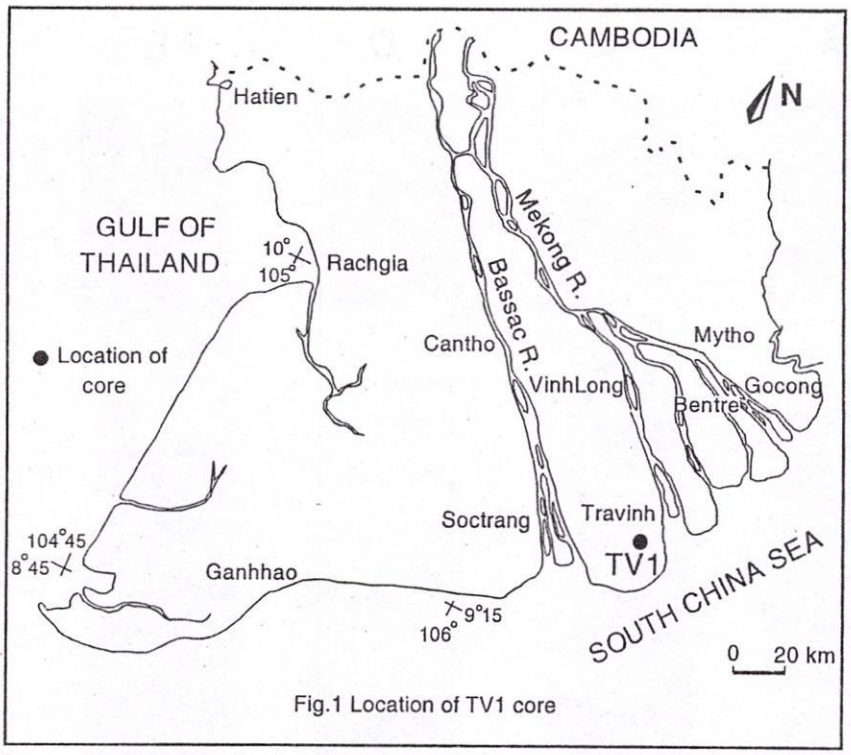

Fig.1 Location of TV1 core

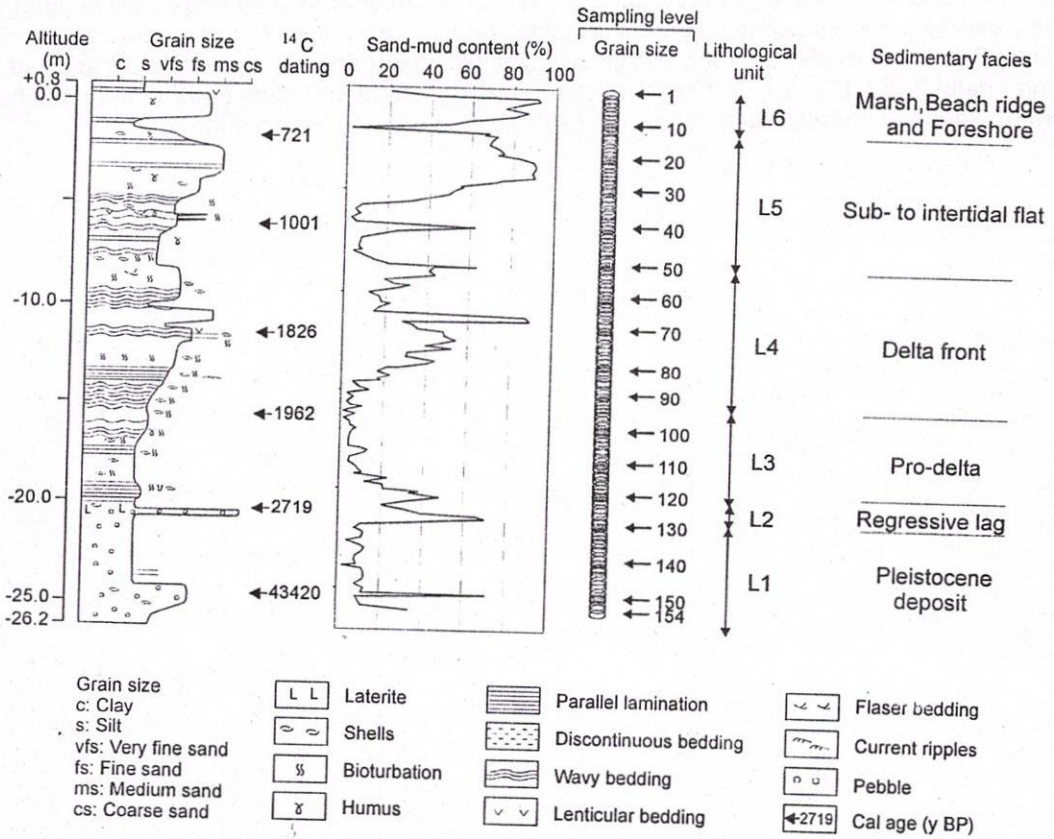

Fig. 2. Lithological division of TV1 core

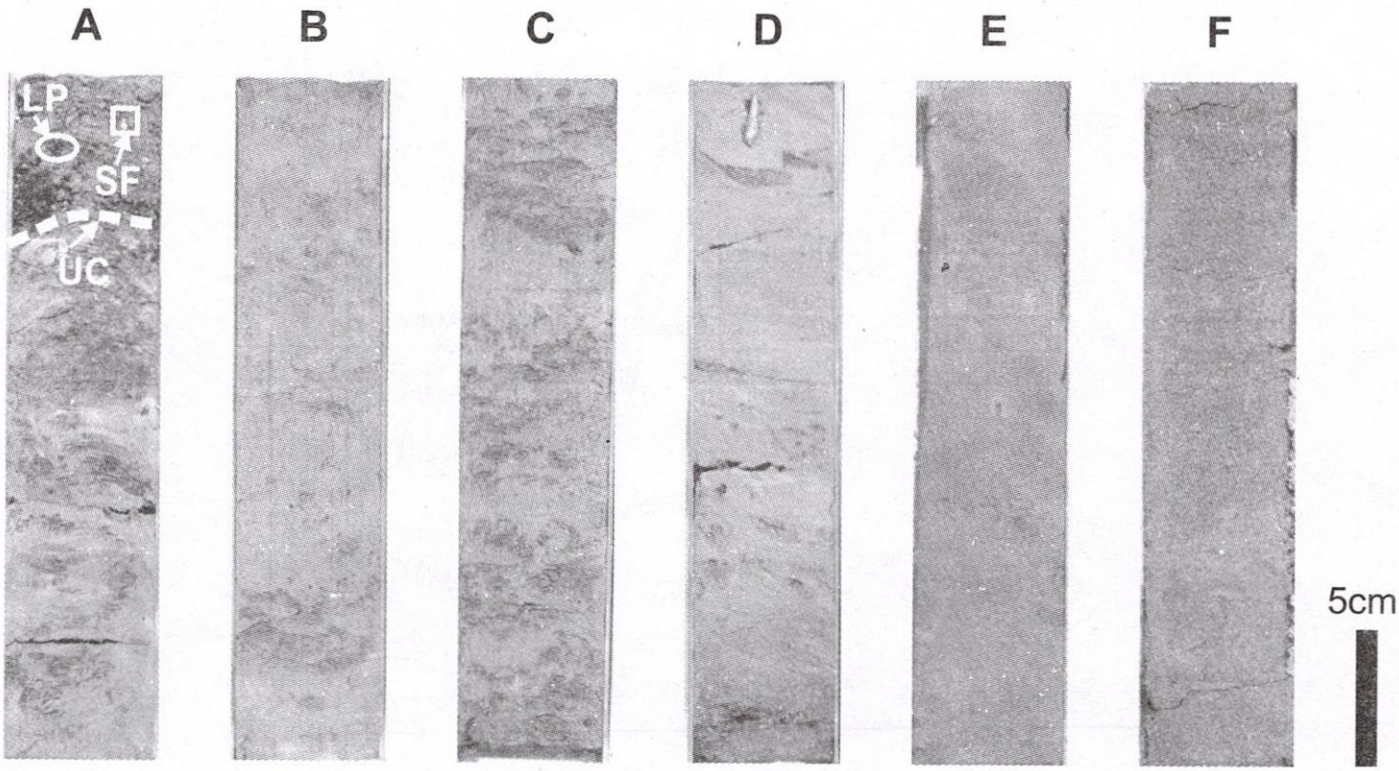

Fig 3. Selected photographs of the Tv1 core samples. A (-20,7 -20.95m): sandy and shelly lag deposit unconformably overlie the Pleistocene sediment. The UC: unconformity, the LP: laterite pebble, the SF: shell fragments. B (-15,7 -15.95m): dark grey silt, silty clay with bioturbation (prodelta). C (-8,45 -8,70m): flaser bedding (delta front). D (-5,7 -5,95m): lenticular bedding and bioturbation (sub- to intertidal flat). E (-2,2 -2,45m): sand flat (sub- to intertidal flat). F (-0,2 -0,45m): sandy beach ridge.