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The Analytical Results of Maximum Ancient Sea-level on Limestone Blocks in Halong Bay, Quangninh, Vietnam and It's Shoreline in Red River Delta

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Abstract

Determining the relative elevation points in the Red River delta corresponding to the height of the current traces of maximum ancient sea level on limestone blocks in Halong bay area, Quangninh province, Vietnam and from the application of survey method, we have drawn a map of ancient shoreline in the Red River delta. The elevation of this ancient shoreline on the topographic map scale of 1/50.000 is about 5.3m. This result quite match with some previous studies of sea level changes in Holocene period of the study area.

Keywords: Current traces, Ancient shoreline, Red river delta, Sea level, Limestone blocks.

1. Introduction

The sea level change during the Pliocene - Quaternary period is due to changes of the ice block on the earth, caused by global climate change, has left many traces, with clear evidences on coastal and continental shelf of Vietnam, such as: topographical and geomorphological features, ... and the evidences of ancient sea level on limestone blocks.

The studies of the curves of the sea level change on the South China Sea and the Red River delta have been considered by many authors, such as: Doan Dinh Lam and W.E.Boyd (2001), Doan Dinh Lam (2003), Tran Nghi (2001), Susumu Tanabe and et al., (2003), Susumu Tanabe and et al., (2006), Nguyen Dai Trung (2016)... Using the different analytical methods, the authors drew the curves of the sea level change and the map of ancient shoreline in various stages very clearly. However, these studies have not yet mentioned the use of the method for determining the relative elevation of the ancient sea levels on limestone blocks during the maximum transgression, corresponding to the elevation points in the Red River delta, as the basis for establishing the map of ancient shoreline.

In this paper, we propose a new approach in order to verify the location of the maximum ancient shoreline during the transgression period in the Red River delta area from the previous studies by connecting the absolute elevation points on the area of the Red River delta corresponding to the current traces of maximum old sea level on limestone blocks in Halong Bay area, Quangninh province, Vietnam.

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2. Field data collection and used methods

The main purpose of this study is:

1) Determine the absolute elevation points in the Red River delta corresponding to the traces of maximum old sea level on limestone blocks in the area of the Ha Long bay area, Quangninh, Vietnam.

2) Draw the map of ancient shoreline of the Red River delta according to the traces of maximum old sea level on limestone blocks in the area of the Ha Long bay area, Quangninh, Vietnam.

Tasks:

- Measure the relative elevation points in the Red River delta corresponding to the traces of maximum old sea level on limestone blocks of the Ha Long bay in the same time.
- Convert the relative elevation points in the Red River delta to absolute elevation based on national landmark.
- Establish the similar elevation points on the topographic map of the scale of 1:50,000 in the Red River delta.
- Combine the similar elevation points on the topographic map to draw the assumed map of ancient shoreline.
- Compare and discuss the obtained results with the previous studies in the area of the Red River delta.

2.1. Field data collection

The process of this study is conducted as follows:

1) Determine the location of the national elevation landmark;

Figure 1. The national elevation landmark and it's coordinate

2) Determine the absolute elevation of a coastal position from the national elevation landmark;

Figure 2. Movement of the absolute elevation from the national elevation landmark

Figure 3. Determine of the standard elevation point according to national elevation landmark to compare with the current traces of maximum old sea level at the same time

3) Measure the current traces of maximum old sea level on limestone blocks at the same time with the position that moved from the national elevation landmark (Fig. 4).

Figure 4. Measurment of the maximum old sea level of the current traces on limestone blocks

The results of measurment of the maximum old sea level of the current traces on limestone blocks in Halong Bay area are conducted at diffrent 16 survey sites (Tab. 1).

Table 1. Elevation of current traces of the maximum old sea level on limestone blocks and their coordinate in the area of Ha Long Bay, Quang Ninh, Vietnam

No	Longitute (Degree)	Latitude (Degree)	Measurement time	Relative elevation (m)
1	107^{0}04'35.95"	20^{0}56'26.103"	1h22'	3.8
3	107^{0}04'42.50"	20^{0}56'27.296"	1h32'	3.7
4	107^{0}04'41.99"	20^{0}56'26.353"	1h34'	3.7
5	107^{0}04'40.48"	20^{0}56'28.046"	1h40'	3.9
6	107^{0}04'39.34"	20^{0}56'30.903"	1h42'	3.78
7	107^{0}04'43.94"	20^{0}56'32.029"	1h44'	3.8
8	107^{0}04'45.21"	20^{0}56'32.445"	1h46'	3.4
9	107^{0}04'46.50"	20^{0}56'31.342"	1h50'	3.76
10	107^{0}05'00.00"	20^{0}56'26.817"	1h54'	3.85
11	107^{0}04'51.80"	20^{0}56'16.311"	2h00'	3.8
12	107^{0}05'06.08"	20^{0}56'15.356"	2h07'	3.6
13	107^{0}05'19.51"	20^{0}56'29.278	2h15'	3.82
14	107^{0}05'31.85"	20^{0}56'35.387"	2h21'	3.85
15	107^{0}05'40.27"	20^{0}56'52.752"	2h29'	3.7
16	107^{0}05'07.70"	20^{0}56'47.362"	2h40'	3.85

2.2. Method

The methods used in this study include: Survey and GIS method. The Survey method used for collecting the field data, as the basis for determining the absolute elevation in the Red River delta from the current traces of the maximum old sea level on limestone blocks according to national elevation landmark.

Method of Mapping - GIS is used to combine the similar elevation points from each survey site on the limestone blocks, to draw the map of ancient shoreline according to absolute elevation data that converted from the limestone blocks.

3. Results

The obtained data from each survey site on the each limestone block are transferred to the absolute elevation according to national landmark (Fig. 5).

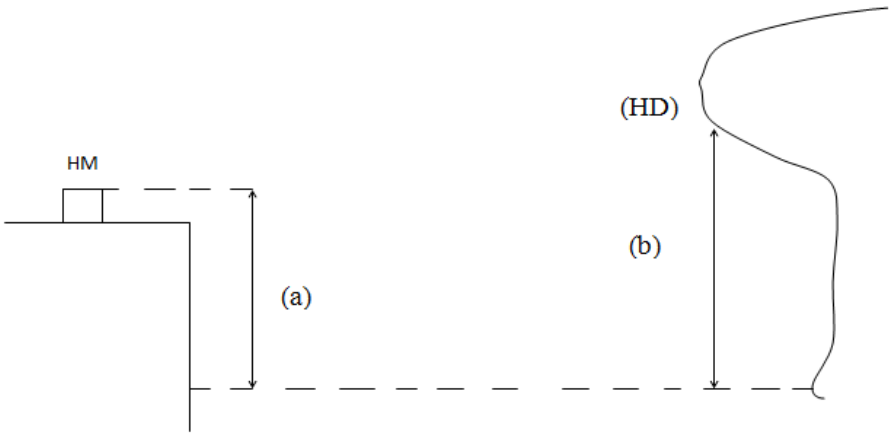


Figure 5. Simulation of the collected survey data and processing data

a: The elevation of the position that move from the national elevation landmark;
b: The elevation of the traces of maximum old sea level on limestone blocks;
HM: National elevation landmark (2.940m);
HD: Elevation of corrosion traces on limestone blocks in Halong bay;

$$HD = HM - a + b \quad (1)$$

Absolute elevation converted from 16 measurement points using the formula (1) is recorded in Table 2.

Table 2. The relative elevation of the traces of maximum old sea level on limestone blocks and their absolute elevation in the Red River delta.

No	**a (m)**	**b (m)**	HD (m)	No	**a (m)**	**b (m)**	**HD (m)**
1	1.832	3.8	5.28	9	1.792	3.76	5.28
2	1.842	3.7	5.17	10	1.782	3.85	5.38
3	1.842	3.7	5.17	11	1.772	3.8	5.34
4	1.847	4.0	5.465	12	1.752	3.6	5.16
5	1.847	3.9	5.365	13	1.722	3.82	5.41
6	1.832	3.78	5.26	14	1.687	3.85	5.475
7	1.837	3.8	5.275	15	1.657	3.7	5.355
8	1.797	3.4	4.915	16	1.622	3.85	5.54

The results in the Table 2 showed that the trace elevation of maximum old sea level on limestone blocks corresponding to over 5m in the Red river delta and their average value is 5.3m.

By processing data of 23 topographic maps with the scale of 1/50,000, the ancient shoreline of absolute elevation of maximum old sea level in the Red river delta is established in Figure 6.

The absolute elevation points in the Red River delta converted from the traces of maximum old sea level on limestone blocks in the Halong bay are combined as a curve that run abreast the slopes of the mountain ranges surrounding the Red River delta plain (Fig. 7).

The mountain ranges run according to NW-SE orientation and parallel to the Red River fault zone with different elevations. They are reflected clearly in the cross sections (Fig. 8).

To make clearly the topographic characteristics surrounding the Red River delta, a series of cross-sections are drawn as shown in Figure 8. On these sections, the surface topography of the Red River delta have low slope and all of them incline into the center. The limitation of the Red River delta is mountain ranges with the slope angles vary in the range of 0-4 degrees (Fig. 8).

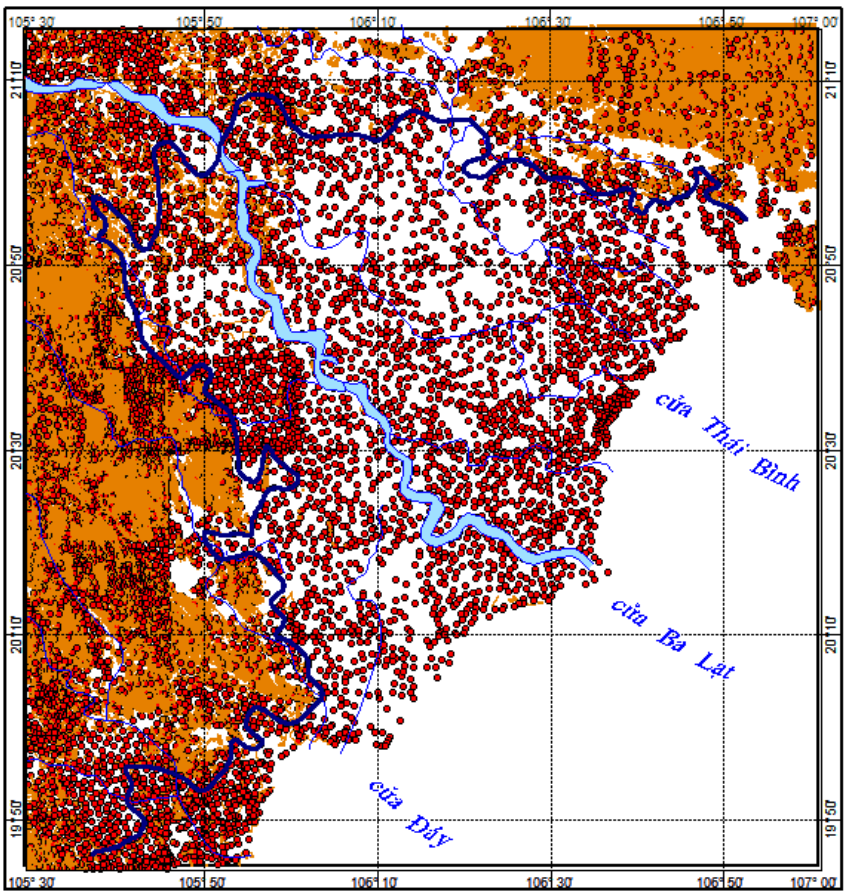


Figure 6. Topographic map of the study area is combined from 23 sheets and shrinked from the scale of 1/50,000

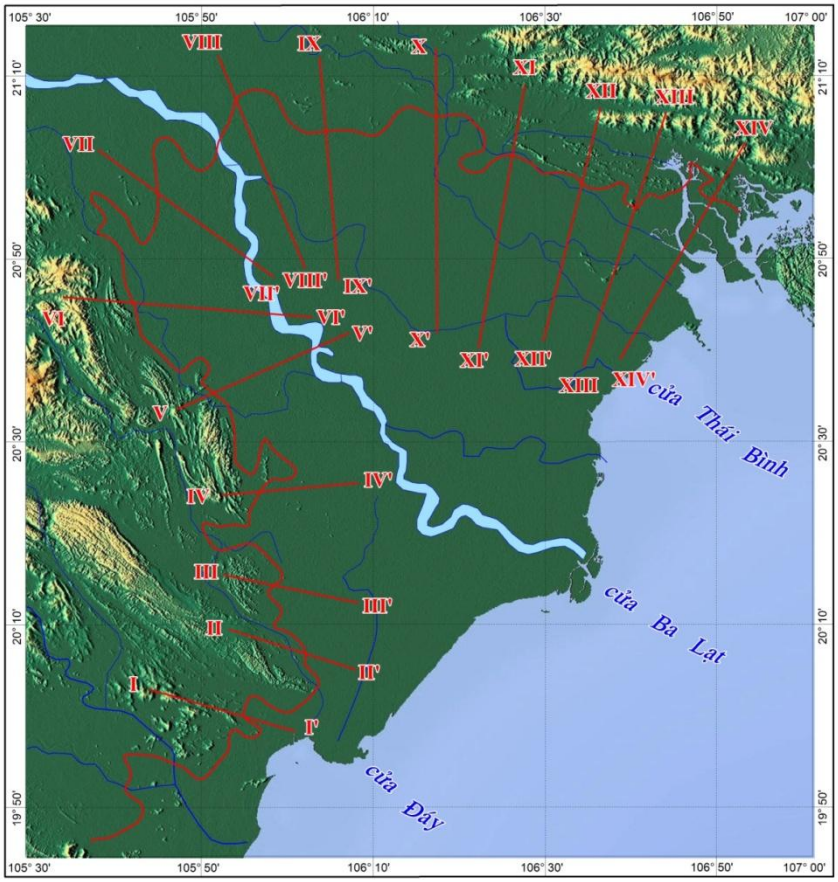
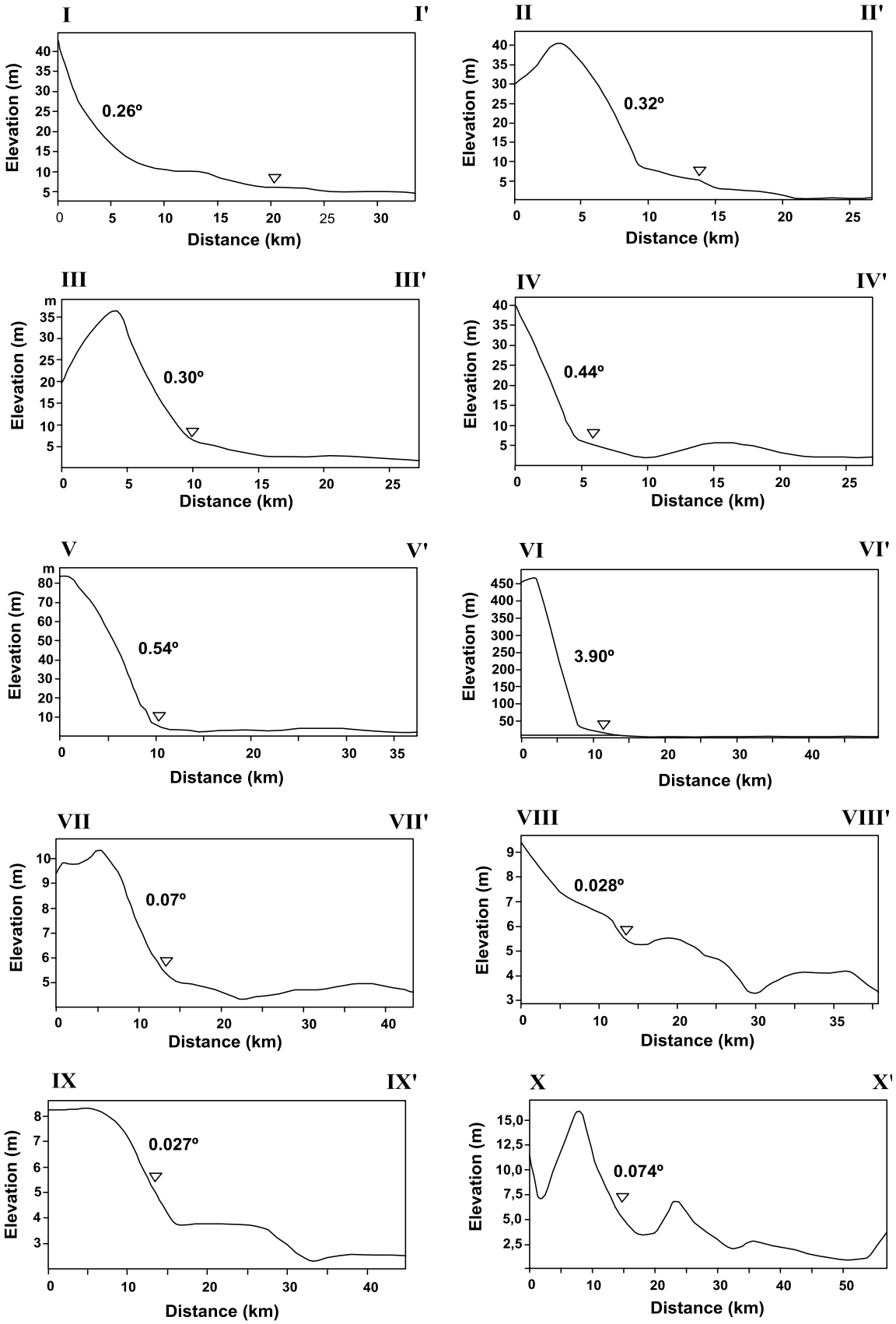


Figure 7. The elevation curve of the trace of maximum old sea level on limestone blocks in the Red River delta


I
I'
0.26°
II
II'
0.32°
III
III'
0.30°
IV
IV'
0.44°
V
V'
0.54°
VI
VI'
3.90°
VII
VII'
0.07°
VIII
VIII'
0.028°
IX
IX'
0.027°
X
X'
0.074°
Elevation (m)
Distance (km)

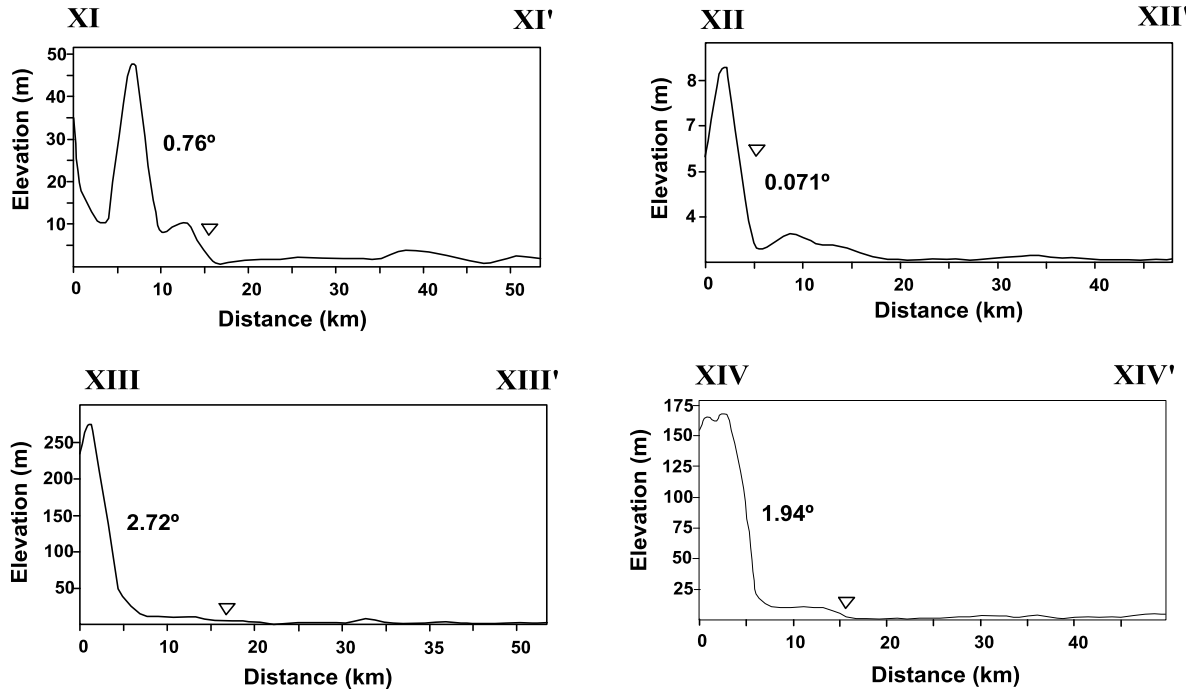


Figure 9. Topographic cross sections surrounding the Red River delta

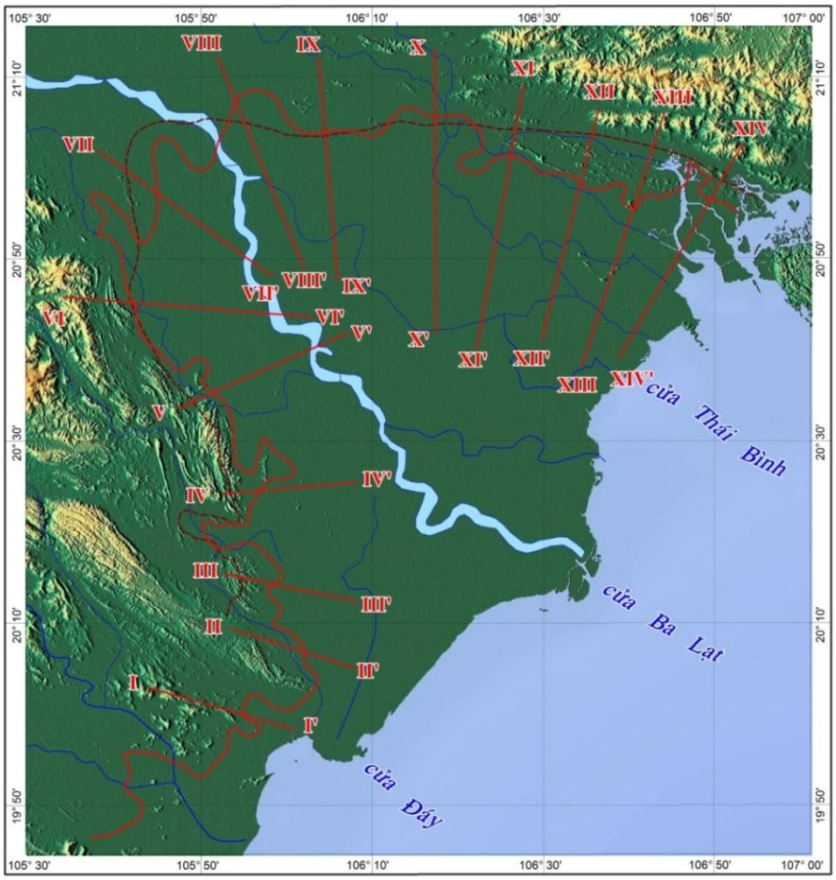


Figure 10. Maximum ancient shoreline in the Red River delta: the solid line is the result of this study and the dashed lines is the result of Doan Dinh Lam (2003)

The curve is corresponding to the current traces of maximum old sea level on limestone blocks in Halong bay, to be drawn in the Red River delta, quite match with the curve of the maximum transgression period in Holocene early-mid of Doan Dinh Lam (2001) (Fig. 9).

This result is also consistent with a recent study of Nguyen Dai Trung (2016), based on the determination of the elevation of the current traces of old sea level on limestone blocks by applying geodetic methods in Trangan area, Ninhbinh province, Vietnam.

4. Conclusions

The analytical results of the elevation of maximum sea-level on limestone blocks in Halong bay area, Quangninh province, Vietnam are corresponding to it's shoreline 5.3m in Red River delta using survey method and topographic map of scale 1/50.000. This is a curve that run abreast the slopes of the mountain ranges surrounding the Red River delta. This result quite matches with the previous studies of sea level changes in Holocene period. However, this is only the initial results and it need to continue to study and compare with the other previous studies concerned.

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