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Letter

The record of mid-Holocene maximum landward marine transgression in the west coast of Bohai Bay, China

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ABSTRACT

This study used benthic foraminifera, diatom, total organic carbon, organic carbon isotope ratios, C/N ratios, and grain-size data from three AMS ^{14}C dated cores collected from the western coastal lowland of Bohai Bay, China, to elucidate the coastal response to relative sea-level change during the Holocene. A layer of peaty clay overlaying early Holocene terrestrial sediment was dated to 8400–8000 cal BP, and the peaty material in the sediment suggests possible vegetation cover before the mid-Holocene marine inundation in the study area. Sedimentary facies and changes in diatom and foraminifera assemblages suggest a five-stage marine transgression–regression history. During the first stage from 8000 to 7855 cal BP, the study area was inundated primarily by freshwater swamp. During the second stage from 7855 to 6000 cal BP the study area was under brackish water influence. In the third stage from c. 6000 to 5750 cal BP, the study area experienced marine influences, and by this time the Holocene transgression reached its maximum landward location and height. This was followed by a period of regression since c. 5750 cal BP. During the last 4000 years, the study area was influenced by freshwater and became a floodplain environment. Thus, this study reveals that the most landward position of the Holocene marine transgression was situated somewhere between the coring locations of DC01 and QX01, which is about 80 km inland from the present shoreline. This means the west coast of the Bay has advanced at an average speed of c. 13 m/a since the mid Holocene. The relative sea level around 6000 cal BP was at -2.64 ± 0.1 m.

1. Introduction

The timing and spatial extent of maximum landward marine transgression and the associated sea-level height during the early-middle Holocene in a given coastal region are important scientific facts to be established for the understanding of how this coast has responded to sea-level change during the current interglacial. This important information is essential for testing and constraining predictive models for the projection of future sea-level change (Lambeck et al., 2010). As predicted (e.g. Church et al., 2013), global sea level is going to rise further during the 21st century, and muddy coasts are particularly vulnerable to such a change due to their low surface elevation. To protect the economic and social development in these coasts, adaptation strategies must be developed based on the understanding of coastal and sea-level histories. Furthermore, the actual pace of sea-level change and coastal sedimentary responses are regionally dependent, and this highlights the significance of a local study to assist the development of coping strategies.

An important area for such study is the coast lowland of Bohai Bay, as it lies in mid-latitude (38°40′N) (Fig. 1). Previous studies on the region's lithostratigraphy and Chenier systems provided some hints about where the most landward shoreline lies and the possible height of the mid-Holocene sea level (e.g. Zhao et al., 1979; Wang and Wang, 1980; Han et al., 1992). However, the dating methods used in these studies lacked accuracy, and the altitudinal survey of the coastal features was poorly conducted. Despite the poor chronological control, and lack of accurate altitude measurements, the results of these earlier studies have benefited later investigations in tracing marine sequences, including the possible landward limit of the latest marine transgression (Fig. 1). Accordingly, we have identified several locations for this study, during which we have surveyed a transect in the western part of the coastal lowland of Bohai Bay and collected three drill cores in order to identify the most landward boundary of the Holocene transgression. The lithological, biological and chronological evidence from these cores presented here help establish the location, height and timing of the maximum landward marine transgression in this coast.

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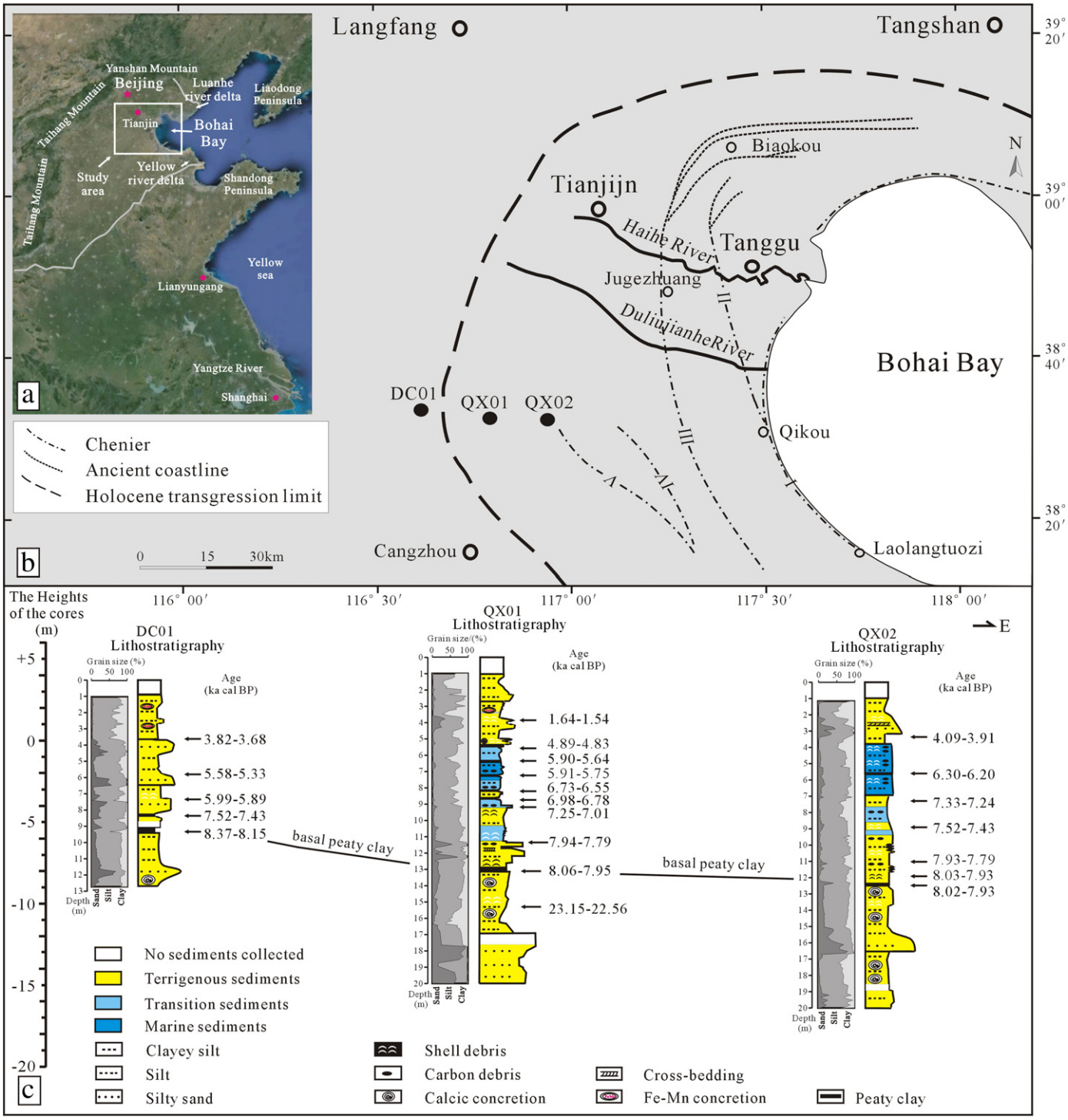

Fig. 1. (a) The study area. (b) Sampling sites and the western coastal lowland of Bohai Bay. Holocene transgression limit is based on a report by Xue (1993). The Chenier ridges and ages are from Su et al. (2011), Wang et al. (2011a,b) and Shang et al. (in preparation). Chenier V: 6700–5540 cal yrs BP, Chenier IV: 5650–4670 cal yrs BP, Chenier III: 4240–3370 cal yrs BP, Chenier II: 2850–1880 cal yrs BP, and Chenier I: 1000–80 cal yrs BP. (c) The lithostratigraphy, grain size and ages of core DC01, QX01 and QX02. Details of the lithology and radiocarbon dates of these cores are listed in Tables 1 and 2.

2. Study area and geological setting

Geologically, the study area is part of a depression situated between the Yanshan Mountain–Taihang Mountain ranges to the northwest, west and southwest, and the highlands of Shangdong and Liaodong Peninsulas to the east and southeast (Fig. 1a). The western part of this depression is filled with Quaternary sediment, while the eastern part remains as a semi-enclosed marine environment, called the Bohai Bay, which is connected to the Pacific through a gap between the two peninsulas and the Yellow Sea. The western lowland of the bay extends for about 200 to 300 km along the present shoreline, and the coast lies between two deltaic plains of the Yellow River in the south and the Luan River in the north (Fig. 1a). Channel shifts of these two rivers have altered significantly the amount of sediment supply to this coast and resulted in the development of a series of Chenier ridges, tidal flats between them (Fig. 1b) (Su et al., 2011) and burial oyster reefs,