



Sedimentary history of the western Bohai coastal plain since the late Pliocene: Implications on tectonic, climatic and sea-level changes

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ABSTRACT

Thick Cenozoic deposits from the western Bohai coastal plain, a tectonic-subsiding region, provide the potential to study the relations between sedimentary environments and tectonic, climatic and sea-level changes. However, sedimentary history of this region extending to the whole Quaternary, as well as their links to tectonic, climatic and sea-level changes are still poorly understood, mainly because of the lack of long-term records with well-constrained chronology. In this study, we present an integrated record based on sedimentology and proxies (grain-size and color reflectance) of a 203.6 m core recovered from the western Bohai coastal plain near Tianjin. The core was chronologically well constrained using paleomagnetic and optically stimulated luminescence dating methods. The results show that from the late Pliocene (~3.3 Ma) to the late Pleistocene (~0.10 Ma), the study region was mainly dominated by fluvial setting, and the extensive incursion of sea water into this region began during the last interglacial period (~0.10 Ma). The sedimentology and the color index suggest that tectonic subsidence of the Bohai Basin during the Plio-Quaternary must have played a significant role in controlling the sedimentary environments in this region. The changes in base-level because of sea-level fluctuations during the Quaternary influenced the fluvial development greatly and led to the alternations of coarse crevasse splay/channel and finer floodplain deposits in the core sequence. In addition, climatic changes since the late Pliocene also have had significant effects on the sedimentary settings in the Bohai coastal plain by influencing the fluvial process with a series of mechanisms.

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1. Introduction

Coastal zones are transitions between continents and oceans, and are vital to the understanding of continent–ocean interaction related to tectonic, climatic and sea-level changes (McMillan, 2002; Limarino et al., 2006; Juhász et al., 2007). The Bohai Sea is a semi-closed marginal sea in eastern China. The study area is very sensitive to the Quaternary sea-level fluctuations because of very flat geomorphology and low altitude (less than 4 m). Large thickness of sediments has been accumulated in the western Bohai coastal plain because of the continuous tectonic subsidence since the Cenozoic era (Allen et al., 1997). The continuous subsidence would be favorable for the preservation of sediments, which

contain the information of climatic and sea-level changes. Therefore, the thick deposits in the western Bohai coastal plain may provide us an opportunity to study the relations between sedimentary environments and tectonic, climatic and sea-level changes.

During the past several decades, most studies on the western Bohai coastal plain have primarily concentrated on sea-level changes and shoreline evolution (Zhao et al., 1979; Wang and Li, 1983; Yang and Xie, 1984), strata architecture of the Bohai coastal plain and marine transgression events (Yang et al., 1979; Wang et al., 1981, 2008b), as well as palaeochannel evolution and its relations to tectonic movements and climatic change (Xu et al., 1996a,b), most of which only span the late Quaternary. However, comprehensive studies on the lithology, sedimentary facies and environmental evolution of the western Bohai coastal plain extending to the whole Quaternary are sparse mainly because of the lack of long-term records with well-constrained chronology. Although Chen et al. (2008) recently reported Quaternary stratigraphy in the Bohai coastal plain mainly based on lithology and microfossils, detailed

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sedimentary facies analyses and associated sedimentological index, the issues of links between depositional environments and tectonic, climatic and sea-level changes were not addressed, which is the focus of the current research.

In this study, a 203.6 m core (BZ2) was recovered near Tianjin west of the Bohai Bay. The chronology of the core was well defined using paleomagnetic and optically stimulated luminescence (OSL) methods, which yielded a basal age of ~ 3.3 Ma (Chen et al., 2008; Yao et al., 2010). We present the first detailed and integrated sedimentological study of the BZ2 core spanning the late Pliocene–Quaternary. The specific objectives of the current paper were (1) to perform detailed facies analyses and establish the sedimentary history of the study area and (2) to tentatively discuss the sedimentary history of the western Bohai coastal plain since the late Pliocene as well as its relation to tectonic, climatic and sea-level changes.

2. Geological setting

The Bohai Sea is an inland sea of China that connects to the Yellow Sea via the Bohai strait (Fig. 1a). The main rivers flowing through the Bohai coastal plain are the Yellow River, the Luanhe River, the Haihe River and the Liaohe River, which originate from the Tibetan Plateau, Taihang Mountain and Yanshan Mountain (Fig. 1). Among them, the Yellow River is the largest and is the main source of sediments in this region. The flat plain slopes

generally eastward from an altitude of approximately 100 m above sea level (asl) in the west to less than 4 m asl in the east. The Cenozoic strata are dominated by fluvial deposits in the piedmont plain, alluvial and lacustrine deposits in the central plain and alluvial deposits with interbedded marine deposits in the littoral plain.

The Bohai Basin is a Cenozoic extensional basin bordered by Taihang Mountain, Yanshan Mountain, the Liaodong and Shandong peninsulas (Fig. 1b). Its basement is divided into a series of alternating uplifts and depressions trending NNE and NE (Allen et al., 1997; Fig. 1b). Previous studies revealed that the Bohai Basin experienced episodic sub-rifting processes from the Eocene to the end of the Oligocene (Allen et al., 1997; Hu et al., 2001), and as a whole the basin began to subside in a post-rift phase of thermal subsidence that has lasted until the present day (Allen et al., 1997). The thickness of sediments in the Bohai coastal plain is variable with uplifts and depressions. For example, the Quaternary sediments in the Jizhong depression and the Huanghua depression (where great subsidence has taken place) are near 500 m thick, whereas those in the Cangzhou uplift are only 200–300 m thick (Wang et al., 2003).

The study area is located at the northwestern part of the Bohai Basin (Fig. 1b). In this region, three formations, Gu'an, Yangliuqing and Ouzhuang, were deposited during the Pleistocene, with fluvial–lacustrine deposits in the Early–Mid Pleistocene and fluvial–marine deposits in the Late Pleistocene, according to Chen and Wu (1997). During the Holocene, Yangjiasi, Gaowan and Qiko

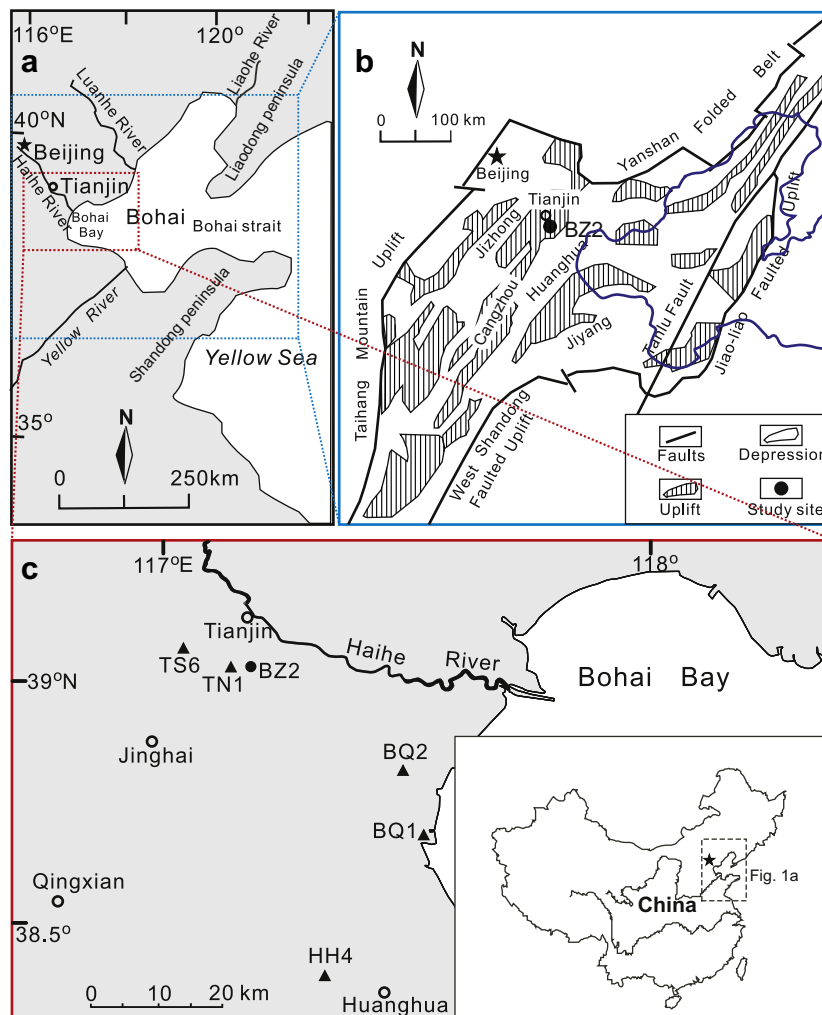


Fig. 1. Simplified map of the study area (a), tectonic structures of the Bohai Basin (b; modified after Hu et al., 2001), the location of the BZ2 core site (solid circle) and the boring sites mentioned (solid triangle) in the text (c).

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