Quaternary Research 83 (2015) 204–215

Contents lists available at ScienceDirect

Quaternary Research

journal homepage: www.elsevier.com/locate/yqres

The Yangtze River deposition in southern Yellow Sea during Marine Oxygen Isotope Stage 3 and its implications for sea-level changes

Zhuyou Sun [a], Gang Li [b,*], Yong Yin [a]

[a] MOE Key Laboratory of Coastal and Island Development, Nanjing University, Nanjing 210093, China
[b] Key Laboratory of Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guang Zhou 510300, China

ARTICLE INFO

Article history:
Received 18 January 2014
Available online 23 September 2014

Keywords:
Yangtze River
Channel deposits
Marine Oxygen Isotope Stage 3
Sea level

ABSTRACT

The depositional history of the lower Yangtze River and sea-level changes during Marine Oxygen Isotope Stage (MIS) 3 was established using three long drill cores from the northern Yangtze deltaic plain and southern Yellow Sea by using sedimentary analysis and AMS ^{14}C dates. Voluminous channel deposits of the lower Yangtze River in MIS 3 were found from the northern deltaic plain and offshore area, with a thickness of over 30 m. The thick channel deposits are characterized by massive medium-to-fine sand deposits with sporadic tidal influence. During MIS 3, the Yangtze River appears to have mainly migrated between the modern river mouth and middle Jiangsu coastal plain, and likely built a delta complex in the field of Yangtze Sand Shoal in northern East China Sea. A large sediment supply and rapid sea-level variations promoted rapid progradation of the delta onto the flat shelf. The highest sea levels during MIS 3 are estimated to have reached 25 ± 5 m below the present sea level.

Introduction

During the past few decades, global sea-level curves in the late Quaternary have been reconstructed by studies on oxygen isotope of deep-sea foraminifers, ice core and coral reef records (Chappell and Shackleton, 1986; Chappell, 2002; Siddall et al., 2008). The reconstructed sea-level curves have been widely used to interpret depositional evolution of river systems on continental margins (Wellner and Bartek, 2003; Anderson et al., 2004; Busschers et al., 2007; Liu et al., 2009, 2010). Well-dated sedimentary sequences and relatively accurate sea-level reconstructions have deepened the understanding of river–sea interaction history in the late Quaternary.

The Yangtze River, one of the largest rivers in the world, has formed a broad tide-dominated delta since the Holocene sea-level highstand (Hori et al., 2001a). Studies on the depositional evolution of the Yangtze River system responding to the sea-level changes mostly concentrate on the last transgression (Chen et al., 2000; Li et al., 2000; Hori et al., 2001a, b; Li et al., 2002). The pre-Holocene depositional history of Yangtze River is poorly known, however, especially during Marine Oxygen Isotope Stage (MIS) 3.

Studies on sea-level changes around the Yangtze River delta during MIS 3 (Lin et al., 1989; Yang et al., 2004; Wang et al., 2013) conflict with the sequence stratigraphic studies on the shelf in the Yellow Sea and East China Sea (Saito et al., 1998; Liu et al., 2003). Oxygen isotope records in Sulu Sea (Linsley, 1996), coral reef records in Vanuatu (Cabioch and Ayliffe, 2001) and coastal depositional records in Red River delta (Hanebuth et al., 2006) indicate that the sea level during MIS 3 in the tropical Pacific was much higher than the global eustatic sea level, which fluctuated at around 60–80 m below present sea level (bpsl) (Siddall et al., 2008). Along the east coast of China, researches on Quaternary stratigraphy widely identified the transgression during MIS 3 (named the Gehu transgression) (Zhao and Qin, 1985; Lin et al., 1989). The highest sea level was estimated at about 10 m bpsl during the late MIS 3 on southern Yangtze deltaic plain (Wang and Wang, 1980; Yang et al., 2004). In contrast, seismic studies found deltaic sequences in southern Yellow Sea and East China Sea and inferred that the regional sea-level change during MIS 3 was almost consistent with the global eustatic sea levels (Saito et al., 1998; Xia and Liu, 2001; Berné et al., 2002; Wellner and Bartek, 2003; Lee et al., 2013).

The divergent judgments about the sea-level changes during MIS 3 have been rarely evaluated because the deep incision of Yangtze River (60–80 m) during the last glacial maximum (LGM) has made old deposits poorly preserved on inner shelf and in modern deltaic plain. The preserved deposits of MIS 3 potentially record the depositional environment in the lower Yangtze River and the highest sea-level position in this stage.

In order to acquire the information about the pre-Holocene deposition of Yangtze River, three long cores were drilled in southern Yellow Sea (Fig. 1). Three cores were located out of the LGM-incised valley where pre-Holocene strata are preserved (Li et al., 2002; Wang et al., 2012). In this study, the pre-Holocene depositional history of Yangtze River system was established from these three cores. Previously reported cores with detail sedimentary records and chronological dates from

* Corresponding author.
E-mail address: gangli@scsio.ac.cn (G. Li).

http://dx.doi.org/10.1016/j.yqres.2014.08.008
0033-5894/

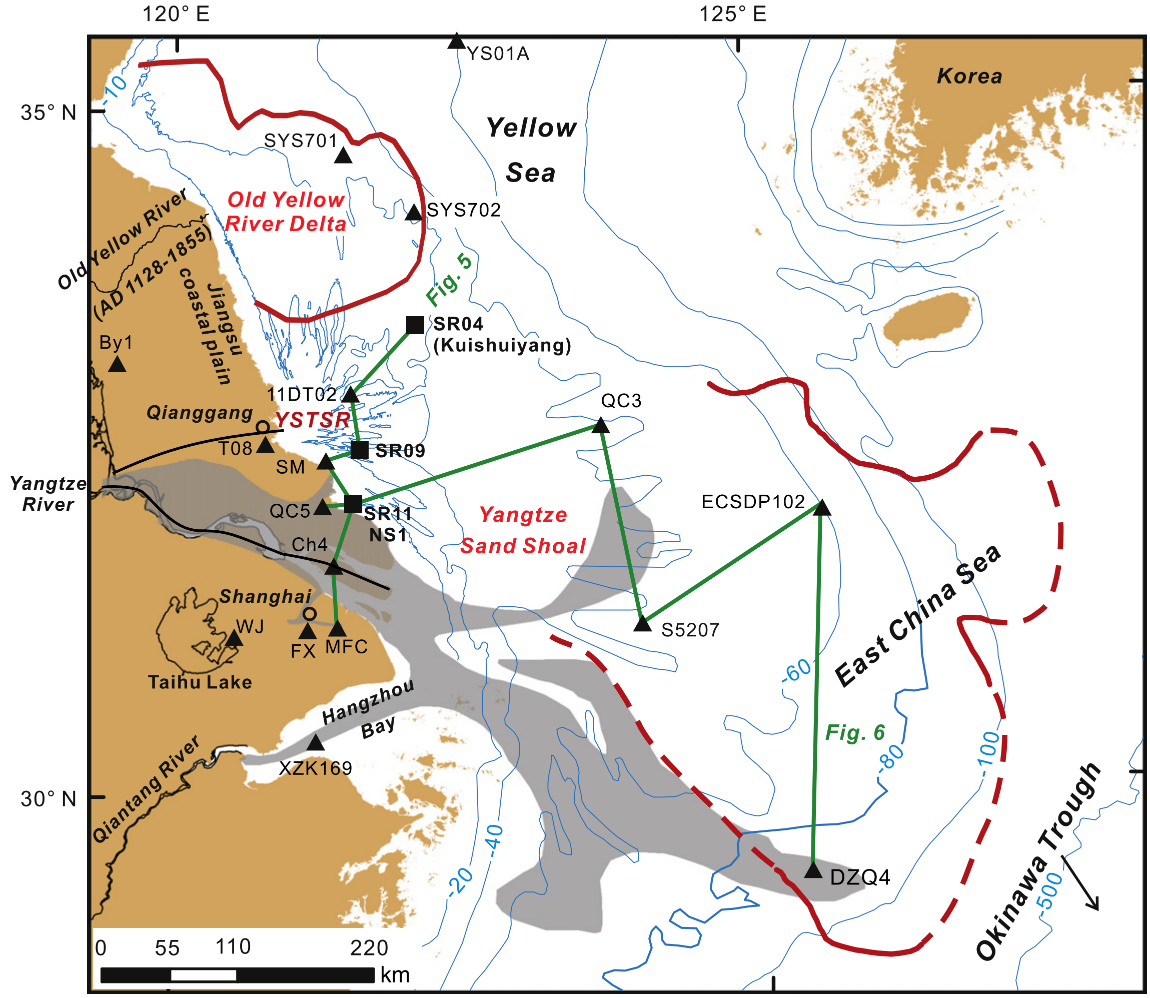

Figure 1. Schematic map of the bathymetry in the southern Yellow Sea and northern East China Sea. Gray area and dark solid lines on Yangtze deltaic plain show the scales of the LGM incised valley and the pre-LGM incised valley, respectively (from Li and Wang, 1998; Wellner and Bartek, 2003). Red lines mark the outlines of the MIS 3 delta complex identified by seismic studies (Xia and Liu, 2001; Liu et al., 2003, 2010; Lee et al., 2013). Drill cores in this study are shown as squares. Main reference cores are labeled using triangles (Zheng, 1989; Jin, 1992; Tang, 1996; Liu et al., 2010; Wang et al., 2012; Lee et al., 2013; Li and Yin, 2013; Wang et al., 2013). The locations of two sedimentary profiles are shown. The chronologic framework of Core MFC is from Wang et al. (2013). YSTSR: Yellow Sea Tidal Sand Ridges.

Yangtze River delta and adjacent continental shelf were collected and were integrated to analyze the sea-level change during MIS 3.

Regional setting

The continental shelf of Yellow Sea and East China Sea is one of the largest shelves in the world, with the maximum width of over 600 km. The East China Sea shelf extends from the coast of China to the Okinawa Trough, having a smooth and flat topography. The continental shelf is shallower than 150 m with an obvious shelf-break. Surficial sediments on the shelf are mainly supplied by Yellow River and Yangtze River. Vast fluvial sediment supply makes the sea-bed topography in the western Yellow Sea obviously higher than that in the east. The Yellow River shifted south of the Shandong Peninsula and flowed into the southern Yellow Sea from AD 1128–1855, forming the Old Yellow River delta (OYRD) (Zhang, 1984) (Fig. 1). In the southern Yellow Sea, a field of tidal sand ridges (Yellow Sea Tidal Sand Ridges: YSTSR) is distributed between the OYRD and the Yangtze River subaqueous delta. The YSTSR consist of more than 70 sand ridges separated by tidal channels and cover an area of 22,470 km^2 (Wang et al., 2012). On the inner shelf of the northern East China Sea, a large sand shoal, named the Yangtze Sand Shoal (YSS), is distributed at water depths of 25–55 m (Fig. 1). Bottom sediments are dominated by fine sand.

Quaternary strata in the Yellow Sea and East China Sea consist of alternating marine and terrestrial sediments in response to glacio-eustatic sea-level changes (Qin et al., 1987). The thickness of Quaternary sediments varies between 100 m and 200 m on the shelf (Jin, 1992; Yang, 1994). About eight marine units were identified from the Quaternary strata in the southern Yellow Sea (Yang, 1994). In the late Quaternary stratigraphy, the most remarkable marine units were dated in MIS 5 and MIS 1 (Yang et al., 1993). In Yellow Sea and inner East China Sea, at least two marine units separated by terrestrial units were discriminated within the strata of MIS 3 (Yang et al., 1993). No terrestrial deposits of MIS 5–3 were found in the strata on the outermost shelf of East China Sea (Tang, 1996).

The Yangtze River delta is tide-dominated with a funnel-shaped topography and several wide distributary channels. Tidal water annually reaches an average of 210 km upstream from the river mouth (Shen, 1998). Modern sandy sediments from Yangtze River are mainly deposited in the river mouth in depths shallower than 10 m (Chen et al., 2000). The modern Yangtze River delta was built in the deep incised valley of the Yangtze dating from the LGM lowstand, which formed when sea level reached its present position at 6–7 cal ka BP (Hori et al., 2001a) (Fig. 1). Seismic analysis on the shelf showed the incised valleys from Yangtze River mainly extended southeastward to the outer East China Sea (Wellner and Bartek, 2003). Submarine relief above the main incised valley depicts a V-shaped trough, south of the YSS