Quaternary Science Reviews 29 (2010) 2424–2438

Contents lists available at ScienceDirect

Quaternary Science Reviews

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

Sedimentary record of environmental evolution off the Yangtze River estuary, East China Sea, during the last ~13,000 years, with special reference to the influence of the Yellow River on the Yangtze River delta during the last 600 years

Jian Liu [a,b,*], Yoshiki Saito [c], Xianghuai Kong [b], Hong Wang [b], Lihui Xiang [d], Chun Wen [e], Rei Nakashima [c]

[a] Key Laboratory of Marine Hydrocarbon Resources and Environmental Geology, Ministry of Land and Resources, PR China
[b] Qingdao Institute of Marine Geology, Qingdao, 266071, PR China
[c] Geological Survey of Japan, AIST, Central 7, Higashi 1-1-1, Tsukuba, Ibaraki 305-8567, Japan
[d] Eastern China Geoexploration Development Bureau for Non-ferrous Metals, Nanjing, 210007, PR China
[e] Ocean University of China, Qingdao, 266003, PR China

ARTICLE INFO

Article history:
Received 12 September 2009
Received in revised form
5 June 2010
Accepted 9 June 2010

ABSTRACT

A 35.60-m-long core (ECS-0702) recovered from a water depth of 22 m in the muddy area off the Yangtze River estuary was analyzed for sedimentary characteristics, clay and detrital mineral components, and element geochemistry as well as by AMS ^{14}C dating to document sediment provenance changes and environmental evolution during the postglacial period in the study area. On the basis of the lithology, the benthic foraminiferal and ostracod assemblages, and the AMS ^{14}C ages, we divided the core into four depositional units (DU1–DU4 in descending order) representing the postglacial sedimentary sequence during the last ~13,000 years. DU 4 was deposited in a littoral to tidal-flat environment during ~13,000–11,500 cal yr BP; DU 3 in a nearshore, subtidal environment upwards to the nearshore shelf with tidal influence in response to the postglacial sea-level rise during ~11 500–7400 cal yr BP; DU 2 in a tide-affected, nearshore shallow-sea environment during ~7400–540 cal yr BP, on the delta-front of the Yangtze River when the delta was actively prograding; and DU 1 in a nearshore shallow-sea environment during the last ~540 years, on the delta-front under modern marine conditions. In DU 1, the depositional rate was much higher than in the underlying units, and the sediment composition reflects more influence from the Yellow River; this unit can therefore be logically linked to the period when the Yellow River last discharged into the South Yellow Sea, from AD 1128 to 1855. According to historical records, this period can be divided into an early stage (AD 1128–1494), when the shoreline near the Yellow River mouth was advancing slowly eastward, and a late stage (1495–1855), when the shoreline was advancing rapidly. The initiation of DU 1 deposition corresponds to the latter part of the early stage, suggesting that since that time, a relatively large amount of sediment from the Old Yellow River mouth area has been transported to the offshore area of the Yangtze River mouth. Our study has identified a high-resolution sedimentary signature associated with the last course shift of the Yellow River in the Yangtze River delta-front, thus highlighting the intricate relationship between sediment sources and sinks in coastal areas. A significant contribution of the Old Yellow River sediments to the Yangtze subaqueous delta during the last ~600 years must be considered when the evolutional history of the Yangtze delta is examined and especially when the influence of the Three Gorge Dam construction on the future changes of the Yangtze Estuary and ecological environments in the East China Sea is estimated.

1. Introduction

The Yangtze River (Changjiang) is one of the five largest rivers in the world in terms of both sediment load and water discharge, transporting a vast amount of sediments annually to the East China Sea (ECS) (Huang et al., 2001) (Fig. 1). Over the last 7000 years, more than half of the Yangtze-derived sediment has been deposited in the delta and estuary system and in the nearshore subaqueous deltaic area, and the remaining sediment has been transported southward to form a “mud belt” on the inner shelf along the coasts of Zhejiang and Fujian provinces (Liu et al., 2007) (Fig. 2). Most previous research has been restricted to the Yangtze delta and estuary and to the mud belt, focusing mainly on delta initiation and evolution, modern sedimentation, topographic features, the late

* Corresponding author at: Key Laboratory of Marine Hydrocarbon Resources and Environmental Geology, Ministry of Land and Resources, PR China. Tel.: +86 532 85755832; fax: +86 532 85720553.
E-mail address: liujian0550@vip.sina.com (J. Liu).

0277-3791/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.quascirev.2010.06.016

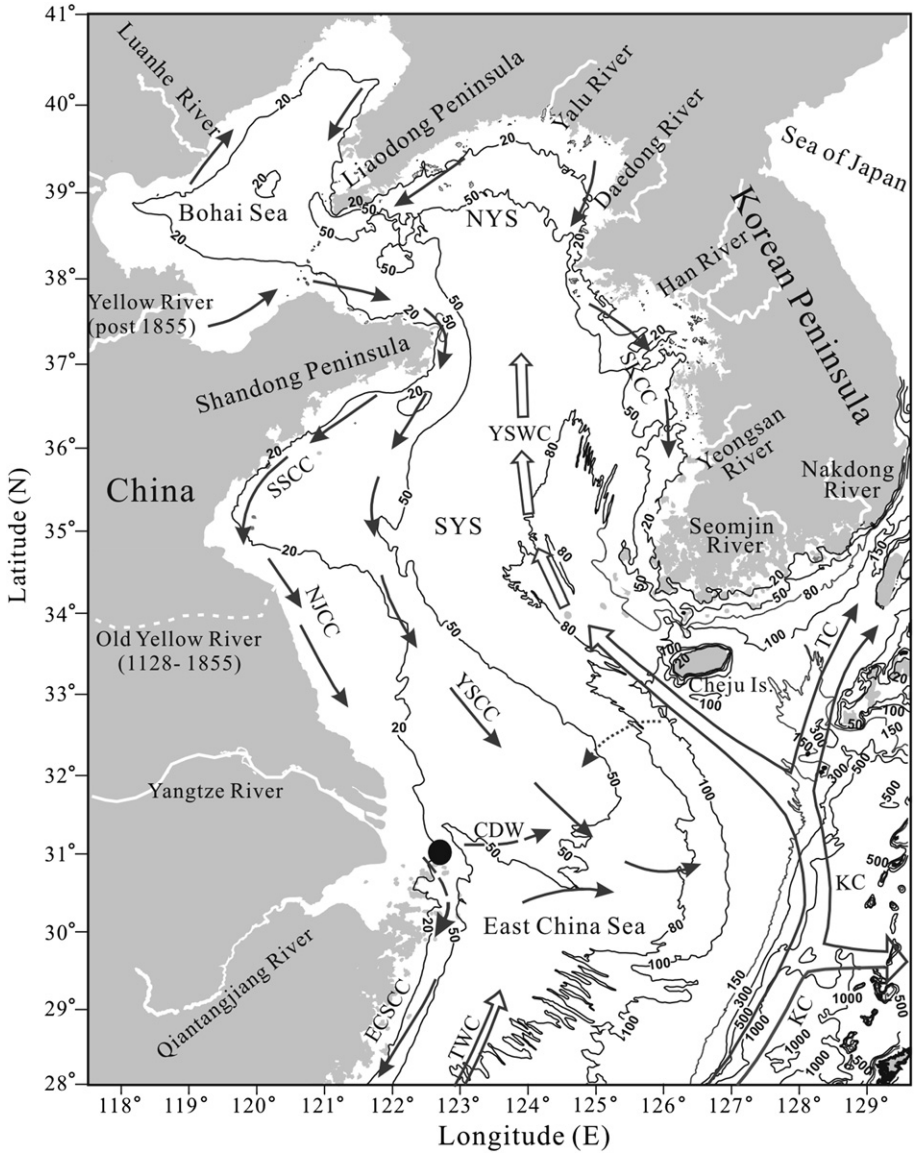

Fig. 1. Schematic map of the bathymetry and regional circulation pattern in the East China Sea and adjacent areas during wintertime (modified after Guan, 1983; Su, 1986). Water depth is in meters. The solid circle offshore of the Yangtze River mouth indicates the position of core ECS-0702. SYS, South Yellow Sea; NYS, North Yellow Sea; KC, Kuroshio Current; YSWC, Yellow Sea Warm Current; TC, Tsushima Current; TWC, Taiwan Warm Current; YSCC, Yellow Sea Coastal Current; SKCC, South Korean Coastal Current; SSCC, South Shandong Coastal Current; NJCC, North Jiangsu Coastal Current; CDW, Changjiang Diluted Water; ECSCC, East China Sea Coastal Current.

Quaternary stratigraphic framework, and sediment transport (e.g., Yang, 1989; Chen and Stanley, 1993, 1998; Hori et al., 2001, 2002; Li et al., 2002; Liu et al., 2006, 2007; Wang et al., 2007). However, less attention has been paid to the nearshore subaqueous deltaic system off the river mouth, where coastal currents flowing along the western coast of the South Yellow Sea (SYS) interact with the Yangtze outflow (Fig. 1). Our knowledge of the nearshore area is limited primarily to the surface sediment distribution (Qin et al., 1987), early Holocene mud-ridge formation (Chen et al., 2003), shallow seismic architecture (Liu et al., 2006, 2007), and late Quaternary evolution of the subaqueous delta (Chen et al., 2000). No drilling core from the subaqueous delta has been subjected to detailed dating and sedimentary analyses to unravel the sediment sources and the development of sedimentary facies in response to deglacial and Holocene sea-level fluctuations.

The Yellow River (Huanghe) is another major river with world-wide influence, which ranks the second and sixth in the world in terms of sediment load and length, respectively (Saito et al., 2001). The Yellow and Yangtze Rivers transport about 1.6×10^9 tons of sediment annually to the oceans, contributing about 10% of the world's annual sediment discharge (Milliman and Meade, 1983), with substantial amounts of organic and inorganic carbon being delivered to the marginal sea like other large rivers. However, a large portion of these biogeochemically important materials is accumulated and buried at the river mouths and subaqueous delta areas, which, together with the remaining parts of shelves, have been found to be a sink rather than a source of global atmospheric CO_2 (e.g., Chen and Wang, 1999; Tsunogai et al., 2003; Cai and Dai, 2004). The study of the two major rivers-derived sediment dispersal and deposition is crucial for us to understand more thoroughly the relevant biogeochemical processes such as the carbon cycle, as well as the "source to sink" sedimentary processes in the coastal and shelfal areas, and thus arose much attention (i.e., Milliman and Meade, 1983; Qin and Li, 1986; Hu et al., 1996; Liu et al., 2007).