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ScienceDirect
Geomorphology 85 (2007) 208–224
GEOMORPHOLOGY
www.elsevier.com/locate/geomorph

Flux and fate of Yangtze River sediment delivered to the East China Sea

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Received 2 February 2005; received in revised form 22 April 2005; accepted 29 March 2006
Available online 8 September 2006

Abstract

Numerous cores and dating show the Yangtze River has accumulated about 1.16×10^{12} t sediment in its delta plain and proximal subaqueous delta during Holocene. High-resolution seismic profiling and coring in the southern East China Sea during 2003 and 2004 cruises has revealed an elongated (~800 km) distal subaqueous mud wedge extending from the Yangtze River mouth southward off the Zhejiang and Fujian coasts into the Taiwan Strait. Overlying what appears to be a transgressive sand layer, this distal clinoform thins offshore, from ~40 m thickness between the 20 and 30 m water depth to <1–2 m between 60 and 90 m water depth, corresponding to an across shelf distance of less than 100 km. Total volume of this distal mud wedge is about 4.5×10^{11} m^3, equivalent to ~5.4×10^{11} t of sediment. Most of the sediment in this mud wedge comes from the Yangtze River, with some input presumably coming from local smaller rivers. Thus, the total Yangtze-derived sediments accumulated in its deltaic system and East China Sea inner shelf have amounted to about 1.7×10^{12} t. Preliminary analyses suggest this longshore and across-shelf transported clinoform mainly formed in the past 7000 yrs after postglacial sea level reached its mid-Holocene highstand, and after re-intensification of the Chinese longshore current system. Sedimentation accumulation apparently increased around 2000 yrs BP, reflecting the evolution of the Yangtze estuary and increased land erosion due to human activities, such as farming and deforestation. The southward-flowing China Coastal Current, the northward-flowing Taiwan Warm Current, and the Kuroshio Current appear to have played critical roles in transporting and trapping most of Yangtze-derived materials in the inner shelf, and hence preventing the sediment escape into the deep ocean.

Keywords: East China Sea; Yangtze River; Clinoform; Delta; Mud wedge; Sea level

1. Introduction

Major rivers play a dominant role worldwide in transferring both particulate and dissolved materials from the land to the coastal ocean. The total suspended sediment delivered by all rivers to the ocean is about 15×10^9 metric tons annually, of which Asian rivers discharge nearly more than 70% (Milliman and Meade, 1983; Milliman and Syvitski, 1992; Syvitski et al., 2005). Most of these sediments, however, are trapped in estuaries or deposited on adjacent continental shelves;

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doi:10.1016/j.geomorph.2006.03.023

only less than 5–10% of the fluvial sediments presently reach the deep sea (e.g. Meade, 1996). The river-dominated ocean margins also play a significant role in global biogeochemical cycles (Chen et al., 2003a,b; Cai and Dai, 2004; Dagg et al., 2004; McKee et al., 2004). The study of estuaries, deltas, and inner continental shelves, therefore has particular relevance as we seek to understand the link between present-day terrestrial processes and coastal marine deposition.

One of the best examples of the river-dominated ocean margins is the epicontinental shelf of the East China Sea, which together with the Yellow and Bohai seas, forms a contiguous shelf of about 0.75×10^{12} m^2 in area (Fig. 1). This wide and shallow shelf receives a large amount of terrigenous materials from two of the largest rivers in the world, the Yellow and Yangtze rivers. The Yellow River alone has discharged totally near 1.63×10^{12} tons sediment to the Bohai and Yellow seas during the past 10 kyr (Liu et al., 2002, 2004). The modern Yangtze River's annual sediment load has been about 480 million tons historically. When combined with the adjacent Yellow River (about 1 billion tons), the total equals ~10% of the global riverine sediment flux to the ocean (Milliman and Meade, 1983).

The Yangtze River originates from the Qinghai-Tibetan Plateau at an elevation of 6600 m, flowing

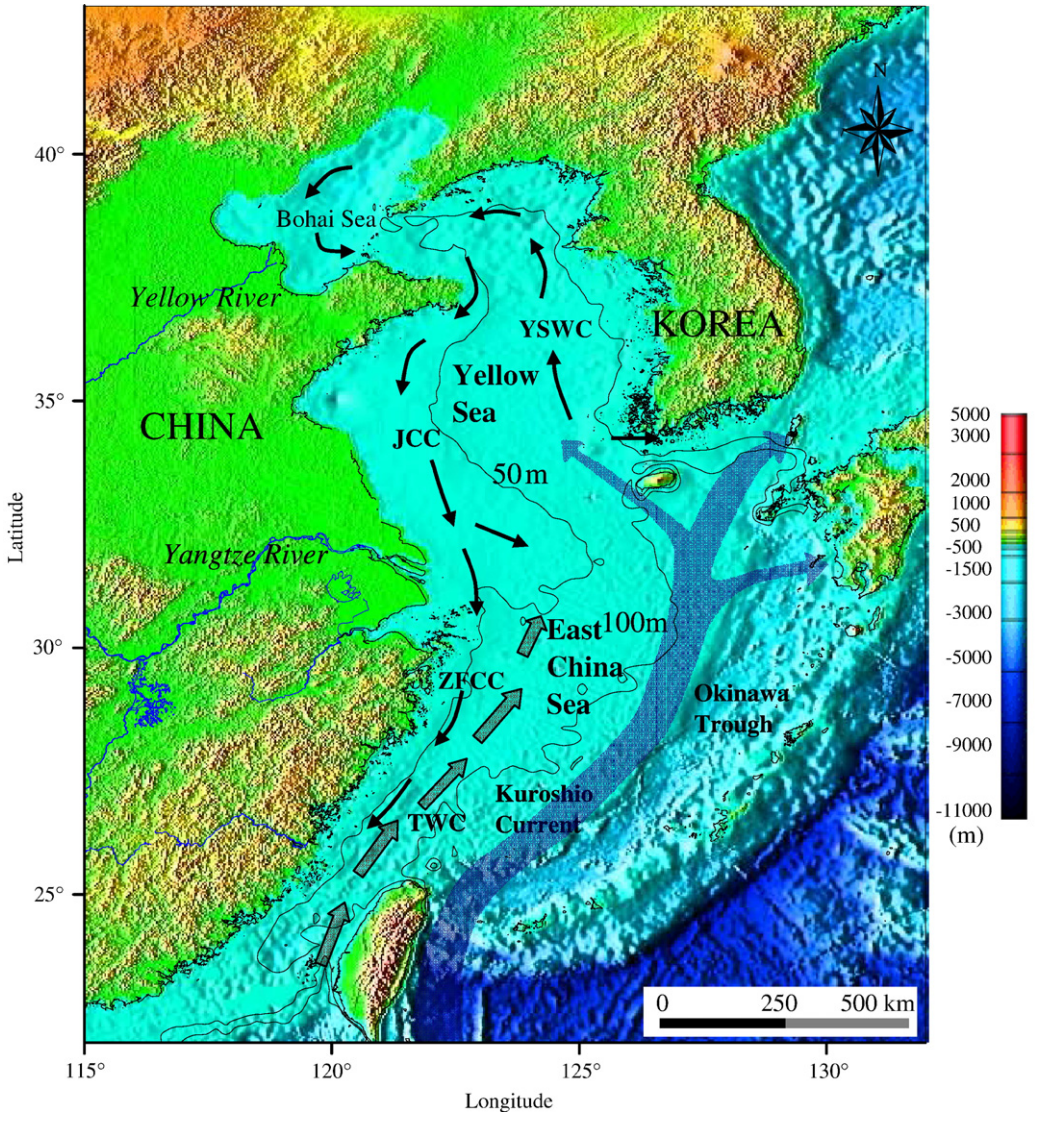

Fig. 1. Bathymetry and regional ocean circulation pattern in the East China Sea and Yellow Sea. JCC (Jiangsu Coastal Current); TWC (Taiwan Warm Current); YSWC (Yellow Sea Warm Current); ZFCC (Zhejiang Fujian Coastal Current).