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Magnetostratigraphy of a long Quaternary sediment core in the South Yellow Sea

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ABSTRACT

Continental shelves serve as a bridge between the continent and ocean and sediments in this region are sensitive to land-sea interaction, sea-level variation and local subsidence. In this study, we present a comprehensive magnetic study of the longest sediment core (CSDP-1, 300.1 m) recovered from the South Yellow Sea. The major magnetic minerals in the studied sediments are magnetite, hematite and greigite. Greigite records a chemical remanent magnetization, which can be removed effectively by thermal demagnetization. The magnetostratigraphy defined in this study contains the Matuyama-Brunhes boundary (M/B, 781 ka) at ~73.68 m, which is consistent with results from adjacent cores. The base of the Quaternary (~2.6 Ma) in the Yellow Sea is recovered for the first time at a depth of 227.16 m. The basal age of the core is estimated to be ~3.50 Ma. It indicates that the first transgression of the Yellow Sea occurred no later than ~1.7 Ma. Succeeding large amplitude regressions occurred in some cold periods such as during MIS 20, MIS 18, and MIS 10. Our results provide the first chronology that brackets the entire Quaternary and we reconstruct the sedimentary evolution of the Yellow Sea with robust age constraints, which provides an important framework for further paleoenvironmental and tectonic studies.

1. Introduction

Continental shelves are among the most active regions for land-sea interaction in the Earth System (McMillan, 2002), and are typically important for economic production and for human recreational activities (Eckert, 1979). Sediments from the continental shelf are highly sensitive to sea-level fluctuations, climate changes, and local subsidence (Troiani et al., 2011). Fluvial material that is transported to this region can either accumulate or be re-transported to the ocean depending on the accommodation space that is controlled by both sea-level and tectonic subsidence (Gerber et al., 2010; Yao et al., 2014). Sedimentation rates on the continental shelf are usually much higher than those in the deep sea, which makes shelf sediments suitable for high-resolution studies (e.g., Liu et al., 2004).

The Yellow Sea (Fig. 1) is a typical continental shelf with extensive area in the east of China. Deposited under relatively shallow water depths (44 m on average), sediment sequences in this region are highly sensitive to sea-level fluctuations as a result of Quaternary glacial-interglacial cycles as well as local tectonics (Qin et al., 1989; Yang et al., 1996). In addition, it is an important sediment reservoir for two globally large rivers, the Yellow River and Yangtze (Changjiang) River, and other small rivers on the Korean Peninsula (Yang et al., 2003). Therefore, sediments from the

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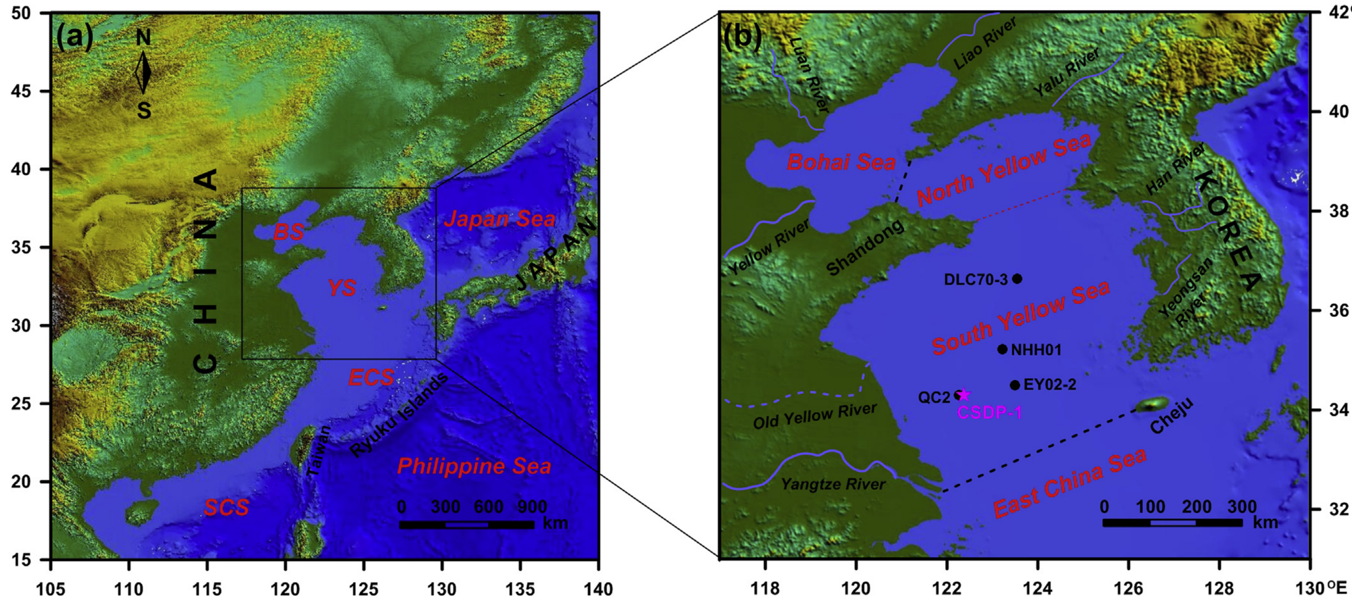

Fig. 1. (a). Schematic map of the marginal sea distribution in the northwest Pacific Ocean (BS: the Bohai Sea; YS: the Yellow Sea; ECS: the East China Sea; SCS: the South China Sea). (b). Map of the Yellow Sea and adjacent areas, with locations of existing long sediment cores, and the cores QC2, EY02-2, NHH01, DLC70-3 are from Zhou and Ge (1990), Ge et al. (2006), Liu et al. (2014a), and Mei et al. (2016), respectively.

Yellow Sea will contain important paleoenvironmental information that is relevant to studying sea-level and tectonic variations, source to sink processes, and East Asian monsoon evolution (Liu et al., 2014a). Nevertheless, most previous studies have focused on shorter time-scales over the last interglacial, such as evolution of the Yellow River subaqueous delta during the Holocene (Yang and Liu, 2007), marine isotope stage (MIS) 3 to MIS 2 (Liu et al., 2010), and the paleoenvironmental history of the central South Yellow Sea (SYS) mud area since the early Holocene (Xiang et al., 2008). Studies on longer time-scales are relatively scarce due to the lack of reliable chronological frameworks.

For long-core sediment sequences, magnetostratigraphy is one of the most efficient ways to establish a reliable first-order chronological framework (e.g., Lanci et al., 2004; Tauxe et al., 2012). So far, magnetostratigraphic studies have been reported for four long cores (QC2, EY02-2, NHH01, and DLC70-3) (Fig. 1b; Table 1) from the Yellow Sea. The 108.83-m QC2 core contains the Matuyama-Brunhes boundary (M/B: ~781 ka B.P.) at 79.95 m (or ~63 m after removing the ~17-m-thick Holocene sand ridge) and a basal age of ~1.8 Ma (Zhou and Ge, 1990). The M/B boundary of core EY02-2, which has a total length of 70 m, was identified at 63.29 m, and its basal age was extrapolated to ~0.9 Ma (Ge et al., 2006). Recent studies have located the M/B boundary in the 125.64-m NHH01 core at 68.64 m with a linearly extrapolated basal age of ~1.06 Ma (Liu et al., 2014a), and the M/B boundary of the 71.2-m DLC70-3 core at 59.08 m (Mei et al., 2016).

Quaternary climate is characterized by glacial and interglacial alternations that have resulted in large-scale sea-level oscillations that influenced the architecture of continental shelf sediments (Yao et al., 2014). Numerous sediment cores from the Yellow Sea and its surrounding coastal plains have revealed that sedimentation in this region is characterized by alternation of marine and lacustrine/terrestrial deposits (Qin et al., 1989). In core QC2 (Fig. 1b), seven marine transgressions divide the recorded paleogeographic evolution into four periods since the Olduvai subchron (Yang, 1993). Comprehensive analyses of seismic profiles and sediment cores from the western SYS reveal that sedimentary environmental changes since MIS 5 were strongly controlled by sea-level fluctuations, with most of the preserved sediments deposited in MIS 5, MIS 3, and MIS 1 and major erosion events in MIS 4 and MIS 2 (Liu et al., 2010). Using foraminifera abundances, eight transgression layers have been identified in core DLC70-3 (Fig. 1b) (Mei et al., 2016). In short, great progress has been made in understanding the sedimentary evolution of the Yellow Sea since the middle Pleistocene, especially over the late Pleistocene. However, the sedimentary evolution history throughout the Quaternary is still not well understood.

In this study, we investigated a 300.1-m-long sediment core from the SYS. Detailed rock magnetic and high-resolution paleomagnetic investigations are presented along with a robust chronology that brackets the entire Quaternary for the SYS. We use this paleoenvironmental reconstruction to outline the sedimentary history of the SYS.

2. General setting

The Bohai Sea, Yellow Sea, and the East China Sea together constitute a marginal sea bounded by China, Korea, and southern

Table 1
Detailed information on long sediment cores from the South Yellow Sea.

Core ID	Water depth/m	Drilling depth/m	Recovery rate/%	Location longitude/latitude	Drilling time
QC2	49.05	108.83	90.4	122°16′E/34°18′N	May, 1984
EY02-2	79.00	70.00	86.5	123°30′E/34°30′N	February, 2001
NHH01	73.00	125.64	91.0	123°13′E/35°13′N	June, 2009
DLC70-3	73.00	71.20	93.0	123°33′E/36°38′N	September, 2009
CSDP-1	52.50	300.10	80.0	122°22′E/34°18′N	June, 2013