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Late Quaternary seismic stratigraphy in response to postglacial sea-level rise at the mid-eastern Yellow Sea

Dong-Geun Yoo [a, b, *], Tae-Soo Chang [a], Gwang-Soo Lee [a], Gil-Young Kim [a], Seong-Pil Kim [a], Soo-Chul Park [c]

[a] Petroleum and Marine Research Division, Korea Institute of Geoscience and Mineral Resources (KIGAM), Daejon 305-350, Republic of Korea
[b] Petroleum Resources Technology, University of Science and Technology (UST), Daejon 305-350, Republic of Korea
[c] Department of Oceanography, Chungnam National University, Daejon 305-764, Republic of Korea

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ABSTRACT

Late Quaternary seismic stratigraphy and depositional history at the mid-eastern Yellow Sea were investigated using high-resolution seismic profiles and core sediments. The results show that the shelf sequence consists of five sedimentary units formed since the LGM: incised-channel fill (SU1), estuarine deposit (SU2), thin sand veneer (SU3), tidal sand ridge (SU4), and central deltaic mud (SU5). The lowermost unit (SU1) above the sequence boundary is interpreted as channel fill deposits mainly formed during the LGM, which belongs to the lowstand systems tract. Three units (SU2, SU3, and SU4), regarded as transgressive systems tract, can be grouped into paralic and marine components separated by a ravinement surface. SU2 lying below the ravinement surface represents a paralic unit that consists of estuarine sediments left behind from shoreface erosion. The top surface of SU2 is truncated by an erosional surface and is overlain by two marine units (SU3 and SU4), which were produced by shoreface erosion that shifted landward during the transgression. SU3, mainly distributed over a wide area of the central part, is very thin, whereas SU4 on the eastern part off the Korean Peninsula forms serial sand ridges, partly modified by modern tidal currents. The uppermost unit (SU5) above the maximum flooding surface, regarded as the highstand systems tract, formed the thin deltaic mud patch derived from the Huanghe River developed after the highstand sea level approximately 7 ka BP.

1. Introduction

The Yellow Sea is a post-glacially submerged epicontinental sea with a flat and broad seafloor less than about 100 m in water depth (Fig. 1; Alexander et al., 1991). During the Holocene transgression, the Yellow Sea experienced environmental changes associated with progressive landward migration of the shoreline (Lee and Yoon, 1997; Liu et al., 2002, 2004). The rate of transgression in the Yellow Sea could have been very rapid because of the low gradient of the seafloor (Milliman et al., 1989). Furthermore, the large tidal amplitude and strong tidal currents seem to have produced a complex and dynamic hydraulic regime for sediment erosion and deposition (Alexander et al., 1991; Lee and Yoon, 1997; Park et al., 2000). Thus, during the postglacial transgression, various sedimentary units, including subaqueous delta, transgressive sand sheet, and tidal sand ridges, were formed and left over a wide area of the shelf showing various seismic facies and lithologic associations (Alexander et al., 1991; Lee and Yoon, 1997; Jung et al., 1998; Park et al., 2000; Jin and Chough, 2002; Liu et al., 2002, 2007, 2004; Shinn et al., 2007; Yang and Liu, 2007). Such deposits are well recorded on the seafloor and bear witness to complex interplay between depositional and erosional processes, associated with sea-level changes and sediment supply. Because of these features, the Yellow Sea shelf is an important site for better understanding of depositional and erosional processes during the late Quaternary. To reconstruct the depositional history of these deposits, sequence-stratigraphic concepts (e.g. Vail, 1987; Posamentier et al., 1988; Hunt and Tucker, 1992; Catuneanu, 2006) have been used to study modern continental shelves. After the successful test for the late Quaternary sequence of high sediment accumulation on the Gulf of Mexico (Boyd et al., 1989), the application of the concept to the Quaternary sequence has been common sense, using high-

* Corresponding author. Petroleum and Marine Research Division, Korea Institute of Geoscience and Mineral Resources (KIGAM), Daejon 305-350, Republic of Korea.
E-mail address: dgyoo@kigam.re.kr (D.-G. Yoo).

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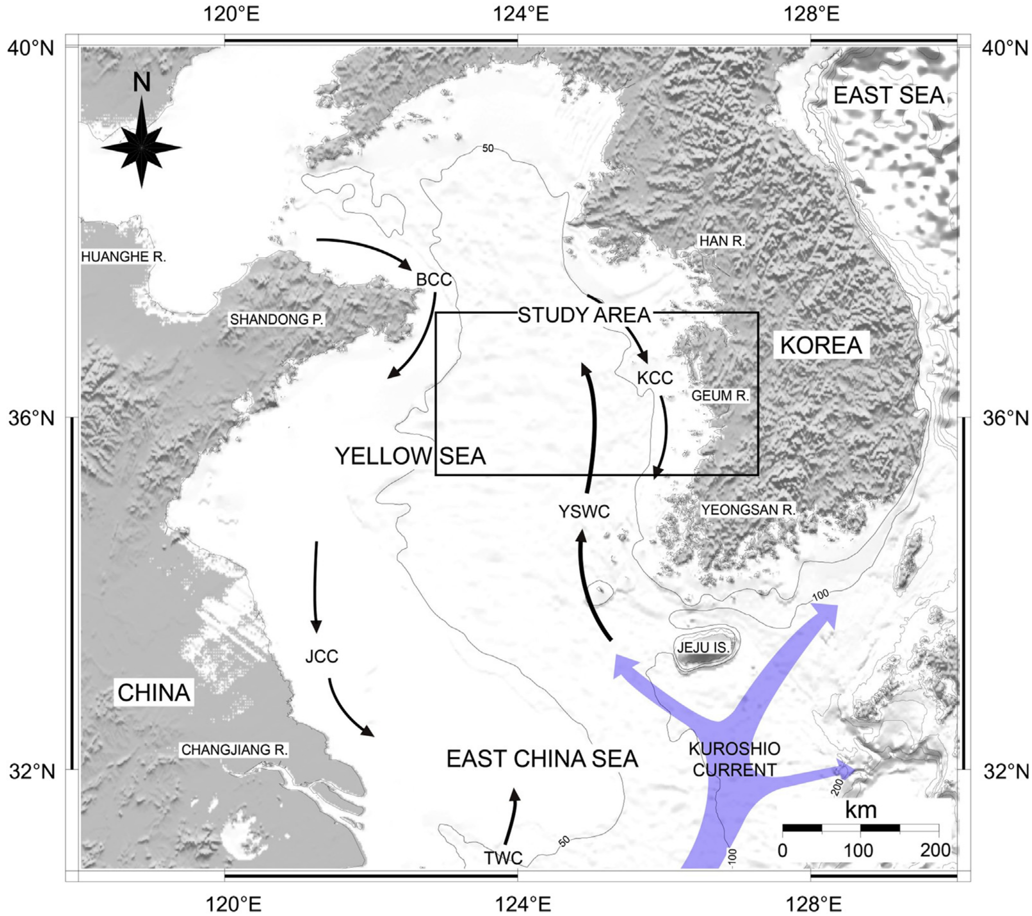

Fig. 1. Physiography of the Yellow Sea. The insert box is the study area shown in Fig. 2. Arrows show a general trend of current systems in the Yellow Sea and the East China Sea (modified from Milliman et al., 1989; Liu et al., 2007). Contours in meters. TWC; Taiwan Warm Current, YSWC; Yellow Sea Warm Current, BCC; Bohai Coastal Current, JCC; Jiangsu Coastal Current, KCC; Korean Coastal Current.

resolution seismic profiles and sediment analyses (e.g., Hernandez-Molina et al., 1994; Okyar et al., 1994; Saito, 1994; Trincardi et al., 1994; Morton and Suter, 1996; Tortora, 1996; Tesson et al., 2000; Yoo and Park, 2000; Karisiddaiah et al., 2002; Yoo et al., 2002; Labaune et al., 2005; Lobo et al., 2005; Rabineau et al., 2005; Zecchin et al., 2008). The present study focuses on the mid-eastern part of the Yellow Sea, where abundant seismic evidence is linked to the existence of transgressive depositional and erosional processes combined with the high-energy condition of tide and waves. In this paper, we describe the acoustic characteristics and depositional pattern of late Quaternary sediments using high-resolution seismic records and sediment data. We then discuss the stratigraphy and depositional history of the Yellow Sea in a low-gradient, tide-dominated, and high-energy shelf setting during the late Quaternary.

2. Regional setting

The Yellow Sea is separated from the Gulf of Bohai by the Shandong Peninsula to the north and is in contact with the East China Sea to the south (Fig. 1). It is a shallow, low-gradient epicontinental sea, and it is less than 100 m deep, with an average water depth of about 55 m. The isobaths in the western Yellow Sea are parallel to the coastline, whereas the eastern part is characterized by ridge-and-swale morphology and numerous islands. These topographic features run in a NE–SW direction, nearly parallel to the direction of present tidal currents (Jung et al., 1998; Park et al., 2006). The seafloor gradually deepens toward the south reaching more than 100 m in water depth in the vicinity of Jeju Island (Fig. 1).

The shelf sediments in the Yellow Sea consist mainly of four types: mud, sand, sandy mud, and muddy sand (Lee and Chough, 1989). Mud occurs in the central Yellow Sea, the old Huanghe delta along the Jiangsu coast, and the southeastern Yellow Sea to the northwest of Jeju Island. Sand is predominantly present in a wide area of the northeastern Yellow Sea as a large-scale sand ridge field. The transitional facies, i.e., sandy mud and muddy sand, are also seen between mud and sand and they seem to originate from a heterogenous mixture of modern and relict sediments.

The general circulation is characterized by a counterclockwise gyre with the northward inflow of the Yellow Sea Warm Current along the Korean coast and the southward flow of the Yellow Sea Cold Current and Jiangsu Coastal Current along the Chinese coast (Beardsley et al., 1985). The Yellow Sea is largely affected by tidal currents. Semi-diurnal tides in this area range from 1.5 to 8 m with the maximum amplitude found in Kyonggi Bay on the western coast of Korea. The general directions of tidal currents on the shelf are N–NE during flood and S–SW during ebb. The tidal currents (50–100 cm/s) play an important role in depositing and redistributing the near-surface sediment in the Yellow Sea (Song et al., 1983; Alexander et al., 1991).

The major source of terrigenous sediment to the Yellow Sea is the Huanghe River. The Huanghe River, the second longest river in China, discharges about 1.1 $*$ 10^9 tons/yr of suspended sediments