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Research paper

Seismic stratigraphy and depositional history of late Quaternary deposits in a tide-dominated setting: An example from the eastern Yellow Sea

Dong-Geun Yoo [a, b, *], Gwang-Soo Lee [a], Gil-Young Kim [a], Nyeon-Keon Kang [a], Bo-Yeon Yi [a], Young-Jun Kim [a], Jong-Hwa Chun [a], Gee-Soo Kong [a]

[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*

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ABSTRACT

Analysis of high-resolution seismic profiles and sediment data from the eastern Yellow Sea reveals that the late Quaternary deposits comprise six seismic units, interpreted as transgressive and highstand systems tracts formed since the LGM. Each unit was deposited during distinctive portions of the sea-level curve associated with hydrodynamic conditions. During the LGM (>19 ka BP), the study area was completely exposed, resulting in subaerial erosion associated with paleo-channel incision by the Huanghe and Korean Rivers. As the shelf was flooded, the incised channels were backfilled fluvial or coastal sediments, forming incised channel-fill deposits (SU1). The paleo-river may have supplied abundant terrigenous sediments to the study area around the paleo-river mouth and adjacent area. These sediments were trapped within the paleo-estuary and formed SU2, regarded as an estuarine deposit. Two types of serial sand ridges (SU3 and SU5) which correspond to transgressive deposits developed. SU3 on the southern part, west of Jeju Island (80–110 m deep) is regarded as a moribund-type mainly formed during the early to middle stage of transgression. These are thought to have ceased growing and remobilizing. In contrast, SU5 (occurring 30–50 m deep off the Korean Peninsula) is generally regarded as active sand ridges deposited during the late stage of transgression and is partly modified by modern tidal currents. As the transgression continued, the near-surface sediments were reworked and redistributed by shelf erosion, resulting in a thin veneer of transgressive sands (SU4). The uppermost unit (SU6) formed the Heuksan Mud Belt (HMB), which is one of the most prominent mud deposits in the Yellow Sea. The lower part of the HMD corresponds to shelf-mud deposited during the late stage of transgression, whereas the upper part consists of a recent shelf-delta developed after the highstand sea level at about 7 ka BP.

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1. Introduction

The sea-level rise that occurred after the Last Glacial Maximum (LGM) was one of the most important geological events to impact continental shelves (Demarest and Kraft, 1987; Nummedal and Swift, 1987; Cattaneo and Trincardi, 1999; Lobo and Ridente, 2014). As the shelf has flooded, coastal environments have progressively migrated landward accompanying erosional and depositional processes (Nummedal and Swift, 1987; Trincardi et al., 1994; Cattaneo and Trincardi, 1999). Various sedimentary units were formed and left over a wide area of the shelf showing different seismic facies and lithologic associations. To reconstruct the depositional history of shelf sequence in terms of sea-level changes, sequence-stratigraphic concepts (e.g., Posamentier et al., 1988) have been applied to modern continental shelves, using high-resolution seismic profiles and sediment data (Saito, 1994; Trincardi et al., 1994; Tortora, 1996; Tesson et al., 2000; Lobo et al., 2005; Rabineau et al., 2005; Zecchin et al., 2008, 2009).

The Yellow Sea is a shallow (less than about 100 m), post-glacially submerged epicontinental sea and forms a relatively flat, wide platform with a low gradient (Lee and Chough, 1989). The post

* Corresponding author. Petroleum and Marine Research Division, Korea Institute of Geoscience and Mineral Resources (KIGAM), Daejon, 305-350, Republic of Korea. Tel.: +82 42 868 3324; fax: +82 42 868 3417.
E-mail address: dgyoo@kigam.re.kr (D.-G. Yoo).

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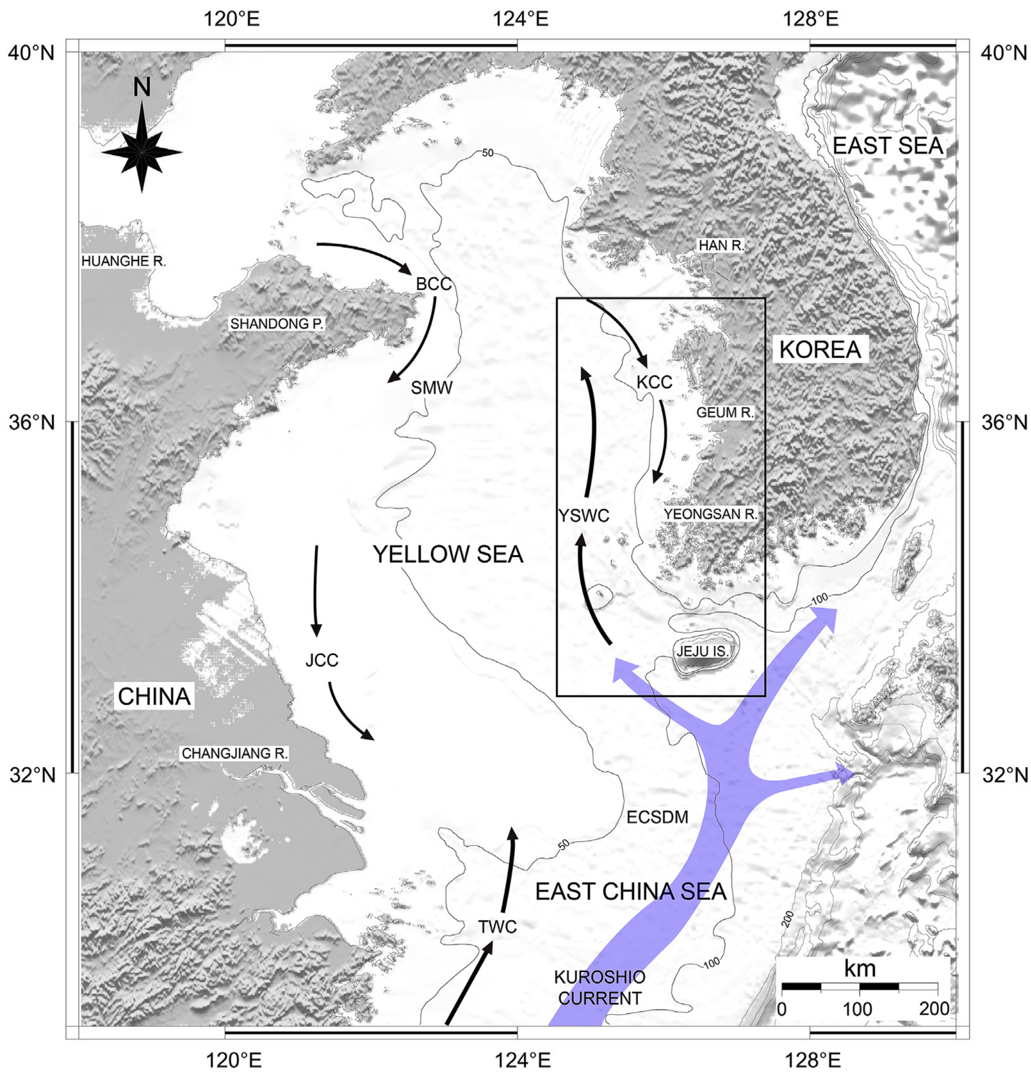

Fig. 1. Physiography of the Yellow Sea and the surrounding area. Arrows show a general trend of current systems in the East China Sea and Yellow Sea (modified after Milliman et al., 1989). Contours in meters. TWC; Taiwan Warm Current, YSWC; Yellow Sea Warm Current, BCC; Bohai Coastal Current, JCC; Jiangsu Coastal Current, KCC; Korean Coastal Current.

glacial transgression in the area began about 19–18 ka BP (Saito, 1998; Liu et al., 2004; Lie et al., 2014). Since that time, the Yellow Sea has undergone a whole suite of dramatic environmental changes resulting from the progressive landward migration of the shoreline. Additionally, the large tidal range and strong tidal currents of the region produce a complex and dynamic hydraulic regime in terms of sediment erosion and deposition (Alexander et al., 1991; Park et al., 2000; Lee and Chu, 2001; Lee et al., 2014). Late Quaternary sedimentary units may have been created and remain in the modern Yellow Sea (Yang and Sun, 1988; Alexander et al., 1991; Lee and Yoon, 1997; Jin and Chough, 1998; Park et al., 2000; Liu et al., 2004; Kong et al., 2006; Shinn et al., 2007; Lee et al., 2014, 2015). Such deposits are well recorded on the seafloor and bear witness to the complex interplay between depositional and erosional processes, which are closely related to sea-level changes. For this reason, the Yellow Sea shelf is a good site for gaining a better understanding of the depositional and erosional processes, particularly combined with rather unique hydrodynamic conditions. In the eastern Yellow Sea, however, relatively little is known about the evolutionary history and sequence stratigraphy of late Quaternary deposits, closely related both the sea-level changes and the hydrodynamic conditions. The present study focuses on the 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 of tides and waves (Fig. 1). Large-scale, shallow, marine geophysical surveys have been conducted by the Korea Institute of Geoscience and Mineral Resources (KIGAM) in the eastern Yellow Sea (KIGAM, 1990, 1991, 1992, 1993, 1994). In this paper, we describe the acoustic characteristics and depositional pattern of late Quaternary sediments using high-resolution seismic profiles associated with the sediment data. We also discuss the stratigraphy and depositional history in relation to the late Quaternary sea-level change and hydrodynamic conditions.

2. Regional setting

The Yellow Sea is a low-gradient epicontinental sea that was completely exposed during the LGM, and is less than 100 m in water depth. The isobaths off the Chinese coast are parallel to the coastline, and the seafloor is rather flat, whereas the seafloor off the west coast of the Korean Peninsula is shaped by numerous ridges and swales (Lee and Chough, 1989). The present study area is located in the eastern Yellow Sea, less than 90 m deep (Fig. 2A). The

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