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Mid-Holocene sea-level fluctuation inferred from diatom analysis from sediments on the west coast of Korea

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ABSTRACT

Diatoms from the KS2009 core sediment on the coast of the West Sea, Kunsan-si and the KR07 trench sediment collected from the neighboring Sabsi island, Korea, were analyzed for Holocene sea-level fluctuations. In KS2009 core sediment, results of AMS ^{14}C dating identified five stratigraphic horizons ranging from 2200 to 9100 BP. The results obtained by measuring the radiocarbon dating from the KR07 were as follows: −0.34 m.a.s.l: 6108 BP, −0.74 m: 6488 BP, −1.46 m: 6838 BP, and −1.58 m: 7208 BP. Diatom assemblages from KS2009 indicated: Facies A (barren zone: KS2009 (−23.5 to −20.3 m)) → Facies B (high tidal flat: KS2009 (−20.3 to −14.6 m)): Holocene marine transgression → Facies C (mid tidal flat: KS2009 (−14.6 to −2.0 m)): falling sea-level – rising sea-level → Facies D (high tidal flat: KS2009 (−2 to 2 m)): rising sea-level. Thus, after seawater influx started at 8300 BP, seawater rose with fluctuations (rising and falling). The KR-07 trench deposit of Sabsi island showed: Facies A' (barren zone: KR07 (−1.58 to −1.18 m)) → Facies B' (bog: KR07 (−1.18 to −0.76 m)) → Facies C' (tidal marsh: KR07 (−0.76 to −0.52 m)) → Facies D' (tidal flat: KR07 (−0.52 to −0.28 m)) → Facies E' (tidal marsh: KR07 (−0.28 to −0.08 m))→ Facies F' (tidal flat: KR07 (−0.08 to 0.06 m)). Transgression occurred first about 8,300 BP at the west coast of Korea: around 6300–6000 BP, there was a drop in the sea-level and around 6000–4000 BP, there was a rapid rise. Also, Repetition of falling and rising occurred since 4500 BP.

1. Introduction

There is a large amount of sediment inflow into the western part of the Yellow Sea from the eastern part of China's Yellow River and the Yangtze River. As a result of this inflow of sediment, the coastline is somewhat gentle. On the other hand, the eastern part of the Yellow Sea near Korea's west coastline has a relatively small supply of deposits and high bedrock exposure, which causes it to have strong indentations (Choi and Dalrymle, 2004). Korea's West Sea is a shallow body of water formed during the Eocene epoch. The Western Sea of Korea has been assumed to be tectonically stable since the Late Miocene (Chough et al., 2000). During the last glacial maximum (LGM), the sea-level was approximately 130 m lower than it is now and the entire area was land, and the modern West Sea was formed as a result of rises in sea-level (Hong et al., 2010). Hence, Korea's West Sea is very sensitive to changes in the sea-level, and there is a well preserved to records of sea-level variations during the Quaternary glacial-interglacial period (Kim and Kennett, 1998; Kim et al., 1999; Li et al., 1999; Liu et al., 2000; Berne et al., 2002). Research into the study and interpretation of the climatic environment change of the Quaternary is an important requirement to effectively understand current climate characteristics and to predict future temperature changes (Jung et al., 2010). After the end of the last glacial epoch, there was a worldwide rise in the temperature and sea-levels (Chernicoff and Venkatakrishnan, 1995). Hence, it is very important to track this period's temperature changes in order to uncover the history of the West Sea's surface fluctuations.

Bloom and Park's (1985) research on Holocene sea-level fluctuations implied that levels rose continuously. Hwang et al. (1997) and Shin (1998) argued that during the Holocene, the sea-levels did not rise continuously and that it rose and descended repeatedly in various orders. Therefore, in order to investigate the history of the West Sea's surface levels, diatoms were collected as objects of study. Because diatoms are very sensitive to changes in salt concentration, nutrient salts, and water temperature, research on the assemblage composition of diatoms contained in the sedimentary layers is widely used for paleo-environmental research such as temperature change and sea-level fluctuations (Kashima, 2003; Freund et al., 2004; Kato et al., 2004; Yabe et al., 2004; Ojala et al., 2005; Vos and Gerrets, 2005). This research aims to

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investigate the sea-level fluctuations of the Holocene on the basis of diatoms taken from the Sabsi Island area and the alluvial plains of the Geum River.

2. Materials and methods

The western coastal area of Korea is influenced by strong tidal currents. Tidal ranges along the western coast of Korean are characterized by high tidal ranges (4–9 m). The Keum River estuary is located on the southwest coast of South Korea. The bottom topography of the river mouth is shallow, deepening to the west (Son et al., 2007). The overall shape resembles an arrowhead (sapsido). The highest point (113 m) is in the western part of the island, which is generally marked by a wide coastal zone. KS2009 core deposit was collected from the alluvial plain (35°58′N, 126°43′E) at the mouth of the Keum River. KR07 trench deposit was collected from Sabsi Island's Dollimanggol area (36°20′N, 126°21′E) (Fig. 1). The area where core KS2009 was collected was 6 m above sea-level, and the core was 29.5 m long. A section of 4 m of the top part was composed of unconsolidated sediments and topsoil: samples were not obtained here. Obtained samples yielded an average size of 4.5–6.5 Φ, with sedimentary facies from fine silt to sandy silt (Fig. 2). The sedimentary facies of KS2009 contained <50% sand-sized particles. The facies corresponds to a mud flat (Mauz and Bungenstock, 2007), located on the upper intertidal. The section from −20.3 to −2.0 m shows alternating sand and silt lamination. KR07 was sampled from a trench approximately 1.7 m deep: the wetland sediment of the top part and the oxidized red-colored layer of the part just below were not sampled. The lowest part of the trench has sand and blue-gray silt, overlain by peat and blue-gray silt (Fig. 3).

A total of 150 samples were collected from the KS2009 core at 10 cm intervals for diatom analysis. From KR07, 86 samples were collected about 2 cm intervals. The dry samples were placed in beakers to which 25 ml of 30% hydrogen peroxide (H_2O_2) had been added. 10% Hydrochloric acid (HCl) was then added to remove organic carbonate, and samples allowed to stand for another 24 h. They were then centrifuged three times at 1700 rpm for 15 s; samples were washed in distilled water to remove chemical residue and salt crystals between centrifuging. Washed samples were prepared for quantitative diatom abundance analysis using conventional microscope slides according to the random settling method of Scherer (1994). Diatoms were identified using a Nikon E400 microscope at magnifications of × 400 and × 1000. The number of microfossils g^{-1} was calculated as follows: Abundance = ((A × B)/(C × D))/E (A = number of specimens counted; B = area of the settling chamber; C = number of fields of view; D = area of field of view; E = mass of sample). The age of KS2009 and KR07 from bulk sediment and peats were determined by AMS (accelerator mass spectrometry) ^{14}C at Korea Institute of Geoscience and Mineral Resources (Tables 1 and 2). Radiocarbon ages were corrected for reservoir effect (Kong and Lee, 2005).

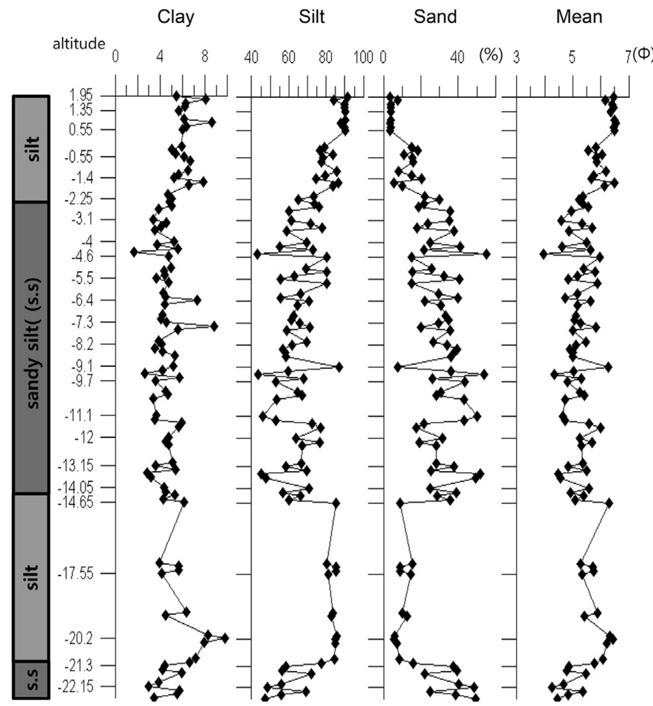

Fig. 2. Down-core variations of sand (%), silt (%), clay (%), mean grain size (φ) and sorting (φ) for core KS2009 with lithology.

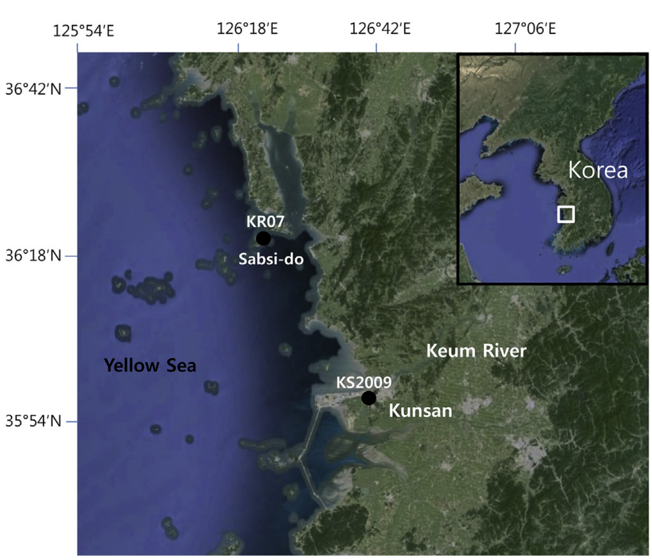

Fig. 1. Sampling locations and topographical map of KS2009 and KR07 (Google earth, 2013).

Table 1
Radiocarbon ages for samples analyzed from the KS2009 core sediment.

Depth (m.a.s.l)	Lab code	^{14}C age[uc] (yr BP)	^{14}C age[c] (yr BP)	Materials
−1.54	OSa090131	4260 ± 50	4088	Bulk sediment
−7.55	OSa090132	6150 ± 50	5978	Bulk sediment
−13.32	OSa090133	6360 ± 60	6188	Bulk sediment
−14.69	OSa090134	6430 ± 50	6258	Bulk sediment
−22.61	OSa090135	9290 ± 70	9118	Bulk sediment

[uc]– Uncorrected for reservoir effect.
[c]– Corrected for reservoir effect.

Table 2
Radiocarbon ages for samples analyzed from the KR07 sediment.

Depth (m.a.s.l)	Lab code	^{14}C age[uc] (yr BP)	^{14}C age[c] (yr BP)	Materials
−0.34	KR07-218	6280 ± 70	6108	Peat
−0.74	KR07-219	6660 ± 70	6488	Peat
−1.46	KR07-221	7010 ± 70	6838	Peat
−1.58	KR07-222	7380 ± 70	7208	Peat

[uc]– Uncorrected for reservoir effect.
[c]– Corrected for reservoir effect.