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Revisiting the origin of organic matter and depositional environment of sediment in the central Ulleung Basin, East Sea since the late Quaternary

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ABSTRACT

By analyzing sedimentary geochemical data from three piston cores in the central Ulleung Basin, East Sea, we discuss the origin of organic matter and the depositional environment of sediments from Marine Isotope Stage (MIS) 3 to 1. Downcore profiles show that the values of TOC (Total Organic Carbon), TN (Total Nitrogen), and $\delta^{13}C_{org}$ are the lowest values during MIS 2 and the highest during MIS 1. The relationship between TOC/TN and $\delta^{13}C_{org}$ shows that most data fall in the region of the marine algae irrespective of MIS stage, which illustrates that the organic matter has been predominantly produced by a marine source rather than by a terrestrial source since the late Quaternary. However, depleted $\delta^{13}C_{org}$ values are discretely observed during MIS 2 and MIS 3, particularly in dark laminated mud (DLM), which appears to reflect the influence of episodic event by the East Asian Monsoon rather than the organic matter source changing by lower sea level.

Previous sedimentological studies in the Ulleung Basin reported that the depositional environment of sediment in MIS 2 was more reducing than during MIS 1 and MIS 3, but our geochemical data do not support this interpretation. The abundance of most redox-sensitive trace elements (e.g., Mn, V, U, and Mo) has not significantly varied from MIS 3 to MIS 1. In addition, the ratios of redox-sensitive trace elements (e.g., Ni/Co, V/Cr, V/Ni, U/Th, and V/(V + Ni)) indicate a predominantly oxic or suboxic environment. The bottom water condition was similarly oxic to suboxic, during times of sediment deposition since the late Quaternary. The sedimentary layers containing tephra and foraminiferal shell fragments illustrate abnormal element/Al ratios, suggesting that these allochthonous sediment sources are one of important factors controlling the geochemical composition of sediments in the Ulleung Basin.

1. Introduction

The East Sea, one of the typical semi-closed marginal seas in the northwestern Pacific Ocean, has been subjected to paleoceanographic changes due to its connection to the open Pacific Ocean through the four straits (Korea, Tsugaru, Soya, and Tatarsky; Fig. 1) (Oba et al., 1991; Keigwin and Gorbarenko, 1992; Lee and Nam, 2003). During the Last Glacial Maximum (LGM), when global sea level was about 130 m lower than the present day (Gorbarenko, 1983; Kim et al., 2000), the oceanographic condition of the East Sea was likely to have been different relative to the present. The $\delta^{18}O$ measured on planktonic foraminiferal tests from this sea have uniquely depleted values compared with the open ocean (Shackleton, 1982; Chappell and Shackleton, 1986; Lee and Nam, 2003), suggesting that the East Sea was nearly isolated from the Pacific Ocean during the LGM (Gorbarenko, 1983; Gorbarenko and Southon, 2000; Kim et al., 2000). However, based on radiocarbon dating and the distribution pattern of river derived lowstand deposits, recent paleogeographic studies have argued that the Korea Strait was not entirely closed during this time, and that the Tsushima Warm Current (TWC) still flowed into the East Sea, even though the inflow volume was relatively smaller than it was during interglacial stages (Park et al., 2000; Lee and Nam, 2003).

Most seismic, stratigraphic, and sedimentologic studies have been mainly focused on the paleoenvironmental changes of sediment deposition in the East Sea since the late Quaternary (e.g., Lee

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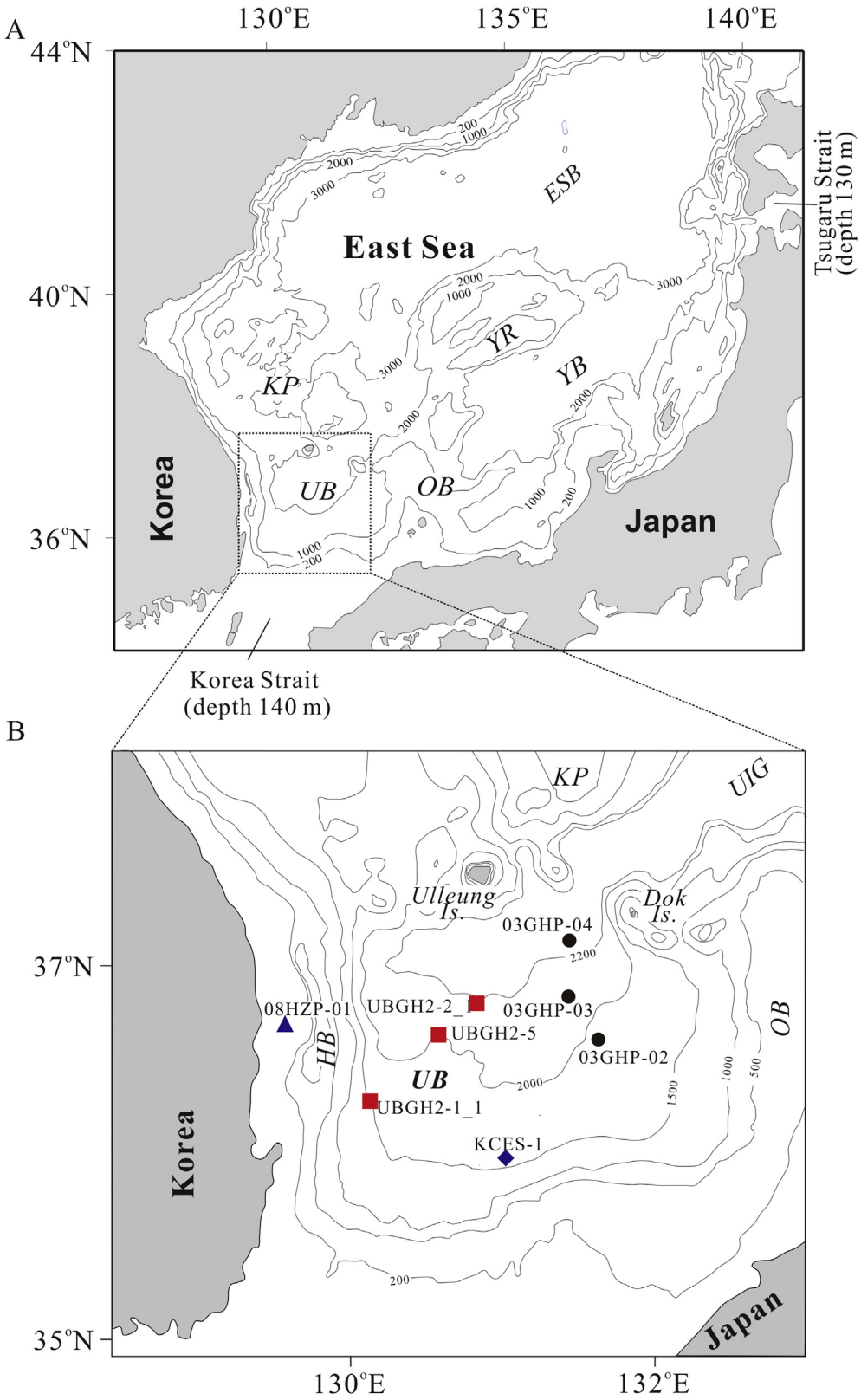

Fig. 1. Location map showing cores 03GHP-02, 03GHP-03, and 03GHP-04 (black closed circles) from the central Ulleung Basin. The location data of cores UBGH2-1_1, UBGH2-5, and UBGH2-2_1 (red closed squares) are from Kim et al. (2013a), and those of core KCES-1 (blue closed diamond) in the Ulleung Basin and core 08HZP-01 (blue closed triangle) in the Hupo Basin are from Zou et al. (2012) and Kim et al. (2010), respectively, which are discussed in the text. Bathymetry in meters (*UB*: Ulleung Basin, *YR*: Yamato Ridge, *ESB*: East Sea Basin, *KP*: Korea Plateau, *UIG*: Ulleung Interplain Gap, *HB*: Hupo Bank, *OB*: Oki Bank). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)