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Physical and acoustic properties of inner shelf sediments in the South Sea, Korea

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ABSTRACT

Core sediment sampling has been conducted to investigate the physical and acoustic properties of inner shelf sediments in the South Sea, Korea. Thirty-two piston core samples were analyzed for sediment texture (grain size as well as, fractions of sand, silt, and clay), physical properties (porosity, water content, bulk density, grain density, and shear strength), and acoustic properties (compressional wave velocity and attenuation). The sediments in the study area consist mostly of homogenous mud. The study area can be divided into two different areas (south of Namhae Island and southeast of Naro Island) by texture, and physical and acoustic properties. The mean grain size generally decreases seaward from the mouth of Yeosu Sound and eastward in the southeast area of Naro Island. The compressional wave velocity decreases southeastward from 1500 to 1480 m/s and then increases to 1520 m/s due to relict sediments deposited in mid-shelf of the South Sea. Porosity, water content, and bulk density show an inverse pattern to velocity. The geoacoustic properties of the study area are generally similar to those of continental terrace sediment studied by Hamilton in the North Pacific. The area south of Namhae Island area matches Hamilton's model better than the area southeast of Naro Island. This result is believed to be related to the higher silt and sand contents as well as lower clay content than southeast of Naro Island.

1. Introduction

The continental shelf is usually covered by unconsolidated sediments with different textual and physical properties. These properties are known as important factors to understand the geological backgrounds of marine environments (Orsi and Dunn, 1990; Weber et al., 1997; Kim et al., 2001). The physical and acoustic properties of marine sediments could also reflect a lithological and geotechnical description of the sediments and have been a great interest to various fields such as seafloor engineering, paleoceanogrphy, sedimentology, marine geophysics, and underwater acoustics (Hamilton, 1970, 1980; Kim et al., 2001; Richardson et al., 2002). Much research, therefore, has been carried out in order to reveal the relationships among physical, acoustic, and textural properties relative to various sedimentary environments (Hamilton and Bachman, 1982; Orsi and Dunn, 1990, 1991; Weber et al., 1997; Kim et al., 2011). According to these studies, the physical and acoustic properties of the sediments depend to a great extent on the lithology, grain size, and composition of the sediment (Hamilton and Bachman, 1982; Orsi and Dunn, 1990, 1991). The distribution of these properties also reflects the change of sediment characteristics (Kim et al., 1992; Weber et al., 1997).

The South Sea shelf of Korea is covered by various sediments affected by sediment input from neighboring rivers and sea-level changes. The sediment facies generally change from Holocene mud in the inner shelf to coarse relict sand in the mid to outer shelf (Kim et al., 1992; Yoo and Park, 2000). Physical and acoustic properties of the sediment could reflect this dynamic change resulting from difference of sediment type. Most marine geological studies in the South Sea shelf, however, have been focused on sedimentology, paleoceanography, and sequence stratigraphy (Park, 1985; Song, 1988; Park and Chu, 1991; Lee, 1992; Park et al., 1999; Yoo and Park, 2000; Han, 2005). Only a handful of studies have been carried out to reveal the relationship between physical and acoustic properties in the South Sea (Kim et al., 1992, 2001, 2005, 2011). Kim et al. (1992) measured the physical and acoustic

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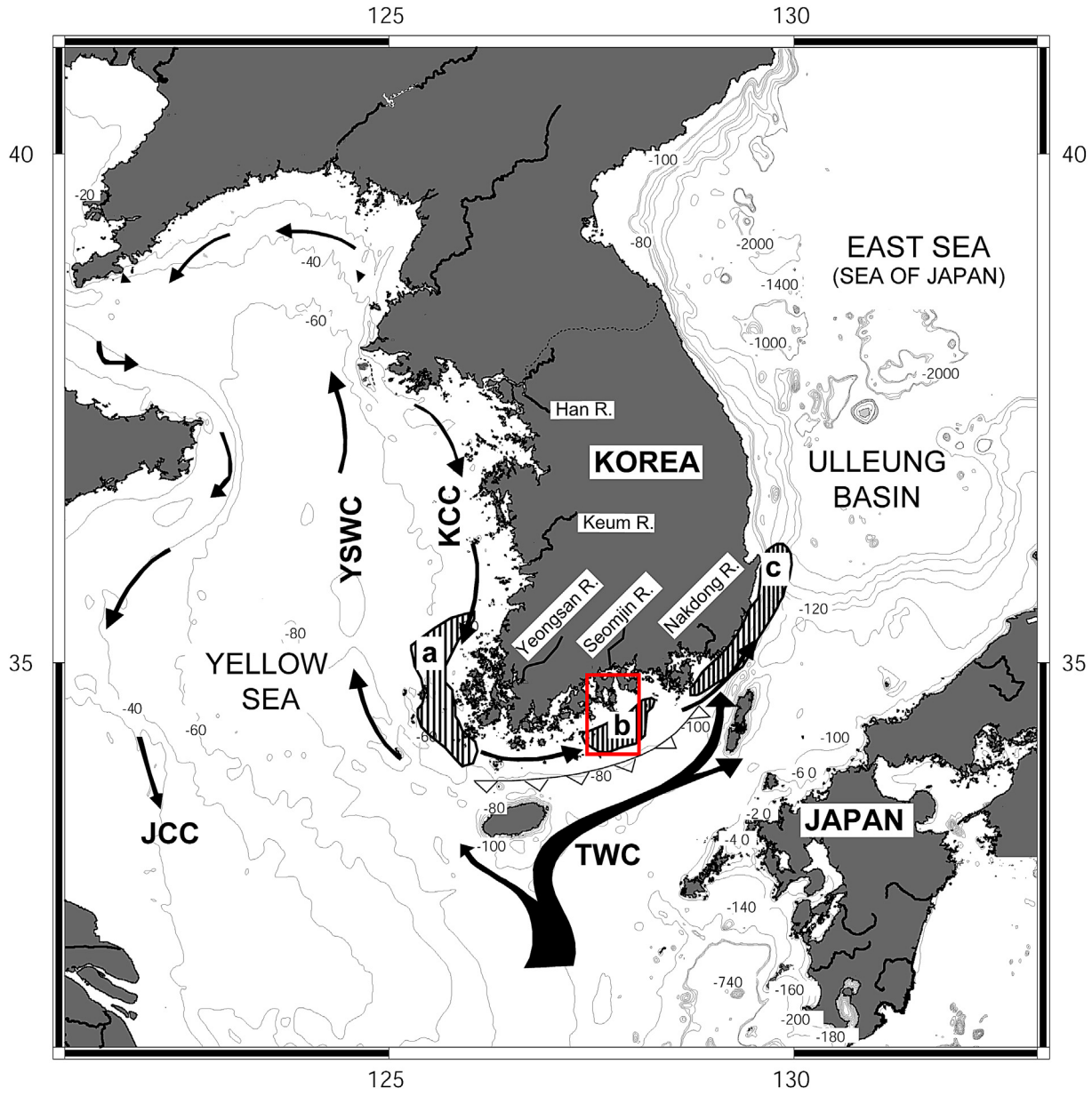

Fig. 1. Map showing surface-current directions, mud belts and bathymetry around the Korean seas. Circulation patterns are characterized by the Tsushima Warm Current (TWC), and, the Korean Coastal Current (KCC). Mud belts around the Korean Peninsula; (a) Southeastern Yellow Sea Mud (SEYSM); (b) Central South Sea Mud (CSSM); (c) Korea Strait Shelf Mud (KSSM). The study area is highlighted by a red box. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

properties in the Holocene mud of the central South Sea and revealed that the physical and acoustic properties match well with the bathymetry of this area. They reported that compressional wave velocity decreases southeastward, whereas porosity and water content increase with water depth in the Holocene mud. Kim et al. (2001) divided the geoacoustic provinces of the South Sea as three different types, based on physical and acoustic properties of sediments. They also identified sedimentary environments and sedimentary processes of this area, using the distributional characteristics of sediment properties and geoacoustic provinces.

However, these previous studies have a regional limitation with an obsolete equipment to measure the compressional wave velocity. Thus, there is a need for better study by precise high-quality data. There is an argument that the Holocene mud deposits of the central South Sea originated mainly from Seomjin River (Park et al., 1996; Kim et al., 2001; Choi et al., 2002). In this study, however, we suggest the possibility of the transport of mud from southwest Korea, using the analyzed data of physical and acoustic properties.

The purpose of this study is to characterize physical and acoustic properties of soft marine sediments obtained from the central South Sea by improved geotechnical property measurements. This paper reports the distribution of velocity and related physical properties of fine grained sediments in the study area. Those results are interpreted in terms of the dispersal pattern of sediment transport. We will further discuss the distribution pattern between two separate depositional environments and establish a relationship between velocity, porosity, density, and sediment texture in the inner shelf of the central South Sea, compared with Hamilton's (1970) data.