Antarctic Circumpolar Current Fluctuation in the Late Neogene: constraint from sediment wave on the Conrad Rise, Indian Sector of the Southern Ocean

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The Antarctic Circumpolar Current (ACC) is the largest and strongest ocean current in the world. It is important for the interoceanic exchange of water, heat, salt and nutrients (e.g. Schmitz, 1995). Also, it is proposed as a key factor for the thermal isolation of the Antarctica (e.g. Zachos et al., 2001). These characteristics of the ACC represent its importance on the climate change, and thus its history has been attracted considerable interest. Because the ACC extends from the sea surface to the ocean floor, it controls sedimentation patterns (Koenitz et al., 2008). Accordingly, fluctuation of the ACC should generate identifiable markers within the sedimentary record that is related to the tectonic, climatic, and oceanographic events (e.g. Rack. 1993).

We investigated the Conrad Rise located in the Indian sector of the Southern Ocean located in the middle of the ACC, in order to reconstruct its fluctuation. We conducted multibeam bathymetry survey, seismic reflection survey, and sediment coring. These surveys revealed natures of seismic units on the southwestern slope of the Conrad Rise (Units A to C, in descending order), and especially “sediment waves” observed in the Unit A.

Unit A shows transparent to low amplitude with sediment wave structure. Sediment waves don’t show systematic changes of its dimension and thickness. Sedimentary core showed that the surface sediment is composed of diatom ooze. The upper part of the unit B shows higher amplitude than that of unit A, and shows planar, parallel configuration with thicker distribution in the shallower part. The lower part of the Unit B shows smaller reflection amplitude, and onlapping and downlapping reflectors. At the units A/B boundary, significant erosional surface is observed only in 3.75-4.24 sec in two-way travel time. Unit C has high-amplitude parallel reflectors at its top and shows chaotic facies below.

Based on morphological characteristics of the sediment waves, oceanographic setting of the Conrad Rise, and components of the surface sediment, it is most likely that whole Unit A is composed of diatom ooze deposited under the ACC. On the other hand, the upper part of the Unit B shows higher amplitude, suggesting different component form that of the Unit A. However, thicker distribution in the shallower part of the upper part of the Unit B indicates deposition with considerable current effect, but without sediment waves. These observations represent difference of sedimentary environment between units A and B. Depth-confined erosional surface represent erosion caused contour current, which also suggest the change of oceanographic setting. As the Unit A likely deposited under the ACC, these a series of change can be related with the fluctuation of the ACC. Extrapolating the surface sedimentary rate of 41.5 cm/kyr (Katsuki et al., 2012) to the unit boundary, we obtained ca. 1 Ma as the estimated age of the Unit A/B boundary.

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