Northward migration of the Antarctic Circumpolar Current during middle to early Pleistocene: Evidences from sediment waves on the Conrad Rise, Southern Indian Ocean

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Abstract

The Antarctic Circumpolar Current (ACC) is the worlds longest and largest current system, therefore, it plays an important role in the global distribution of heat, nutrients and greenhouse gasses. While past changes in the ACC have been reconstructed by a number of studies using sedimentary records in the Southern Ocean, a detailed understanding of the relationship between its temporal and spatial variability and the changes in the climatic system remains unclear. We found the sediment waves on the southern slope of the Conrad Rise in the Indian sector of the Southern Ocean, and proposed an idea that the sediment wave is a direct physical evidence for the ACC flow (Oiwane et al., 2014). However, the records of bathymetric and seismic profile are significantly limited in the Southern Indian Ocean, thus the distribution of sediment wave and ACC migration history are still not well understood.

In this study, we conducted multi-channel seismic (MCS) reflection surveys on the northern slope of the Conrad Rise and Del Caño Rise during the R/V Hakuho-maru KH-16-1 cruise. These data reveal large-scale sediment wave structures with continuous and parallel reflectors that have low to moderate reflection amplitudes in the upper part of the seismic section on the northern Conrad Rise (51.5°S). These MCS data are quite similar to those of southern Conrad Rise (54°S) (Oiwane et al., 2014). However, there are no sediment wave structures on the Del Caño Rise (43.5°S, 46°S). Based on these MCS data, the ACC flow axis was not located on the Del Caño Rise during the Plio-Pleistocene. The basal age of sediment wave unit is estimated to be middle to early Pleistocene based on the extrapolation of sedimentation rates from piston cores form the Conrad Rise. Thus, we conclude that the northward migration of the ACC was obviously occurred at middle to early Pleistocene. Although the timing of ACC migration is younger than the late Pliocene cooling (McKay et al., 2012), the northward migration of the ACC and Southern Ocean fronts has been linked with a significant thinning from stage 4 to 3 of the East Antarctic ice sheet (EAIS) in the early Pleistocene (Suganuma et al., 2014). The reorganization of the Southern Ocean circulation had probably an influence on the elevation of EAIS due to reduction in moisture transport from the subtropical ocean to the Antarctica.

Keywords: Southern Ocean, Conrad Rise, sediment wave, Antarctic Circumpolar Current

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