Nutrient distribution and its transport system in the intermediate and deep layers of the Okinawa Trough

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The Okinawa Trough, which reaches the maximum depth of 2300 m, is separated from the Philippine Sea by a submarine ridge associated with the Ryukyu Island chain. Water in the depths shallower than ~700 m can be exchanged between the Okinawa Trough and the Philippine Sea because the Kuroshio flows into the trough from the channel east of Taiwan (sill depth 775 m) and flows out through the Tokara Strait (sill depth 690 m). In contrast, deep water below about 800 m depth cannot be exchanged through these channels by horizontal advection and diffusion processes. The Kerama Gap, located at the middle of the Ryukyu Island chain, is narrow (about 50 km wide) but is the deepest channel (sill depth 1100 m) connecting the Okinawa Trough to the Philippine Sea. The previous studies showed that deep water in the Okinawa Trough is ventilated by near-bottom overflow through the Kerama Gap, which is regarded as a branch from the northeastward Ryukyu Current at intermediate depths over the eastern slope of the Ryukyu Island chain. Sills of undersea canyons, gaps or passages have the potential to significantly change the properties of near-bottom waters flowing over them through strong vertical mixing caused by breaking of internal gravity waves and hydraulic jumps. These processes around the sill play a crucial role in warming and hence upwelling the waters. From this perspective, we focus on the Okinawa Trough, which is probably a significant upwelling area of North Pacific Intermediate Water (NPIW) on the return pathway to its formation region in the Okhotsk Sea.
In this study, using data from two cruises, T/V Kagoshima-maru (KG1708) and R/V Mirai (MR17-03C), in May and June 2017 around the Okinawa Trough, we examine the nutrient distribution on the isopycnal surfaces. As a result, we found the following features. The nitrate concentration on the 26.7 σ_θ isopycnal surface, which corresponds to the core density of the NPIW in the Okinawa Trough, is high in the Kerama Gap probably because of the vertical mixing with the lower-layer rich nutrient water. And then, the nitrate concentration gradually decreases along the Kuroshio path in the Okinawa Trough, probably by experiencing vertical mixing with upper-layer poor nutrient water during northward advection. The results of this study support that the Okinawa Trough is an upwelling area of NPIW.

Keywords: Okinawa Trough, Ryukyu Current System, Upwelling

