Water Mass Analysis of Tsushima Strait by Multiple Tracers and seasonal contribution of various origin.

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Tsushima strait is an important pathway for connecting the East China Sea (ECS) and the Sea of Japan. In order to monitor currents in this region, various in-situ temperature and salinity datasets were used for developing numerical simulation models. However, the water origin of currents in this region lacked of systematical understanding. Because of shallow depth and various currents pass through, the chemical properties of Tsushima Strait water changed rapidly. Multiple tracers analysis is a comprehensive method to approach detailed and instantaneous status of water mass. This study used Rare Earth Elements (REEs), $\delta^{18}O$, combing with CTD data (Temperature, Salinity, Fluorescence) and routine data (Nutrients, Dissolved Oxygen), to analyze water mass mixing of Tsushima Strait.

All samples (3 seasons, from 5 cruises) were collected at Tsushima Strait (Line 129.38E, 34.88N to 130.15E, 33.83N) from 2015 May to 2016 October used T/S Nagasaki Maru (Nagasaki University). The salinity, temperature, DO and fluorescence data were collected by CTD, the DO samples were measured on-board by automatic titration. Nutrients and $\delta^{18}O$ samples were stored for laboratory analysis. The REEs samples were filtered by 0.2μm membrane filter and acidified to pH 1.5 by hydrochloride acid in clean booth immediately, then extracted by NOBIAS PA1 chelate resin (Hitachi High-Tech) and measured by ICP-MS (Element 2, Thermo Fisher Scientific) in a cleanroom on land.

CTD and multiple tracers datasets show that: (Ⅰ)The Changjiang Diluted Water (CDW) and Kuroshio Intermediate Water (KIW) are important end members of this region, according to the temperature-salinity diagram. (Ⅱ)Fluorescence vertical profiles and horizontal sections shows unbalanced distribution. High fluorescence mainly occurred in subsurface layer of east channel in spring and fall, especially shallower than the thermocline in fall. (Ⅲ)Post-Archean Average Australian Shale (PAAS) normalized REEs patterns show similar water mass mixing in this region in different season, and high Ce/Ce* suggests the particle influence. These results suggest the nutrients origin of Tsushima Strait water might be CDW. Further, to understand the dominant water mass, we calculated the mixing ratios by least square method with five parameters, including salinity, Dy/Ho, Ho/Er, Er/Tm and Tm/Yb. End member dataset included Yellow Sea Cold Water (YSCW), Taiwan Warm Current (TWC), KIW and CDW (Private communication, Hongliang Ma, Ocean University of China). Calculation result suggests the two sides of Tsushima Strait water were dominated by different origin over 3 seasons. The west channel show clear stratification. YSCW and CDW influenced the surface and the subsurface layer in spring and fall, however, the layer deeper than 100 m was dominated by KIW. The east channel was mainly controlled by CDW throughout the year. Results also suggests CDW is the vital water origin of Tsushima Strait, according to the collaboration of CDW domination region and high fluorescence layer. The water mass distribution and seasonal changes in Tsushima Strait were revealed in this study, and multiple tracers are efficient method for the water origin analysis. Our results and method will provide evidence for improving current simulation models.

Keywords: Water mass analysis, Rare Earth Elements, Tsushima Strait

