Reconstruction of ventilation history of the Japan Sea based on physical properties data collected during IODP Exp. 346

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The Japan Sea is a semi-enclosed marginal sea located at the eastern edge of Asian continent and under the influence of east Asian monsoon. The primary production is controlled by nutrient supply from the East China Sea by summer monsoon, while deep water ventilation is promoted by winter monsoon cooling of the surface water of the Japan Sea. Perfectly continuous sediment splice sequences were established at Sites U1422-U1427 and U1430 which have been correlated among others using apparent dark-light cycles. The coverage of water depths are, in ascending order, 330 m at Site U1427, 903 m at Site U1426, 1072 m at Site U1430, 1785 m at Site U1423, 1909 m at Site U1425, 2808 m at Site U1424, and 3429 m at Site U1422, which enable us to reconstruct the temporal variation of depth distribution of organic carbon flux related to the past primary production and deep water ventilation in the Japan Sea.

For calculation of the mass accumulation of organic carbon (OC flux) at each site, we used the perfectly continuous records of dry bulk density (DBD) and total organic carbon content (TOC) calculated from shipboard measurements such as gamma-ray attenuation (GRA) density with grain density and a strong negative correlation between TOC and photo RGB values, respectively. Linear sedimentation rate (LSR) of each site was estimated based on the projection of the age model established at Site U1424 by tuning the GRA variation onto LR04 benthic oxygen isotope curve. Based on the consistent correlation among sites, depth distribution of OC flux was reconstructed for 1 ky step during the last 1.5 million years.

Princple component analysis for depth-temporal OC flux distribuion suggests that three princple component explain 74% of the total variance. Principle component (PC) 1 loading was positively correlated with all the sites except for the U1427 (330 m), while PC2 loading was correlated positively with sites shallower than 1000 m and negatively with those deeper than 2000 m. PC3 loading was correlated negatively with sites around 1000 m and positively with other sites. Such depth dependent patterns suggest that primary production (PC2) and ventilation (PC1) at middle to deeper depth were primary controls on the OC deposition. PC3 may indicate stronger middle depth ventilation or (oppositely) formation of oxygen minimum zone.

We also examined the color variation of these sediments using metric hue. Sediment color varies between dull green (higher hue) and olive (lower hue). Average metric hue is about 88 degree for all the site and variability is smaller for shallower sites. The metric hue at Site U1425 (1909 m) varies in harmony with the score of PC1, and lower metric hue is associated with larger PC1 score. Namely, higher OC flux (a lower oxygenation level) was associated with more olive color, which could be interpreted that dull green background (detritus) color was overridden by olive color reduced iron. Such an agreement between independently estimated variables suggests that the deep water ventilation intensity in the Japan Sea could be independently reconstructed as a proxy of winter monsoon intensity.

Keywords: Japan Sea, Organic carbon flux, Ventilation, IODP Expedition 346

