

Bottom-water oxygenation in the southern Japan Sea during the late Quaternary based on the foraminiferal assemblages

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Late Quaternary hemipelagic sediments in the Japan Sea are characterized by alternating beds of light and dark layers which are synchronous basin-wide (Oba et al., 1991; Tada et al., 1999). In this study, benthic and planktonic foraminiferal analysis are carried out to understand temporal variations of sea floor and sea surface environments during the times of dark layer deposition, based on the sediment core IMAGES MD01-2407 (water depth 932m) in the southern Japan Sea.

The dark layers in this core can be classified into six types by containing benthic foraminiferal assemblages, as follows: Barren-type, *Brizalina*-type, *Islandiella*-type, *Eilohedra*-type, *Angulogerina*-type, and mixture-type (Usami et al., 2007).

Considering benthic foraminiferal assemblages and sediment fabrics, the barren-type dark layer is formed in euxinic bottom-condition, and the *Brizalina*-type one indicates an anaerobic (anoxic) (below 0.1mL/L O₂) condition during the deposition. These two types of dark layers mainly resulted from euxinic/anoxic bottom water. In contrast, the dark layers of *Eilohedra*-type and *Islandiella*-type were caused by increasing productivity, and thus, consequent oxygen consumption due to degradation of organic matter at sediment surface. It is supported by abundant *Globigerina bulloides* and high organic carbon contents in the dark layers of *Eilohedra*-type and *Islandiella*-type. *Angulogerina*-type dark layer was not associated with neither anoxic nor dysoxic bottom water, because *Angulogerina ikebei* lives in oxic bottom under the Intermediate Water in the modern Japan Sea. Consequently, this type of dark layers might be related to relatively increased productivity under the oxic sea floor condition. Similarly, mixture-type dark layer likely reflect subtle productivity increase in comparison with adjacent layers.

The temporal variation of these dark layer types seems to correspond to global climatic (sea level) changes. Both in the MIS6 and MIS2, thick dark layers lacking in benthic foraminifera were deposited. however, two thick layers are considered to be deposited under different environmental settings each other. In the MIS6, the planktonic fauna are fully dominated by *Globigerina bulloides*, and the benthic fauna in just below and above the dark layers are dominated by *Angulogerina ikebei*, while these assemblages were not observed in MIS2. These results suggest that the ventilation was substantially active in MIS6, and surface water circulation might be more or less active even in the dark layers deposition. Bottom water ventilation in the southern Japan sea appears to have been subject to fluctuation of winter cooling intensity in addition to global sea level changes during the late Quaternary.

Oba et al., 1991: Paleoenvironmental changes in the Japan Sea during the last 85,000 years. *Paleoceanography*, 6, 499-518.

Tada et al., 1999: Land-ocean linkages over orbital and millennial timescales recorded in late Quaternary sediments of the Japan Sea. *Paleoceanography*, 14, 236-247.

Usami et al., 2007: Foraminiferal response to late Quaternary climate variability in the Japan Sea : Concerning low oxygen environment and productivity. 9th International Conference on Paleocyanography [Shanghai, China], Program and abstracts, 216.