Glacial - Interglacial changes of biogenic contents in the Japan Sea during the last 640kyrs based on high resolution XRF scanning

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Distinct alternations of the dark and light colored layers in hemipelagic sediments of the Japan Sea during the last glacial cycle reflect drastic changes in paleoceanographic conditions in the sea corresponding to the Dansgaard-Oeschger Cycles (DOC) and sea level changes (Oba et al., 1991; Tada et al., 1999). Although origin of a thick and thinly-laminated dark layer deposited during the last glacial maximum (LGM) was explored some extent, there are no studies that examined the origin of other thinner and less distinctly laminated dark layers in detail because of the limitation of sampling resolution.

We applied our new XRF micro-scanning method (using Horiba XGT-2700) to wet sediment MD01-2407 core in the south central part of the Japan Sea to conduct high-resolution (1.25 cm interval) quantitative analysis of the major elements. We measured concentration of Al, Si, S, K, Ca, Ti and Fe. Using these data, we estimated contents of major components such as biogenic silica (Bsi), biogenic carbonate (Bca), and terrigenous material (Ter). We compared them with L* (gray scale) to examine their relation with the dark layers. We also estimated org-C from L* because L* shows clear negative correlation with concentration of org-C. We calculated defined excess S which is defined as the difference between the content of S and that for normal marine estimated from org-C based on the following assumption: 1) excess S(%)=S-0.36*org-C (Tada et al., 1999).

The age model during the last 50kyrs is constructed based on six datum dated by 14C with two marker tephra layers. Then, we compared the oxygen isotope of planktonic foraminifera (18Opf) to the SPECMAP standard oxygen isotope curve (Martinson et al., 1987). The most important difference between 18Opf curve of MD01-2407 and that of the SPECMAP occurs during LGM, when negative excursion of 18Opf is occurred because low salinity surface water developed due to isolation of the sea and excess precipitation over evaporation over the sea (Matsui et al., 1998). These negative excursions of 18Opf are also seen in two dark layers with high excess S before 50ka those are corresponded to MIS 6.2 and 6.4. We compared the relationship between 18Opf curve of MD01-2407 and that of the SPECMAP from MIS 6.2 to LGM and established the 18O stratigraphy of MD01-2407 during the last 160kyrs.

The result suggests that the Bca content shows several hundred to thousand years scale variations during the last 160ky. Bca content tends to be higher in dark layers during MIS 3 and its variability was closely associated with DOC whereas it tends to be lower in dark layers during MIS1, 4, and 5. There dark layers are characterized with low Bca content, contains less preserved planktonic foraminifera, suggesting that dissolution of carbonate in these dark layers. On the other hand, no significant dissolution occurred in laminated dark layers during MIS 2, 3, and 6. Bsi content is high only during the interglacial maxima suggesting high biogenic silica productivity.

We used changes of Bsi and Bca content and excess S during the last 160kyrs for estimating the glacial-interglacial stages based on 18Opf curve of MD01-2407 and finally constructed the age model during the last 640kyrs. The temporal variation of the correlation coefficient between L* and Bca content shows that the correlation coefficient is negative during glacial stages and positive during interglacial stages.

During glacial stages, low oxygenation level caused by water column stratification and relatively low surface productivity was probably responsible for good preservation of carbonate in dark layers. On the other hand, during interglacial stages, enhanced surface productivity caused by upwelling may have caused increasing organic matter decomposition and consequent increase in partial pressure of carbon dioxide in the intermediate water and resulted in dissolution of carbonate deposited in dark layers.