Redox history of deep water in the Japan Sea during late Pleistocene based on trace elements

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The Japan Sea is a semi-closed marginal sea surrounded by Eurasia continent and Japanese and Sakhalin islands and its oceanography has been sensitively affected by climate changes in the past. Redox condition of the Japan Sea has been varied between oxygen-rich (oxic) and oxygen-poor (anoxic to euxinic) conditions repeatedly, which resulted in deposition of light and dark layers. Possible mechanism(s) of anoxic deep water developments in the Japan Sea has been discussed comprehensively such as high surface productivity and density stratification of the water column caused by isolation due to low sea levels during the glacial stages (Tada et al., 1999). This study aims to reconstruct redox history of Japan Sea deep water during the last 150 ka. (MIS1-MIS6) when significant changes in the bottom water redox condition have been previously reported (e.g. Watanabe et al., 2007). We used the sedimentary cores recovered during IODP Exp. 346, from Sites U1423 and U1425 in the northeast and central parts of the Japan Sea.
After acid digestions, about 100 samples were analyzed by ICP-MS and ICP-AES for major and trace elemental compositions. Results indicate that studied samples from dark colored muddy layers are enriched in redox sensitive elements such as Mo, U, and V, while these elements show low concentrations in the light-colored layers. Highest Mo concentrations are found in dark layers in MIS2 (glacial stage) and MIS5 (interglacial) that exceed 10 ppm, more than ten times higher than the average concentration in mudstone inferred from AUCC values (Average of Upper Continental Crust, McLennan 2001). These high Mo values consist with features of sulfidic oceanic conditions such as modern Cariaco Basin and Black Sea where high burial flux of S-bonding Mo occurs, indicating that those dark layers of the Japan Sea reflect euxinic depositional environment . To characterize anoxic-euxinic conditions in the Japan Sea, we compared Mo /U ratios in each dark layer. The Mo/U ratios in the dark layers in MIS2 are high, meanwhile the Mo/U ratios in MIS5 are relatively low. These high and high but relatively low Mo/U in MIS2 and MIS5 resemble to the pattern from similar to that from the restricted Cariaco Basin with sulfidic water column is development and high productive open-ocean settings such as eastern tropical Pacific marginal region, respectively. The difference of pattern of Mo and U enrichment in the euxinic dark layers in glacial and interglacial stages could be due to oceanic setting condition in each stage. In the glacial stage with low sea level, the Japan Sea was isolated from surrounding ocean that caused development of sulfidic water column and enhanced Mo burial into sediment. On the other hand, euxinic depositional condition in interglacial stage would have been formed below oxygen minimum zone developed by high organic matter sink from high productive surface water depth.

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