Bottom-water oxygenation condition and surface-water productivity during the Early Triassic based on pelagic sequence in Inuyama

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After the largest mass extinction event in the Phanerozoic at the Permian/Triassic (P/T) boundary, biotic recovery from the extinction required about 5 Myr that corresponds to the entire Early Triassic. The absence of radiolarian bedded chert across the P/T boundary for several million years is widely recognized in the pelagic sequence of Japan and is considered as results of long-lasting anoxic conditions in deep ocean. Despite efforts of intensive studies, previous works examined the bottom water oxygenation condition only based on compilation of discontinuous and fragmented lithologic sequences from several different regions. To examine the extent, duration, cycle and stability of the anoxic condition, and their relationship with surface-water productivity in superocean Panthalassa during the Early Triassic, high-resolution reconstruction of the continuous Lower Triassic pelagic sequence within the Jurassic accretionary complex in central Japan was conducted for the first time based on the detailed geologic mapping and lithostratigraphic correlation of the sequence in Inuyama area, central Japan.

The reconstructed Lower Triassic pelagic sequence is approximately 11 m thick, and is divided into 7 lithologic units. Age diagnostic radiolarian fossils of the late Early Triassic (Spathian) and the early Middle Triassic (Anisian) were previously reported from the upper part of the sequence, and the over 150 cm thick interval dominated by black shale beds in the lowermost part of the sequence is considered as representing the Earliest Triassic black shale beds judging from its lithostratigraphic position. Carbon isotopic analysis of total organic carbon was conducted to reconstruct high-resolution carbon isotopic record covering the entire Early Triassic, which was compared with inorganic carbon isotopic records from Tethys. Overall similar pattern of the two curves allows us to correlate the age of the shallow marine sequence of Tethys to the pelagic sequence of Panthalassa.

Then, we reconstructed bottom-water oxygenation condition in the deep-sea environment and surface-water productivity of Panthalassa during the Early Triassic, and examined the relationship between them. Bottom-water oxygenation condition was reconstructed based on the degree of lamina preservation observed on soft-X-ray radiographs. The observation revealed relatively oxygen-poor but unstable bottom-water oxygenation condition oscillating between oxic and anoxic with high frequency from Griesbachian to Smithian, followed by the gradual recovery to the oxic environment during Spathian. We also measured the abundance of redox-sensive trace element V, normalized by terrigenous element Al_2O_3, as the indicator of bottom-water oxygenation condition, which generally shows similar variation with bottom-water oxygenation condition estimated from the degree of lamina preservation. SiO_2/Al_2O_3, which indicates the productivity of biogenic silica in the surface-water, were also measured in order to examine its relationship with bottom-water oxygenation condition in long time scale, however, there is no clear correlation between SiO_2/Al_2O_3 and the degree of lamina preservation in 10^5 to 10^6 year-scale.

In addition, high-resolution reconstruction of the degree of lamina preservation and SiO_2/Al_2O_3 were conducted on the black shale unit to examine the relationship between environmental changes in surface-water and bottom-water immediately after the P/T boundary in shorter time scale. Variations in SiO_2/Al_2O_3 seem to be high in anoxic condition and low in oxic condition in 10^4 to 10^5 year-scale, suggesting changes in bottom-water oxygenation condition have been closely related to changes in surface-water productivity in 10^4 to 10^5 year-scale during the accumulation of black shale unit in Panthalassa.