Recovery of the ocean environment in the aftermath of the K/T boundary event deduced from a marine carbon cycle model

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After the mass extinction event at the Cretaceous/Tertiary (K/T) boundary, about 65 Myr ago, a rapid and complete breakdown of the vertical gradient of the carbon isotope ratio (d13C) between the surface and deep waters occurred. This is known as ”Strangelove Ocean”. The normal,biologically productive ocean is characterized by the vertical gradient of d13C, i.e., d13C of surface waters is larger than that of deep waters. This is a result of ’biological pump’, which transfers 12C preferentially from the surface to deep waters through settling down and dissolution of particulate organic matters in the water column. Breakdown of the gradient seen at the K/T boundary however implies a limited productivity, not a complete cessation of productivity, because d13C both of the surface and deep waters goes to about 1.5 per mill, not to -6. per mill, suggesting that the biological pump did not ceased completely just after the K/T boundary.

In order to reveal the recovery of ocean environment from the K/T boundary event, we developed a vertical one-dimensional marine carbon cycle model. This model includes physical, chemical, and biological processes in the ocean. We adopt the multi-G model for decomposition of particulate organic carbon, assuming that the particulate organic carbon is composed of three kinds of organic compounds with different decay time. Using this model, the vertical profile of each chemical component (such as total inorganic carbon,alkalinity, PO_4, and Ca) in the ocean can be estimated. The breakdown of the vertical gradient of d13C between the surface and deep waters may be reconstructed without assuming a complete cessation of export production from the surface waters. Reconstruction of the marine environmental change at the K/T boundary based on an inversion analysis with d13C data will be discussed.