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The oceanic carbon cycle implicated in the d13Ccarb and the d13Corg variations from the terminal Ediacaran to the Early Cambrian

T. Ishikawa (1), Y. Ueno (2), T. Komiya (1), D. Shu (3), Y. Li (4), N. Yoshida (5), and S. Maruyama (1)

(1) Department of Earth and Planetary Sciences, Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8551, Japan (ishikawa.t.ab@m.titech.ac.jp), (2) Global Edge Institute, Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8550 Japan, (3) Department of Geology and Key Laboratory for Continental Dynamics, Northwest University, Xian 710069, China, (4) School of Earth Sciences and Resources Management, Changan University, Xian 710054, China, (5) Department of Environmental Science and Technology, Tokyo Institute of Technology, 4259 Nagatsuda Midori-ku Yokohama, Kanagawa Prefecture 226-8502, Japan

The terminal Neoproterozoic and its transition into the Cambrian witnessed major evolutionary and geochemical changes (e.g. Knoll, 1994). Evolutionary features include extinction and subsequent radiation events (e.g. Brasier, 1994; Knoll, 1994; Knoll and Carroll, 1999; Shu 2008). Geochemical changes comprise secular variations of the global carbon cycle expressed as variations of the d13C isotope records. A representative d13C curve for inorganic carbon (d13Ccarb) across the Precambrian/Cambrian boundary (Pc/C boundary) shows the existence of large fluctuations (e.g. Kirschvink et al., 1991; Narbonne et al., 1994; Kaufman et al., 1995; Amthor et al., 2003; Maloof et al., 2005, Ishikawa et al., 2008). This indicates a significant change of the oceanic carbon cycle at that time. On the other hand, the d13C values for total organic carbon (d13Corg) have rarely been reported together with the d13Ccarb across the boundary. Therefore, the precise relation between the d13Ccarb and the d13Corg and the global carbon cycle at the Pc/C boundary are still ambiguous. This work presents a first high-resolution d13Corg chemostratigraphy of drill core samples across the Pc/C boundary in the Three Gorges area, South China. Based on the results, this work additionally proposes variations of the sizes of the oceanic carbon reservoirs by a calculation of the carbon cycle model at the Pc/C boundary. The Three Gorges section extends from the uppermost Ediacaran dolostone (Dengying Formation), through the lowermost Early Cambrian muddy limestone (Yanjiahe Formation) to the middle Early Cambrian calcareous black shale (Shuijingtuo Formation). The δ13Corg values exhibit relatively invariant values averaging at -31 permil. By comparison between the d13Ccarb and d13Corg, we recognize two different terms in this period. The first term from the Pc/C boundary to the early Nemakit-Daldynian (ND) is characterized by the decoupling of d13Corg and d13Ccarb, stable d13Corg and the significant negative excursion of d13Ccarb, which could be explained by the carbon cycle with two reactive pools of inorganic and organic carbon, distinguished in the Neoproterozoic (Rothman et al., 2003; Fike et al., 2006; McFadden et al., 2008). The second term from the middle ND to Atdabanian is distinctive in parallel variation between the d13Ccarb and d13Corg, consistent with the conventional, steady-state models of the carbon cycle. We consider that the d13Corg of the carbon in an unusually large oceanic reservoir of organic carbon would not be driven by the variation of input and output fluxes because the residence time of such a large DOC reservoir could be longer than that of the inorganic carbon reservoir. We calculated masses of two reactive carbon reservoirs in the ocean, when the d13Ccarb varies from the terminal Neoproterozoic to the early Cambrian. According to the calculation, we suggest the significant negative d13Ccarb anomaly across the Pc/C boundary results from the increased remineralization of a large reservoir of organic carbon. Also we propose the two step increase of d13Ccarb in the early ND is derived from the two step increase in the sinking rate of organic particles. We interpret the large reservoir of organic carbon had dramatically declined in the late period of ND. In addition, we have estimated the fraction of buried organic carbon in the middle ND to Atdabanian, and found that the organic carbon burial was enhanced in the late ND, and then it increased from Tommotian to Atdabanian after a temporal reduction in basal-Tommotian. Hence, it implies the lowering of pCO2 and the subsequent global cooling in the late ND. This possibly caused the global-scale regression in the basal-Tommotian (Ripperdan, 1994), and led to the low organic carbon burial in the early Tommotian.