

Carbon and Oxygen isotope chemostratigraphy of the upper Early Cambrian section, Three Gorges area, South China

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Many paleontological studies show that animals drastically evolved through the Atdabanian to Toyonian stages in the late Early Cambrian, called as 'Cambrian Explosion' (e.g. Conway Morris, 2000; Babcock and Peng., 2007; Shu, 2008). On the other hand, the oceanic environment during this animal evolution has been still obscure. In particular, the elucidation of secular change of carbonate carbon isotope ratio ($\delta^{13}\text{C}_{\text{carb}}$), a proxy for the dissolved inorganic carbon in the ocean, is important to estimate the oceanic environmental change, but the estimate is still controversial.

The $\delta^{13}\text{C}_{\text{carb}}$ from the Atdabanian to Toyonian stage in the late Early Cambrian has been reported in several sections; Siberia (Brasier and Sukhov, 1998), Morocco (Maloof et al., 2005), and Canada (Dilliard et al., 2005). However, those data in the Morocco and Canada cover only a part of those stages. On the other hand, the $\delta^{13}\text{C}_{\text{carb}}$ reported in Siberia covers through the Atdabanian to Toyonian and shows two positive excursions in the Botomian stage and negative one in the latest Early Cambrian (Brasier and Sukhov, 1998). Those positive excursions are thought to correspond to increasing appearance of Archaeocyathids and that the negative one can be accounted for by the mass extinction of Archaeocyathids in Siberia section (Brasier and Sukhov, 1998). Those excursions are seemed to be distinctive $\delta^{13}\text{C}_{\text{carb}}$ variations and are named as CARE, MICE, and AECE, respectively (Zhu et al., 2006). However, it has still not confirmed that those excursions are observed in any section through the Atdabanian to Toyonian stages in the world.

In this study, we have performed scientific drilling of the Early Cambrian sections in the Three Gorge area, South China. This section covers the Early Cambrian black shale (Shuijingtuo Fm.), alteration of black limestone and black shale (Shipai Fm.), and muddy black limestone (Tienheipan Fm.) in ascending order. According to paleontological study of Zhu et al (2003), trilobites, corresponding to Atdabanian stage, appear at the upper part of the Shuijingtuo Formation (Zhu et al, 2003). And also, the Shipai and Tienheipan Fms. are generally expected to correspond to the Botomian stage.

And also, we conducted carbonate carbon and oxygen isotope analyses of the drill core, sampled on intervals about 1m. As a result, we found one negative carbon isotope excursion through this section. The $\delta^{13}\text{C}_{\text{carb}}$ starts decreasing gradually from +1 permil in the upper Shuijingtuo Fm., and the $\delta^{13}\text{C}_{\text{carb}}$ continuously drops down to -12 permil in the middle Shipai Fm. Subsequently, the $\delta^{13}\text{C}_{\text{carb}}$ continuously increases up to about +2 permil through the upper Shipai Fm. to the lower Tienheipan Fm. These continuous changes of the $\delta^{13}\text{C}_{\text{carb}}$ profile and lack of positive correlation between carbon and oxygen isotope ratios both strongly suggest that the $\delta^{13}\text{C}_{\text{carb}}$ preserves the primary isotopic composition, probably reflecting seawater chemistry at that time. We cannot find positive $\delta^{13}\text{C}_{\text{carb}}$ excursions corresponding to CARE and MICE in South China. However, the large negative excursion in this study can be correlated to the negative drop, AECE, in the latest Early Cambrian in Siberia. The extremely negative value of -12 permil shows that the environmental change, which triggered the extinction of Archaeocyathids in Siberia, occurred also

in China, and it might have been major in the world.

Keywords: Early Cambrian, carbon isotope ratio, oxygen isotope ratio, chemostratigraphy