

Stable nitrogen chemostratigraphy from the Ediacaran to early Cambrian

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Secular change of organic nitrogen isotope ratio from the Ediacaran to early Cambrian and implication for transition of a limiting nutrient.

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The Ediacaran is one of the most important periods in the history of evolving life when multicellular animals firstly appeared on Earth. However, it is still unclear what caused the emergence of the animals and biological evolution at that time.

Nitrogen is one of the essential elements of life and the limiting nutrients, which include nitrogen, phosphorus, silica and iron at present. Therefore, reconstruction of past nitrogen cycle from the Ediacaran to early Cambrian is important to understand bioactivity and biological evolution at the time, though data of nitrogen isotopic ratio of organic matters in the Ediacaran to Cambrian still lacks. This work presents the nitrogen isotope ratios of drill core samples from the Ediacaran to the early Cambrian in order to estimate transition of seawater nutrients in the Ediacaran to Cambrian.

It is well known that the Three Gorges area section in South China still preserves fresh and continuous strata from the Ediacaran to Cambrian. We collected drill core samples from the latest Cryogenian Nantuo tillite through Doushantuo and Dengying Formations (Fms) in the Ediacaran to the early Cambrian Yanjiahe and Shuijingtuo Fms in ascending order (e.g. Ishikawa et al., 2008; Sawaki et al., 2010). We analyzed nitrogen and carbon isotope ratios of organic matters of black shale, limestone and dolostone in the drill core sample from the Doushantuo to the Shuijingtuo Fms with EA-IRMS at JAMSTEC.

The $\delta^{15}\text{N}$ values are scattered around +6 permil in the lower and middle Doushantuo Fm., and they gradually decrease from ca. +6 permil in the upper Doushantuo Fm through ca. 1 permil in the lower Yanjiahe Fm and 0 permil around the Yanjiahe/Shuijingtuo boundary to -1 permil in the middle Shuijingtuo Fm. On the other hand, $\delta^{13}\text{C}_{\text{org}}$ values are settled around -30 permil in the lower and middle Doushantuo Fm, and fall to -38.7 permil just below the Doushantuo/Dengying Fm boundary. They rise back to ca. -30 permil in the Dengying Fm, and stay around -30 permil to the Shuijingtuo Fm. The correlation between $\delta^{15}\text{N}$ and $\delta^{13}\text{C}_{\text{org}}$ values is obscure.

Phosphorus and/or nitrate are the most severe limiting nutrients at present. In Northern Pacific and southern Indian Ocean where nitrate is abundant, organic matters have low $\delta^{15}\text{N}$ values whereas they show high $\delta^{15}\text{N}$ values in nutrient-poor equatorial Pacific because isotope fractionation during the assimilation decreases with decrease of nitrate content. The decrease in the $\delta^{15}\text{N}$ value from the upper Doushantuo to Shuijingtuo Fm suggests that the nitrate content increased in the late Ediacaran, possibly concomitant to decrease in phosphorus content (Komiya

et al., 2009). The correlation implies that decrease in phosphorus and increase in nitrate content, possibly because of oxygenation of seawater, switched the most limiting nutrient from nitrate to phosphorus.

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