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南中国エディアカラ紀の炭酸塩炭素・酸素同位体比と有機炭素同位体比分析

The $\delta^{13}\text{C}_{\text{carb}}$, $\delta^{13}\text{C}_{\text{org}}$ and $\delta^{18}\text{O}_{\text{carb}}$ profiles of the Ediacaran carbonate rocks in South China

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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 the earth. However, it is still ambiguous the relationship among the abrupt biological evolution and climatic change. We analyzed carbon and oxygen isotopes of ca.400 samples of carbonate and organic carbon isotope of ca.100 samples from drill cores at Three Gorge area, South China. The $\delta^{13}\text{C}$ profile of carbonate displays five negative anomalies. And the $\delta^{13}\text{C}$ profile of organic matters displays almost constant value. The oxygen isotopes display very high $\delta^{18}\text{O}$ values around 0 permil in the early Ediacaran. We compared the $\delta^{13}\text{C}_{\text{carb}}$ profile with fragmented $\delta^{13}\text{C}_{\text{carb}}$ profiles in other sections such as Siberia, Australia and Oman in the world. The $\delta^{13}\text{C}_{\text{carb}}$ profile of this work possesses all of the anomalies in other sections. The consistency indicates that the $\delta^{13}\text{C}_{\text{carb}}$ of this work represents the global oceanic $\delta^{13}\text{C}_{\text{carb}}$ change in the Ediacaran. The lack of correlation between $\delta^{13}\text{C}_{\text{carb}}$ and $\delta^{13}\text{C}_{\text{org}}$ can be explained by three different ideas. One is the shutdown of primary production. In this case, the carbonate and organic carbons were supplied from only riverine or atmosphere. However, the presence of algae fossils through the Ediacaran and no correlation of total organic carbon contents with their carbon isotope values are inconsistent with the idea. Second is the fractionation factor between inorganic and organic carbon during the primary production changed completely synchronous to the change of inorganic carbon isotopes. However, the quite large variation in the calculated fractionation factor requires the biological shifting synchronous to the $\delta^{13}\text{C}_{\text{carb}}$ change. It is possibly unrealistic. Third is the presence of quite large dissolved organic carbon reservoir, which conceals the concomitant $\delta^{13}\text{C}_{\text{carb}}$ change with the $\delta^{13}\text{C}_{\text{org}}$ change. General speaking, the DOC reservoir is always smaller than dissolved inorganic carbon reservoir in carbon cycle of the Phanerozoic ocean. The presence of much larger DOC reservoir than the DIC reservoir is one of the most distinct features between the carbon cycles in the Ediacaran and Phanerozoic. The negative excursion of $\delta^{13}\text{C}_{\text{carb}}$ is caused by extensive remineralization of the DOC (Fike et al., 2006). Post-depositional alteration causes the $\delta^{18}\text{O}$ value to decrease because interstitial water commonly has low $\delta^{18}\text{O}$ value and the recrystallization proceeds under the warmer condition than the deposition. In addition, the interstitial water commonly has low $\delta^{13}\text{C}$ values. Therefore, the secondary alteration usually causes decrease in both oxygen and carbon isotopes. Anticorrelation between $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ is obvious and ubiquitous in the lower Doushantuo

Formation. The occurrence of anticorrelation and their high $\delta^{18}\text{O}$ values suggests the carbonates of drill core samples still preserve the primary signature of even the oxygen isotopes. In the case, the high $\delta^{18}\text{O}$ values indicate that surface temperature was relatively low in the early Ediacaran. Especially, there is a relatively large positive excursion of $\delta^{18}\text{O}$, together with quite large negative excursion of $\delta^{13}\text{C}$ and geological evidence for eustatic sea-level falling in the middle Doushantuo Formation. The presence of positive excursion of $\delta^{18}\text{O}$ and eustatic sea-level falling indicates the global cooling in the middle Ediacaran. This cooling event possibly corresponds to the 580 Ma Gaskiers glaciation, which is the most severe glaciation in the Ediacaran. On the other hand, the $\delta^{18}\text{O}$ in the upper Doushantuo Formation, with a large negative excursion of $\delta^{13}\text{C}$ (Shuram excursion), shows negative excursion. In addition, geological evidence lacks during the Shuram excursion, which does not support a glaciation-related event, and requires another cause.

Keywords: $\delta^{13}\text{C}_{\text{carb}}$, $\delta^{13}\text{C}_{\text{org}}$, $\delta^{18}\text{O}_{\text{carb}}$, Ediacaran, Climatic change, carbon cycle