

The demise of the positive carbon isotope excursion in the Paleoproterozoic Francevillian Basins, Gabon

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In the history of the carbon cycle on the Earth, ~2.2-2.1 Ga was an unprecedented interval with positive $\delta^{13}\text{C}_{\text{carb}}$ (>5‰) recorded in carbonate rocks all over the world (Martin et al., 2013). It is called the Lomagundi-Jatuli event (LJE) and interpreted as the result of high rate of organic-carbon burial in the same period (Karhu & Holland, 1996); however, how it ended still remains unexplained. The Paleoproterozoic sedimentary sequence of the Francevillian basins in Gabon has a negative shift of $\delta^{13}\text{C}_{\text{org}}$ (Gauthier-Lafaye & Weber, 2003), which is assumed to correspond to the end of the LJE (Kump et al., 2011). In addition, it also has fossil horizons of possible eukaryotes (Albani et al., 2010) or large colonial organisms (Edou-Minko et al., 2017). Thus, the Francevillian basins are the key to clarify the relation between the changes of ecosystem and carbon cycle of the period; however, $\delta^{13}\text{C}_{\text{carb}}$ stratigraphy has not been well established because carbonate rocks are minor in the main Franceville basin. We focused on the neighboring Lastoursville basin, which has carbonate-rich facies, and investigated the detailed $\delta^{13}\text{C}_{\text{carb}}$ stratigraphy. The Paleoproterozoic sequence in the Lastoursville basin consists of FA (sandstones; >30 m), FB (carbonates and mudstones; ~200 m), FC (cherts; ~10 m), and FD (mudstones and carbonates; >80 m) formations in ascending order. We analyzed $\delta^{13}\text{C}_{\text{carb}}$ and $\delta^{13}\text{C}_{\text{org}}$ of the samples (carbonates and mudstones in FB-FD) obtained from the outcrops and the drill cores. As a result, we identified the negative shift of $\delta^{13}\text{C}_{\text{carb}}$ from +5‰ to -2‰ in the middle of the FB formation as the demise of the stable positive excursion (+5‰~+8‰). At the same interval, the carbon isotope fractionation ($\Delta = \delta^{13}\text{C}_{\text{carb}} - \delta^{13}\text{C}_{\text{org}}$), changed from ~30‰ in the lower FB, suggesting carbon fixation by the Calvin cycle, to ~45‰ in middle FB, suggesting methanotrophic activity. By the stratigraphic correlation with the Franceville basin, the $\delta^{13}\text{C}_{\text{carb}}$ negative shift apparently underlies the fossil horizons at the uppermost FB. It means that the major change in the carbon cycle preceded the appearance of the macroscopic organisms in the Francevillian basins.

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