Carbon isotope composition of seawater in the aftermath of the Lomagundi carbon isotope excursion

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It has generally been accepted that $\delta^{13}C$ values of seawater returned to 0‰ in the aftermath of the ~2.22-2.06 Ga Lomagundi carbon isotope excursion (LCIE). The end of the LCIE has been constrained by high-precision ages in Fennoscandia and South Africa between ~2.11 and 2.06 Ga. Recently published chemostratigraphic data for the ~2.03 Ga Wooly Dolomite of Western Australia suggest a short-lived, high-amplitude carbon isotope excursion in the aftermath of the LCIE (Bekker et al., 2016). The age-equivalent Gumbu Group of South Africa carries a similar $\delta^{13}C$ signature (Buick et al., 2003), supporting global extent for this anomaly.

The Paleoproterozoic Union Group of the SE Slave Craton, NW Canada consists of: a) the lower dolostone unit with C isotope values up to +9.5‰; b) black shale unit; c) lower basalt unit dated at 2045.8 ± 1.0 Ma (Sheen et al., 2018); d) the upper dolostone unit with near-zero $\delta^{13}C$ values grading to the upper basalt unit; and e) red and green mudstone unit. Geochronologic data require that the lower dolostone unit is not correlative to and is older than the Wooly Dolomite, whereas field observations provide no evidence for a significant time gap between deposition of the lower dolostone and lower basalt units. The lower dolostone unit has highly negative and stratigraphically variable $\delta^{13}C_{org}$ values, resulting in fractionation between organic and carbonate carbon as large as 50‰. Fractionation between organic and carbonate carbon is much smaller for the upper dolostone unit and around 30‰. While organic matter from the lower dolostone unit indicates methane cycling, stratigraphically invariable carbonate $\delta^{13}C$ values suggest that they record basinal and, likely, global seawater composition in the aftermath of the LCIE and before the Wooly Dolomite excursion.

Combined with the literature data, the Union Island Group carbonates record a dynamic state of the carbon cycle with multiple short-lived, high-amplitude carbon isotope excursions in the aftermath of the LCIE and before ~2.0 Ga, reflecting a transitional stage to the Boring Billion. The redox state of the atmosphere-ocean system likely also fluctuated during this transitional stage. Whatever processes were that caused and ended the LCIE, they repeated themselves several times before the carbon cycle reached a new steady-state that continued for the following billion years.