Carbon cycle anomalies and black shale deposition in the Lower Cambrian Strata, eastern Tarim Basin, China

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During the Lower Cambrian, the Tarim plate was a small, isolated craton located near the equator. It was independent from the Australian and Indian sector of the Gondwana Supercontinent and was surrounded by deep oceanic basins. The Xishanbulaq Formation of the base of Lower Cambrian was a dark or black shale, and evolved gradually upward into micritic limestone, dolomite or other carbonate rocks. The black shale with lots of pyrite and radiolarian cherts and an average TOC of about 4.0%, was considered to be one of the main hydrocarbon source rocks in the Tarim Basin.

However, the carbon cycle of this section displayed great anomalies. From the end of Ediacaran to the Lower Cambrian, $\delta^{13}C_{carb}$ exhibited frequent oscillations, and the biggest negative excursion of $\delta^{13}C_{carb}$ (~ -8.0‰) was near the PC/C boundary with a sharply decreases down to -7.8‰ from 0.2‰. Oxygen isotopes also showed to be covariant from -4.8‰ to -17.0‰, and the maximum negative excursion was -12.2‰ near the PC/C boundary. The highest organic carbon contents could reach 10%, corresponding to the negative peaks of $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ in the black shale. This large negative excursion associated with the base of the Cambrian System also have been recognized in South China, Siberia, Laurentia, West Africa, Mongolia and West Asia , named with BAsal Cambrian Carbon isotope Excursion (BACE). Here, this is the first record of BACE from the Tarim plate.

The diamictit in the underlying Hankalchough Formation indicated a warming interglacial epoch in the lower Cambrian, with high atmospheric CO_2 during BACE. Episodes of high burial ratio of organic materials and long-term duration of $\delta^{13}C_{carb}$ in negative regions required additional huge ^{13}C-depleted carbon input to offset the buried organic materials. Thus, anomalous negative $\delta^{13}C_{carb}$ in organic-rich shales at the peak of BACE were considered to be derived from a huge influx of isotopic light carbon into the ocean-atmosphere system over a short period. Possible source contained volcanic and/or organic fluxes of CO_2, methane and/or DOC due to the overturn of a stratified ocean.