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# A new carbonate carbon and uranium isotope record of the Early Mississippian TICE event from the Williston Basin, North America

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The Early Mississippian witnessed one of the largest positive $d^{13}C$ excursions of the Phanerozoic, known as the TICE event. In carbonate platform sections from North America, Europe, and China, $d^{13}C$ values rise to a maximum of +5 to +7‰ before falling back to values near 0‰, consistent with a major perturbation to the global carbon cycle. Little is known, however, about the expression of the TICE event in restricted epeiric seas, such as those that flooded the interior of North America. In addition, the cause of the anomaly remains uncertain, with some studies invoking the expansion of marine anoxia that drove enhanced organic carbon burial, although black shales that record anoxia are abundant prior to, but not during, the TICE event. Here, we present a new Lower Mississippian carbonate $d^{13}C$ record from the Williston Basin (North Dakota), with limestone accumulating in a restricted epeiric sea. A fabric-specific $d^{13}C$ curve generated from four drill cores that intersect the Lodgepole Limestone clearly reveals the presence of the TICE event, with $d^{13}C$ values rapidly rising from 0 to ~+5‰, reaching a prolonged plateau >+8‰, and then systematically falling back to ~+2‰. In addition, we investigated carbonate $d^{238}U$ values as a proxy for global ocean redox conditions during deposition of the Lodgepole Limestone. In our composite section, $d^{238}U$ values begin near −0.2‰ and then rapidly decline to a nadir of ~−0.8‰ in the initial stages of the TICE event. Interestingly, $d^{238}U$ values then rapidly recover to near-modern carbonate values and remain unchanged for the remainder of the section despite the TICE event continuing and $d^{13}C$ persisting at >+8‰. This $d^{238}U$ pattern is nearly identical to the TICE event previously reported from an open ocean section in Nevada. We suggest that highly productive and/or euxinic anoxia rapidly spread in the oceans at the onset of the TICE event, thus driving strong $^{238}U$ removal from seawater and very low carbonate $d^{238}U$ values. This was rapidly followed, however, by a shift to less productive, non-euxinic anoxia or suboxia that led to less $d^{238}U$ fractionation, but still promoted sufficient organic carbon burial to drive strongly positive $d^{13}C$ values.