Sedimentological constraints on the Bitter Springs delta13C Anomaly

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Large magnitude (>10‰) carbon isotope (δ13C) excursions in carbonate-bearing sediments of Neoproterozoic age increasingly constrain the chronology of the Neoproterozoic stratigraphic record and have significant implications for our understanding of the evolution of the Precambrian biosphere. The ~825 Ma ‘Bitter Springs Anomaly’ (BSA) is an interval of δ13C variability to depleted (-4‰) values from enriched (+5‰) values and is considered a robust stratigraphic marker and an indicator of carbon cycle perturbations that preceded the severe ice-ages of the Cryogenian. We present paired sedimentological and stable isotopic (δ13C and δ18O) data to show that the isotopic variability that defines the BSA is facies-dependent and its defining features rely on end-member paleoenvironments. The inflection points from enriched (+5‰) to depleted (-4‰) δ13C values that define the excursion occur systematically with major facies changes between evaporative lacustrine environments and deeper-water microbial and grainstone carbonates respectively. A first-order relationship between δ13C and δ18O (R²=0.75) across the facies changes indicates proportional end-member mixing along these changing environments. This coupling of isotopic values and sediment composition indicates that local modification of δ13C in basin waters controls δ13C variability and that these excursions are not representative of whole-ocean chemistry. This association would also satisfy δ13Corg values shown to vary sympathetically with δ13C. Thus, our findings illustrate that some features of composite δ13C records derived from Precambrian strata may be relics of isolated water-bodies as they respond to local hydrology and base-level. The anomalous δ13C features in this part of the record may be analogous to similar excursions throughout the better-constrained Phanerozoic record that are evidently the function of local basinal conditions. This suggests that some Neoproterozoic excursions exhibit limited constraint on the function of Earth’s biosphere through time.