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Phase- and facies-specific carbon, clumped, and calcium isotopes of the Kinderhookian-Osagean Boundary Excursion

NOAH T ANDERSON[1], MATTHEW BRAUN[2], ELIZABETH M. GRIFFITH[3], MATTHEW R SALTZMAN[2] AND KRISTIN BERGMANN[1]

[1]Massachusetts Institute of Technology
[2]Ohio State University
[3]The Ohio State University
Presenting Author: nanderso@mit.edu

The Kinderhookian-Osagean Boundary Excursion (KOBE) is one of the largest positive carbon isotope excursions in the Phanerozoic. Possible end-member interpretations of these and other Paleozoic positive carbon isotope excursions include burial diagenesis, meteoric diagenesis associated with global sea level fall, phase-specific isotope effects, local to platform-scale variations in the $\delta^{13}C$ of DIC, or increased carbon burial. Exceptionally preserved carbonates from the Early Mississippian Gilmore City Formation in north-central Iowa provide an opportunity to integrate facies analyses, petrography, and geochemistry of the excursion interval.

The top several meters of both cores exhibit depleted $\delta^{13}C$, fluid $\delta^{18}O$, and $\delta^{44/40}Ca$ compositions, elevated manganese concentrations, and vertical calcite-filled fractures, all consistent with meteoric diagenesis. Below this, however, mineral $\delta^{18}O$ does not increase alongside changes in D_{47}, evincing sediment-buffered diagenesis in lower portions of the core. Low clumped isotope (D_{47}) temperatures (median = 32°C), seawater-like fluid $\delta^{18}O$ values (median = -1.3‰), and preservation of original carbonate fabrics at the petrographic scale all suggest that carbonates faithfully record the onset and main phase of the KOBE. TD_{47} and $\delta^{18}O$ data from sediment-buffered intervals show 3–5°C cooling associated with the positive $\delta^{13}C$ excursion of ~3 ‰ in these sections.

We do not observe a strong dependence of $\delta^{13}C$ composition on facies in our measured sections. The peloidal to fossiliferous grainstone facies that carries the peak of the KOBE is also present above and below the excursion; algal cortoids are present at the peak of the excursion (~6‰) as well as on the falling limb (~3‰). Trends in $\delta^{13}C$ persist across parasequence boundaries with only minor shifts, indicating a subordinate role for facies changes in the overall excursion.

Phase-specific isotope analyses of crinoid ossicles, most abundant during the excursion peak, show a median +0.8‰ $\delta^{13}C$ offset (maximum +1.7‰) from coeval bulk carbonate. Point-counting of thin sections shows that crinoids comprise no more than 60% of fossiliferous grainstones; thus, we estimate the maximum effect of elevated crinoid $\delta^{13}C$ to be ~0.5‰. Preliminary measurements of crinoids, rugose corals, and brachiopods tend to have cooler D_{47} temperatures and limited to no $\delta^{44/40}Ca$ offset compared to nearby bulk carbonate.