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Localized recycling or basin scale forcing? Carbon storage in Tournaisian carbonate mud mounds

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Earth's climate is regulated by the long-term balance between inputs and outputs within the global carbon cycle. Global carbon perturbations in deep time provide natural test cases for assessing how carbon outputs in the Earth System respond to perturbations. Importantly, evaluating how carbon storage changed during these transitions and whether change was driven by localized conditions or broader basin-scale forcing offers critical insight into carbon–climate feedbacks through time.

The Tournaisian stage of the Early Carboniferous provides an opportunity to address this problem. During the Tournaisian, Waulsortian carbonate mud mounds developed across Laurentia. These framework poor large micritic buildups, tens of meters of relief, are interpreted as products of microbially mediated carbonate precipitation. Their development in the Tournaisian places them within the biostratigraphic interval characterized by the Tournaisian Carbon Isotope Excursion (TICE; ~355 Ma), a globally recognized +6–7‰ shift in $\delta^{13}C_{carb}$. This sustained excursion is interpreted as signaling enhanced organic carbon burial and expanded marine anoxia. The temporal association between mound development and the TICE raises a key question: did these mounds form through localized phenomena, or were they responding to broader basin-scale changes recorded in the marine carbon isotope record?

To evaluate this relationship, we investigate a biostratigraphically constrained section in the Funeral Mountains of California, where mound development is stratigraphically confined to the rising limb of the TICE. We present paired carbonate ($\delta^{13}C_{carb}$) and organic carbon ($\delta^{13}C_{org}$) isotope data together with total organic carbon (TOC) measurements collected along parallel mound core and adjacent non-mound transects spanning the TICE interval. Carbon isotope offsets ($\Delta^{13}C = \delta^{13}C_{carb} - \delta^{13}C_{org}$) provide a framework for distinguishing open-marine buffering from localized recycling. Consistent $\Delta^{13}C$ values (~25–30‰) and parallel isotopic trends across facies would indicate precipitation from a shared dissolved inorganic carbon reservoir and support basin-scale influence on mound growth. In contrast, elevated $\Delta^{13}C$ or facies-dependent decoupling would suggest enhanced local organic matter recycling and microbially mediated carbon burial. By resolving whether Waulsortian mounds reflect localized carbon recycling or broader basin-scale forcing, this study advances our understanding of how marine carbon storage responds to major carbon isotope perturbations.