Using $\delta^{13}C_{carb}$ and $\delta^{34}S$ as indicators of diagenesis in an interbedded shale and carbonate system

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The climatic shifts during the Late Paleozoic Ice Age resulted in a series of high-frequency, high-amplitude sea level fluctuations. The resulting cyclothems, i.e. rhythmic deposition of interbedded shales and carbonates, allow for the potential reconstruction of both primary carbon preservation and later diagenesis.

This study utilizes $\delta^{13}C_{carb}$ and $\delta^{34}S$ records from two cores within the Midland Basin of West Texas to consider the interplay between organic matter preservation and destruction. We explore the relationships between mudstone facies, basinal location, and degree of diagenetic alteration through isotopic and petrographic analysis. In particular, we will look for isotopic evidence of sulfate reduction. During sulfate reduction, the consumption of organic matter generates bicarbonate and hydrogen sulfide, leading to the eventual precipitation of carbonate and pyrite. As sulfate reduction progresses, the available sulfur pool becomes more isotopically positive while the dissolved inorganic carbon becomes more isotopically negative.

The measured bulk $\delta^{13}C_{carb}$ values in these cores are predominantly in the range of only limited secondary alteration. These $\delta^{13}C_{carb}$ values exhibit cyclicity similar to other time-correlative basins, potentially capturing a global carbon signal. However, infrequent horizons exist with more isotopically negative $\delta^{13}C_{carb}$ and isotopically positive $\delta^{34}S$, consistent with extensive sulfate reduction. These diagenetically-influenced horizons are more prevalent in the distal core, though are not clearly associated with a particular facies or productivity indicator. We will compare the petrography and other geochemical indicators between the two cores to identify potential factors making sulfate reduction favorable. Overall, the combination of isotopic and petrographic analysis to identify sulfate reduction-driven diagenesis allows for greater confidence of primary signals, allowing these records as placed in a global context.