Internal wave OMZ nutrient model for cyclical facies shoaling from cross bedded glauconitic sand to thrombolytic bank, Cambrian Trempealeau Formation, Huron County, Ohio

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The factors responsible for prolific carbonate and organic productivity of ancient carbonate banks such as those in the Cambrian of the Great American Carbonate Bank are poorly understood because of the disparities and poor understanding of Cambrian relative to modern organisms and ecosystems. A nutrient model independent of the biology of the organisms that relies on time independent oceanic processes and produces bedforms and minerals indicative of those processes sheds light on a data set from the subsurface of the Cambrian Trempealeau Formation in Ohio. Core from the Conroy Well #2, in Huron County, Ohio, penetrates the Knox Unconformity and dolostones and siltstones of the "B-zone" of the Trempealeau Formation. Six lithofacies are identified, incuding: 1) cross laminated glauconite rich dolomitic quartz siltstone; 2) cross laminated dolomitic quartz siltstone; 3) dolorudstone; 4) silty, burrowed dolomudstone; 5) thrombolitic dolomudstone; and 6) stromatolitic dolomudstone. Eight shallowing upward cycles separated by minor erosional surfaces are documented. The lower portions of cycles are dominated by glauconitic and cross laminated facies and the upper portions are dominated by microbial carbonate facies. Rudstones tend to be between the cross bedded glauconitic facies and the microbial facies. The deeper, cross laminated facies had previously been interpreted as hummocky cross stratified storm deposits.

In light of new information from Mississippian and Permian models of carbonate settings that incorporate physical oceanographic processes and nutrient pathways observed in modern oceans, evidence indicates productivity was enabled by the contribution of upwelling caused by internal wave mixing of nutrients from an oxygen minimum zone (OMZ). The cross bedded glauconite sand in the deepest facies is similar to that observed associated with pycnocline and OMZ processes in modern oceans, such as seen on the Peru Shelf, and as has been proposed for Mississippian mudmounds and the Permian Reef. The precipitation and accumulation of glauconite at the base of the OMZ in this model is the product of dysoxia produced by sinking organic matter in the water column stalling and decomposing at the pycnocline. Leaching and dissolution of iron within the OMZ results in free ions that are available for glauconite precipitation and replacement. The cross bedding in this example are produced by Internal waves and tides along pycnoclines that are similar in size and form to sand waves documented in modern oceans such as in the Mediterranean and the South China Sea. Mixing of the nutrient rich waters of the OMZ by internal waves and tides results in upwelling of nutrient and carbonate rich waters onto the shallower bank, contributing to carbonate and organic productivity. Rising, warming, depressurizing alkaline waters results in ample amounts of carbonate available for skeletal organisms, coatings, precipitation, and cementation. The bank, thus prograded over its rudstone flank or fore-bank deposits, filling accommodation prior to the next flooding event. The erosional

surface at the base of the next cycle may be formed by exposure, transgression, and/or wave erosion by internal waves at the pycnocline.