Neodymium and oxygen isotopic constraints on Upper Ordovician paleoceanographic evolution across the Dubuque/Maquoketa contact in NE Iowa and SE Minnesota

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ABSTRACT

Measurements of conodonts, phosphatic brachiopods, and authigenic phosphate show no consistent trends in $\delta^{18}O_{phos}$ values but do show a gradual 2-3 unit ε_{Nd} increase across the Dubuque/Maquoketa contact in NE Iowa and SE Minnesota. The lithologic transition between the limestone-rich Dubuque Formation, and the shalely Maquoketa Formation is often marked by a phosphatic hardground. Interpretations from previous studies have suggested that the phosphate was deposited during a time of upwelling of cool, nutrient rich, and oxygen poor water; the longer term shift from Dubuque Formation to the Maquoketa Formation is interpreted as the lithologic expression of a transgressive-regressive subsequence. The relative importance of climatic and circulation changes across the contact was tested along a north-south transect at three locations in IA and MN. Temperature trends were estimated using $\delta^{18}O_{phos}$, and the potential source region(s) of local waters were estimated using ε_{Nd}.

Conodont $\delta^{18}O_{phos}$ paleothermometry was done with conodont separates from samples with high enough conodont abundances ($\leq$250 µm/sample) to yield sufficient Ag_3PO_4 for mass spectrometry analysis. To minimize potential

artifacts from inter-species variability, species-specific separates were run for all conodont samples when possible. In addition, mixed separates, inarticulate brachiopods and authigenic phosphate were analyzed in selected samples to increase the number of temperature estimates and to assess the direction and possible magnitude of diagenetic overprinting. To determine if circulation fluctuated over the formational contact, ε_{Nd} values from the phosphatic inarticulate brachiopod, *Leptobolus* were measured. A shift in $\varepsilon_{Nd(t)}$ values would indicate changes in the source regions or in the mixing patterns of water mass(es) in the region.

The $\delta^{18}O_{phos}$ results do not support past models that have invoked upwelling of cool nutrient rich water and/or a transgressive event flooding the carbonate ramp with cool open ocean water as partially responsible for the change in lithologies seen in the Dubuque and Maquoketa Formations, but there is a consistent offset of ~1‰ between the conodonts *Drepanoistodus suberectus* and *Panderodus gracilis*. In addition, ε_{Nd} values from the Dubuque Fm. range from -8.6 to -6.5 and they increase to -5.8 to -4.8 in the overlying Maquoketa Fm. Our results are consistent with a paleoceanographic model influenced by sea level rise. The Dubuque and Maquoketa Formations represent a transgressive-regressive sub cycle with highstand occurring at the contact between the two formations. During the transgression, fresh-water runoff from the Taconic highlands and an easterly wind could have generated a quasi-estuarine gyre that resulted in surface currents flowing basinward and out of the epeiric sea while cool ocean water flowed into the epeiric sea through the Sebree Trough. The

incursion of ocean water and/or runoff from the Taconic highlands is documented by increasing ε_{Nd}. This interpretation and the apparent lack of temperature change suggest that the Dubuque/Maquoketa transition is best interpreted as being forced by circulation patterns, rather than cooling from a climatic event.