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Multi-proxy Approach to Understanding the Initiation and Termination of OAE II

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Cretaceous oceanic anoxic events (OAE's) have long been targeted for paleoenvironmental study because they reflect large scale changes in the coupled ocean-atmosphere carbon cycle that are rapid in onset and short in duration. As a result, they hold great promise for illuminating the controls on abrupt and short-term oceanographic and climatic change. Despite 25 years of focused research, however, we remain ignorant of the specific mechanisms that initiate and terminate organic carbon burial at scales sufficient to cause OAE's. For example, there is preliminary evidence suggesting that a perturbation in nutrient cycling occurred in the marine realm during the Cenomanian-Turonian OAE II and may have driven enhanced production resulting in widespread oxygen deficiency, but no clear idea of what initiated and terminated this perturbation has emerged. Similarly, although it has long been speculated that carbon burial during OAE II was of sufficient magnitude to draw down atmospheric CO_2 levels, there have been no direct proxy measurements of changes in pCO_2 across the event. It has also been suggested, based on oxygen isotopic analyses of marine microfossils, that global temperatures rose to maximum levels through the Late Cenomanian just prior to OAE II. The most common hypothesis proposed to account for such increases in temperature invokes higher rates of volcanic out-gassing of CO_2, yet pCO2 proxy data from terrestrial sources that are consistent with this conclusion have yet to be collected.

This study seeks to address these deficiencies by linking the marine and terrestrial records of OAE II and by applying a multi-proxy approach to the reconstruction of environmental changes during the event. In an effort to assess changes in nutrient cycling we have employed the SEDEX method to identify separate phases of phos-

phorus (P) in samples from a hemipelagic site within the Western Interior basin of North America. To evaluate changes in atmospheric pCO_2, the stomatal index method was applied to fossil plant cuticle from a time equivalent paralic site. The data indicate that increases in pCO_2 during the pre-OAE II interval correspond to increased burial fluxes of detrital and authigenic P. This suggests that enhanced chemical weathering due to global warming may have increased the P flux to oceans and possibly contributed to initiation of enhanced organic matter production during the Late Cenomanian. However, the onset of OAE II, as indicated by the distinctive positive carbon isotope excursion, coincides with a major decrease in the burial flux of authigenic P, indicating that P was efficiently recycled in the marine system during the event. Following the isotope excursion rates of P burial rose significantly, indicating that a major decrease in P recycling coincided with the termination of OAE II. Based on analysis of coeval trends in the burial of iron (Fe) phases we propose that reactive Fe in pore and bottom waters may have played a role in the burial and/or recycling of P, and thus acted as an important control on the evolution of OAE II.