Production and Preservation in the Cretaceous Western Interior Sea

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The burial of organic carbon in sediments constitutes a transfer of carbon from the oxidized atmospheric reservoir (CO_2) to the reduced lithospheric reservoir (CH_2O), and functions as an important control on atmospheric carbon dioxide and oxygen levels over geologic time. Increase in primary production of organic matter and decrease in its decomposition (preservation) have been hypothesized as the main mechanisms responsible for this transfer of carbon from atmosphere to lithosphere. However, the relative contribution of each process continues to be a source of debate. In the Cretaceous period, there are several well−studied intervals of organic−rich sedimentation (e.g., "oceanic anoxic events") during which basinal sediments likely became temporary sinks for atmospheric CO_2 with concomitant oceanic and climatic perturbations. Such events offer an ideal opportunity to study the controls on, and consequences of enhanced carbon burial. Although significant progress has been made through the use of many proxy methods, the lack of detailed time scales has made flux estimates difficult, thus placing an inherent limitation of the quantification of Cretaceous productivity and preservation.

In this study, Evolutive Harmonic Analysis has been applied to the rhythmically bedded deposits of the Cenomanian/Turonian Bridge Creek Limestone Member (Western Interior Basin) to develop a high−resolution orbital time scale during and following Oceanic Anoxic Event II. This time−scale allows calculation of accumulation rates for selected geochemical constituents that represent proxies for important processes in the depositional environment. The analysis identifies two distinct intervals of elevated organic carbon accumulation (during OAE II, and just following OAE II), and permits evaluation of the productivity and preservation hypotheses within them. The results indicate that the causes of organic matter burial are more complex than the classic end−member production and preservation models suggest. Based on these results we present a geochemical model that illustrates the controls on organic matter burial by assessing the linkage between organic carbon and molybdenum accumulation in sediments. The model explains our main findings that: 1) the first order control on organic carbon accumulation in Western Interior fine−grained deposits is the rate of export of organic matter to the sulfate reduction zone (SRZ), which is controlled by primary production and export, bulk sedimentation rate, and location of the SRZ in the sediment/water column; and 2) a threshold level of preservational conditions (combination of the last two factors in #1) dictates whether or not changes in production will impact organic carbon burial. In addition to the Bridge Creek data, a spatial data set from the Hartland Shale Member will be used to further illustrate the model.