I graduated from Penn State in 2009. My senior year (2008-2009) I was the president of the Geology club and doubled the size of members. I received two partial scholarships during my junior and senior years. Upon graduation, I enrolled at the University of Nebraska – Lincoln to study vertebrate fossils and stable isotopes. During the two years of my M.S. degree I was supported as a teaching assistant for an introductory geology lab. I defended in the summer of 2011 and graduated. I decided to stay at the University of Nebraska – Lincoln for my Ph.D., but changed my focus to calcareous nannofossils. I am now the head teaching assistant for the introductory geology lab and plan to graduate by 2014.

Nannofossil cyclostratigraphy of the Upper Cretaceous Niobrara Formation, Kansas, U.S.A.

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Abstract

Traditionally, Cretaceous nannofossils have been assigned ages using relative age dating zonation schemes (e.g., Perch-Nielsen, 1985; Burnett and Whitham, 1999) with little use of geochronologic dates for first and last occurrences. I would like to geochronologically calibrate the ranges of calcareous nannofossils of the Santonian to Lower Campanian using samples from the Niobrara Formation of Kansas. I will accomplish this by correlating the Kansas section of the Niobrara with existing macrofossil data as well as direct calibration with a Coniacian through Santonian section in Colorado dated cyclostratigraphically by Locklair and Sageman (2008).

Background

Due to load-induced subsidence and global eustatic rise, the Western Interior region was filled by marine waters episodically from the Albian through the Maastrichtian (Kauffman and Caldwell, 1993). Following peak regression of the Greenhorn marine cycle, a late Turonian transgression flooded the seaway and hemipelagic carbonate-rich sediments were deposited from the Texas Gulf Coast to the Western Canadian Sedimentary Basin until the early Campanian (Kauffman and Caldwell, 1993). In the central part of the Western Interior these hemipelagic units are termed the Niobrara Formation and they unconformably overlie the middle Turonian Codell Sandstone Member of the Carlile Shale. The Pierre Shale overlies the Niobrara Formation. Formal members of the Niobrara include the Fort Hays Limestone and the overlying Smoky Hill Chalk.

One of the striking depositional features of the Niobrara Formation is chalk-marl interbedding on a 10 meter scale. The cycles between chalk and marl are thought to be caused by dilution driven by the Earth's orbital cyclicity. Locklair and Sageman (2008) applied spectral analysis to look at these cycles and calculated the duration of the Niobrara Formation to range from 6.1 to 6.7 myr and the Santonian to range between 2.24 to 2.53 myr. Comparing their data with bentonites dated using the Ar-Ar method, they realized that the construction of an orbital timescale provides better constraints at high resolution.

Chemostratigraphy employing carbon and oxygen stable isotopes has been shown to be a powerful tool for correlating and dating Upper Cretaceous strata on a global scale (Gale et al., 1993; Voigt, 2000; Jarvis et al., 2002; Liu, 2009). An important marker that can be correlated is the Santonian – Campanian Boundary Event. This event has been estimated to occur near 83.8 Ma and is evidenced by a negative spike in $\delta^{18}O$ values and a positive excursion in $\delta^{13}C$ values (Liu, 2009). This event has been recognized in Europe (Schönfeld et al., 1991), in the central North Pacific (Douglas and Savin, 1975), in the southern Atlantic Ocean (Huber et al. 1995), and

along the Gulf Coast of the United States (Liu, 2009).

Materials and Methods

Materials for this project are outcrop samples from the composite section of the type area of the Smoky Hill Member of the Niobrara Formation (Hattin, 1982). Samples have already been collected from this complete Coniacian to lower Campanian section at 10 cm intervals. This provides a sample resolution of approximately 2,500 years. Previous work on a short interval of this composite section confirmed excellent preservation of calcareous nannofossils (Blair and Watkins, 2009), making this is an ideal location for this study.

Calcareous nannofossils will be studied using a light microscope in the University of Nebraska nannofossil laboratory. Preparation of the collected samples will follow Bown and Young's (1998) method of making smear slides. Scanning electron microscope (SEM) photographs will also be taken to confirm identification of all taxa. Range charts will then be created for all of the nannofossil species identified in the samples. Stable isotopes and carbonate content will be sampled at 0.5 m intervals from the Santonian to the Lower Campanian. Correlation of these chalk-marl cycles, isotope curves, and biostratigraphy with data from Locklair and Sageman (2008) will allow me to assign geochronologic dates.

Importance

The results of this project will be useful from paleooceanographic, paleoclimatic, and industrial perspectives. The Niobrara Formation is an unconventional shale gas and oil play in the Denver-Julesburg Basin, North Park Basin, and Powder River Basin. Precise dating of the calcareous nannofossils will aid in understanding depositional rates in the Niobrara. The geochronologic dates given to the ranges of nannofossils and the high precision of the biostratigraphy can be used to better understand evolution and extinction rates on a regional to a

global scale. In the United States, nannofossil ages can be correlated with producing and non-producing areas along the Gulf Coast (e.g., the Austin Chalk Formation in Texas and the Mooreville Chalk Formation in Alabama). The use of a stable isotope curve will provide a better understanding of how these different nannofossils reacted to environmental changes through time.

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