Investigation of a Paleolake Environment in the Late Miocene, Nebraska

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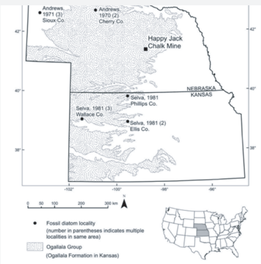
Introduction

Fresh water diatom deposits of the North American grasslands may hold the key to understanding the connection between diatom evolution, development of grasslands and global climate (Kidder and Gierlowski-Kordesch 2005). While the interaction between these parameters hinges on the silica cycle, they have yet to be adequately explored, particularly in the Late Miocene. This study investigates a paleolake sediment core from Scotia, Nebraska to paint the picture of the paleolake environment in the grasslands of North America during the Late Miocene.

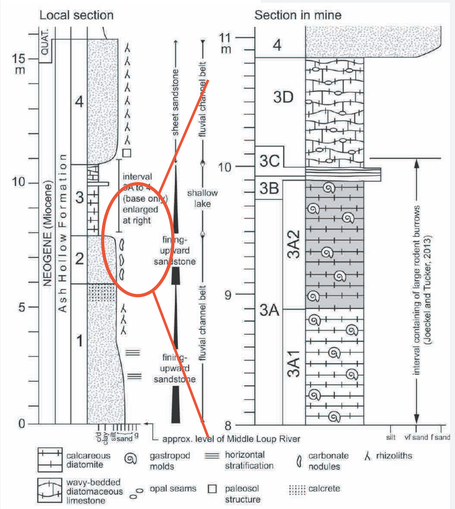
Goals

1) Estimate the period of time that the paleolake was present on the landscape.
2) Examine the changes in stratigraphic markers, planktonic taxa *Strelnikoviella* and *Aulacoseira* as well as benthic taxa *Tetracyclus* and *Surirella*, to determine ecological setting of the lake.
3) Examine additional proxies (volcanic ash and phytoliths) to determine regional sources of silica to the lake.

Core Section



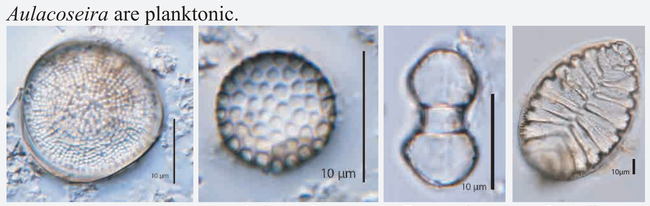
A core section (CORE 4aSc14, Joeckle 2012) was taken from the Happy Jack Chalk mine near Scotia Nebraska. The core consists of 10.6 ft. of lake sediments from the Upper section of the Ogallala Formation (Bishop et al. 2018).



Stratigraphic section near core drilling site (Bishop et al. 2018).

Diatoms of Interest

Strelnikoviella is endemic to western North America. Furthermore, *Strelnikoviella ogalallica*, *Aulacoseira lapilla* and *Tetracyclus khursevichiae* were described from these deposits. *Surirella sp.* and *Tetracyclus* are characteristic of benthic habitats. *Surirella sp.* inhabits fine sediments and turbid water while *Tetracyclus* inhabits clear water. *Strelnikoviella* and *Aulacoseira* are planktonic.



Strelnikoviella *Aulacoseira* *Tetracyclus* *Surirella*

Methods

1) The core was divided into 22 sections and subsamples were disaggregated, weighed and digested with nitric acid.

Subsamples were disaggregated with a mortar and pestle and weighed out to a known mass.

2) Four replicate, quantitative micro-slides were created using Battarbee Chambers and mounted using Zrax mounting medium.

Preparing samples for Battarbee chambers

3) Microscopic analysis and diatom/ash identification was conducted using an Olympus BX53 microscope with an oil immersion objective (100x) with a numerical aperture NA=1.4

Determining # diatom valves/mg of sediment in samples

Calculations

$$\frac{\textit{mg of sediment digested}}{\textit{mL Battarbee processed volume}} \times \textit{mL solution in Battarbee}$$

$$= \textit{mg of sediment in Battarbee}$$

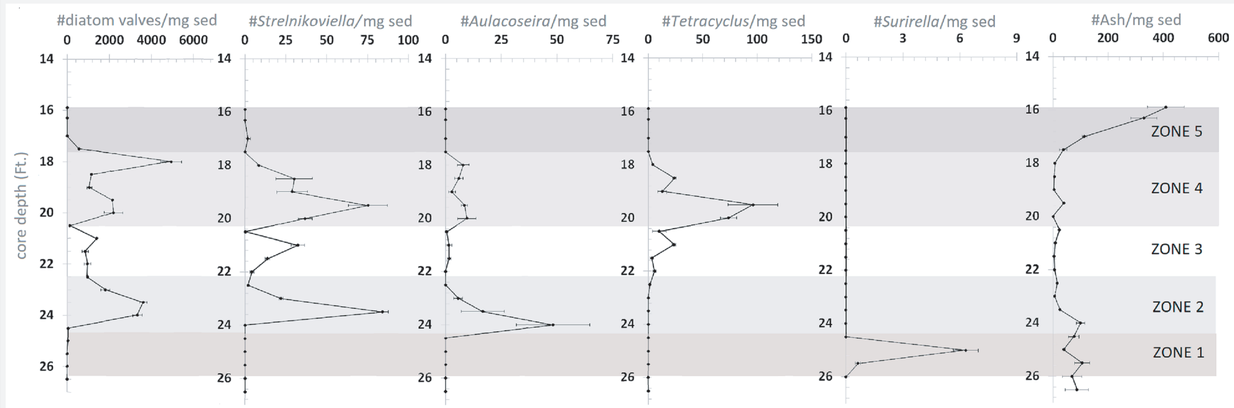
$$\frac{\textit{mg of sediment in Battatrbee}}{\textit{area of Battarbee mm}^2} \times \textit{area of known section mm}^2$$

$$= \textit{mg of sediment in inspected area}$$

$$\Downarrow$$

$$\frac{\textit{\# diatoms counted}}{\textit{mg of sediment in inspected area}}$$

Results



ZONE 1 contains high levels of volcanic ash as well as the only occurrence of *Surirella* in the core.
ZONE 2 brings an increase in diatom abundance as well as a high concentration in planktonic taxa *Strelnikoviella* and *Aulacoseira*.
ZONE 3 shows a decrease in diatom abundance and the introduction of the benthic taxon *Tetracyclus.*
ZONE 4 shows diatom peak abundance. *Tetracyclus* is also at its maximum abundance.
ZONE 5 concentration of volcanic ash dramatically increases and diatoms are no longer present.

Discussion

Estimated age of core

The average sedimentation rate for a relatively productive lake is 1mm/year. Since this core is 10.6 ft of sediment, that would mean it is ~3500 years old. However, this core has been significantly compressed since its deposition during the Late Miocene. To make up for that compression, we estimate the age to be between 5,000-10,000 years.

Ecologic Setting

ZONE 1: The presence of *Surirella,* a benthic diatom that lives in fine grained sediments, indicates a shallow, turbid environment.

ZONE 2: The introduction of planktonic species, but no benthic diatoms suggests that this zone represents the lake's period of greatest water depth.

ZONE 3: Increase of the benthic dweller *Tetracyclus* indicates a shallowing or increase in water transparency.

ZONE 4: Diatoms are at their peak concentration in the core. The corresponding peak in *Tetracyclus* could indicate that the water was at its maximun transparency.

ZONE 5: There is a dramatic increase in volcanic ash. The water becomes so turbid that diatom production ceases.

Conclusions

1) **Estimated age of paleolake**: 5,000-10,000 years

2) **Ecologic setting**: The ecologic setting of the lake changes over time. In ZONE 1, the water is turbid. In ZONE 2, the water depth is at its greatest. By ZONE 3, the water has become transparent enough to favor *Tetracyclus*. By ZONE 4 the water reaches its maximum transparency.

3) **Regional Silica input**: No phytoliths were observed throughout the core. It is possible that they quickly dissolved upon entering the lake (Kidder and Gierlowski-Kordesch 2005). Volcanic ash was present throughout the core, especially at its start and end.

Acknowledgements

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References

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