Exploring New Information from an Old Archive: A Record of Abrupt Climate Change from Brown's Lake

Evie Sanford | Advised by Dr. Eva Lyon
Department of Earth Sciences

Background

For as long as the earth has existed, the climate has been changing. One of the most important recent of these climate changes is the Younger Dryas. The Younger Dryas is a prime example of an abrupt climate change that returned parts of a warming world, the northern hemisphere, to near-glacial conditions.

The Younger Dryas is a 1,300-year period that lasted from 12.9-11.7 ka BP. It is well-studied through various forms of proxy data from many parts of the world, including through lake sediments. Through this study Brown's Lake is analyzed through multiple points of geologic data.

Location

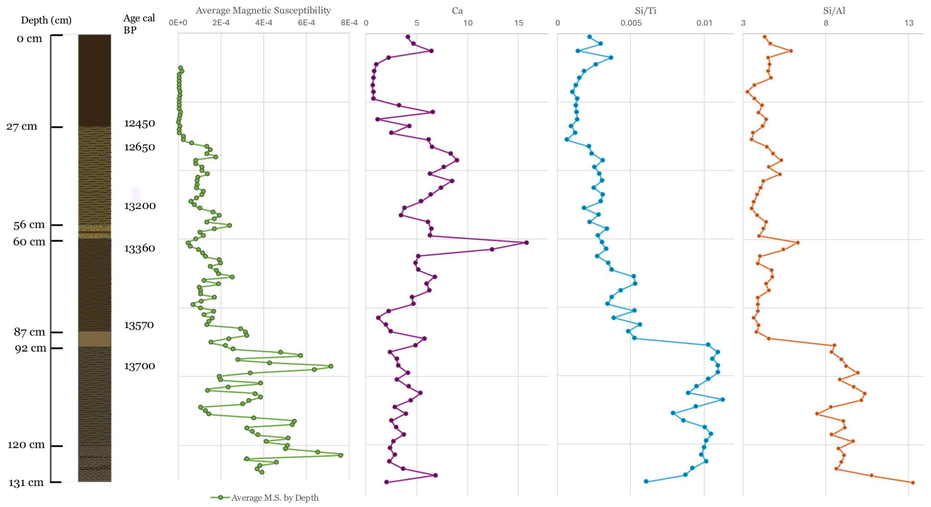
Brown's Lake is a seven-acre glacial kettle lake located about 4 km (2.5 miles) west of Shreve, in the Southern portion of Wayne County, Ohio (40.6807000°N, 82.0623472°W). It is located on Brown's Lake Bog Preserve that also contains glacially formed kame topography and Brown's Lake Bog, a virgin boreal acidic bog.

Methods

This independent study is based on a ~7.5 m core collected in the summer of 2021, from which the 5.5-6.5 m and 6-7 m sections were specifically used.

A multi-proxy approach was taken to analyze the core within the lab. During this thesis, magnetic susceptibility, pXRF, lithologic, and diatom analyses were conducted. Additionally, four radiocarbon dates were collected and sent off for AMS radiocarbon dating. Diatoms were isolated from organic material and analyzed with a scanning electron microscope.

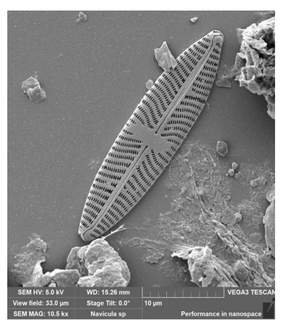
Composite Graph

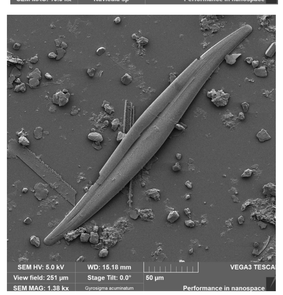


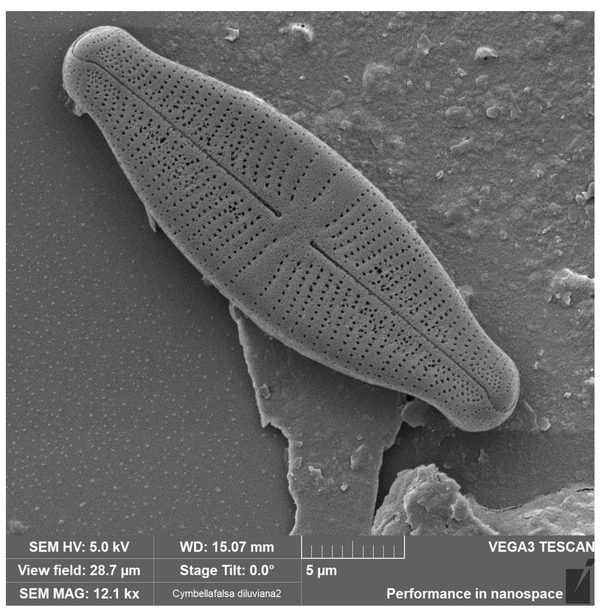
Showing composite core lithology (left) with ages presented from the 'rbacon' model (right of the core), total graphs of average magnetic susceptibility (green), calcium concentration (purple), silicon (Si)/titanium (Ti) ratio (blue), and silicon (Si)/aluminum (Al) ratio (orange).

Diatoms

Diatoms are organisms which create elaborate skeletons (frustules). They present a useful approach to gather long-term data on ecological systems and change.







Left, top-to-bottom: *Navicula cari, Gyrosigma acuminatum*
Right: *Cymbellafalsa diluviana*

Conclusions

The data presented within this thesis highlight the changes visible in the limnological record of Brown's Lake leading up to and during the early Younger Dryas.

The radiocarbon dates establish the existence of Brown's Lake's existence over the course of the Holocene epoch, at least over the duration of most of the Bølling–Allerød and the beginning of the Younger Dryas.

Visible effects: intermittent influxes of aeolian sedimentation, a change in acidity to an alkaline environment indicated by lack of diatom preservation shown physically through slide analysis on SEM and chemostratigraphically through the Si/Ti and Si/Al ratios, and magnetic susceptibility peaks at coarser sediments and a drastic relative decrease that corresponds to a deposition of black mud.

Diatoms, which have silica shells, do not preserve well in alkaline (or high pH) environments (Hubbard & Riley, 1984; Van Cappellen et al., 2002). This is shown through the pitting of the external valves within the *Cymbellafalsa diluviana* photo. Could be likely reason for no diatom preservation up core. Alkaline transition at 13640 cal yr BP.

Impacts

This study provides data for the sparse Ohioan and Midwestern record of the Younger Dryas.

Analysis supports the assumption that Brown's Lake was a relatively young freshwater lake that experienced alkaline conditions leading up to the Younger Dryas period.

This data provides understanding of large-scale climate change events to help improve our understanding of the Earth's climate system and to help predict future climate changes.

References

- Hubbard, L.M.L., and Riley, J.P., 1984, Kinetic studies of the rate of dissolution of silica and diatom tests in sea water: Journal of the Oceanographical Society of Japan, v. 40, no. 2, p. 148–154, at https://doi.org/10.1007/BF02302495.
- Van Cappellen, P., Dixit, S., and van Beusekom, J., 2002, Biogenic silica dissolution in the oceans: Reconciling experimental and field-based dissolution rates: Global Biogeochemical Cycles, v. 16, no. 4, p. 23-1-23–10, at https://doi.org/10.1029/2001GB001431.

Acknowledgements

Thank you to my advisor Dr. Lyon for her knowledge and support. This research was made possible through the funding of The Copeland Foundation and the Earth Science Department through funding of radiocarbon dates and travel. Additional thanks to Dr. Jeffery Stone for his wisdom and use of SEM lab.