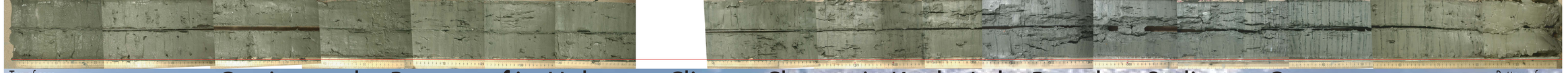

Top of core

Bottom of core

Getting to the Bottom of it: Holocene Climate Change in Keuka Lake Based on Sediment Cores

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Abstract

Keuka Lake of the Finger Lakes region of New York offers a continuous record of sedimentation since the last deglaciation. The depth of the lake has allowed for undisturbed sedimentation and analysis of this record will provide insight into the paleoclimate changes that have occurred during the Holocene. With the use of a piston core we recovered a four meter core form one of Keuka Lake's deepest sections. The core spanned the entire Holocene and entered the proglacial sediment. The majority of the core was highly mottled 0-336cm, however, from 336-379cm the core displayed distinct laminations that consisted mostly of charcoal. The core was analyzed using magnetic susceptibility, mean grain size, charcoal frequency, organic content, and carbonate content. We radiocarbon dated three samples for age control. The percent carbonate, mean grain size, and charcoal frequency correlated positively indicating four periods of climatic change when the temperature rose and precipitation increased in either volume or intensity. Using an age depth model the dates of the four climatic events range from (12,350 ybp - 10,600 ybp: 350-310cm) (9,750 ybp - 8,000 ybp: 290-250cm) (5850 ybp – 4550 ybp: 200-170cm) and (1750 ybp – 652 ybp: 40-15cm).

Introduction

- The climate in the northeastern US was more moist between 10,000 and 8,000 ybp and it was 2°C warmer 9,000 ybp based on pollen from White Mountains, NH (Shuman et al., 2002; Davis et al.,1980)
- We used charcoal, LOI, magnetic susceptibility, and grain size to examine the past 14,000 years in Keuka Lake (Fig. 1) to determine changes in precipitation and temperature as part of the Keck research team studying the Holocene climate in the Finger Lakes region
- The depth of Keuka Lake, scoured by the last glacial advance, allows for continuous sediment deposition
- The Keck research team also explored Lake Seneca and Lake Canandaigua

(Fig. 1) Keuka Lake after snow fall, Lake Ontario is at the top of the picture (http//:earthobservatory.nasa.gov)

Depositional Model

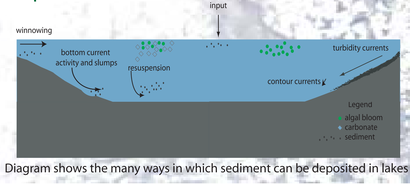
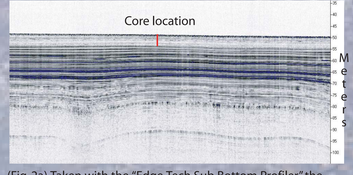
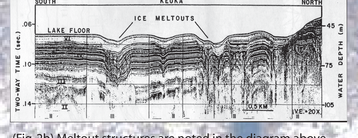


Diagram shows the many ways in which sediment can be deposited in lakes



(Fig. 2a) Taken with the "Edge Tech Sub Bottom Profiler" the red bar represents where the core was taken. The upper finely laminated section of the profile are the Holocene sediments, below them lay proglacial pink clays. Note the sediment is undisturbed.



(Fig. 2b) Meltout structures are noted in the diagram above. Meltout structures arise from glacial ice that becomes buried by or is driven into sediment, once there it can take much longer to melt. Sediment is deposited on top of the ice as it melts causing unconformities in the sediment. Keuka is known for having more meltout structures than the other lakes (Mullins et al., 1996)

(Fig. 4) Extraction of the core from its tube using a router

Methods

Field

- "Edge Tech Sub Bottom Profiler" used to examine underlying strata and choose a core site free of meltout zones (Fig. 2) and relatively undisturbed.
- Core site off Urbana delta was chosen for its increased possibility of organic debris
- Core was taken from the central long axis of the lake
- We used a piston core to collect the core (Fig. 3)
- The core was taken back to the lab to be opened (Fig. 4)

(Fig. 3) Piston coring device used on Lake Keuka

(Fig.6) The second round of LOI for the sediment in the muffle furnace, a two hour, 1000 degree burn that eliminates the carbonate present.

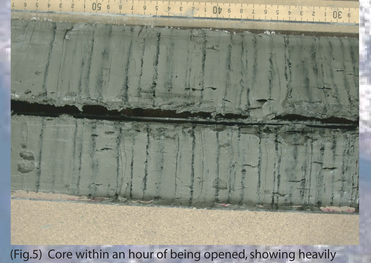
Lab

Mean Grain Size
- Four centimeter sample interval
- Organics and carbonates removed using glacial acetic acid (Rea,1981; Hovan,1995).
- Grain sized determined by Coulter laser particle size analyzer

Charcoal
- Sieving for charcoal was done every 10 cm
- We sieved for charcoal that was >149 microns and between 125 and 149 microns.
- Charcoal frequency per sample determined by counting number of pieces present
- Stereoscope used to count individual charcoal pieces (Whitlock, 2001)
- Numerous charcoal layers were present near the bottom of the core (Fig. 5)

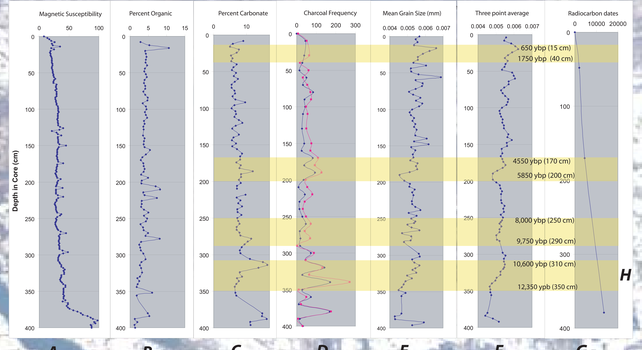
LOI
- LOI used to determine percent organics and percent carbonate
-Samples were baked in a muffle furnace (Fig. 6) at 550° C for an hour to burn off organics and reweighed to measure percent organic loss
- Samples were baked for two hours at 1000°C to burn off carbonate and reweighed to measure percent carbonate loss modified by Dean (1974)

Carbon Dating
- C-14 dating for the three samples (47 cm, 170 cm, and 379 cm) was preformed at Beta RadioCarbon Dating Laboratory



(Fig.5) Core within an hour of being opened, showing heavily laminated section around 300cm

Results



A Magnetic susceptibility (MS) showed little correlation with other data sets, MS decreases gradually from the bottom of the core to the top

B Percent organic content also correlates poorly with other data sets, however there are six distinct increases in organic content possibly from terrestrial sources

C Percent carbonate content displayed four periods of increased production with a gradual decrease in percent content from the bottom of the core to the top

D Charcoal frequency data shows four or possibly five periods of increased fire activity, the grain sizes 125 to 149 microns and >149 microns correlated well

E Mean grain size data displays four locations of increased mean grain size, grain size increased slightly from the bottom to the top of the core

F The three point running average demonstrates the broader trends of mean grain size and the four periods of increased grain size

G Carbon-14 dating quantified three dates along the core

H The yellow shaded areas represent the periods where the carbonate LOI, mean grain size and charcoal data correlate, the ages of the four climatic events based on C- 14 dating are: 12,350 ybp - 10,600 ybp: 350-310cm, 9,750 ybp - 8,000 ybp: 290-250cm, 5,850 ybp – 4,550 ybp: 200-170cm, 1,750 ybp – 652 ybp: 40-15cm

Conclusions

The results of this study indicate a positive correlation of mean grain size, charcoal frequency and carbonate content. The positive correlation of these three data sets indicates the possibility of four periods climatic change. The four climatic events noted are (12,350 ybp - 10,600 ybp: 350-310cm) (9,750 ybp - 8,000 ybp: 290-250cm) (5850 ybp – 4550 ybp: 200-170cm) (1750 ybp – 652 ybp: 40-15cm). During these periods, temperature rose and precipitation increased in either amount or intensity. These changes lead to increased carbonate production, increased mean grain size, and an increase in forest fire frequency.

Acknowledgements

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