RECONSTRUCTION OF THE LATE GLACIAL ENVIRONMENTAL HISTORY OF BROWN'S LAKE BOG, NORTHEASTERN OHIO

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INTRODUCTION

Since the last glacial period in Northeast Ohio, the area has undergone a series of environmental changes. Characterizing these changes is important to understanding the complex switch from glacial to interglacial conditions that North America experienced between 25,000 and 12,000 years ago (Yu and Wright, 2001). This study uses the lithology and environmental magnetism of bog sediments to interpret local environmental changes experienced since the last glacial period in northeast Ohio.

The study of environmental magnetism has become an increasingly common technique used to study Quaternary sediments over the past 20 years (Oldfield, 1991). The rise of technology in the field now makes it possible to isolate several magnetic parameters in a single sediment sample. These magnetic properties are useful for interpreting the nature of deposition, transport, erosion, and diagenetic alteration of sediment. The resulting data may also be used individually or in combination as a proxy for environmental and climate change. This paper is focused on a magnetic and lithologic interpretation of sediments from Brown's Lake Bog in northeast Ohio.

LOCATION

Brown's Lake Bog is located in northeast Ohio near the southern boundary of glaciated terrain, 4 km west of Shreve (Figure 1). The bog has formed within a kettle depression created by stagnate ice as the Laurentide ice sheet retreated from northeast Ohio approximately 16, 680 years ago (Shane and Anderson, 1993). In 1966 The Nature Conservancy purchased Brown's Lake Bog, and in 1968 the bog was named a National Natural Landmark for its natural preservation and unique ecology. In July of 2002, two 12.4 m sediment cores were extracted from the bog. Three distinct lithologic intervals reflect a classic deglacial sequence of environmental change within the catchment area of the basin. A previous study by Shane and Anderson (1993) used palynological records from 55 sites including Brown's Lake Bog to document significant environmental changes between 15,000 and 9,000 BP in the southern Great Lakes region. Shane and Anderson (1993) identified four distinct time zones of

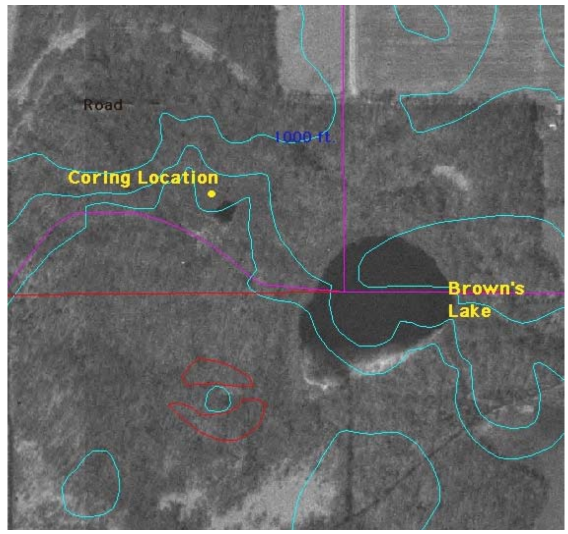

Figure 1. This view of Brown's Lake Bog marks Brown's Lake, elevation contours, and the location from which cores were extracted.

change corresponding to their pollen data. Their conclusions were based on correlation between bogs and were not necessarily expressed at each site. Part of this study is to compare the regional conclusions of Shane and Anderson (1993) with the single record at Brown's Lake Bog.

Methods

Two sediment cores were extracted from Brown's Lake Bog using a modified square-rod Livingstone piston corer. Core sediment samples of 1 cm^3 were taken at 4 cm intervals for loss on ignition. Data was collected for this test using 550° and 1000° ovens to prepare the samples. The University of Arizona provided AMS Radiocarbon dates on three samples prepared by the Limonlogic Research Center at the University of Minnesota.

From an increase in inorganic sediment at 9.76 m depth to the base of the core at a depth of 12.42 m, thirty-nine 2.5 cm segments of sediment were extracted at 6.5 cm intervals for magnetic analyses (Figure 3). The sediment was placed in 5.83 cm^3 plastic boxes. Four magnetic parameters were measured for each sample. High and low frequency magnetic susceptibility was evaluated for each sample using a Bartington MS2 meter. Saturation isothermal remanent magnetism (SIRM) and isothermal remanent magnetism (IRM) were induced by an impulse magnetizer. Anhysteretic remanent magnetism (ARM) was induced using an alternating frequency demagnetizer. Each sample was measured by a "spinner" magnetometer.

LITHOLOGY

Of the 12.42 m of sediment extracted from Brown's Lake Bog, the first three meters of each core (mostly organic) was discarded at the site. The remaining 9.42 m of sediment exhibits three major lithologic intervals.

The first sediment interval from 12.42 m to 12.35 m is diamicton. It consists of large clasts in a fine brown sand to silt matrix. The clasts average 1.5 cm in diamter, are sub-rounded to subangular, and compose approximately 40% of the sediment over this interval. From 12.35 m to 12.19 m, the sediment lacks large clasts, but maintains a relatively large grain size of well-sorted fine to medium light brown sand.

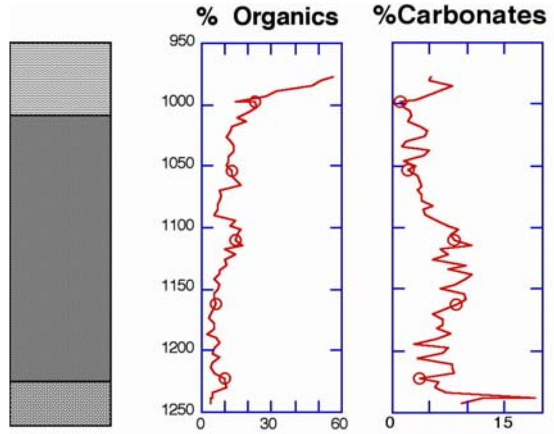

Figure 2. A rapid increase in %Organics clearly marks the beginning of the Holocene at approximately 1000 cm. %Carbonates indicates the presence of glacial sediments below 1230 cm.

A second interval, from 12.19 m to 10.24 m, is composed of olive, grey, and brown mottled silt. Black bands of heavy mottling, which occur from 12.08 m to 11.80 m are separated by a light brown massive fine silt. Darker brown to olive mottled silt from 11.62 m until 11.47 m gives way to a black band of mottling. A rhythmic pattern of faint light brown banding occurs at approximately 20 cm intervals from 11.44 m to the end of the second interval.

A third interval is defined by the presence of fibrous organic material. Fibrous organic material first appears at 10.24 m. Fibers are included in brown silt and fine sand from 10.24 m to 9.88 m. Over this interval the concentration of fibers increases with decreasing depth. At 9.88 m the sediment is approximately 30% silt and sand, 70% fibrous organic. By 9.62 m, the sediment is nearly 100% organic (Figure 3). From 9.62 m to 9.21 m the organic matter is a small fibered, tightly woven gyttja. From 9.21 m to 3 m the core is composed of peat, varying slightly in color and fiber size.

FINDINGS

The magnetic and lithologic characteristics of sediment from Brown's Lake Bog may be used to interpret the environmental history of the basin from the late glacial to Holocene period. Three distinct intervals are discernable in the sediment lithology, magnetics, total organics, and total carbonates from the bog. Three AMS Radiocarbon ages help to constrain this record (Table 1). The bottom-

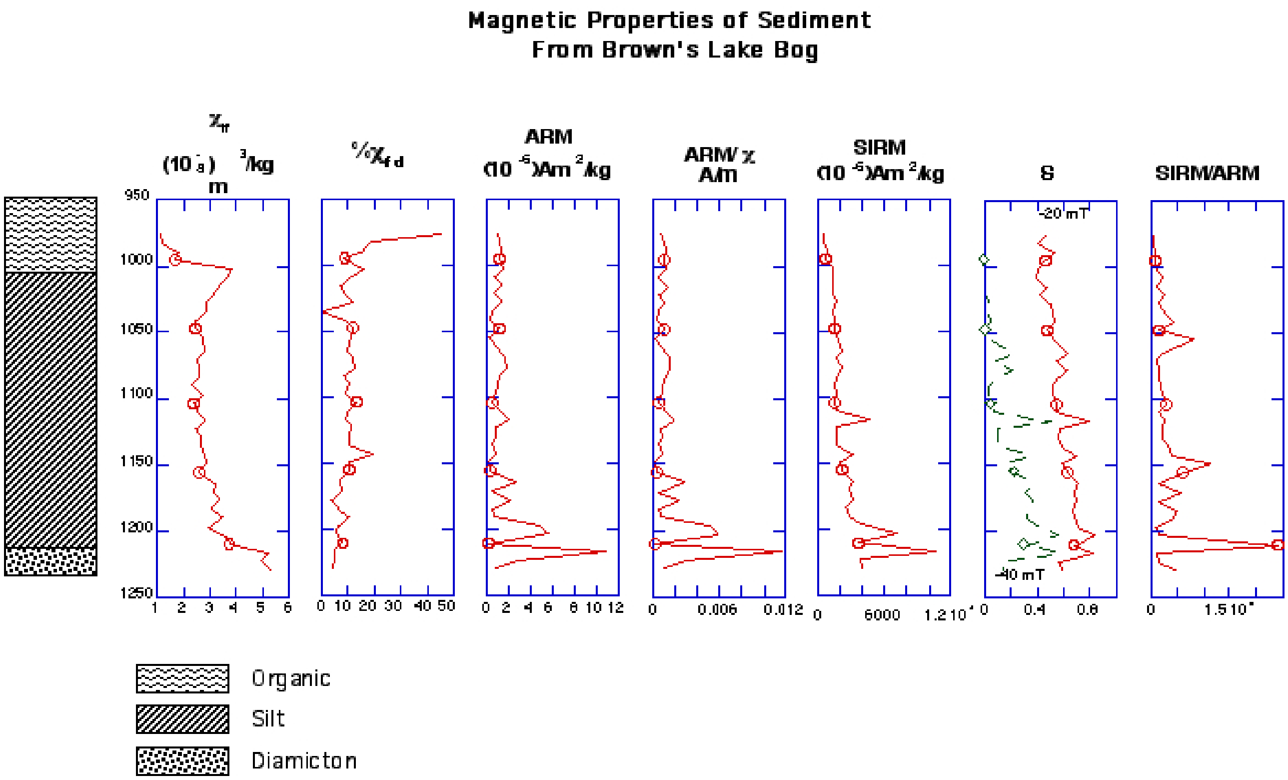

Figure 3. A variety of magnetic parameters support the presence of three distinct intervals in sediments from Brown's Lake Bog.

most interval was deposited during the glacial occupation of Brown's Lake Bog. This is based primarily on the lithology of the sediment and high magnetic readings (suggesting large grain size) over this interval. The second interval represents the change to lacustrine conditions. An increase in fine grain particles and decrease in magnetic particles is marked by a decrease in several magnetic parameters. During lacustrine conditions, the aeolian sediment input is particularly high. This is shown by trends in SIRM and S-ratio values. The transition to the upper-most interval is most apparent in the sharp increases in total organics and low-frequency magnetism. A rapid increase in %Xfd at this depth suggests a high concentration of fine grain magnetite. This trend is associated with increased biological productivity and warmer temperatures.

The Brown's Lake Bog sediments compare and contrast the regional conclusions by Shane and Anderson (1993). The abrupt transition from glacial to lacustrine sedimentation seen in the bog sediments is consistent with the rapid glacial retreat and increasing temperatures suggested by Shane and Anderson (1993). The sediments deposited at Brown's Lake Bog following glacial retreat, however, are more difficult to relate to Shane and Anderson (1993). Significant rises in SIRM and %Xfd for sediment deposited

Table 1. Uncalibrated radiocarbon ages obtained from Brown's Lake Bog.

Sample depth	^{14}C age (yr BP)	+/-	Material
856-858	9004	83	branch fragments
923-926	10254	60	aquatic plant material
1235-1237	14660	60	aquatic plant material

between 10,254 BP and 14,660 BP suggest a period of increased erosion and sedimentation. While it is difficult to decide conclusively, one of these rises may correlate to the colder European Younger Dryas (11,000 BP) identified by Shane and Anderson (1993). The third interval, marked by a rise in organics and warmer temperatures at a depth of approximately 1000 cm, is consistent with Shane and Anderson (1993).

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