THE ENVIRONMENTAL MAGNETIC RECORD OF THE LAST GLACIAL-INTERGLACIAL TRANSITION FROM ECKURD'S POND, URBANA, OHIO

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INTRODUCTION

The Laurentide Icesheet is believed to have invaded Ohio roughly 25,000 BP reaching its maximum extent near Cincinnati at approximately 19,000 BP (Lowell, 1995). The advance history of the Laurentide Icesheet in Ohio is relatively well documented however, the retreat history is less well-constrained. The focus of the Keck Ohio Project 2001 was to determine the age and rate of the retreat of the last glacial movement from Ohio. This was accomplished by acquiring numerous bog basin sediment cores from a north/south transect and obtaining a radiocarbon date from each bog bottom. A greater understanding of the Laurentide Icesheet retreat pattern will follow as more transects are completed.

The focus of this study is using magnetic properties of sediment cores as proxies for both environment and climate change. Environmental magnetism is a relatively new field and has gained increasing use and recognition as a field of environmental study (Oldfield, 1991). By analyzing the magnetic properties of samples, information concerning the grain size and magnetic mineralogy can be gathered for interpretation of the environmental conditions in which the sediment was deposited. This paper is concerned with the magnetic properties of sediment retrieved from a bog basin in southwestern Ohio. The sediments collected span from the Late Pleistocene through much of the Holocene.

By conducting a series of tests involving anhysteretic remant magnetism (ARM), isothermal remant magnetism (IRM), saturation isothermal remant magnetism (SIRM) and magnetic susceptibility tests on the 3.7 m sediment sequence, information pertaining to the sediments' magnetic particle grain size, magnetic mineralogy, and the magnetic mineral concentration within a sample will give information reflecting on previous environmental conditions (Verosub and Roberts, 1995). Fluctuations in erosion of soils within the basin as well as variations in eolian input external to the site will be interpreted in the context of the changing dynamics of the retreating Laurentide Icesheet, global climate fluctuations, and internal changes in the geologic and ecologic evolution of the basin.

LOCATION

Ekurd's Pond is a 1.5 square kilometer closed basin formed on an ice-contact ridge located in the interlobate morainal area of western Ohio (83° 40' 05'' E longitude and 40° 05' 00'' N latitude) between the cities of Dayton and Bellefontaine (Fig. 1). The basin is thought to have been created by surrounding eskers resulting in an enclosed catchment area.

METHODS

Three overlapping cores were extracted from the basin and together yield a 3.7 meter sequence of near continuous sediment. After

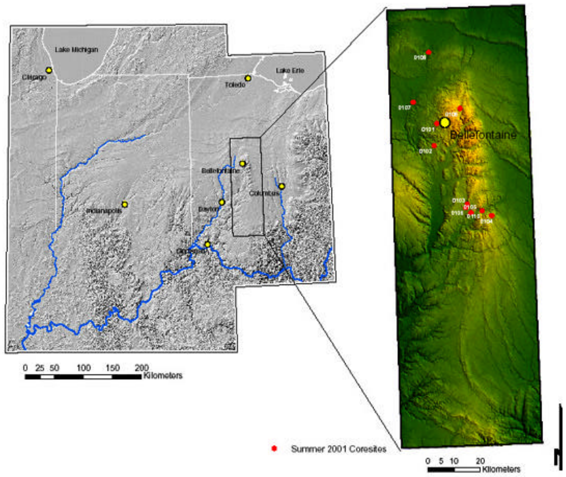

Fig.1. A relief map of the upper mid-western United States with a close-up view of the coring sites in Ohio. Eckurd's Pond (site 0103) is shown by the large white arrow.

extraction, each core was physically described and preliminary lab tests (LOI, grain size and magnetic susceptibility) were conducted on either one or all of the cores. Material for AMS dating was also collected and sent to Beta Analytic Inc. and the University of Arizona for C-14 dating analysis. Further magnetic research was conducted using two of the three cores provided from Eckurd's Pond.

Sediment was sampled every four cm from the 3.7 m core for a total of 88 samples. The sediment was then packed into 5.83 cm^3 plastic boxes and a series of magnetic tests were conducted on each of the samples. All tests were conducted at room temperature. The tests consisted of magnetic susceptibility (using the Bartington MS2 system), which is a basic measurement often providing insight regarding the magnetic concentration within a sample. SIRM (2.5 Telsas) may be used to estimate sediment flux into a basin and also provide magnetic mineralogy information. IRM (at –20, -40, -100 and –300 mT) also has the ability to help distinguish the magnetic mineralogy of a sample. ARM (peak frequency of 0.1 T and a bias field of .05 mT) provides information

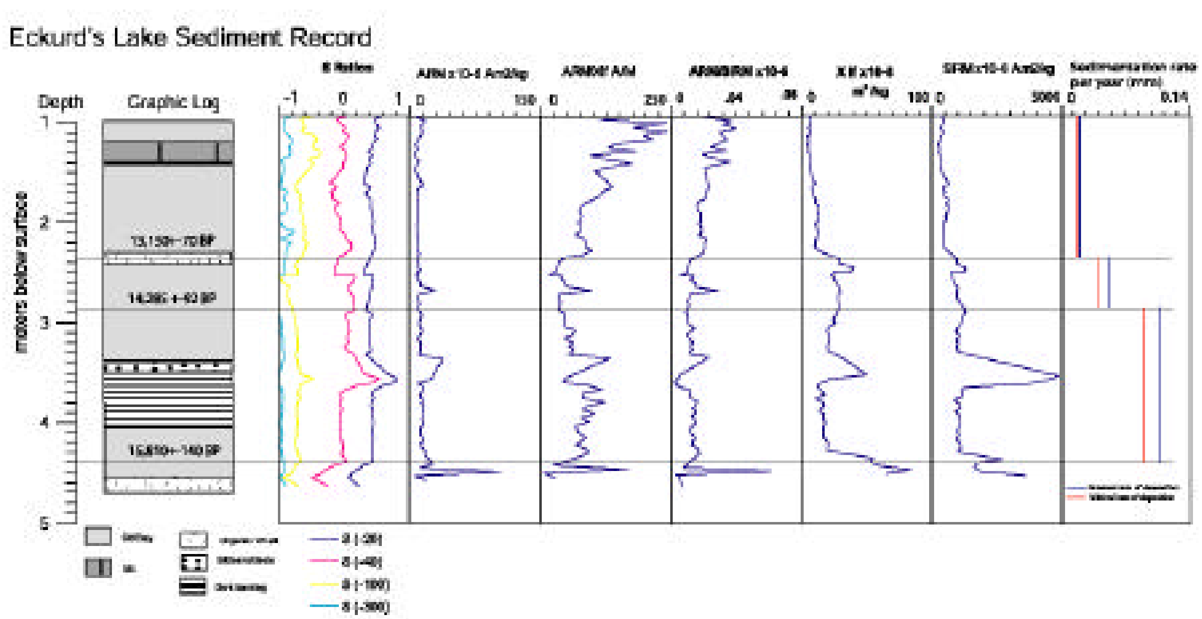

Fig. 2. Stratigraphic log of the core sediments along with AMS dates (Conventional radiocarbon dates) as well as magnetic parameters used to interpret the core's magnetic components

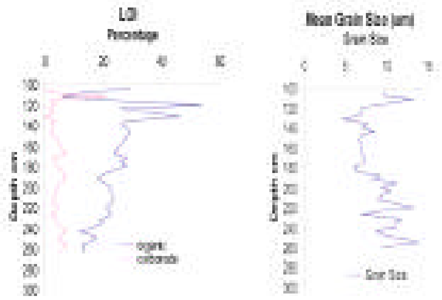

Fig. 3. Graph showing percentage of organic and carbonate material found in sediment. Organic material increases throughout the Holocene.

pertaining to concentrations of magnetic grain size within a sample. S-ratios (IRM/SIRM) are often calculated to interpret the ratio between ferromagnetic and anti-ferrimagnetic material within a sample (Verosub and Roberts, 1995).

By combining two or more of the above primary magnetic tests, many parameters can be constructed allowing for a greater array of environmental interpretation. Such parameters include ARM/X_{lf}, which generally increases as the ratio of fine grain magnetic material within a sample increases and ARM/SIRM, which may act similar to ARM/X_{lf} reaching high values with increase in fine grain concentration (Gillian, 1997). Graphs were constructed of the numerous magnetic parameters used to interpret past environmental conditions (Fig. 3).

FINDINGS

Radiocarbon analyses, total organics, total carbonate, grain size and a suite of environmental magnetic analyses define this record of environmental change through the glacial-interglacial transition and much of the Holocene. Three distinct units are recognized based on the lithologic character, grain size, organic content and magnetic susceptibility. The lowest unit represents the changing landscape from the ice-contact, immediate postglacial setting to lacustrine deposition. A basal AMS radiocarbon dating from this site and four adjoining bogs suggest general ice retreat before 15,810 +/- 140 BP (AA45069). A 2-meter sequence of lake silts was then deposited within a 2,000 year period, according to AMS radiocarbon dates of 13,150 +/- 70 BP (Beta-163007) and 14,285 +/- 92 BP (AA5070) at 2.34 m and 2.83 m respectively below ground surface. These lower two units are capped by a more organic-rich silt recording the transition into the Holocene.

A distinct sudden change in magnetic properties (shown in ARM/SIRM, X_{lf}, SIRM and ARM) occurs about 13,150 BP directly correlating to a large influx of organic rich silt. This point in time simultaneously shows an increase in grain size, shown in high values of ARM/X_{lf}, to the catchment. The input of organic matter has also been increasing into the basin from 13,150 BP to the present day (Fig.3). The distinct magnetic change at 13, 150 BP may possibly be a result of the low sedimentation rate in comparison to that of the basin's earlier years, particularly between 15,810 BP and 14,285 BP (Fig. 2). Eolian activities are not thought to be large contributors to the magnetic record before 13,150 BP, but due to the lowering of S-ratio after that date, wind blow silt may have played a significant role throughout the Holocene.

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Main lithological characteristics of Eckurd's Lake s

Depth (cm)	Lithology
100-120	Dark brown mud mixed with
120-134	Brownish silt banding through
134-154	Brownish finer grain silt than
	Core Break.