GLACIAL OHIO 2001: THE LAST GLACIAL TRANSITION RECORDED IN LAKES AND BOGS, SOUTHWESTERN OHIO

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PROJECT OVERVIEW

The major objectives of Keck Ohio-2001 were to document the retreat of the Laurentide ice sheet across western Ohio and to analyze sediments laid down since the Last Glacial Maximum (LGM) as a record of environmental change. This was accomplished by dating organic material in, and examining the characteristics of sediments cored from small basins located on drift deposited during the last Ice Age. Ten sediment cores were extracted from bogs and lakes along an 80-kilometer, north-south transect from the classic interlobate region centered on Bellefontaine, Ohio (Figure 1).

Participants of Keck Ohio-2001 processed the paleoenvironmental records from eight cores, which include parts of the last glacial-interglacial transition. This work improves the chronologic resolution of the deglacial history and subsequent climate events in Ohio. These data contribute to a better understanding of climate variability in the Great Lakes region of North America.

Students assembled in Dayton, Ohio and then traveled to the Canadian Rockies to study modern glacial and lacustrine systems. We visited Angel, Athabasca, Hilda, Peyto and Saskachewan Glaciers in Banff and Jasper Provincial Parks over the five-day trip. At each field stop students described and built facies models, which included many of the features that they would subsequently encounter on a continental ice sheet scale in Ohio. Observing the evolution of a series of lakes from kettles to bogs in the Canadan Rockies provided the basis for interpreting sediment cores in Ohio.

The group returned to Ohio to extract cores in the field. Students began their laboratory analyses at the Keck Environmental Laboratory housed in the Department of Geology at the University of Dayton.

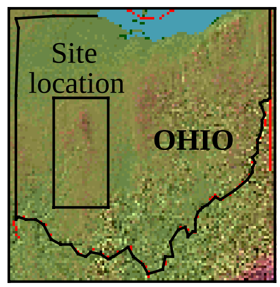
BACKGROUND AND GLACIAL GEOLOGY

Ice sheet advance and retreat patterns are an important record of global environmental change (Broecker and Denton, 1989). The characteristics of sediments laid down during and since the last deglaciation is a record of environmental change. These records include abrupt climate oscillations such as the Younger

TABLE 1. Radiocarbon dates (Keck Ohio - 2001).

Core #/Interval	Lab #*	Radiocarbon Age
0101 B3 95098	Beta-158291	11,860+/-270 BP
0102 B4 17-20	Beta-158292	12,130+/-200 BP
0102 A6 4-10	AA45068	35,120+-820 BP
0103 A4 17.5-19.5	AA45069	15,810+-140 BP
0103 B1 33-34	AA45070	14,285+-92 BP
0103A268-71**	Beta-163007	13,150+/-70 BP
0104 B3 54-55	AA45071	12,324+-80 BP
0104 B5 68-73	AA45072	15,350+-100 BP
0105 A6 67-70 + 64-73	Beta – 158293	9,960 +/- 100 BP
0105 B8 74--75	AA45073	15,563+-91 BP
0106 A5 58-60	AA45074	14,986+-98 BP
0106 B2 46-48	AA45075	16,090+-100 BP
0107 A3 8-16	AA45076	13,490+-110 BP
0107 B3 48-52	AA45077	14,360+-120 BP
0109 A7 74-78	AA45078	14,600+-91 BP
0109 B4 78-82	Beta-158294	10,000+/-19 BP
0110 B7 29-31	AA45079	16,170+-97 BP
0110 A4 8-10	Beta – 158295	13,370 +/- 280 BP

(*Labs: Beta = Beta Analytic, AA = U. Arizona AMS lab.), * *C-14 analysis funded from the Copeland Research Funds, College of Wooster.



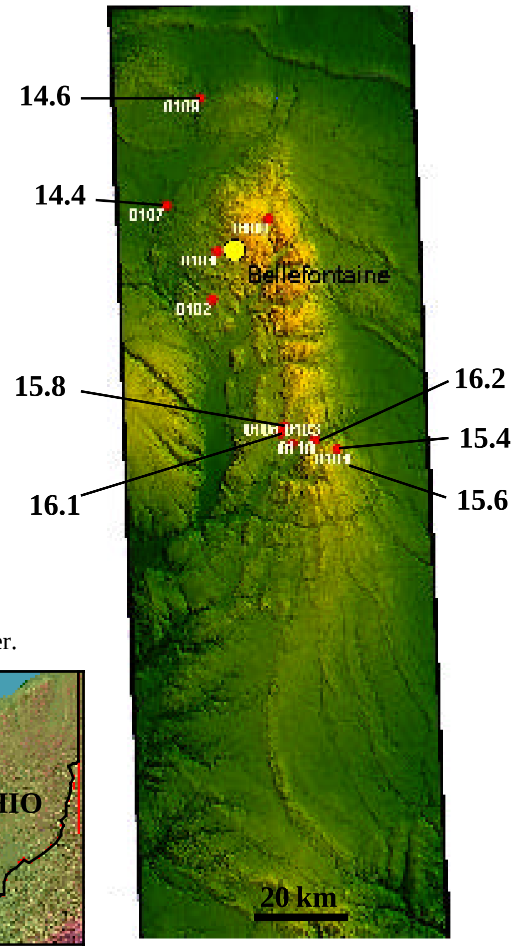


Figure 1. Core site locations for Keck Ohio 2001 project. The sampling transect is centered on the inter-lobate region of western Ohio. Ice retreat dates are plotted on the detailed map. Dates are in 1000s years before present.

Dryas climate reversal at 10,900-10,000 ^{14}C yr BP.

The late Wisconsin glacial history in southwestern Ohio is one of the best-dated records from North America, and has contributed to our understanding of the timing of global interhemispheric glaciation (Lowell et al., 1990, Broecker and Denton, 1989). Stratigraphic studies and hundreds of radiocarbon dates show that the history of the southern margin of the Laurentide Ice Sheet consisted of several pulses of advance and readvance between 22,000 and 18,000 BP (Ekberg et al., 1993). In contrast, the deglacial sequence and the character of the glacial transition across Ohio particularly for the interval older than 14,000 BP is relatively unknown.

The study region (Figure 1) includes a complex series of recessional moraines and ice-contact topography. The low regional topography in this area of southwestern Ohio contributes to the preservation of a marked lobate geometry of moraines, and crosscutting relationships of landforms resulting from the multiple fluctuations of the Lake Erie Lobe. Shane (1987) has provided a general understanding of the deglacial and vegetation history of the region based on pollen analysis from four basins in Ohio. Our work builds on this background.

METHODS

This project adopts a strategy successfully employed in the Lake District of Chile and in the Southern Alps of New Zealand to improve our understanding of climate change (Moreno et al., 2001). In Ohio, a series of sediment cores were extracted along a transect normal to the latest retreat of the Laurentide Icesheet.

Each Keck participant experienced all aspects and methods of field mapping and coring, and the laboratory methods involved in core

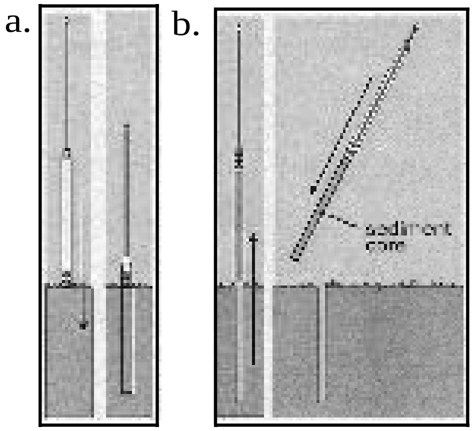


Figure 2. Schematics of the modified Livingstone piston corer. a - corer is pushed into the sediment one meter at a time. b - the core barrel is removed from the hole and sediment is extruded. A brochure describing the coring techniques and the project can be accessed at http://tvl1.geo.uc.edu/ak/keck1.pdf http://tvl1.geo.uc.edu/ak/keck2.pdf

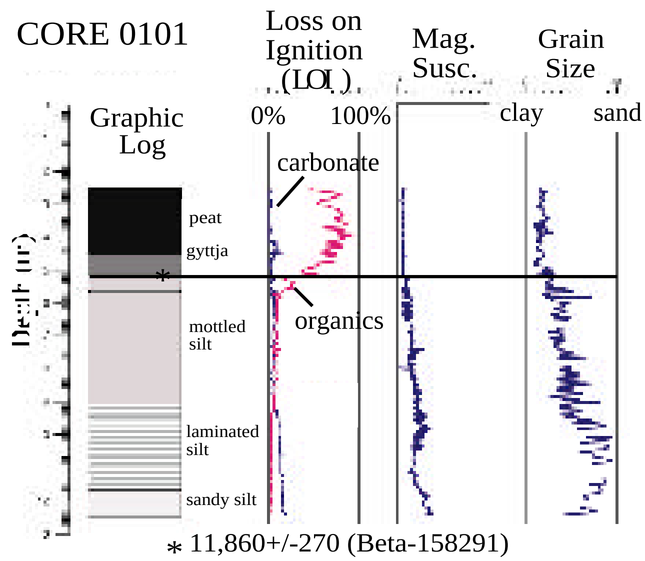


Figure 3. Suite of core analyses that served as a starting point for student projects. Note the overall increase in organic content, and decreases in grain size and susceptibility through the glacial transition. This core (0101) was not chosen for further analyses.

analysis and archiving. Each lake and bog basin was surveyed using either GPS or electronic total station. Sediment thickness was measured by tile probing along a grid. A GIS data set was prepared for each basin and location, and isopach maps were generated. Based on this information, coring sites were located at the deepest, accessible part of the basin. Two side-by-side cores offset by one meter were extracted with a modified Livingstone corer (Figure 2).

The range of sediment types encountered at the sites was remarkably rich. The depth of mud in each of the basins ranged from four to seventeen meters and included peats, marls, laminated and massive silts and clays, and gyttja (amorphous organic material). The only obvious similarities in all the cores was the glacial to interglacial transition characterized by either a gradual or abrupt increase in organic content and a decrease in grain size (Figure 3). The landforms on which the closed basins were sampled ranged from ice-contact sediments of kames and eskers to moraines composed of glacial till.

Each core was described and photographed, sampled for radiocarbon dating, and measured for magnetic susceptibility, total organic and carbonate content, and grain size (Figure 3).

Two radiocarbon ages on each core were obtained from either bulk samples of peat and gyttja submitted to Beta Analytic Inc. for conventional radiocarbon dating or from detrital organic material submitted for Accelerator Mass Spectromety (AMS). AMS dating was performed through the Limnological Research Center (LRC) at the University of Minnesota, where the samples were processed prior to submission at the accelerator facilities at the University of Arizona (Table 1).

Toward the end of the project each participant wrote a proposal to analyze further one of the cores at his or her institution. Students performed additional analyses according to interests and available facilities. These analyses included pollen, diatom, geochemical, environmental magnetism, and detailed grain size analyses.

STUDENT PROJECTS

Individual student projects included paleoecological studies using, diatoms by Margaretta Meyer (Beloit College) and pollen by Monica Kaitz (Amherst College). Geochemical studies by Louisa Bradtmiller (Smith College) and Kim Sunderlin, (Franklin and Marshall College) explored cation exchange capacities and clay mineralogy, and diagenetic changes within the sediment, respectively. Scott Bagocius (The College of Wooster) focused on the record of environmental magnetism using a suite of magnetic analyses in conjunction with physical sediment parameters. Lisa King (University of Cincinnati) evaluated the rythmic sedimentation as a record of annual or episodic sedimentation. Jessica McDonough (University of Dayton) focused on an extensive marl lake deposit and its geochemistry possibly related to lake level fluctuations. Joel Byersdorfer (Whittman College) took a sedimentologic approach to his core analyses, identifying a sand anomaly, which he interprets as having a fluvial origin.

At the close of the project each student will be expected to contribute their data to the NOAA/NGDC Paleoclimatology Program, Boulder Colorado, USA database for use by other climate researchers worldwide. Students are also required to supply the landowner at their site with the results of their projects.

SUMMARY OF RESULTS

A synthesis of the bog AMS radiocarbon dates shows that ice withdrew from the interlobate region about 16,000 years ago from the southernmost sites to 14,500 BP from the northern sites (Figure 1). This additional spatial and temporal coverage of western Ohio improves our understanding of the deglacial history of this area.

Some participants were able to suggest that changes in their cores may be linked to some of the well-documented, abrupt climate reversals that occurred during the glacial transition. These climate-driven changes include the Bøllering – Allerød and Younger Dryas events (Yu and Wright, 2001). Other changes noted in the cores were attributed to the more local evolution of a particular basin. The differentiation of the local versus larger-scale (global), climate-driven origin in the cores is fundamental to further studies concerned with reconstructing the environmental history of the Midwest during the last glacial transition.

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