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GEOMORPHIC, SEDIMENTOLOGIC AND CLIMATIC IMPLICATIONS OF INORGANIC HORIZONS IN RITTERBUSH POND, VERMONT

A Proposal Presented
by
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ABSTRACT

Lake sediment cores from Ritterbush Pond (Eden, VT), recently analyzed in conjunction
with pollen research (Lin, 1996), showdistinct variations over the last 12,000 14C years in organic carbon content as approximated by loss-on-ignition (LOI). Numerous horizons of laminated, inorganic sediment (clay and silt) are visually identifiable within a pair of overlapping cores comprised primarily of gytja. Fourteen 14C dates indicate that several inorganic horizons were deposited in relatively short time intervals. The dates suggest that such horizons represent depositional events.such as hillslope denudation caused by a period of increased rainfall, which has implications for climate change during the Holocene. I propose to determine the spatial distribution of these inorganic horizons, to investigate their physical stratigraphy, to explore geomorphic reasons for their origin, and to infer sedimentologic mechanisms for their deposition.

Introduction
Ritterbush Pond is located in the Town of Eden, Lamoille County. Vermont (Figure I). It
was recently cored in conjunction with pollen and stable isotope research of Holocene «12 ka) sediments (Lin, 1996; Lini et al, 1995). The pair of overlapping cores (a total of 5.75 meters) show distinct variations in organic carbon content as approximated by loss-on-ignition (LO!) (Figure 2). . Numerous horizons of laminated, inorganic sediment (clay and silt) are visually identifiable within the gytja, organic sediment that is gradually deposited as a result of the primary productivity of organisms living in and around the lake. Fourteen 14C dates have been obtained for one core (RT-2), and six of those dates bracket three of the inorganic horizons. The dates indicate that the horizons were deposited rapidly (Figure 3), suggesting that such horizons represent discrete depositional events, such as hillslope denudation caused by a period of increased rainfall, which may have implications for climate change during the Holocene.

Background
Pollen Anaylsis
Traditional lake core analysis in New England has focused on the pollen records found in
the Holocene organic material contained within lake basins as a proxy for climate change and vegetation cover. The transition from the Wisconsinan glaciation to the present interglacial stage has been documented using the change in pollen spectra over time, which reflects the expansion of tree species northward as the ice sheet receded The Younger Dryas stade, a return to cooler

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climate conditions between 11,000 and 10,000 14Cyr B.P., has a recognizable pollen signal (Davis

and Jacobson, 1985), and is accompanied by-an increase in inorganic sediment due to decreased , . productivity and in some regions proximity of the ice sheet (Thompson et al, 1996). With the
.exception of research on the Younger Dryas, the significance of inorganic material found within the lacustrine stratigraphies of New England has been largely ignored.

Ritterbush Pond
Previous Work
Ritterbush Pond has been studied only in regard to the existence of mountain glaciers in
New England. Wagner (1970) investigated Ritterbush Pond and Lake Mansfield as possible cirque basins, and identified morainal.features in the surrounding areas. This interpretation was quickly disputed (Stewart, 1971; Connally, 1971), but remained unresolved as the existence or absence of mountain glaciers could not be proven conclusively. Sperling (1989) re-examined. Wagner's work and interpreted a basal radiocarbon age of 10.7 ka from Ritterbush Pond as the age' of deglaciation, Current accepted theory holds that mountain glaciers did not exist in either the White or Gr~en Mountains at the close of the Wisconsinan (Thompson et al., 1996): Sperling (1989) does provide data useful tothis study including a dated core with stratigraphic description,
. and pollen analysis for Ritterbush Pond.
Recent investigations at Ritterbush Pond include a detailed pollen chronology anddeglacial
climate and vegetation history (Lin, 1996). Li identified the inorganic peaks visually and by their low LOr values, and hypothesized that they were due to sediment resuspension or flood events. Her climate reconstruction does not address the climatic implications of the horizons.
Proposed Research
This investigation is possible due to the unusual characteristics of the basin and the
sediment record, 'most notably, the steepness of the slopes surrounding the pond (Figure 1). Steep" slopes have agreater chance of failure and higher rates of erosion than gentle slopes composed of 'similar material. Samples of gytja above and below three of the inorganic horizons have been 14C_

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dated to constrain their ages. In each case, the dates bracketing the horizon fall within two sigma, but are inverted; the date at the top of the horizon is older than the date below (Figure 3)..This suggests that there has been scouring and redeposition Ofolder sediment. These 14C dates are consistent with a rapid influx of inorganic material into the basin, possibly carried into the basin by turbidity currents, due to increased rates of hillslope erosion.
The upper and lower contacts between the inorganic horizons and the gytja vary from sharp
to gradational, indicating that more than one mechanism may be depositing the inorganic layers. The most likely mechanisms, turbidite sedimentation and subsequent suspension settling, and transport of material from the lake margin to the center of the.basin (sediment focusing), should be distinguishable by comparison of micro-stratigraphy and spatial distribution of the horizons. The . ~.. inorganic layers that have terrestrial or fluvial sources should be relatively continuous and thicken shoreward in the direction of the sediment source, deltas and alluvial fans at the lake margin. Reworked sediments may be discontinuous. By tracing the inorganic horizons to their source and by constraining ages, I will in o r g a n 2 0

changed over time, and that the inorganic layers had isotopic values indicative of terrestrial carbon organic material, I plan to use stable carbon isotopes to determine the source of the carbon found in the inorganic horizons and the gytja surrounding them (Lini et al., 1995).

Loss-on-Ignition (LOn
Extensive paleoclimate proxy data (pollen analyses) have been recovered from the ponds
and bogs of New England, resulting in a regional, deglacial, vegetative chronology (Davis and
Jacobson, 1985; Anderson et al, 1992; Spear, 1989). A traditional analytical tool for the estimation
of organic carbon content is loss-on-ignition (LOI). Numerous lake core studies have published
LOI records (Thompson et al,1996; Anderson et al, 1992; Peteet et al, 1990; Spear, 1989; Winkler

1985a) but none are continuous nor have they been performed at the detailed scale I propose to use 1.

(l cm intervals). Therefore, it is difficult to use existing LOI records to identify the timing and
distribution of inorganic horizons in other lakes.

Sediment focusing
Sediment focusing is defined as the movement of sediment to the deepest part of the basin
(Lehman, 1975). Focusing results in non-uniform deposition of

action, and 4) random redistribution of sediment due to wave activity at the lake margin. The . effect of these processes on sediment stratigraphy is not

England during the Holocene. By defining the spatial and temporal distribution of the inorganic horizons, it will be possible to 1) estimate long-term.rates of organic matter accumulation within the lake, 2) estimate average rates of inorganic sedimentation and rates ofhillslope denudation for

the watershed, 3) identify periods of hillslope instability and 4) use the depositional history of ..
Ritterbush Pond to infer periods of increasedrainfall intensity or duration in Northern Vermont during the Holocene.

Plan of Investigation
Field Work
Work to date has included the retrieval of three continuous cores from Ritterbush Pond
using a modified Reasoner coring device (Reasoner, 1993). The locations of these cores were selected using bathymetry and isopach

.to facilitate processing of ~e core segments. Measurements will be taken every 3 em for the length of the core and each core will be run twice to allow for calculation of statistical error. The

Estimated Timetable

January - March 1997
- Sediment probing at Ritterbush Pond - COMPLETE -Practice core retrieval - COMPLETE
-Retrieval of 3 cores for analysis - COMPLETE
March - June 1997

-Lab analysis of cores.

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14C measurements at Lawrence Livermore
. -Surficial mapping of the Ritterbush drainage basin
-Write abstract for GSA
September - December 1997
-Continue laboratory analysis
-Present findings at National GSA meeting in Salt Lake City, Utah
-Presentation of progress report to the Geology Department
-Begin thesis writing (methods, previous work, figure creation etc.)
-Derermine if additional cores are necessary .
January 1998 - COMPLETION
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Figure 1: Location of Ritterbush Pond

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