Figure 14. Foreset beds in the Carroll Delta, unconformably overlain by fluvial sand and gravel.

STOP 6. POND CORE STRATIGRAPHY, SEDIMENTOLOGY, AND CHRONOLOGY (Cherry Pond viewpoint, Route 115). From this vantage point, there is a good view of the Johns River basin in the foreground. To the right, we look north across Cherry Pond to the Israel River valley and the upper Connecticut River valley in the far distance. Cherry Pond is located either just within the limits of glacial Lake Israel (Baileys Stage), or in the headward part of the spillway that drained Lake Israel waters southwest into glacial Lake Whitefield. The elevation of this spillway is about 338 m. Lake Whitefield occupied the Johns River valley, and the Whitefield airport is situated on a delta built into this lake.

In 1999 we obtained three cores (A, B, and C) from Cherry Pond sediments, as well as several cores from other sites in the northern White Mountains. Dorion (2000, 2002) described the stratigraphy of these cores and their implications for interpreting the late-glacial environment of the region. The lower parts of the Cherry Pond cores show varves (annual sediment layers) deposited into Glacial Lake Israel (Fig. 15). The present Cherry Pond was a sub-basin on the floor of this ancestral lake. We attempted to date the earliest varves, which presumably were deposited at the ice sheet margin. This would tell us when the valley became ice-free and hence suitable for occupation by Paleoindians. However, after careful sieving of the A, B, and C cores, we were disappointed to find only a few degraded pieces of organic material (macrofossils) in the varves. From other pond cores in the area, we know that vegetation, insects, and other invertebrate fauna were present at the glacier margin. The margin was receding very slowly, approximately 50 to 150 m per year on average, during late-glacial time (Dorion *et al.*, 2001).

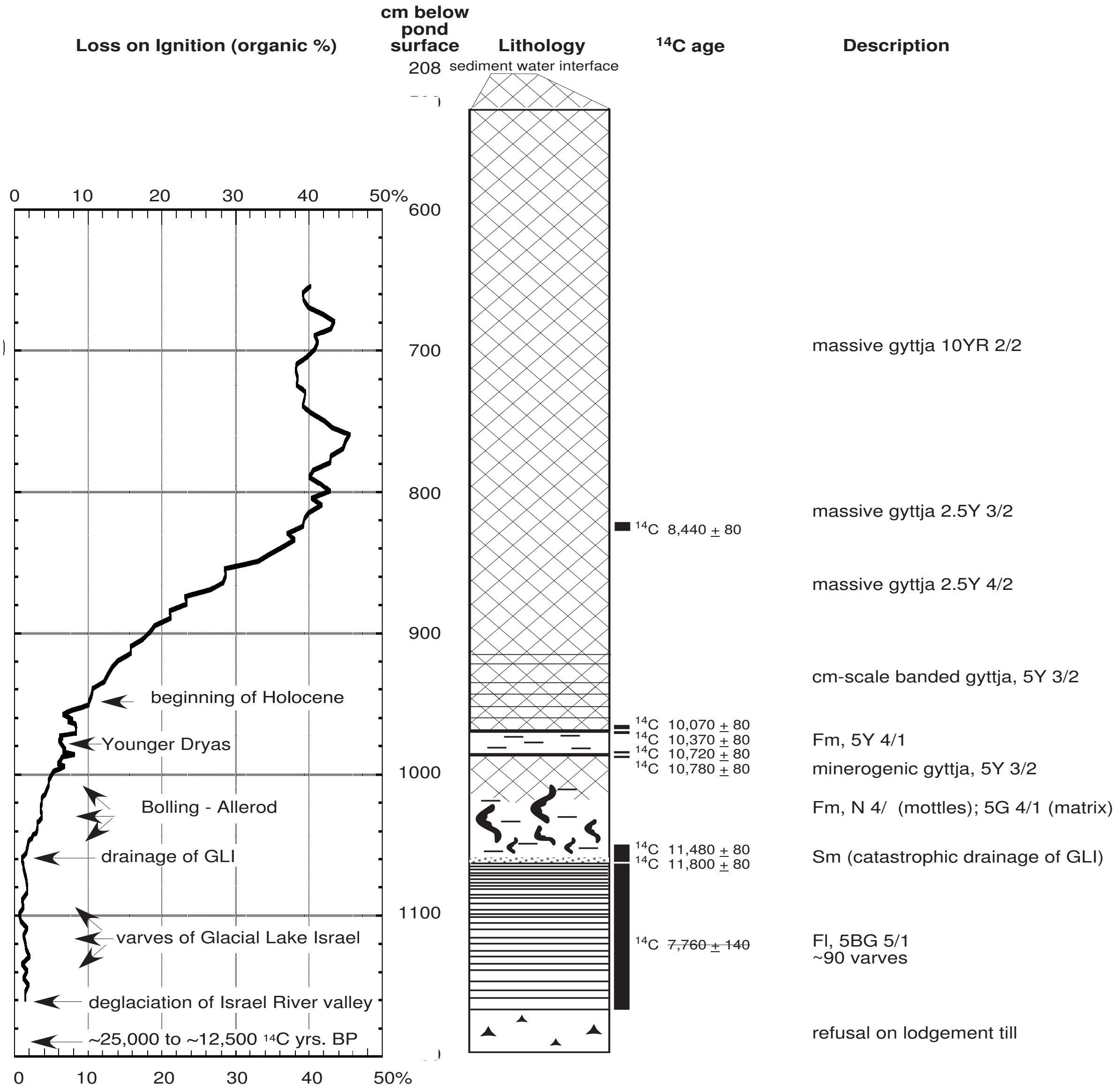

Figure 15. Analysis of Core B from Cherry Pond in Jefferson, NH. The anomalous age (with strike-through) from the varves is not understood. The varves were generally barren of macrofossils except for scarce, chitinous insect parts, moss stems and leaves, and degraded leaf fragments. Macrofossil abundance increased rapidly near the top of the varve sequence. The massive sand bed (Sm) likely represents the drainage of glacial Lake Israel and influx of coarser sediment from adjacent slopes.

Our hypothesis to explain the scarcity of organic matter in the varves relates to how glacial meltwater can discharge at the ice margin. In one scenario, glacial meltwater can exit from the mouth of an ice tunnel, flowing downslope as a subaerial stream before entering the glacial lake. Vegetation would be periodically washed into the meltwater stream (via cutbank erosion) and carried out into the lake, where it settles to the bottom along with the clay, silt, and sand to form a varve. However, in the Israel Valley, glacial meltwater most likely discharged through a tunnel at the base of the ice margin and directly into Glacial Lake Israel as a subaqueous stream (or jet). Since the glacial stream dumped its sediment load directly from the ice tunnel into the lake, it could not incorporate vegetation living on stream banks or the nearby valley side slopes. Perhaps small nonglacial streams could have carried material into the lake? This is not likely as there is abundant data supporting an arid steppe environment during late-glacial time; the streams so prevalent today in the White Mountains would have been dry or non-flowing. In Greenland today, along the ice sheet margin, only about 15 cm of annual precipitation falls, mostly as snow. The White Mountains average over 100 cm today with significantly greater amounts at higher elevations. The floral assemblages, landforms, and climate of parts of the western ice sheet margin of Greenland today may serve as a modern analog to the Laurentide Ice Sheet environment during deglaciation in New Hampshire and Maine.

We sieved the entire varve sequence from the A, B, and C cores and obtained 59 mg of plant and insect material. The basal radiocarbon age of 7,760 ^{14}C yr BP (Fig. 15) was clearly anomalous. However, the other seven radiocarbon ages closely agree with the core stratigraphy and, on a regional scale, with other late- and postglacial events in New Hampshire and Maine (Thompson *et al*.,1996; Borns *et al.*, 2004; Ridge, 2004). These ages suggest that the ice sheet had melted back to the northwest, out of the Israel Valley, at or before 11,800 ^{14}C yr BP. We can still estimate the time of deglaciation because Jack Ridge (Tufts University), using a modified gray-scale imaging system, counted 90 varves from the base of the varved section of the core to the top, suggesting that glacial meltwater entered the lake for 90 years before being diverted to another valley. We visually counted 93 varves during core analysis at the University of Maine - Orono Paleoecology Lab. This would place the time of deglaciation close to 12,000 ^{14}C yr BP, in close agreement with the other evidence presented here.

For the next 1000 years, following the drainage of Glacial Lake Israel, the bottom sediments of Cherry Pond were mixed to some extent by burrowing organisms, as seen in the "mottling", or redoximorphic features. The high silt and clay content of this section of the core reflects an open landscape with bare ground in places and probably wind-deposited loess (silt and fine sand). Periodically, high winds would entrain silt and fine sand from glacial sediments and river alluvium in valleys and deposit this loess as a blanket across the landscape. An ongoing research question regarding the silt and fine sand sections we find in pond cores during this time is: To what extent was the sediment of eolian (loess) origin? Or, was the sediment deposited by alluvial processes? Based on archaeological evidence from the Heden Paleoindian Site (Spiess *et al.*, 1995), we know that eolian deposition continued during postglacial time and throughout the Younger Dryas.

Beginning at about 10,700 ^{14}C yr BP, the razor-sharp transition in the core from silty organic-rich gyttja back to barren gray mud marks the onset of the Younger Dryas (Y-D) chronozone. We obtained ^{14}C ages from the terminal Bolling - Allerod stratigraphic interval, and also from the immediate onset of the Y-D from within its distinct stratigraphic zone. We repeated this process for the Y-D termination and the immediate onset of the Holocene stratigraphic interval (Figure 15). Records from the Greenland Ice Sheet show the Y-D onset occurred in 3 to 20 years (Stuiver et al., 1995). World-wide temperatures dropped abruptly and the major ice sheets of the northern Hemisphere as well as glaciers in the southern Hemisphere expanded once again (Lowell et al., 1995). It was during this abrupt climatic change that Paleoindians moved into northern New England. We do not see any sedimentary evidence in the Cherry Pond record or other pond records that glaciers (or ice caps) readvanced into the Israel Valley or other parts New Hampshire or Maine. If this had occurred, we would expect to find diamicton (or till) interbedded in the cores.

The Younger Dryas chronozone terminated as abruptly as it began, and the Holocene Epoch began at about 10,070 ^{14}C yr BP. This is noted in the cores as a return to the organic-rich gyttja. By about 9,500 ^{14}C yr BP, the Paleoindian tradition had vanished in northern New England. The once open steppe was quickly closing in with the forests we know today, as mean annual precipitation dramatically increased. Where foot travel was once rapid and visibility nearly unlimited, dense forest now covered New England and restricted travel greatly.

END OF TRIP. Continue N for 5.8 miles to U. S. Route 2. Follow Route 2 W to St. Johnsbury, and then take I-91 N to Lyndonville.

ACKNOWLEDGEMENTS

We are especially grateful to the following persons and companies who granted permission to visit the stops on this field trip and enabled us to carry out research visits on other occasions: Nigel Manley of the Society for Protection of New Hampshire Forests in Bethlehem (Stops 1 and 2); Doug Ingerson, Jr. of Chick's Sand and Gravel in Dalton (Stop 3); Mr. and Mrs. Bob Warren in Carroll (Stop 4); and Tim Bradstreet of Pike Industries, Inc. (Stop