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The Millers River Delta (Jahns and Willard, 1942) is a large outwash delta developed along the edges of pro-glacial Lake Hitchcock during late Wisconsinan ice-retreat. The delta has traditionally been attributed to sediment input from the Millers River (Emerson, 1898; Jahns, 1967; Brigham-Grette and Wise, 1988), but morphologic and geologic evidence suggest that most of the sediment was derived from glacial ice within the Connecticut River Valley. We, therefore, interpret this delta as a classic lacustrine ice-contact morphosequence (Koteff, 1974; Koteff and Pessl, 1981).

Lying at the junction between the narrow upper Connecticut River Valley and the broad southern Connecticut Valley, the Millers River Delta records the change from broad valley to narrow valley deglaciation during the retreat. The history of lake level lowering in northern Lake Hitchcock (the lake north of the delta which originally was separated from the main body of Lake Hitchcock by a short river flowing across the top of the delta) is recorded very nicely in this area. The field trip will examine evidence for the syndepositional position of the ice margin, discuss the probable source of the sediment, and examine evidence for the stages of the lake level drop. We will also discuss the probable effects of paleo-groundwater flow on the stages of river incision.

GEOLOGIC SETTING

The Millers Falls Delta lies in the northeastern corner of the Mesozoic graben that creates the broad Connecticut Valley through Massachusetts and Connecticut. To the north the Connecticut River flows through a narrow valley that roughly follows the boundary between the phyllites of the Connecticut Valley Synclinorium and the gneisses of the Eastern Highlands. The delta occupies the junction between the broad and narrow portions of the Connecticut Valley. The Millers River Valley is incised into the Paleozoic gneisses of the Eastern Highlands and joins the Connecticut Valley within the area choked by the delta.

During ice retreat in central New England, a large pro-glacial lake (Lake Hitchcock) filled the ice free portions of the Connecticut Valley (for a summary of the late glacial history of the Connecticut Valley, see Koteff and others, 1988). The southern end of the lake was constrained by a dam created by a readvance moraine near Middletown, Connecticut, and the northern end approximated the ice margin in the valley as the ice retreated up the valley. The maximum extent of Lake Hitchcock was from about Middletown, Connecticut, to Peacham, Vermont. The demise of the lake occurred when the morainal dam was breached, draining the lake relatively rapidly. Because the Millers Falls delta divided the lake into a northern narrow portion and a southern broad portion, it had to be breached before the northern portion could be drained. Thus, the timing of lake level drop north of the delta post-dated that to the south.

ICE RETREAT

Ice retreat in New England, including the Connecticut River Valley, is generally thought to have occurred by stagnation zone retreat (Koteff and Pessl, 1981). Basically, this mode of ice retreat entails a stepped retreat in which major sections of glacial ice stagnate, probably due to topographic impediments, and develop outwash features along their leading edges. As the stagnated ice melts, it gives way to normal valley (e.g. lacustrine) conditions and there is a new frontal edge to the ice sheet. It is hypothesized that the sediment for the outwash deposits is supplied by the ablation of the upthrusting edge of the active glacier (the dirt machine of Koteff, 1974).

In Connecticut Valley south of the Millers River delta, the nearest major outwash deposits are the Long Plain delta in Sunderland (Jahns, 1951) and the Barnes delta in Southampton and Westfield (Larsen, 1972). The Long Plain delta clearly developed after the basin to the south was clear of ice and is thought to record the presence of ice in the Montague basin north of Mount Toby (Brigham-Grette and Wise, 1988). The Barnes delta is thought to have developed while in contact with ice filling the basin to the north. The lack of any other outwash deposits suggests that the entire basin extending north from the Holyoke Range to Greenfield was freed of ice in a single stagnation event. A second stagnation event would then account for the removal of ice from the Montague basin. With the removal of the ice from the Montague basin, the ice edge in the Connecticut Valley lay near the present northern edge of the Millers River delta, and so the delta began to develop. This edge corresponds to the position of a buried bedrock obstacle (Tighe and Bond, 1988) which we infer impeded the movement of the glacial ice down the Connecticut Valley.

The melting of the ice to the north of the Millers River delta caused the cessation of major sedimentation on the delta (there may have been some minor continued sediment input from the Millers River Valley and smaller feeder streams) and created northern Lake Hitchcock. Although generally considered a continuation of the main body of Lake Hitchcock

(Stewart, 1961; Koteff and others, 1988), northern Lake Hitchcock was separated from the main body of the lake by the barrier of the delta. It is probable that a short river flowed from northern Lake Hitchcock to the main body of the lake.

GEOLOGY OF DELTA

The Millers River delta consists of three separate morphologic portions: Montague Plain, Turners Falls, and French King terrace. The Millers River separates Montague Plain from French King Terrace, and the bedrock barrier of the Mineral Hills and Willis Hill separate the Turners Falls portion from Montague Plain. Seismic surveys (Weston Geophysical, 1966; Tighe & Bond, 1988) indicate the thickness of the deltaic sediments ranges up to about 300 feet within the pre-glacial Connecticut River channel underlying French King Terrace and Montague Plain. The present channel of the Connecticut River crosses the bedrock barrier and flows over Turners Falls, probably reflecting historical flow patterns across the top of the delta.

The leading edge of the delta is morphologically distinct along the edges of Montague Plain (Montague-Turners Falls Road follows the base of the delta front), but is relatively indistinct along the Turners Falls portion. Jahns (1966) attributed the gentle slopes along the edge of the Turners Falls portion to beach erosion; we, however, prefer to attribute it to delta front collapse caused by groundwater percolation through the delta from the Connecticut River following the lake level drop to the south and before the incision of the delta by the river. The evidence, however, is insufficient at this time to distinguish between these two hypotheses, although the lack of beach erosion along the edges of Montague Plain would tend to detract from Jahns' (1966) explanation.

Kettles are prominent features in both Montague Plain and French King terrace. In Montague Plain there is a line of kettles extending from the Millers River gorge to the edge of the delta. The linear depression created by these kettles has been called a former channel of the Connecticut River (Emerson, 1898), but Jahns' (1966) mapping of late-stage channels across Montague Plain shows that the last flow directions emanate from the mouth of the Millers River Valley and cross this line. We attribute this line of kettles to ice caught in a lateral/medial moraine buried beneath the delta sands. The multiple large kettles in the French King terrace are consistent with a nearby ice margin.

The Connecticut River valley in Massachusetts north of the French King terrace contains only small kame deltas and river terraces that grade to the Lily Pond channels (Campbell and Hartshorn, 1980). There is no evidence of any stream deposits grading to the north end of the delta. The sediments at the north end of the delta contain both thrust and collapse features. Since flow indicators in the topset beds of the French King terrace show southward stream flow, we propose that this terrace was bounded to the north by ice.

POST-DEPOSITIONAL HISTORY

Following the deposition of the Millers River delta, the ice margin continued to retreat northward up the Connecticut Valley. The delta filled the junction between the narrow valley to the north and the broad valley to the south, thereby dividing Lake Hitchcock into two lakes. Because the outlet to the lake system lay to the south in central Connecticut, water should have flowed across the top of the delta deposits from the northern lake into the southern lake.

When the morainal dam in central Connecticut was breached, the level of southern Lake Hitchcock dropped relatively rapidly. The lake level to the north of the Millers River Delta, however, remained high until the river breached the delta deposits. This breaching can be expected to have occurred by upstream nickpoint migration. Changes of the channel direction may have occurred by groundwater flow through the deltaic sediments and upgradient migration of spring-fed streams until river capture occurred. We hypothesize that this may have occurred in the vicinity of Turners Falls. The original channel through the White Ash Swamp channel in Greenfield (Jahns, 1966) was captured and diverted to the present channel by groundwater seeping to the old delta front.

As the river incised into the delta, it finally encountered a bedrock barrier commonly called the Lily Pond barrier. The highest notch through this barrier was initially encountered, but the river then jumped to a lower, upstream notch and then finally to its present, downstream notch. These various river levels are clearly recorded to the north by river terraces grading to each of these notches (Jefferson, 1898; Campbell and Hartshorn, 1980). The causes of the changes to new channels are again attributed to groundwater seepage through the lower notches leading to river capture.

The timing of capture of the Millers River is not clear. Either pre-lowering or post-lowering scenarios are possible. The Fall River was probably diverted to its present course to Turners Falls when the Connecticut River was diverted away from White Ash Swamp channel.

CONCLUSIONS

The Millers River Delta was apparently formed in contact with stagnant glacial ice in the Connecticut River Valley. Thus, it is a classic lacustrine ice-contact morphosequence.

Following ice retreat northward in the Connecticut Valley, this delta divided lake Hitchcock into two distinct water bodies. As the lake level dropped in the southern portion, the delta delayed the drop to the north.

The incision of the river into the delta proceeded in stages. The procession of these stages was influenced by bedrock topography and groundwater flow patterns.

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Bernardston
Greenfield
Gill
Erving
Montague
Turners Falls
Millers Falls
Montague City
Riverside
Start
Lunch
Hales Crossing
Lake Pleasant
Deerfield
Barton Cove


White Ash Swamp
Start
Riverside
Barton Cove
Barrier
CONNECTICUT
RIVER
Delta Top
Rock
Millers Falls
Kettles
MONTAGUE
Turners Falls Airport
The Narrows
Deep Hole
Delta Top
Montague City
Country Hill
River

ROAD LOG

Meeting point: Turners Falls Overlook on Route 2 just west of Turners Falls Bridge.

This vantage point shows the present gorge of the Connecticut River where it has cut totally through the deltaic sediments down to the underlying bedrock. The bedrock falls serve as baselevel for the upstream portion of the Connecticut River. The tops of the surrounding hills are at or near the level of the delta top.

0.0 Proceed East on Route 2.

0.1 Turn Right across Turners Falls Bridge.

0.7 Turn Left at light onto 3rd Street.

The top of this hill is the delta top. This hill slope was created by the incision of the Connecticut River into the delta (Jahns, 1966).

1.5 Bear Right onto Montague Road.

2.3 Proceed Straight.

The gentle slope marks the front of the delta in this area. We hypothesize that this gentleness is due to collapse under artesian groundwater conditions following the lake level drop to the south; Jahns (1966) considered this to be a beach.

3.3 Note the steep delta front to the left. We are riding along the base of the delta front. When the vegetation is absent, channels can be identified by their coarser grain-size.

4.0 Turn Left.

4.1 STOP 1

Within the gravel pit to the left we will see topset and foreset beds of the delta. These deposits indicate flow toward the delta front and do not indicate beach reworking.

Proceed onto the delta and continue straight. Note the gentle topography off to the sides created by the late channels across the delta; the road is very nearly parallel to flow direction.

4.8 Continue Straight.

5.9 Turn Right onto paved road.

6.9 Turn Left onto Green Pond Road.

7.2 STOP 2
The depressions to the north and south are kettles. They are part of a line of kettles that we believe mark a marginal morraine buried beneath Montague Plain. Lake Pleasant to the south occupies the largest kettle in western Massachusetts (Larsen in Tighe & Bond, 1988).

Proceed.

7.5 Turn Left onto dirt road.

8.0 Turn Right onto paved road.

8.9 Turn Left.

9.4 STOP 3
Much of the top of the delta is covered with dune deposits. This is especially true around the Turners Falls Airport which we are next to. Here we will look at some stabilized dunes. Just to the north lies the present Connecticut River.

Turn Around and proceed eastward to Millers Falls.

11.1 Turn Left and cross the Millers River. The River has cut across the delta to join the Connecticut River about a mile downstream.

11.5 Turn Right toward Route 2.

12.1 Proceed East on Route 2.

12.7 STOP 4
The landfill to the right is used for sewage sludge from the Erving Paper Mill. At the east end of this pit there are some excellent examples of till overlain by lake clays. These clays must have been deposited in an ice-marginal lake. No obvious river terraces grading to the delta have been mapped in the Millers River Valley.

Turn around and proceed back west on Route 2.

13.6 Turn Right toward Route 63 north.

13.9 Turn Right onto Route 63.

15.1 As we pass under the power lines, we reach the north end of the delta. Note the lack of stream terraces grading to the north end of the delta.

16.0 Turn Right into Northfield Mountain reception center.

16.3 LUNCH

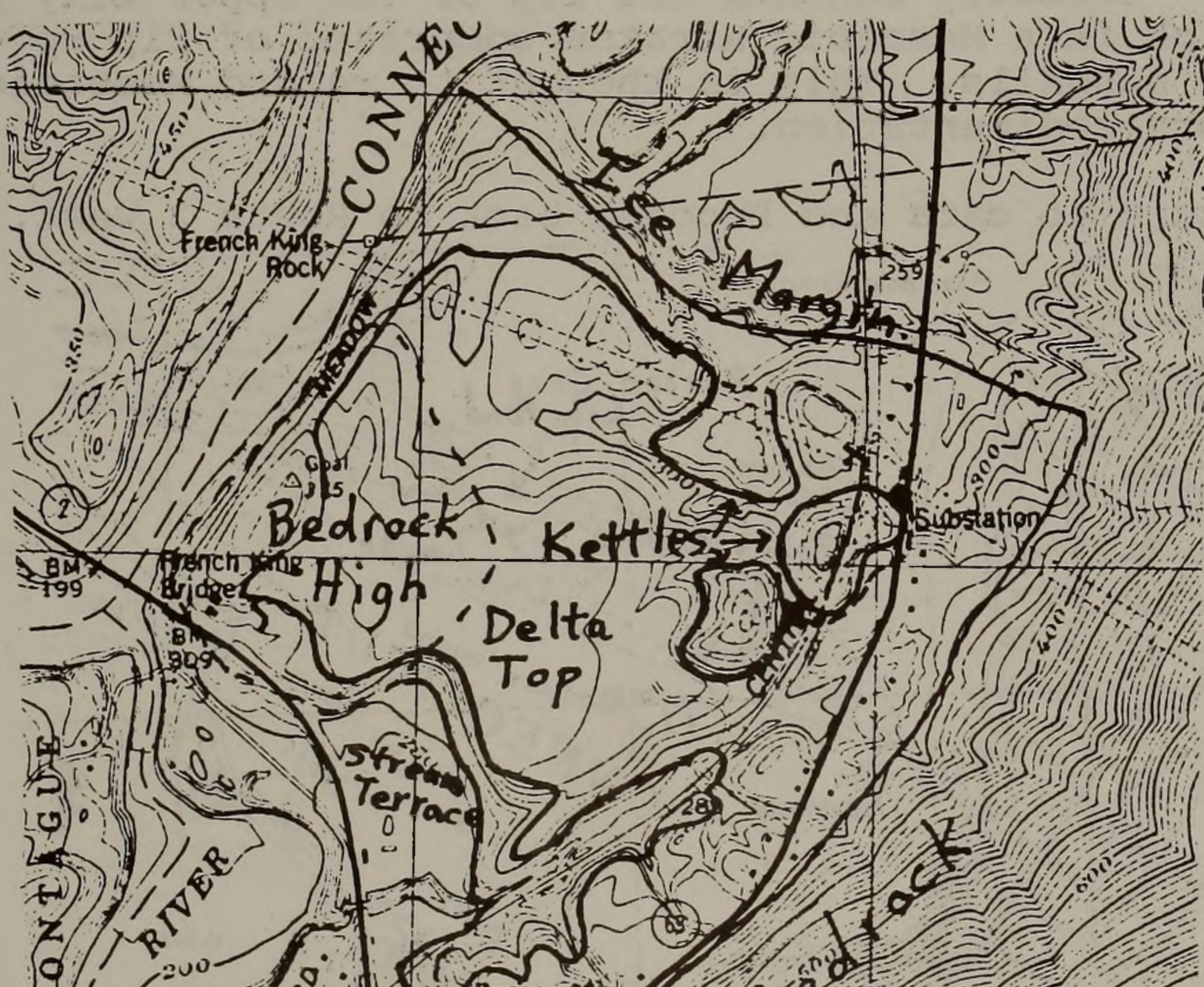
After lunch return to Route 63 and proceed back south toward delta.

7.4 STOP 5

Proceed back along road about 50 yards and follow trail back into woods to train tracks. Cross tracks and proceed to trail junction. In front of us lies a large (about 10 acre, >50 ft deep) kettle. This kettle is essentially dry. Just behind us lies another large kettle transected by the tracks. A third large kettle lies a short distance to the northwest. This large kettle is scheduled to be filled during construction of the Erving Industrial Park (Tighe & Bond, 1988).

Proceed back to the tracks and follow them northward across the causeway to the cut. Excavations along this cut have found both thrust and collapse structures. Sedimentary structures indicate flow toward the south.

Return to cars and proceed south.



18.5 Turn Right.

18.5 Turn Right onto Route 2 west.

19.5 Connecticut River.

19.6 STOP 6
Walk back to French King Bridge. This provides a good vantage for viewing the geomorphic relations around the north end of the delta. French King Rock in the Connecticut River just to north of the bridge is a large boulder.

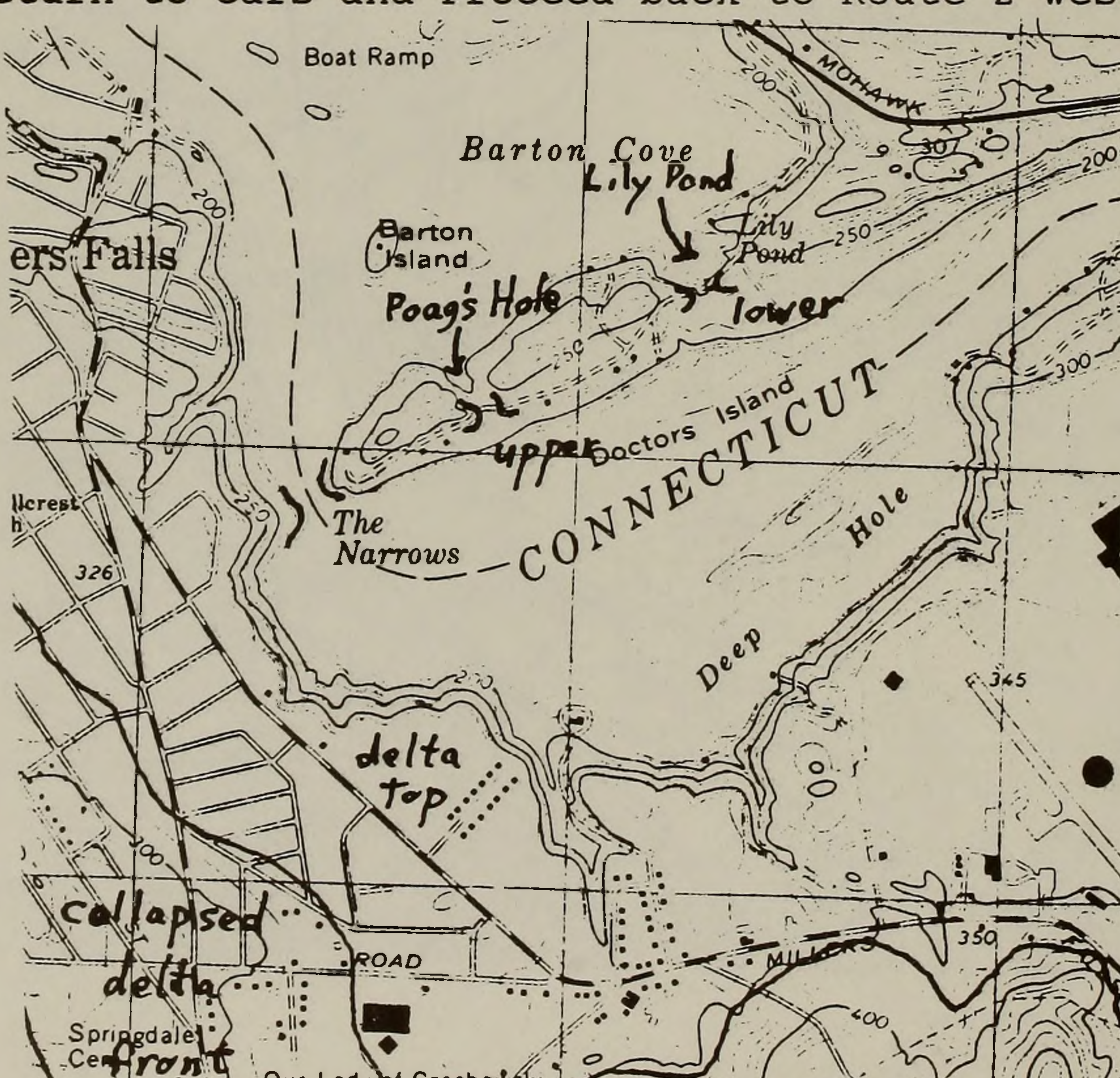
Return to the cars and proceed west.

21.9 Turn Left.

22.3 STOP 7
This is the Lily Pond Barrier. As we walk down to the notches, stream terraces can be seen along the east side of the peninsula. The first notch is the lower Lily pond notch. The plunge pool was the site of Lily Pond (Jefferson, 1898) before the water level was raised at the Turners Falls dam. The second notch is the the upper Lily Pond notch, where the plunge pool was called Poag's Hole. The end of the peninsula borders the present notch called the Race.

Directly beneath the lip of the upper Lily Pond notch is a Mesozoic stratum comprised of rip-up clasts and mudballs. This is thought to record Mesozoic storm sedimentation.

Return to cars and Proceed back to Route 2 west.



23.5 Proceed straight.

23.7 To left is starting point for trip.

24.3 STOP 8
The sand pit to the left contains excellent exposures of foreset and topset beds indicating southwestward current directions. The boundary between topset and foreset can be seen, and it should be noted that the boundary is actually a zone indicating that sedimant is delivered to the delta front as packets which then slump down the slope. The existence of this boundary zone makes determination of water levels from the boundary highly questionable, at least with the degree of accuracy Koteff and Larsen (in Koteff and others, 1988) have claimed.

Return to cars. Route 2 west toward I-91 follows the White Ash Swamp channel until it reaches Route 5.

END OF TRIP