GLACIAL GEOLOGY AND HISTORY OF THE NORTHERN HUDSON BASIN, NEW YORK AND VERMONT

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REGIONAL DEGLACIATION

Twelve recessional ice fronts are reconstructed in the northern Hudson basin (figure 1) from field work (LaFleur, private files; DeSimone 1977, 1985) and reinterpretation of existing data (Chadwick 1928; Stewart and MacClintock 1969, 1970; Connally 1973). Five additional ice fronts, A through E on figure 1, were modified from LaFleur (1965a, 1979) and Dineen et al (1983) and are included in a summary chart of deglacial events (figure 2).

Lowland Lake Levels and Transitions

Tilted water planes identify six significant intervals of water level stability punctuated by intervals of falling water level (figure 3). The six stable water levels are: Lake Albany, Lake Quaker Springs, Lake Coveville, Fort Ann I, Fort Ann II, and Fort Ann III. The data also support a distinct lowered Albany water level which may have been stable for a short time. The Albany, Quaker Springs, and Coveville water planes are clearly curved and asymptotic southward. The flat Fort Ann water planes probably represent only the most distal portions of similarly curved water planes originating in the northern Champlain Lowland. The low gradients of the Quaker Springs and Coveville water planes are appropriate for the distal portions measured. The gradients of the Albany and lowered Albany water planes are 2.6 ft/mi and 2.7 ft/mi, respectively. This compares favorably with tilts calculated by Fairchild (1917) at 2.4 ft/mi, by Stoller (1922) at 2.5 ft/mi, and by LaFleur (1965b) at 2.7 ft/mi.

The retreating Hudson Lobe defended Lake Albany through ice position 5. Clay deposited at 380-390 ft near Greenwich and the Greenwich outwash fan at 400 ft record there the maximum level of Lake Albany. A falling or lowered Lake Albany accompanied the retreating ice from position 5 through position 6 to position 7 while sediment was continuously deposited at the mouth of the Batten Kill. The Hudson Lobe defended a stable Lake Quaker Springs from position 7 through position 12 and into the Champlain Lowland. Fluvial-lacustrine sand deposited at tributary mouths, river terraces, terraced clay, and delta morphology delineated the Coveville and Fort Ann water levels, detailed later in the text.

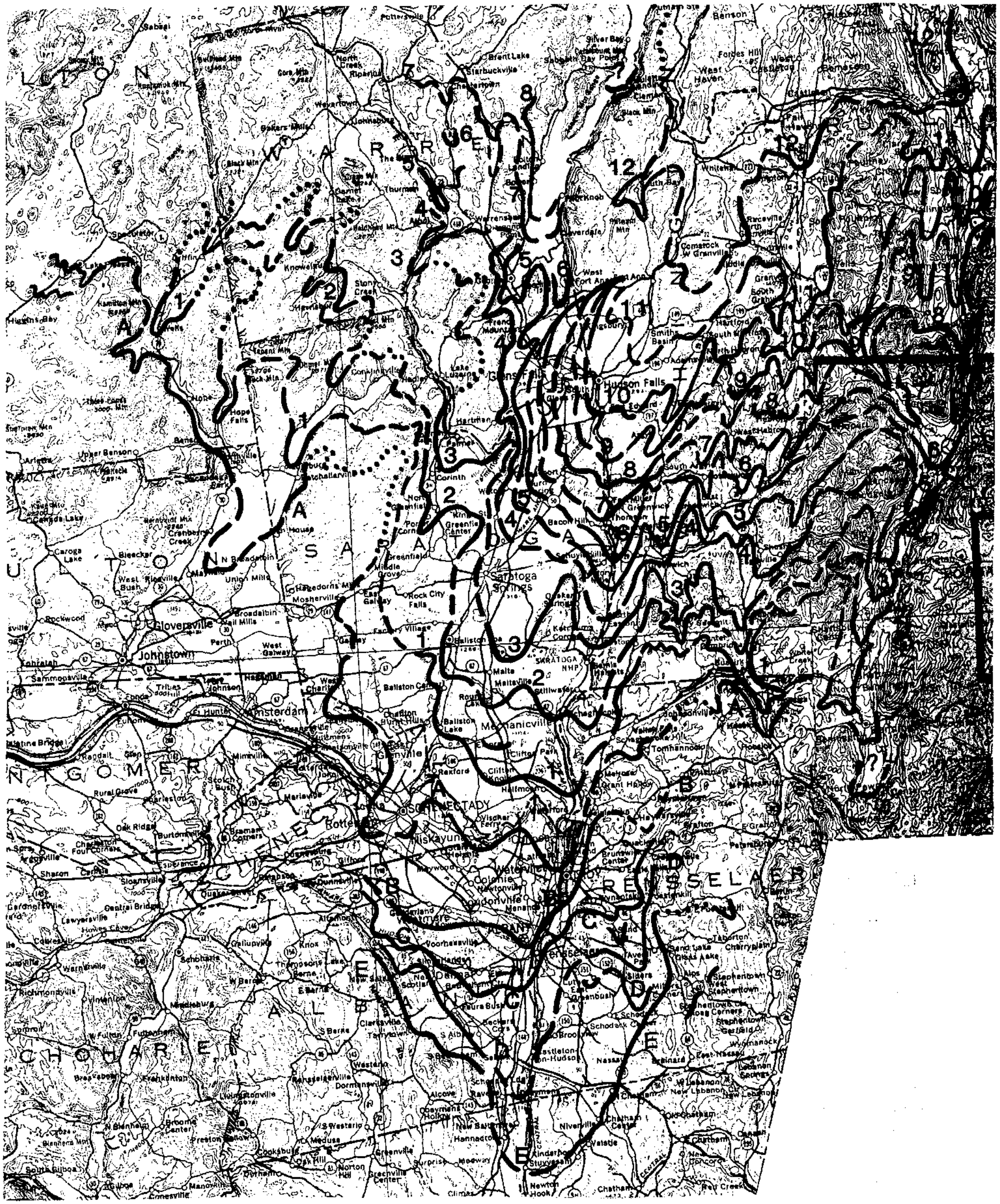

Figure 1: Retreatal ice margins in the northern Hudson basin. Scale is reduced to **76%** from a 1:500,000 base map.

KM Kame Moraine KT Kame Terrace KD Kame Delta Ksg Kamic sand & gravel IB Ice Block OW Outwash SF Subaqueous Kame Fan

TIME-STRAT UNITS	APPROX YRS BP	LAKE LEVEL	ICE MARGINS	SIGNIFICANT EVENTS
MACKINAW INTER-STADIAL		QUAKER SPRINGS	Welch Hollow (12)	Welch Hollow KM,KT; Lake Granville 420'; Mettawee & Poultney OW
			West Pawlet (11)	So. Granville till & Ksg 600'; Blossoms Corners moraine (Vt); Lake Pawlet outlet to Black valley
			Argyle Valley (10)	Argyle esker 330' & KD 320'; minor ice surge; Tamarack Swamp Ksg;Black valley kames & eskers; Lake Pawlet 700' with ice at Pawlet
			Danby (9)	Glens Falls Delta & matured Batten Kill Delta; Valley Crossroads SF 260'; Danby Four Corners moraine (Vt)
			Harper Road (8)	Early Glens Falls Delta 320'; Patten Mills KT; Harper Road SF 270'; Barkley Pond kames; Lake Cossayuna
	13,700		Black Valley (7)	Lake Albany fell to 310' Lake Quaker Springs; Batten Kill Delta 310'; Hoosic Delta 300'; Black valley moraine; Patten Mills KT
PORT BRUCE STADIAL		LOWER ALBANY	Carter Swamp (6)	Lowered Lake Albany 340'; Greenwich OW; local Batten Kill valley impondments; Hoosic terraces 320'-330'; Hudson 380' Delta; Glen Lake IB; Carter Swamp KM; Manchester moraine (Vt); Lake Sunnyside KM
			Moreau-Clark Pond (5)	Greenwich OW FAN 400'; Clark Pond KM; Eldridge Swamp IB; Camden valley KT's; Palmertown KT 460' to Moreau Pond KM 420'; Glen Lake Stagnation
		ALBANY	Wilton-Battenville (4)	Wilton KM 450'; Luzerne Mts Ksg 450-500'; Hartman Terrace 670'; Batten Kill OW & KT 420'; Battenville moraine; Saratoga IB; Cambridge OW
			Archdale-Corinth (3)	Archdale KM; Arlington moraine (Vt); Hoosic Delta 360-370'; Hoosic & Round Lake IB's; Woodland Lake KM (Corinth ice); Lake Corinth 670'; Hidden Valley moraine & local impondments of Lake Warrensburg
			Willow Glen (2)	Willow Glen & Country Knolls KD's 350'; early Hoosic Delta 370'; Hale Mt moraine (Vt); Corinth ice @ Porter Corners; Lake Sacandaga 760'; Milton Delta 420'; Ballston IB
			Waterford (1)	Waterford SF 200'; Halfmoon & Grooms KD's 340'; Hoosic terraces & OW 420-390'; North Hoosick moraine & Lake Hoosic; The Notch & Chestnut Woods Channels; Niskayuna IB; Lake Sacandaga expands to Batchelorville; Clifton Park till; Schenectady Delta
			Niskayuna (A)	Schen. & Scotia eskers; ice @ Schen. drumlins; Pollock Rd KD 300+'; Poestenkill Delta 320-330'; Speigletown-Melrose KT 400'; Lake Tomhannock; ice @ Nipmoose Hill & W. Hoosick; Hoosick Falls KM & Lake Hoosic
			Guilderland (B)	Guilderland KT 350'; McKnownville till; Loudonville Kame Complex 350-390'; Rensselaer SF 300'; North Greenbush KT 380'; Sycaway KT 400';
			Meadowdale (C)	Meadowdale moraine 400'; Voorheesville KD 350'; Wemple SF 140'; Hampton SF 300'; Wynantskill-Pine Bowl -Poestenkill Ksg 450'
			Schodack (D)	East Greenbush-Schodack KT 350'; Schodack OW Fan 320'; West Sand Lake-Burden Lake Ksg 600'; New Salem Ksg & OW 450'
	14,700?		Pine Swamp (E)	Pine Swamp-Nassau Lake Ksg & OW 500'; Sand Lake-Glass Lake Ksg & OW 800'; Snake Hill OW 850'; Ives Corner Ksg & OW 900'

Figure 2. Summary of ice retreat events in the northern Hudson basin

Lake level transitions — intervals of falling water level — were either gradual or rapid. Continuous sedimentation of the Greenwich outwash fan from 400 ft to 340 ft and the absence of erosional escarpments or dissection features in the northern Hudson Lowland are evidence for a slowly falling Albany water level. Rudimentary calculations using ice retreat rates of 500-1000 ft/yr (Schafer 1968) suggest an average water decline of 2 ft/yr as the Hudson Lobe retreated from the Moreau-Clark Pond ice margin to the Black Valley ice margin, a distance of approximately 6 miles as measured on the Schuylerville quadrangle.

There is considerable evidence that the Quaker Springs-Coveville and Coveville-Fort Ann I transitions were initiated by high discharge through the glacial Mohawk Valley and eastern outlet channels, which resulted from water level fluctuations in the Ontario Lowland (Stoller 1922, LaFleur 1975, 1979, 1983, Hanson 1977). Extensive erosion in the lower Fish Creek valley from Grangerville to Coveville indicates the Grangerville channel carried high discharge during the Coveville-Fort Ann I transition (DeSimone 1977, p35). The channel topography is strongly fluted in the southeastward flow direction ; lake clay remnants are preserved in the shadows of eroded drumlins; and till and bedrock were scoured from 240-200 ft above Coveville.

Clark and Karrow (1984) correlated falling water levels in the Ontario and St. Lawrence Lowlands (lower Iroquois and post-Iroquois) with drainage around Covey Hill into Lake Fort Ann in the northern Champlain Lowland. This inflow to Lake Fort Ann increased outflow from the southern end of the Champlain Lowland along three Fort Ann channels (Fort Edward, Durkeetown, Winchell). Accompanying erosion deepened these outlet channels until the water level stabilized at a lower elevation. Accordingly, the Fort Ann I-Fort Ann II transition is correlated with Clark and Karrow's Level II-Level III transition and the Fort Ann II-Fort Ann III transition is correlated with their Level III-Level IV transition. The final Fort Ann III-Champlain Sea transition, Clark and Karrow's Level IV-Level V transition, resulted in abandonment of the Fort Ann channels and establishment of a late glacial-Holocene drainage configuration in the northern Hudson Lowland.

Timing and Rate of Retreat

Hanson (1977) noted a northward sediment volume decrease in kame deltas, which might suggest an increased melting rate of the Hudson Lobe as it retreated northward. Ice Margins E through 6 (figure 1) are generally well-represented by kame deltas, kame moraines, and kame terraces deposited along the margin of the Hudson Lobe. Kame moraines, kame terraces, and thick outwash sequences accurately delineate these ice margins in the Taconic Highlands. A late Port Bruce age is inferred for these events (LaFleur 1979).

Ice margins 7 through 12, with the exception of the Argyle Valley ice margin (10), record accelerated retreat. Thinner outwash sequences with less kamic sediment in the Taconic Highlands, and a general absence of significant ice-marginal sediment along the Hudson Lobe is consistent

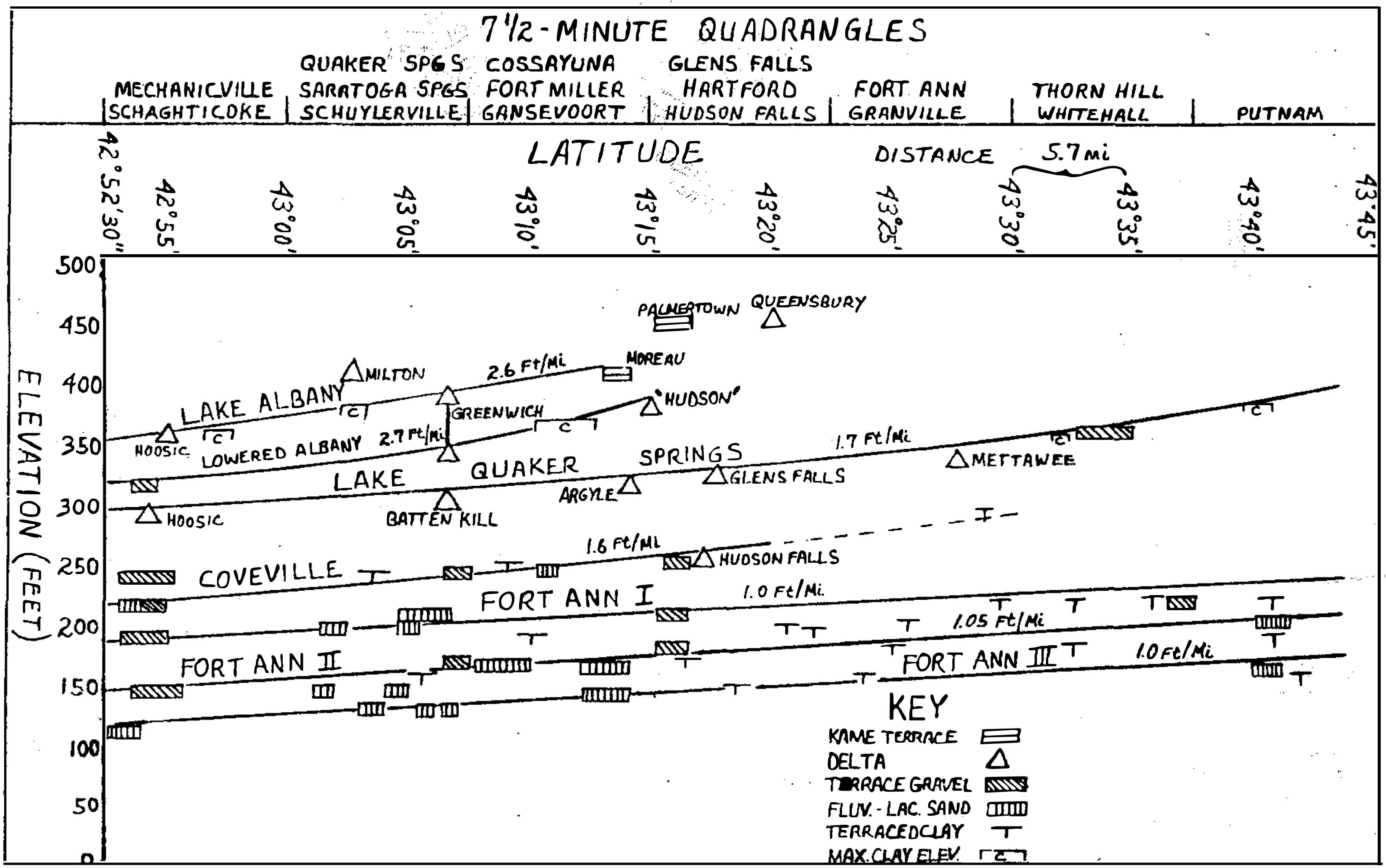

Figure 3: Tilted water planes in the northern Hudson and southernmost Champlain Lowlands. The average gradients were measured between the endpoints of each water plane. Additional data can be found in Woodworth (1905), Chapman (1937), Wagner (1969, 1972), and Parrot and Stone (1972).

with this view. Each of these later ice margins record a shorter pause in an overall more rapid retreat, as documented by the small subaqueous fans in the Argyle Valley associated with ice margins 8 and 9. Undoubtedly, this more rapid retreat through the northern Hudson Lowland was, in part, topographically controlled — a consequence of progressively diminished nourishment of the Hudson Lobe from its four feeder sublobes (Caldwell, Queensbury, South Bay, Whitehall). Ice apparently retreated from the Lake George graben most rapidly because that ice was pinched between the steep bordering highlands at the northern end of the graben. Ice persisted longer in the Taconic foothills and in the South Bay sublobe, both adjacent to the primary Whitehall sublobe. This span of more rapid retreat is tentatively assigned an early Mackinaw age. For the convenience of discussion and in the absence of radiocarbon dates, it may be appropriate to consider the final transition from Lake Albany to Lake Quaker Springs at the Black Valley ice margin (7) as the Port Bruce-Mackinaw "boundary" in the Hudson Lowland.

Deglacial Style

Taconic Highland deglaciation was characterized by a thinning ice cover that exposed till-veneered hills and also by active ice tongues in those valleys oriented parallel to the direction of ice flow. Ice tongue margins retreated sporadically through intervals of rapid retreat, slow retreat, and halted retreat. Topographic control determined the location of distinctive kame moraine sediment bands along the base of moderate to high relief slopes against which an ice tongue impinged for a significant interval. Minor kame moraine segments and isolated kames and eskers record pauses of shorter duration. Foreset-type fan or deltaic sediment was deposited from retreating ice margins into local impondments temporarily dammed by sediment and/or ice. Outwash sequences were deposited in more freely drained valleys. Heads of outwash are recognized on the basis of morphology, profiles of depositional gradients, and textural relationships in the sediment. Abandonment of ice from a valley segment was topographically controlled and had no necessary effect on the retreat of adjacent ice tongues. Hence, continuous stagnation zones were not uniformly present along the ice front.

The retreating Hudson Lobe defended ice-marginal Lakes Albany and Quaker Springs. Melting ice contributed a large sediment volume to the lake basin and a characteristic lacustrine sequence was deposited (Dineen and Rogers 1979). A basal facies of interbedded gravel and sand with turbidites and minor flowtill grades and fines upward to clay and silt rhythmites of the middle facies. These rhythmites grade and coarsen upward to silt and sand beds of the upper facies deposited in shallow-water portions of the basin. Discrete meltwater sources in the Hudson Lobe deposited kame deltas, esker deltas, and smaller subaqueous fans, which generally decrease in number and sediment volume to the north. The typical fining upwards sequence in smaller kame deltas and subaqueous fans deposited from retreating meltwater sources contrasts the progradational sequence of major kame deltas deposited during intervals of halted retreat. Kame terrace and kame moraine sediment accumulated along the margins of the Hudson Lobe predominantly along the base of high relief escarpments such as the Palmertown Range, the Luzerne Mountains, and the Taconic escarpment.

Major tributaries transported a large sediment volume to the lake basin and significant deltas were deposited at the mouths of the Hudson River, Mohawk River, Batten Kill, Mettawee River, and Hoosic River. The typical stratigraphic profile, as illustrated by the Batten Kill delta, consists of horizontally-stratified to cross-stratified topset gravel and sand beds that prograde over and often truncate predominantly cross-stratified foreset gravel and sand interbeds. This facies laterally interfingers with and overlies horizontally-bedded, finely cross-laminated, and ripple-laminated bottomset sand, silt and clay.

No stratigraphic evidence for a major readvance correlative to the Luzerne readvance was observed. All reconstructed ice margins are apparently recessional and record intervals of slowed or halted retreat. Ice positions 1 and 10 approximately coincide, respectively, with the limits of the Shelburne and Burlington drift borders in the Vermont Valley. There is no evidence that these are readvance positions (Larsen 1972; Wagner et al 1972; DeSimone 1985). Minor ice surges probably occurred as indicated at Clifton Park (Dineen et al 1983) and in the Argyle valley (DeSimone 1985).

DETAILED WOODFORDIAN HISTORY

Woodfordian ice advanced generally southward and southwestward along the bedrock structural grain (figure 4). The Taconic Highlands were abraded and streamlined into a drumlinoid landscape mantled by variably-thin till. Deglacial sediment buried a similarly abraded and streamlined topography in the Hudson Lowland. Thick till accumulated in several lowland drumlin clusters and in isolated upland pockets. A well-compacted unoxidized gray lodgement till facies in both lowland and highland regions is composed of an unstratified silty to clayey matrix (75%) with subrounded to rounded pebble, cobble, and boulder clasts (15-30%) of predominantly local lithologies.

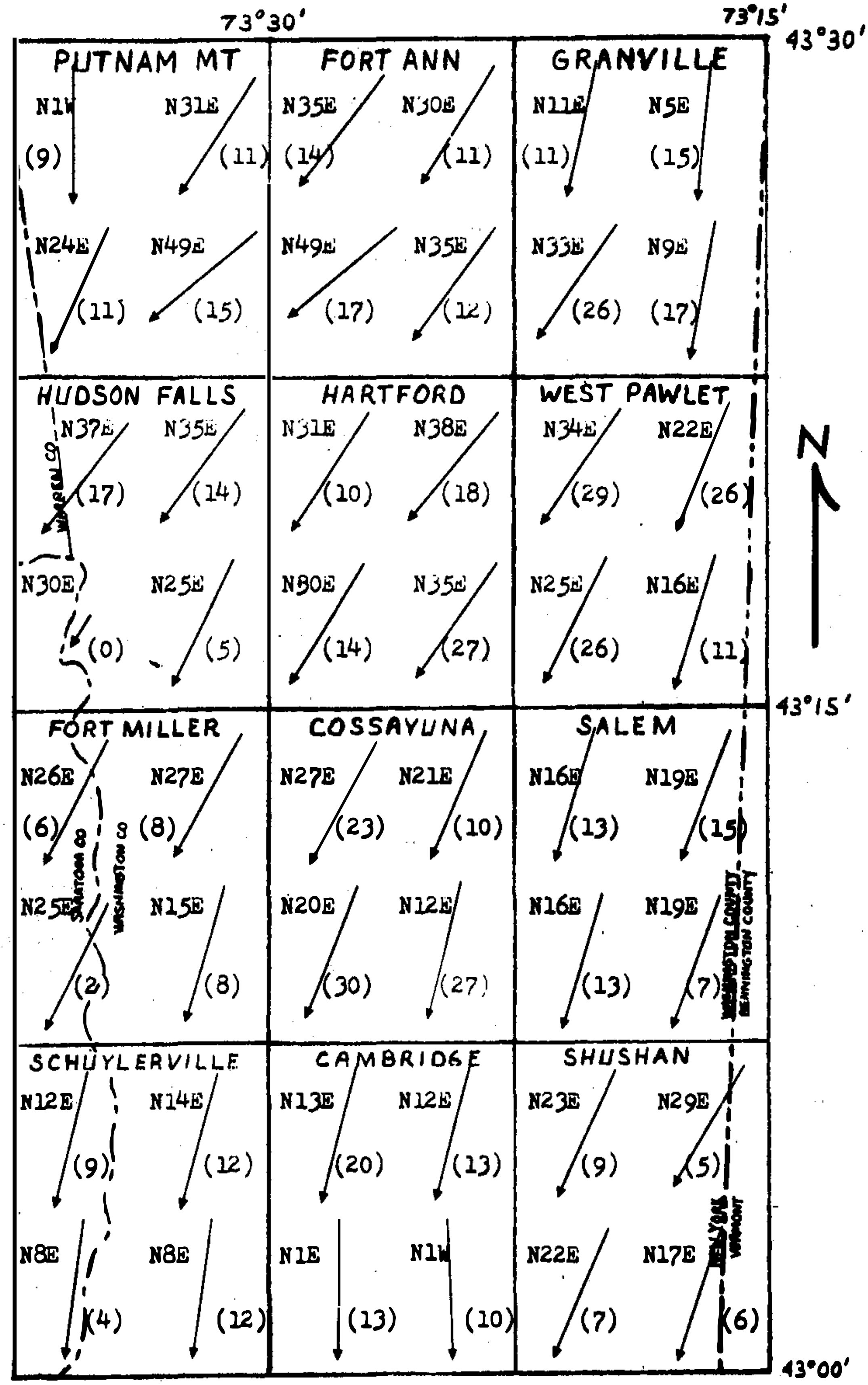

Figure 4: Summarized ice flow directions are depicted at a scale of 1:250,000. Drumlin axes, roc-drumlin axes, and striations were used. The average compass direction for each quadrant of a quadrangle is given and the number of axes used to determine this average is indicated in parentheses.

Albany Deglacial Phase

Waterford Ice Margin (1). Small kame deltas or subaqueous fans were successively deposited into Lake Albany at Waterford, Halfmoon, and Grooms Church. The Hudson Lobe blocked the Hoosic valley east of Schaghticoke and terrace/outwash sediment accumulated from Buskirk (420 ft) to Valley Falls (390 ft), perhaps filling a local impondment (figure 5). The Wampecack valley ice tongue extended through South Cambridge and South Easton and a meltwater channel was incised along Whiteside Creek. The Cambridge valley ice tongue terminated at North Hoosick and defended glacial Lake Hoosic where considerable silt and clay accumulated south of Hoosick Falls. Meltwater flowed through the Notch (1050 ft) and the Chestnut Woods pass (1180 ft) from ice impinged against the Chestnut Woods and Barber Hills ridge and deposited outwash sediment through the White Creek area. The Vermont Valley sublobe approximately coincided with the Shelburne drift border between North Bennington and South Shaftsbury but this is apparently not a readvance position. An ice tongue north of Batchelorville defended glacial Lake Sacandaga and meltwater was contributed from ice that terminated at Hope Falls and Wells on the Harrisburg and Lake Pleasant quadrangles, respectively.

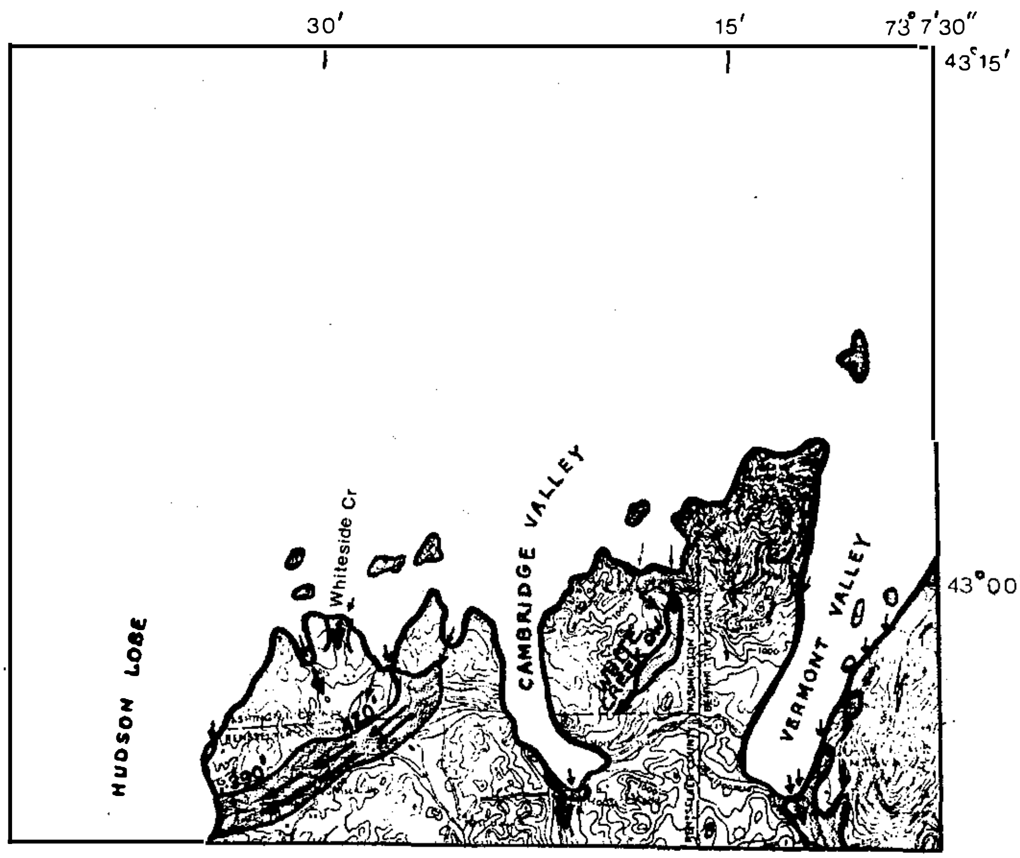

Figure 5: Waterford ice margin

Willow Glen Ice Margin (2). The Willow Glen and Country Knolls (south of Round Lake) kame deltas were deposited along the margin of the Hudson Lobe. The lower Hoosic valley was ice-free and the glacial Hoosic River deposited early deltaic sediment (370 ft) into an expanding Lake Albany (figure 6). The retreating Wampecack and Cambridge valley ice tongues terminated near West Cambridge and Center White Creek, respectively, and deposited outwash sediment and contributed meltwater to the Hoosic River. Glacial Lake Hoosic drained down the Hoosic valley as the Cambridge valley ice tongue retreated northward. Outwash sediment accumulated in the Pencil valley from meltwater originating in ice impinged against Chestnut Ridge and the thin sandy till ridge at the head of the Pencil valley. The Vermont Valley sublobe retreated to the Hale Mountain moraine. The Corinth ice tongue terminated in the Porter Corners area; meltwater flowed down the Kayaderosseras valley and deposited the Milton delta (420 ft) into an ice-marginal impondment. Glacial Lake Sacandaga lowered to 760 ft but was still defended by ice in the lower Sacandaga valley. The Ballston ice block was abandoned in the Ballston channel.

Archdale-Corinth Ice Margin (3). Sediment northeast of Deans Corners on the Quaker Springs quadrangle and south of Saratoga Lake identified the Hudson Lobe margin as depicted by Chadwick (1928, p903). Basal gravel of the lowermost lacustrine facies accumulated along the edge of the Battenkill-Hudson channel near Bemis Heights (Dahl 1978; LaFleur 1979). Significant ice blocks were abandoned in the Battenkill-Hudson channel near the mouth of the Hoosic River and in the Colonie channel at Round Lake. Deposition of the Hoosic delta continued and Lake Albany expanded to the area west of Willard Mountain. Meltwater flowed through the pass between Schuyler Mountain and the Willard-Whelden ridge and deposited a small outwash fan into Lake Albany. The Archdale kame moraine accumulated against the flank of Herrington Hill and outwash sediment was deposited downvalley from the terminus of the Wampecack ice tongue near Fly Summit (figure 7). Outwash sediment accumulated in the Cambridge and Pencil valleys as the ice retreated and minor ice-marginal kamic sediment was deposited southwest of Coila on the Cambridge quadrangle. The higher Taconics of the Shushan quadrangle and southwestern Vermont were deglaciated. Some meltwater flowed through the Bates pass (1280 ft) and deposited outwash gravel in the White valley east of Cambridge. The Vermont Valley sublobe retreated to the kame and kame moraine sediment of the southern end of the Arlington moraine north of Shaftsbury (Stewart and MacClintock 1969, p85-86; 1970).

Some ice-marginal sediment accumulated on the slopes of the Palmertown Range above the more extensive Wilton kame moraine of later origin. An extensive stagnation kame moraine accumulated at the margin of the Corinth ice tongue through Randall Corners and Woodland Lake on the Corinth quadrangle. Lake Corinth (670 ft) was impounded between this ice margin and accumulated sediment of the previous margin near Greenfield Center. Horizontally-bedded and ripple-laminated sand and silt was deposited into Lake Corinth. The extension of this ice front into the Adirondacks is not precisely known but it may correlate with the Hidden Valley moraine (Connally and Sirkin 1971). Local impondments amid abandoned ice in the upper Hudson Valley from Stony Creek to Corinth filled with outwash-terrace gravel and sand and constituted Lake Warrensburg, which emptied into Lake Corinth.

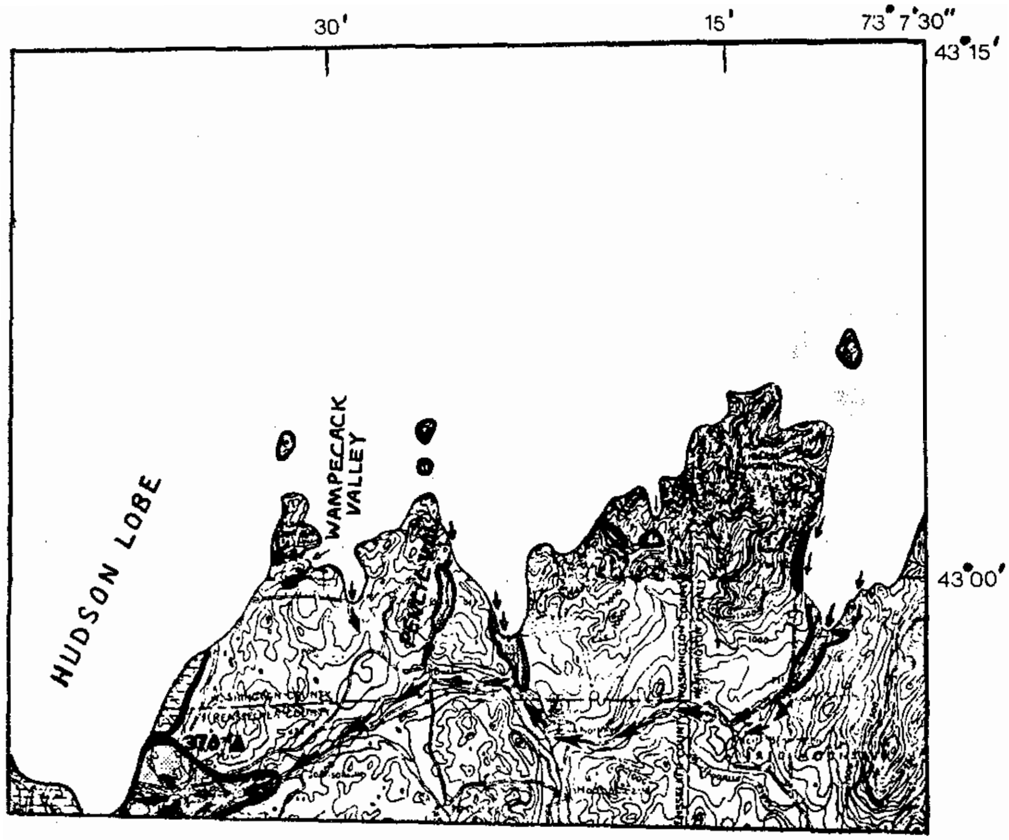

Figure 6: Willow Glen ice margin

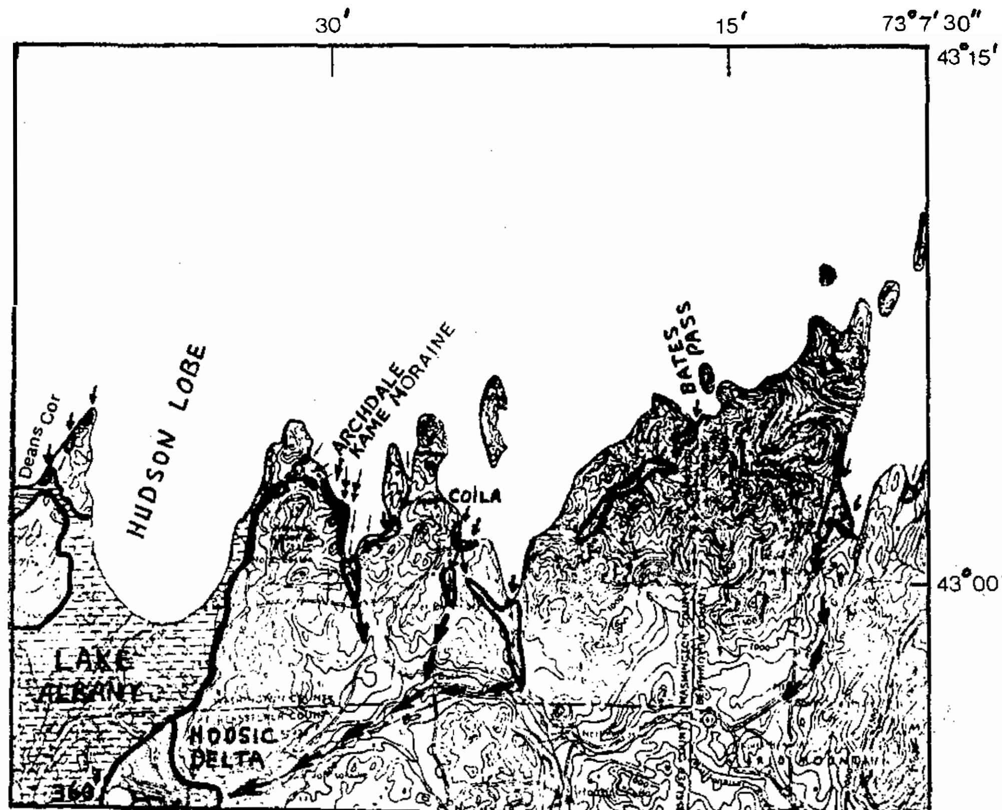

Figure 7: Archdale-Corinth ice margin

Wilton-Battenville Ice Margin (4). The Saratoga ice block was abandoned and Kendrick Hill (Chadwick 1928) was deglaciated. The Hudson Lobe blocked the Batten Kill valley at Greenwich and a small kame terrace (420 ft) was deposited against the northern flank of Schuyler Mountain. The Battenville moraine and associated kames accumulated in the Batten Kill valley and outwash gravel with sand was deposited to 420 ft between till-veneered hills westward to Greenwich (figure 8). Thin (20-45 ft) outwash sediment was deposited from the head of the Lauderdale valley at 540 ft and merged with the extensive (100-150 ft thick) outwash deposited in the Cambridge valley from a head of outwash at Eldridge Swamp. Meltwater from Vermont's Green valley, near West Arlington, contributed to outwash sediment that was deposited up to 580 ft elevation through the NY-VT border area. The Vermont Valley sublobe retreated to the Arlington area and kame terrace sediment accumulated northwest of Arlington. Extensive ice-marginal sediment was deposited in the Wilton embayment along the base of the Palmertown Range at approximately 450 ft and along the base of the Luzerne Mountains from 450-500 ft (Connally 1973). The 670 ft Hartman terrace gravel was deposited and represents the last sediment associated with Lake Corinth. Kamic sediment accumulated along the margin of the Caldwell sublobe (Chadwick 1928) at 800 ft and at 900 ft along Warrensburg Road.

Moreau-Clark Pond Ice Margin (5). The eastern margin of the Hudson Lobe retreated to a position partly located from a water well log which recorded 90 ft of basal gravel beneath later clay in the Battenkill channel southwest of Greenwich. Lake Albany reached its maximum extent as the ice retreated to this position and clay was deposited south of Bald Mountain and in the Hartshorn valley to 390 + ft. Meltwater from the Hartshorn ice tongue and the glacial Batten Kill deposited the Greenwich outwash fan-delta at 400 ft into Lake Albany (figure 9). The Clark Pond kame moraine accumulated against the flanks of the hills south of East Greenwich and outwash sand and gravel was deposited around minor ice blocks at Hedges Lake, Dead Lake, and Schoolhouse Lake. Ice persisted in the Camden valley and kame terrace sediment accumulated to 850 ft along the NY-VT border and at similar locations against the eastern flank of this valley in Vermont. Late active(?) ice may have occupied the large circular basin northwest of Mt. Equinox which would account for the kame terrace sediment above 1000 ft in the upper Green valley as interpreted from Stewart and Mac Clintock (1970). The higher Taconics east of the Camden valley were deglaciated and the Vermont Valley sublobe retreated to the Sunderland area. A local impondment dammed by sediment at Arlington, Lake Batten, may have expanded against the retreating Vermont Valley ice.

The 460 ft kame terrace at the base of the Palmertown Range just south of the Hudson River and the 420 ft Moreau Pond kame moraine accumulated along the western margin of the Hudson Lobe. The Queensbury sublobe stagnated in the Glen Lake region and sediment accumulated from 500 ft to a 460 ft delta deposited in a temporary impondment through Queensbury (Chadwick 1928). Ice marginal sediment at 600 ft (Interstate 87, exit 21) located the terminus of the Caldwell sublobe.

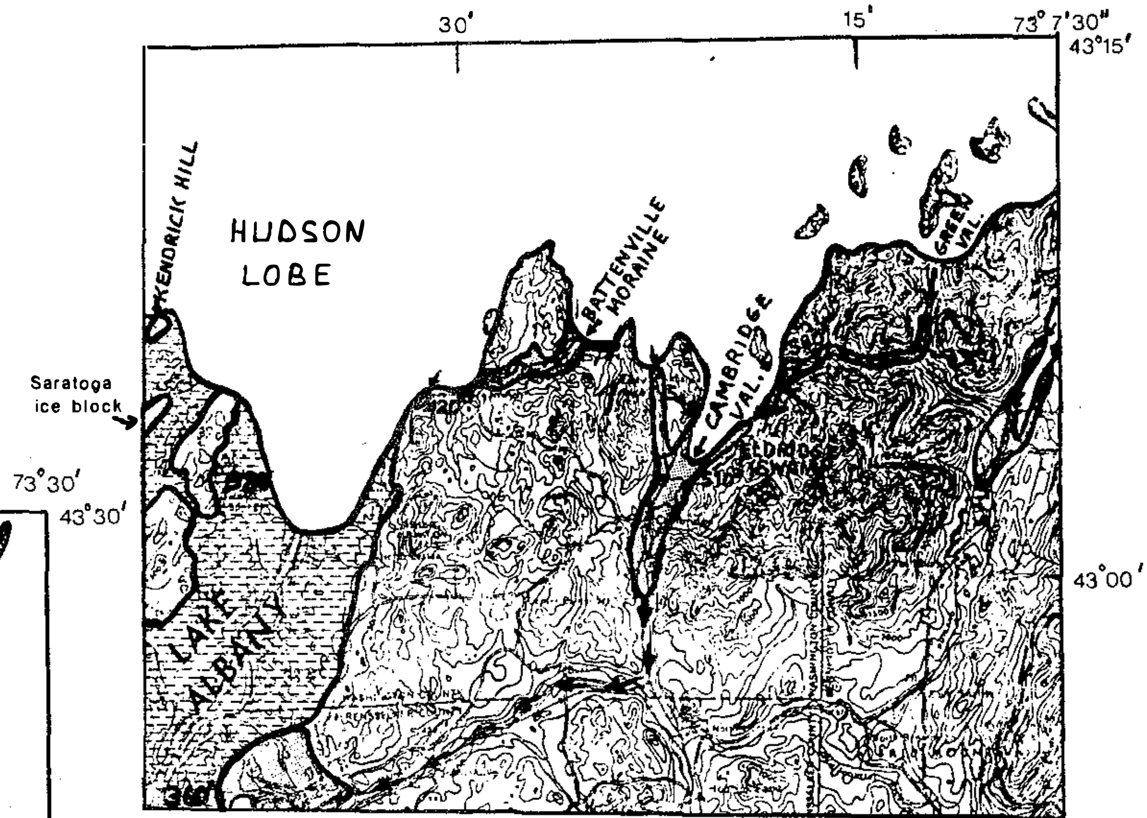

Figure 8: Wilton-Battenville ice margin

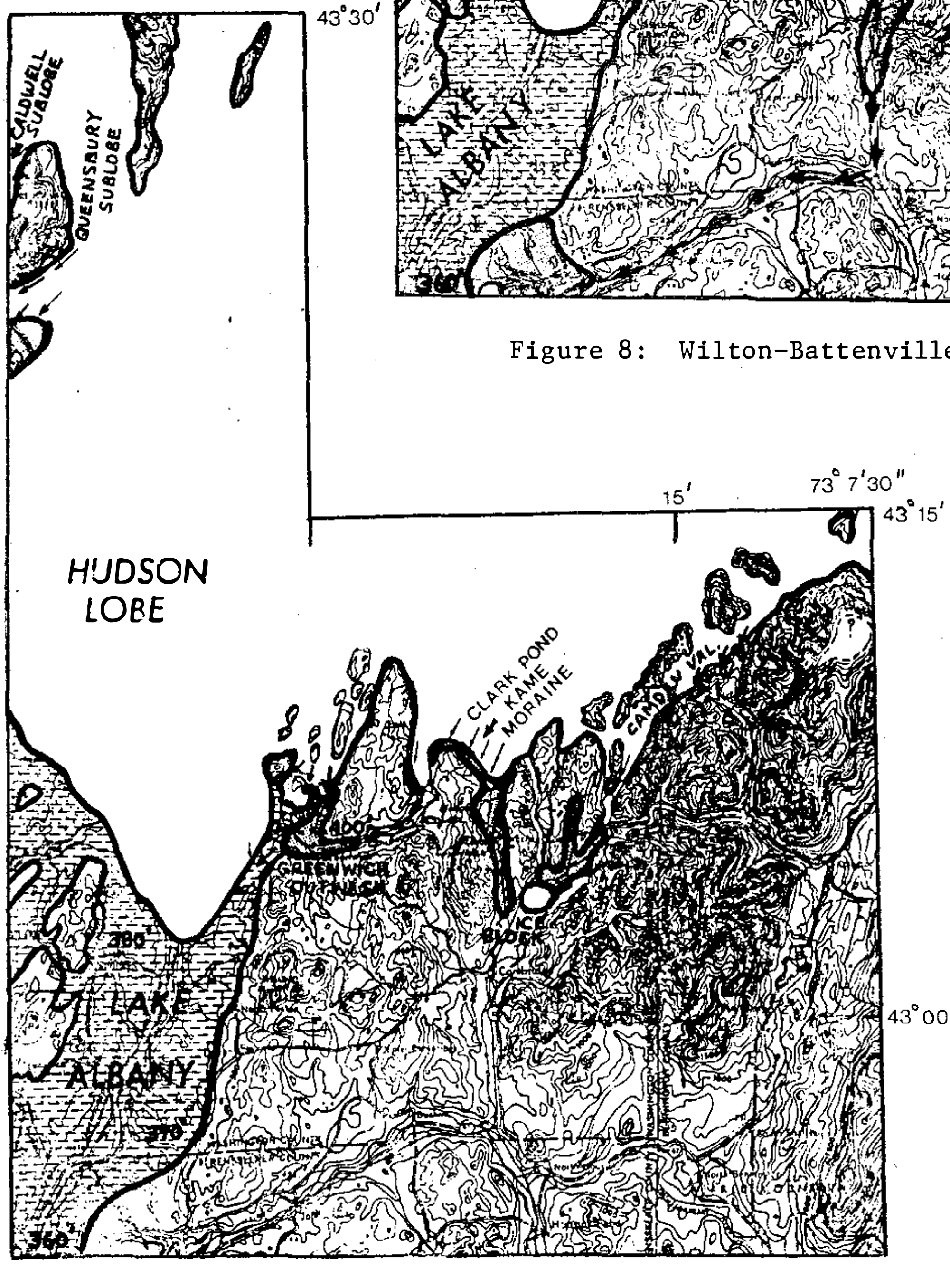

Figure 9: Moreau-Clark Pond ice margin and maximum Lake Albany

Carter Swamp Ice Margin (6). Lake Albany gradually fell to 340-350 ft measured at Greenwich as indicated by continuous deposition of the Greenwich outwash fan without significant dissection or terrace formation as might be expected if the lake level fell rapidly. The 320-330 ft terrace sediment of the Hoosic River was deposited at the time. A Whittaker valley ice tongue terminated across the southern end of Carter Swamp and a small band of kame moraine accumulated west of the swamp. Deltaic gravel and sand prograded into a temporary meltwater impondment dammed by sediment and/or ice at Battenville. A similar ice and sediment dam at Eldridge Swamp diverted meltwater in the upper Batten Kill through the Shushan-Rexleigh channel (figure 10). The Salem and Black valley ice tongues retreated from their junction and meltwater from the above three sources deposited extensive deltaic and outwash sediment perhaps into the same isolated impondment dammed at Battenville or a similar one dammed at East Greenwich. Continual retreat of the Salem and Black ice tongues would account for the predominant foreset-type deltaic gravel and sand interbeds observed. The distal foreset sand and fine gravel beds grade southward to ripple-laminated and finely cross-laminated fine sand and silt bottomset beds.

The Manchester moraine through Manchester, Manchester Depot, and Barnumville approximated the terminus of the Vermont Valley sublobe. Chadwick's (1928, p909) 380 ft terrace of the Hudson west of Glens Falls was correlated with deposition of the Greenwich outwash fan. The Glen Lake ice block was abandoned and the active margin of the Queensbury sublobe retreated to the Lake Sunnyside area.

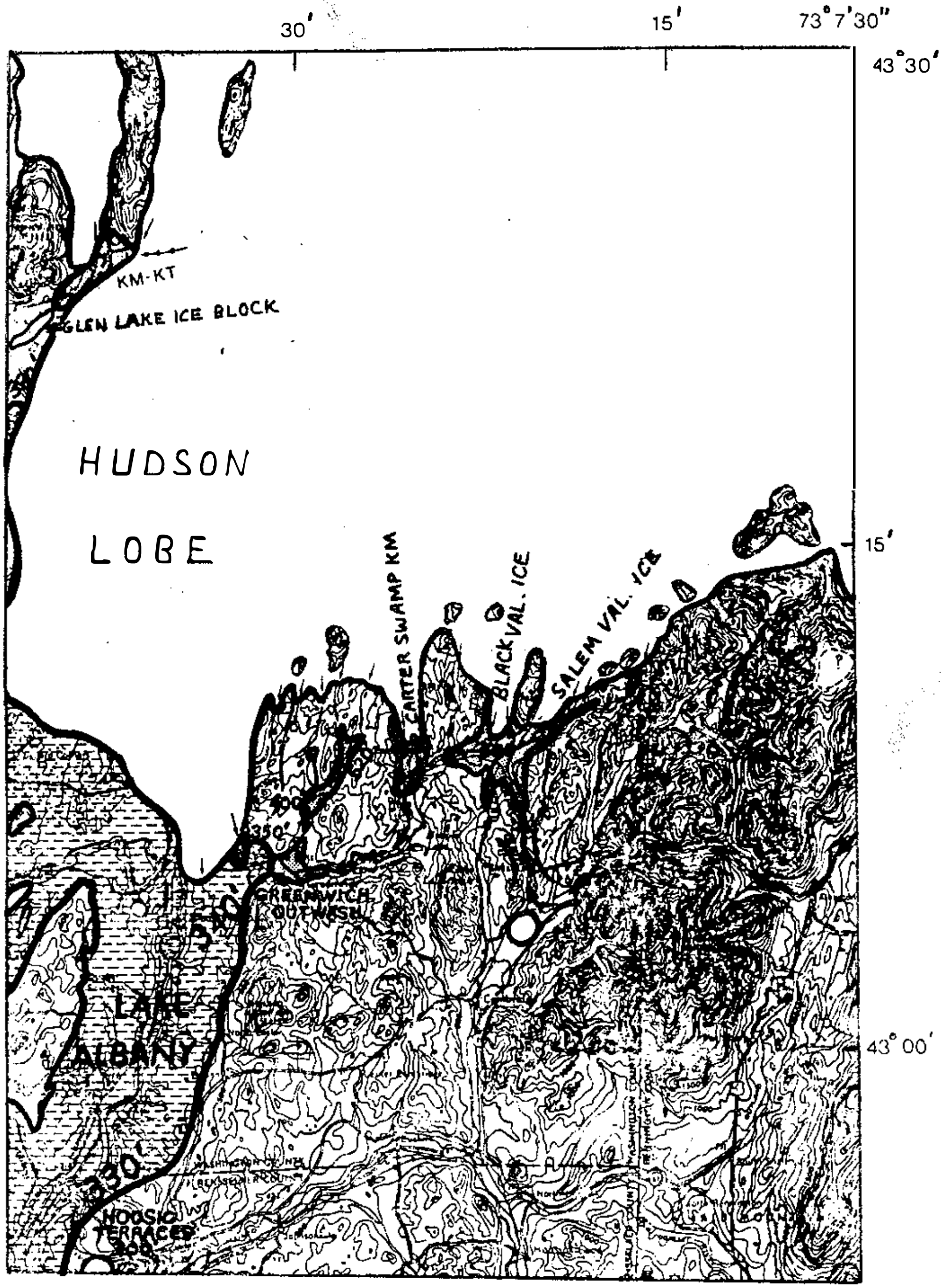

Figure 10: Carter Swamp ice margin and a lowered Lake Albany

Quaker Springs Deglacial Phase

Black Valley Ice Margin (7). Lake Albany continued to fall and stabilized at the 310 ft level of Lake Quaker Springs measured at the latitude of the Batten Kill delta (figure 11). Woodworth (1905, p177) first observed the "... falling off in altitude of the deltas successively northward from that of the Batten Kill" and noted their failure to coincide with an Albany water plane. He concluded, "... these lower deltas were not made in the waters of Lake Albany." Delta elevations and the distribution of lacustrine sediment in the northern Hudson Lowland confirmed an absence of the higher waters of Lake Albany north of the Black Valley ice margin (DeSimone 1983, 1985). The Glens Falls delta (330 ft), Batten Kill delta (320 ft), Argyle esker delta (320 ft), Mettawee delta (330-340 ft) and perhaps the 360 ft sediment at the junction of the Poultney and Castleton Rivers in Fair Haven, VT, were all deposited into a stable Lake Quaker Springs at or near its maximum level.

Numerous ice tongues protruded into minor valleys in the Taconic Highlands of Washington County and small outwash sequences were deposited from these heads of outwash. The Black ice tongue terminated near Bean Rd where kamic sediment and a thick till accumulation may be of morainal origin. Minor kamic sediment reworked by later outwash sedimentation identified the margins of the West Beaver and Beaver valley ice tongues. A distinct meltwater channel with a threshold at 660 ft perched above the south rim of Scott Lake locates another segment of the ice margin. A change in gradient of the outwash sequence profile identified the margin of the Salem valley ice tongue, and meltwater eroded till along the valley flank. The Vermont Valley sublobe and Mettawee ice tongue terminated along the kame moraine and kame terrace sediment at East Dorset and South Dorset, respectively.

Previous sediment and/or ice dams at Battenville and perhaps at East Greenwich and Arlington were breached and any local impondments drained. Dissection of previously deposited valley fill occurred in response to the lower base level of Lake Quaker Springs and the unimpeded meltwater flow initiated deposition of the extensive Batten Kill delta. A prevailing lake or longshore current transported sand south from the delta and this sand accumulated as a distinct blanket over clay through the central portion of the Schuylerville quadrangle.

The Hoosic River breached its Albany delta and redeposited sediment in its 300 ft Quaker Springs delta. The western margin of the Hudson Lobe may have followed Palmer Ridge and similar ridges through the Fortsville area. The extensive Patten Mills kame terrace and ice-marginal sediment in the Diamond Point and Trout Lake area west of Lake George were deposited.

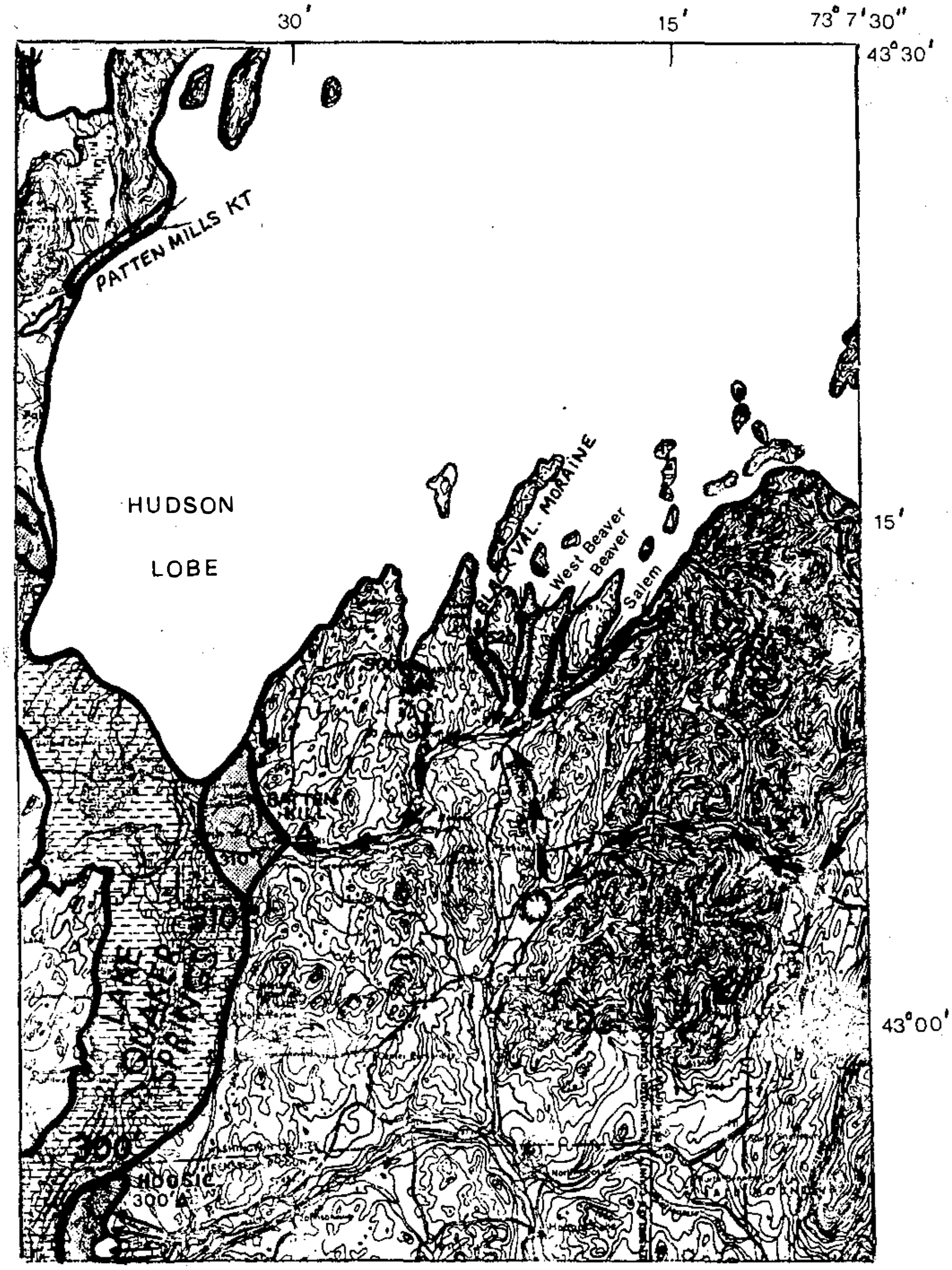

Figure 11: Black Valley ice margin and Lake Quaker Springs

Harper Road Ice Margin (8). Deposition of the Batten Kill delta and the Patten Mills kame terrace continued as the Hudson River initiated its Glens Falls delta at 320 ft (figure 12). The western edge of the Hudson Lobe probably retreated to the bedrock ridges traversed by Chestnut (Sanford's) Ridge Rd on the Glens Falls quadrangle. The Hudson Lobe protruded into the Fort Edward channel north of Fort Miller and into a pre-Woodfordian channel east of Gansevoort identified from water well logs, seismic data, and bedrock exposures. Some stratified gravel and sand accumulated between and on the flanks of drumlins clustered northeast of Fort Miller while the surface till was reworked by meltwater into a gravel-enriched lag. A retreating meltwater source deposited the small lobate subaqueous fan exposed along Harper Road in the Argyle valley. The sediments in the section fines upward from interbedded gravel and sand to lake sand and finally to lake clay, which draped over and buried the deposit.

The ice front east of Barkley Pond was indicated by several small coalesced kames and outwash sediment deposited into glacial Lake Cossayuna. One water well log from an outwash fan along the western shore of Cossayuna Lake recorded 120 ft of clay beneath 15 ft of sand. Outwash sediment was deposited in the Black valley from 500 ft west of Chamberlin Mills to 480 ft near West Hebron. The distal outwash south of West Hebron at 480 ft is silty and suggests isolated impondments dammed by the Black valley moraine. Meltwater flowed from the head of the West Beaver valleys at 700 ft south of Chamberlin Mills and Tiplady, respectively, and eroded a channel to 600 ft at the Hebron-Salem town line. The Mettawee ice tongue terminated near East Rupert and the Vermont Valley sublobe retreated to the base of Dorset Mountain as indicated by kame terrace and or kame moraine sediment (Stewart and MacClintock 1970).

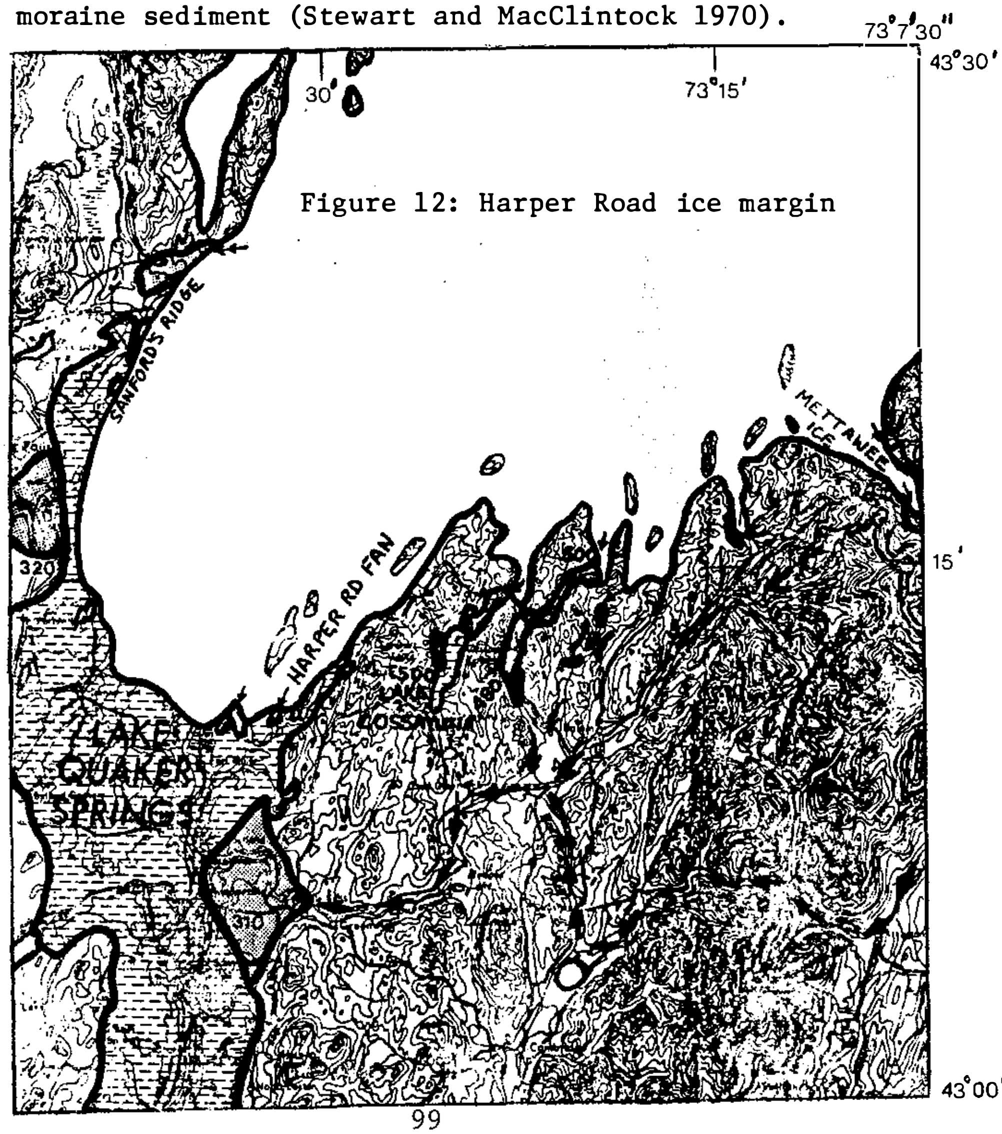

Figure 12: Harper Road ice margin

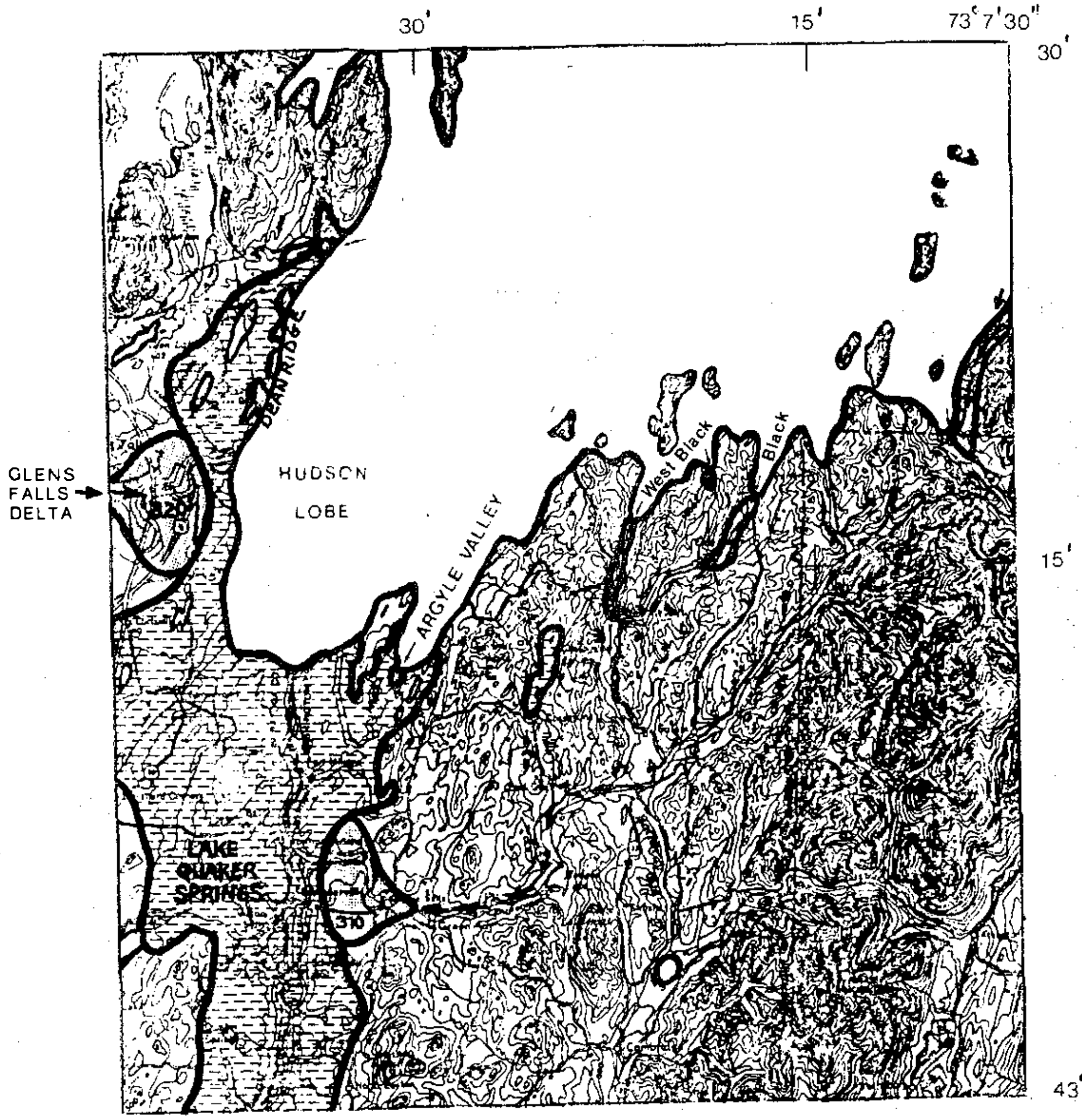

Figure 13: Danby ice margin

Danby Ice Margin (9). The Glens Falls delta prograded into Lake Quaker Springs but retreating meltwater sources decreased the sediment supply to the Batten Kill delta. Another clay-buried subaqueous fan was deposited in the Argyle valley near the junction of Pleasant Valley Rd and West Valley Rd (figure 13). Outwash sequences are recognized in the West Black and Black valleys. The Mettawee ice tongue retreated to the North Rupert area and the Danby Four Corners moraine accumulated along the margin of the Vermont Valley sublobe (Stewart and MacClintock 1969, p119). Two water well logs from Clark Rd and Mott Rd on the Fort Miller quadrangle recorded basal gravel beneath lacustrine clay and helped delineate the Hudson Lobe. The western edge of the Hudson Lobe probably followed the bedrock ridges traversed by Dean Rd on the Glens Falls quadrangle, in accordance with Chadwick's (1928) technique of using these northeast-trending ridges north of Glens Falls to contain the retreating Hudson Lobe.

Argyle Valley Ice Margin (10). An extensive esker and esker delta complex was deposited from a meltwater source in the Argyle ice tongue, and ice-marginal sediment accumulated east of Tamarack Swamp as this ice stagnated (figure 14). The nearly continuous esker at 330-340 ft can be traced from the southern end of the swamp through North Argyle to the apex of the delta at 320-330 ft deposited into Lake Quaker Springs. Lacustrine clay onlapped and nearly buried the fluvial-deltaic gravel and sand. Folded, contorted gravel and clay containing pods of a gravel-derived till on the top and flank of the esker may suggest a minor ice surge but not a major readvance during this interval. The Argyle ice decayed in Tamarack Swamp and enabled lake waters to invade the swamp while the remainder of the ice front was stable. Meltwater in the highlands east of the swamp incised the channel east and south of Black Mountain and flowed across the present town landfill area where an upper section of the lodgement till was reworked to a crudely-stratified gravel lag. Coarse-grained sediment is preserved as short esker segments along the Safford Rd meltwater route and deltaic sediment accumulated against and at least partially beneath dead ice in the swamp. Fine-grained pebble gravel and horizontally-bedded sand in the distal portion of the sequence fine upward to lacustrine silt and clay. The geomorphic expression of this latter sequence suggests deposition in a tunnel beneath the ice or in an open crevasse occupied by Lake Quaker Springs.

A cluster of kames and short esker segments located the margin of the Black ice tongue near Braymer. The Mettawee ice tongue terminated near Pawlet and, to the northeast, along a line approximated by the limits of the Burlington drift border (Stewart and MacClintock 1969, 1970), but this is not a major readvance position (Larsen 1972, Wagner et al 1972). Lake sediment near 700 ft between Pawlet and North Rupert was deposited in a local ice-dammed Mettawee valley impondment designated Lake Pawlet.

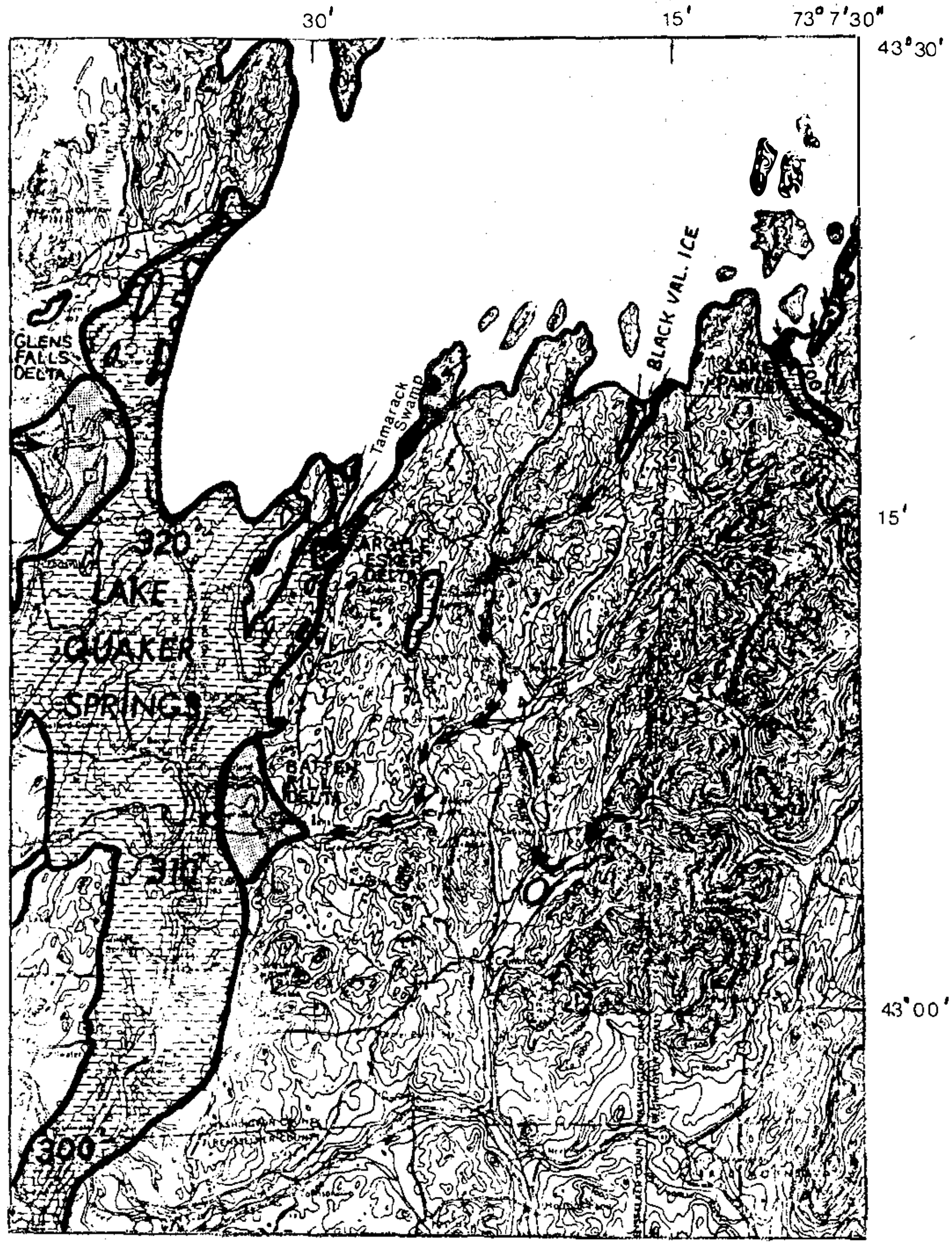

Figure 14: Argyle Valley ice margin

Figure 15: West Pawlet ice margin

West Pawlet Ice Margin (11). The Hudson Lobe, confined to the Whitehall and South Bay sublobes, retreated more rapidly northward (figure 15). A ridge of thick lodgement till confined the ice near South Granville. Stratified gravel and sand accumulated along the western margin of this ice to 600 ft while outwash was deposited into the Black valley. The Black ice tongue retreated to the valley head at West Pawlet and meltwater eroded an extensive area of till and bedrock from 600-560 ft, possibly from the drainage of Lake Pawlet around the ice front to the Black valley. The Mettawee ice tongue retreated to the Blossoms Corners moraine through North Pawlet, Wells, and east of Lake St. Catherine. Kame terrace and morainal sediment in the Vermont Valley at Chippenhook, Clarendon, and East Clarendon are correlated to this ice margin.

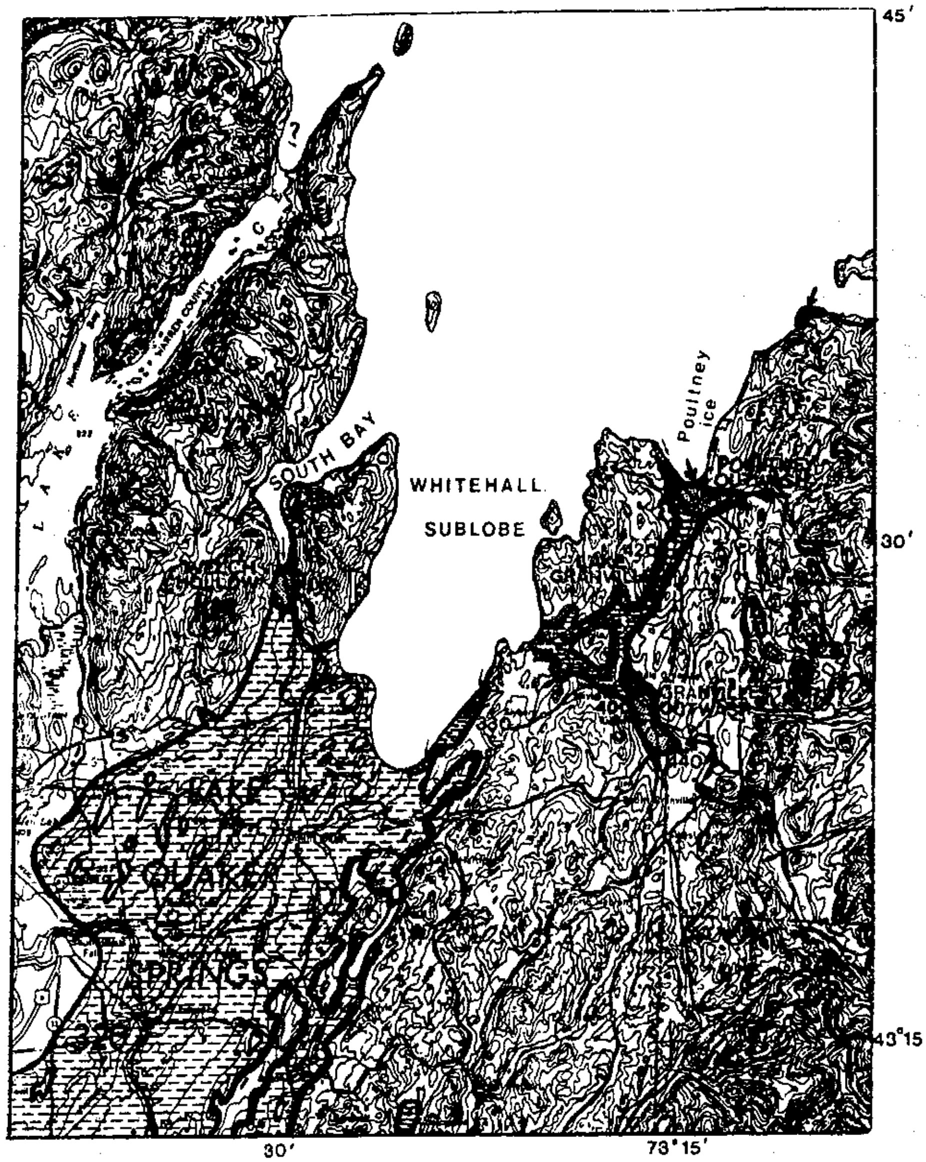

Figure 16: Welch Hollow ice margin

Welch Hollow Ice Margin (12). An extensive kame moraine and kame terrace complex accumulated at the margin of the South Bay sublobe (Connally 1973). Lake Granville at 410-420 ft, redefined from its earlier use (Behling 1966, Stewart and MacClintock 1969) occupied the lower Mettawee valley and was probably defended by the Whitehall sublobe at North Granville or Truthville (figure 16). The Mettawee River deposited outwash into the lake through Granville and meltout of stranded ice in Middle Granville resulted in slumping and faulting of the distal outwash-lacustrine sand and fine gravel. Meltwater from the Poultney ice tongue deposited outwash into the northern arm of the lake at Poultney. Clay, silt, and sand accumulated in the central portion of the lake basin from Truthville to Middle Granville to Raceville. Recession of the Whitehall sublobe from North Granville drained Lake Granville and allowed deposition of the Mettawee delta (330-340 ft) into Lake Quaker Springs. The Castleton, Birdseye(?), and West Rutland(?) moraines of Vermont (Stewart and MacClintock 1969, p123) are correlated to this ice margin.

Lake Coveville

Sediment contribution to Lake Coveville in the Hudson Lowland was limited to the pebble gravel, sand, and silt transported by tributary streams. A stable Lake Coveville was delineated by prominent Batten Kill terrace gravels at 240 ft and the sandy Hudson Falls delta of the Hudson River at approximately 260 ft (figure 17). Terraced clay at 240 ft on the Schuylerville quadrangle, at 250 ft on the Fort Miller quadrangle, at 260 ft on the Hudson Falls quadrangle, and the minor 280-300 ft terrace of the Mettawee River were coeval with Lake Coveville. Hoosic River terraces at 220 ft and the 220 ft sediment east of Hemstreet Park on the Mechanicville quadrangle are similarly correlated.

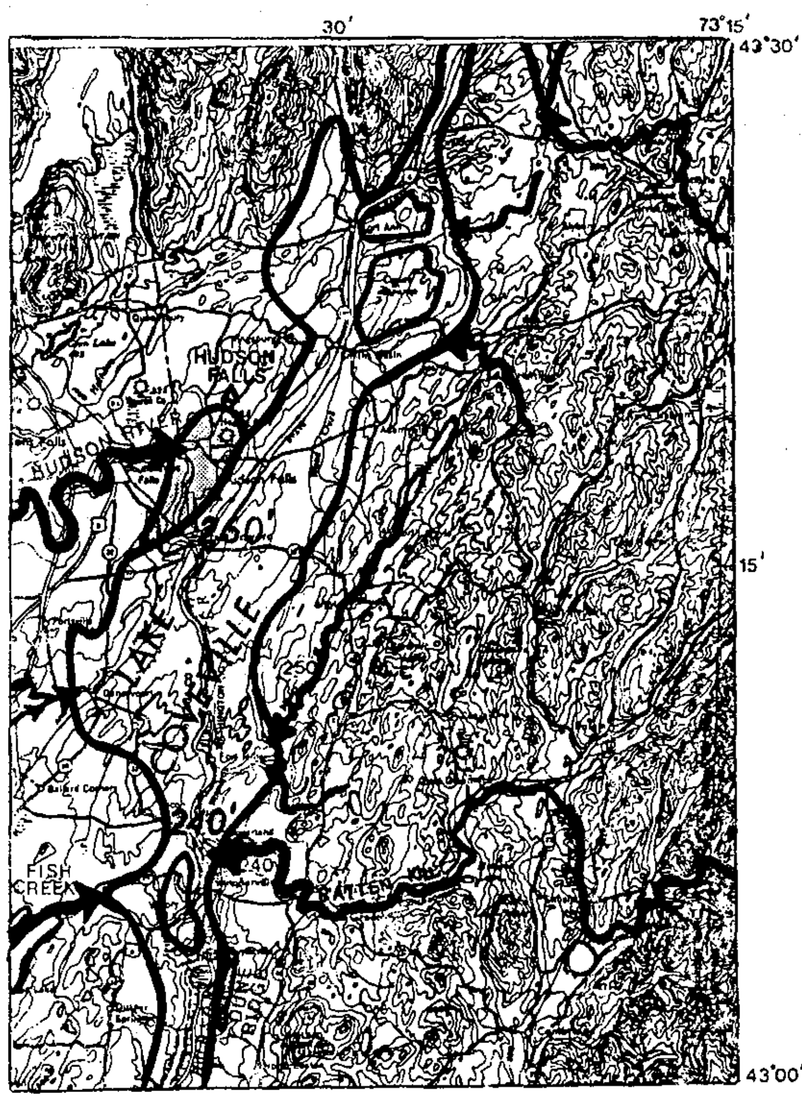

Figure 17: Lake Coveville

Fort Ann Water Levels

Fort Ann Channels. The Fort Ann channels include the primary Fort Edward channel (Woodworth 1905, p198), the Durkeetown channel (Chadwick 1928, p914), and the Winchell channel. These Champlain Lowland outlet channels were broadly defined during the Coveville phase and extensively excavated through clay, till, and bedrock during the Fort Ann phase. The Hudson-Champlain canal and the Hudson River below Fort Edward occupy the Fort Edward channel. Dead Creek, the distal portion of the Moses Kill, and the headwaters of Wood Creek occupy the broad Durkeetown channel. Winchell Creek and the distal portion of Big (Mill) Creek occupy the Winchell channel. All of these modern streams are underfit and follow entrenched courses with narrow floodplains on the channel bottoms. Eroded clay, till, and bedrock comprise the channel escarpments with predominantly eroded clay in the channel bottoms.

Fort Ann I. Fort Ann waters in the Hudson Lowland are most appropriately considered a broad shallow river, 10-20 ft deep, with a significant south-flowing current capable of eroding the soft lacustrine bottom sediment and transporting sand. Tributary streams deposited sediment (fluvial-lacustrine sand) where they joined the Fort Ann waters and the prevailing current transported this sand southward. These thin (<10 ft) sand units were deposited on an eroded clay terrace or till/bedrock surface during times of normal (stable) Fort Ann discharge. The Fort Ann I level in the northern Hudson Lowland was indicated by fluvial-lacustrine sand at 200 ft on the Schuylerville quadrangle, Hoosic River terraces at 180-190 ft, a prominent Hudson River terrace at 210 ft, and Poultney River terraces at 220 ft (figure 18). Terraced clay at 200 ft on the Schuylerville and Fort Miller quadrangles is similarly correlated.

Fort Ann II. The stable Fort Ann II level in the northern Hudson Lowland is indicated by fluvial-lacustrine sand at 160-170 ft through the Schuylerville and Fort Miller quadrangles and by prominent terraces of the Hoosic River at 150 ft, the Batten Kill at 170 ft, and the Hudson River at 180 ft (figure 19). Terraced clay at 180 ft north of Durham's Basin on the Hudson Falls quadrangle is correlated to this level.

Fort Ann III. The final Fort Ann III level is indicated by the 100-120 ft-level sediment near Reynolds on the Mechanicville quadrangle and by fluvial-lacustrine sand at 130-140 ft on the Schuylerville and Fort Miller quadrangles (figure 20). Terraced clay at 130-140 ft on the Schuylerville quadrangle is similarly correlated. The Winchell and Durkeetown channels were abandoned when the water level fell below their present sills at 180 ft and 170 ft, respectively. Lake Fort Ann discharge from the Champlain Lowland was confined to the Fort Edward channel, which was deepened to 150 ft at Smith's Basin and to 140 ft at Fort Edward.

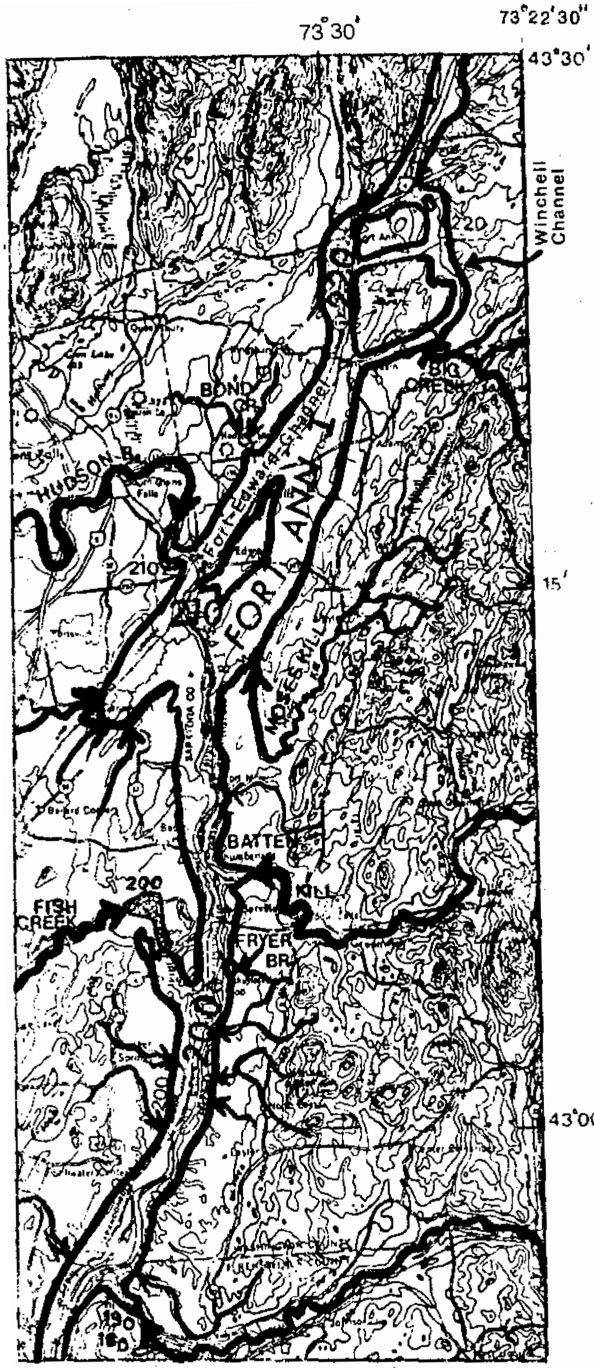

Figure 18: Fort Ann I

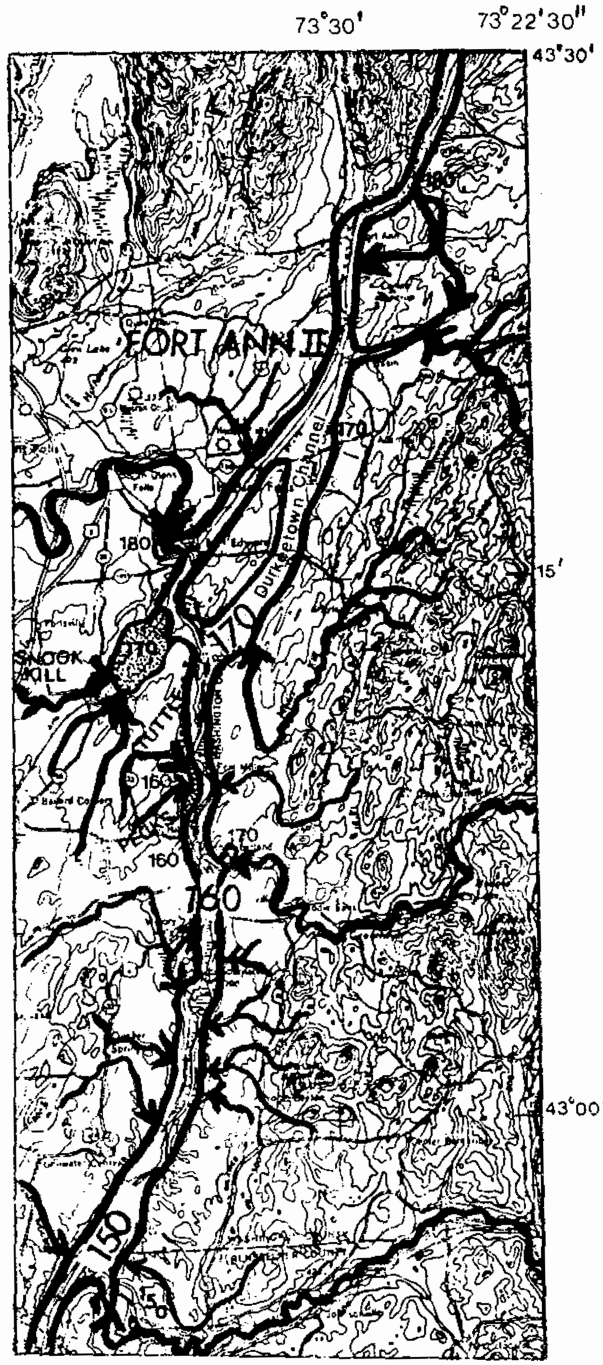

Figure 19: Fort Ann II

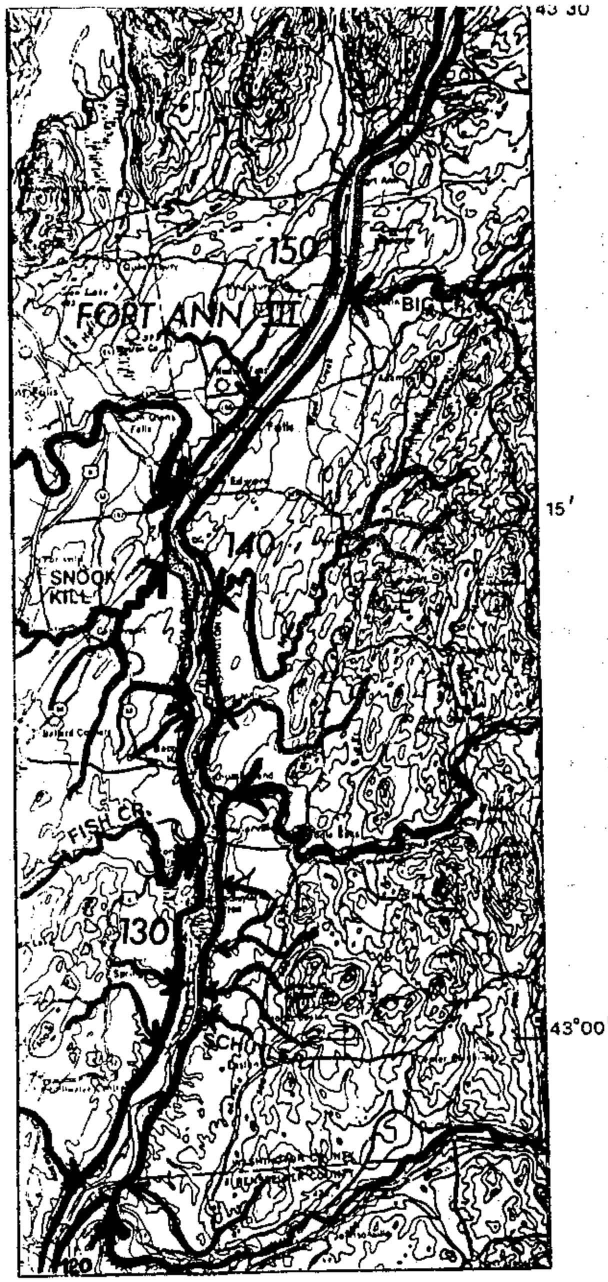

Figure 20: Fort Ann III

REFERENCES CITED

Behling, R.E., 1966, Surficial Geology of the Equinox, Londonderry, and Pawlet Quadrangles, Vermont: Unpublished Open File Report, Vermont Geological Survey.

Chadwick, G.H., 1928, Ice Evacuation Stages at Glens Falls, New York: G.S.A. Bulletin, v. 39, p 901-922.

Chapman, D.H., 1937, Late Glacial and Post-glacial History of the Champlain Valley: American Journal of Science, v. 34, p 89-124.

Clark, P., and Karrow, P.F., 1984, Late Pleistocene Water Bodies in the St. Lawrence Lowland, New York, and Regional Correlation: G.S.A. Bulletin, v. 95, p 805-813.

Connally, G.G., 1973, Surficial Geology of the Glens Falls Region, New York: N.Y.S. Museum and Science Survice, Map and Chart Series #23.

Connally, G.G., and Sirkin, L.A., 1971, Luzerne Readvance Near Glens Falls, New York: G.S.A. Bulletin, v. 82, p 989-1008.

Dahl, J.K., 1978, Surficial Geology of the Mechanicville and Schaghticoke Quadrangles: R.P.I., Master's Thesis.

DeSimone, D.J., 1977, Glacial Geology of the Schuylerville Quadrangle: R.P.I., Master's Thesis, 77 p and map.

__________, 1983, A Northern Limit for Glacial Lake Albany: G.S.A. Abstracts with Programs, Northeastern Section, v. 15, no. 3, p178.

__________, 1985, The Late Woodfordian History of Southern Washington County, New York: R.P.I., Ph.D. Dissertation, 145 p and maps.

Dineen, R.J., and Rogers, W.B., 1979, Sedimentary Environments in Glacial Lake Albany in the Albany Section of the Hudson-Champlain Lowlands: N.Y.S.G.A., Guidebook, 51st Annual Meeting, Trip A3, p87-119.

Dineen, R.J., et al, 1983, Bedrock Topography and Glacial Deposits of the Colonie Channel Between Saratoga Lake and Coeymans, New York: N.Y.S. Museum, Map and Chart Series #37.

Fairchild, H.L., 1917, Post-glacial features of the Upper Hudson Valley: N.Y.S. Museum and Science Service, Bulletin 195, p22.

Hanson, E.L., 1977, Late Woodfordian Drainage History in the Lower Mohawk Valley: R.P.I., Master's Thesis.

LaFleur, R.G., 1965a, Glacial Lake Sequences in the Eastern Mohawk-Northern Hudson Region: N.Y.S.G.A., Guidebook, 37th Annual Meeting, Trip C, pC1-C23.

____________, 1965b, Glacial Geology of the Troy, New York, Quadrangle: N.Y.S. Museum and Science Service, Map and Chart Series #7.

____________, 1975, Sequence of Events in the Eastern Mohawk Lowland Prior to Waning of Lake Albany: G.S.A., Abstracts with Programs, Northeastern Section, v. 7, no. 1, p87.

____________, 1979, Deglacial Events in the Eastern Mohawk-Northern Hudson Lowland: N.Y.S.G.A., Guidebook, 51st Annual Meeting, Trip B6, p326-350.

____________, 1983, Mohawk Valley Episodic Discharges — The Geomorphic and Glacial Sedimentary Record: National Association of Geology Teachers, Guidebook, p45-68.

Larsen, F.D., 1972, Glacial History of Central Vermont: N.E.I.G.C., Guidebook, 64th Annual Meeting, Trip G-1, p296-316.

Parrot, W.R., and Stone, B.D., 1972, Strandline Features and Late Pleistocene Chronology of Northwestern Vermont: N.E.I.G.C., Guidebook, 64th Annual Meeting, Trip G-3, p359-376.

Schafer, J.P., 1968, Retreat of the Last Ice Sheet in New England: G.S.A., Special Paper 115, p291.

Stewart, D.P., and MacClintock, P., 1969, The Surficial Geology and Pleistocene History of Vermont: Vermont Geological Survey, Bulletin no. 31.

________________________________, 1970, Surficial Geologic Map of Vermont: Vermont Geological Survey.

Stoller, J.H., 1922, Late Pleistocene History of the Lower Mohawk and Middle Hudson Region: G.S.A. Bulletin, v. 33, p515-526.

Wagner, W.P., 1969, The Late Pleistocene of the Champlain Valley, Vermont: N.Y.S. G.A., Guidebook, 41st Annual Meeting, Trip D, p65-80.

___________, 1972, Ice Margins and Water Levels in Northwestern Vermont: N.E.I.G.C., Guidebook, 64th Annual Meeting, Trip G-2, p319-342.

___________, et al, 1972, Till Studies, Shelburne Vermont: N.E.I.G.C., Guidebook, 64th Annual Meeting, Trip G-5, p377-388.

Woodworth, J.B., 1905, Ancient Water Levels of the Champlain and Hudson Valleys, N.Y.S. Museum and Science Service, Bulletin 84, p65-265.

ROAD LOG

Key:

US = United States Routes		E = East
NY = New York State Routes		W = West
WC = Washington County Routes		N = North
JCN = Junction		S = South

Miles traveled	Miles from last point	
0.0	0.0	JCN NY 29 and US 4. Follow NY E across Hudson River. Ahead is the Batten Kill delta (310-320 ft Lake Quaker Springs).
0.9	0.9	NY 29 climbs the foreslope of the delta approximately along the axis of maximum thickness of gravel and sand. The banks along the road reveal the coarsening-up-stratigraphy.
2.2	1.3	JCN NY 29 and Old Schuylerville Road - turn left (N) onto Old Schuylerville Rd. Water well logs record up to 65 ft of deltaic gravel and sand in the area.
3.0	0.8	Hollingsworth-Vose landfill road - turn right.
3.5	0.5	<u>STOP 1</u>: Hollingsworth-Vose landfill. Deltaic topset and foreset beds of the Batten Kill's Quaker Springs delta. Return to JCN NY 29.
4.8 Option A	1.3	JCN NY 29 and Old Schuylerville Rd. - turn right (W) onto NY 29. If Hollingsworth-Vose landfill is inaccessible (very possible) continue 0.1 miles past Old Schuylerville Rd JCN to JCN NY 29 and Windy Hill Rd. Turn left (N) onto Windy Hill Rd and continue 0.8 miles to Tracy Bros. excavation where deltaic gravel and sand, lake clay, and lodgement till are exposed. Return to NY 29 and pick up road log at Wilbur Ave JCN.
4.8	0.05	JCN NY 29 and Wilbur Ave - turn S onto Wilbur Ave. Water well logs and exposures indicate deltaic sediment thins rapidly southward through 30 ft to less than 10 ft. Notice the clay dug up from

Miles traveled	Miles from last point	
		the pond farther along the road.
6.0	1.2	Groundwater flows out along the SG-clay contact at the heads of these gullies in Fryer Brook. We observed a pipe with a diameter just right for your arm at the head of one gully in 1977.
6.2	0.2	Notice the clay gullies as Wilbur Ave. crosses Fryer Brook.
7.1	0.9	We're traversing the dissected clay plain and delta sand is gone so we cross Flately Brook and turn to the E.
7.5	0.4	Observe the shoreline profile of Lake Quaker Springs. No beach sediment is preserved.
7.9	0.4	JCN NY 40 - turn right (S) onto NY 40. Till on your left and the lake clay plain on your right with the tops of a few drumlins poking through.
8.7	0.8	JCN NY 40 and Burton Rd.- turn left (E) onto Burton Rd.
8.8	0.1	Meltwater flowed between Schuyler and Whelden mountains and deposited an outwash fan into Lake Albany. Minor exposures along the stream to your right (S) reveal gravel overlying clay and basal lodgement till.
10.0	1.2	JCN Burton Rd and Easton Station Rd Bear right onto Easton Station Rd.
11.2	1.2	JCN Easton Station Rd., Intervale Rd., and Water Rd. Turn left and continue on Easton Station Rd.
11.4	0.2	JCN Easton Station Rd. and WC 74 - turn right (S) onto WC 74
11.7	0.3	<u>STOP 2</u>: Archdale kame moraine. Exposure of clinoform sand and gravel beds in the moraine. Minor slumping of beds.
12.6	0.9	<u>STOP 3</u>: Nessle Bros Meats parking lot.

Miles traveled	Miles from last point	
		An excellent overview of the Archdale kame moraine deposited against the flank of Herrington Hill. This kame moraine band can be traced southward along the west side of Fly Swamp and across the valley at the southern end of the swamp where a head of outwash is recognized. Return N on WC 74.
16.9	4.3	JCN WC 74 and NY 372 - turn left onto NY 372.
17.1	0.2	Batten Kill crossing in Greenwich.
17.4	0.3	JCN NY 372 and NY 29 - turn right (E) on NY 29 and bear right past the traffic light to stay on NY 29.
20.2	2.8	Note the terrace-outwash gravel and sand we're crossing with thin till and bedrock uplands to the north. At small rises and around curves in NY 29 till and bedrock are often exposed where the upland thin till and bedrock topography protrudes through the gravel and sand.
21.4	1.2	Note the old excavation into a kame ahead on your left. This is associated with the Battenville moraine.
22.0	0.6	NY 29 used up the till and gravel of the Battenville moraine where the moraine crosses the valley in Battenville. There is hummocky kamic gravel and sand ahead on your left.
24.0	2.0	The fairly flat outwash and terrace gravel and sand we're crossing was deposited by meltwater from the ice margin.
24.4	0.4	<u>STOP 4</u>: Tracy Bros excavation. Horizontally-stratified gravel and sand overlies cross-stratified gravel and sand. Meltwater from the Carter Swamp ice margin deposited this deltaic sediment with sediment sources from the N and E. The Batten Kill has terraced the S end of this deposit.

Miles traveled	Miles from last point	
24.5	0.1	JCN NY 29 and NY 338 - continue E on NY29.
25.2	0.7	East Greenwich Post Office - park here and walk 0.1 miles W on NY 29. STOP 5: Lodgement till exposure N side of NY 29. Both lowland and highland lodgement till facies are similar in Washington County. Why? In contrast, the lodgement till of the Adirondacks is quite different from the Hudson lowland till. Return W along NY 29.
25.9	0.7	JCN NY 29 and NY 338 - turn right (N) onto NY 338.
27.0	1.1	JCN NY 338 and Ferguson Rd. Continue on NY 338N. There is an excavation just to your right off of Ferguson Rd where a thick graded gravel bed was observed. How would you describe the sedimentary environment which produced this feature?
27.3	0.3	Notice the hummocky ice marginal sediment on your left.
27.4	0.1	Carter's Pond Nature Trail on your right.
27.6	0.2	Carter's Pond Wildlife Management Area. Lunch Stop.
29.0	1.4	JCN 338 and Bunker Hill Rd.- bear left on NY 338.
32.9	3.9	JCN NY 338 and NY 40 - turn right (N) onto NY 40.
33.5	0.6	Notice the smooth rounded drumlinoid topography developed in these thinly-veneered bedrock highlands.
36.6	3.1	JCN NY 40 and NY 197 - turn right and continue on NY 40. The village of Argyle sits atop a modest esker delta deposited into Lake Quaker Springs. Lake clay nearly buried the delta.
38.1	1.5	STOP 6: Esker gravel and lake clay. NY 40 rides atop this esker which fed the Argyle delta. Lacustrine clay has partly,

Miles traveled	Miles from last point	
		and in places completely, buried the esker gravel and sand. Observe the deformed clay and gravel beds here. Is the deformation consistent with what you'd expect from meltout of buried and/or adjacent ice or would you suggest a minor ice surge after deposition of the clay to account for the stratigraphy? Continue N on NY 40 along the crest of the esker.
39.5	1.4	JCN NY 40 and WC 45 in North Argyle - turn right (E) onto WC 45.
40.4	0.9	JCN WC 45 and Coach Rd. - bear left on combined WC 45-Coach Rd.
40.9	0.5	Turn left and continue on Coach Rd.
41.7	0.8	STOP 7: Harrington Farm excavations expose part of a meltwater sediment complex deposited at the base of the Taconic front along the eastern edge of Tamarack Swamp. The ice tongue responsible for the esker and delta through North Argyle and Argyle stagnated in the swamp. The major meltwater source for this sediment can be traced eastward along Safford Rd. to the town landfill. Coarser gravel and sand, horizontally-bedded and cross stratified, is exposed east of the road. The more distal portion of the delta fan exposed here contains laminated and ripple-laminated sand. A third excavation to the SW in the middle of the swamp contains the most distal and finest-grained sand, silt, and clay beds. The morphology of this last deposit suggests deposition in a tunnel or crevasse in the ice and indicates the rotting ice in Tamarack Swamp was inundated by Lake Quaker Springs.
44.8	3.1	JCN Coach Rd and NY 40 - turn right (N) onto NY 40.
47.5	2.7	JCN NY 40 and NY 149E - turn right (E) onto NY 149.
55.0	7.5	JCN NY 149 and NY 22 - turn left (N) onto NY 22.

Miles traveled	Miles from last point	
58.1	0.4	Turn right and cross the gray bridge over the Mettawee River.
58.2	0.1	Turn left onto Depot Rd.
58.4	0.2	Turn left at old depot onto Dump Rd (landfill entrance) STOP 8: The north-flowing Mettawee River deposited this outwash gravel and sand in a significant local impondment. The exposed sand, silt, and clay beds accumulated in this Lake Granville whose elevation was approximately 420 ft. Clay is also preserved in the Mettawee valley from Middle Granville westward to Truthville with more silty sediment north of Raceville. There are some concretions in the clay here. Mildly deformed sediment particularly at the north end of the exposure probably resulted from meltout of abandoned ice in the lake. The Hudson ice lobe probably blocked the lower Mettawee valley at Truthville and contained Lake Granville. Retreat of this ice drained the lake and the Mettawee River deposited its delta into Lake Quaker Springs.
59.1	0.7	Retrace route to JCN NY 22A - turn right (W) onto NY 22.
62.8	3.7	JCN NY 22 and WC 17 - continue on NY 22 This surface is the top of the Mettawee delta.
63.4	0.6	JCN NY 22 and NY 40 - turn left (S) onto NY 40.
70.7	7.3	JCN NY 40 and NY 149W - turn right (W) onto NY 149.
73.4	2.7	STOP 9: Winchell channel overlook. Park as far off the road as possible and be careful of the traffic! The Winchell channel was one of three channels (the Durkeetown and Ft. Edward are the other two) which carried the outflow of Lake Fort Ann in the Champlain valley through the northern Hudson valley. The present surface stream, Big or Mill Creek, enters the channel from the south through a bed-

Miles traveled	Miles from last point	
		rock gorge (seen as a notch in the distance) and meanders across the channel bottom to Smith's Basin. The channel bottom consists primarily of lake clay while clay, till, and bedrock are all exposed on the flanks of the Winchell channel. This pattern generally holds for the other two channels as well except there is considerably more eroded bedrock along the primary Ft. Edward channel.
76.3	2.9	JCN NY 149 and WC 43 - turn left (S) onto WC 43
79.0	2.7	JCN WC 43 and NY 196 - continue on WC43
84.2	5.2	JCN WC 43 and NY 197 - turn right (W) onto NY 197
86.6	2.4	We're crossing the bottom of the broad Durkeetown channel and will climb up its western escarpment. North-flowing Wood Creek and south-flowing Dead Creek are underfit streams in the bottom of the channel.
88.1	1.5	We're descending into the Ft. Edward channel.
88.6	0.5	Hudson-Champlain canal crossing - the canal follows the bottom of the Ft. Edward channel.
88.8	0.2	JCN NY 197 and US 4 - turn left (S) onto US 4.
101.8	13.0	JCN US 4 and NY 29 W - trip ends. Turn right onto NY 29 W to return to Skidmore campus.