DEGLACIATION AND CORRELATION OF ICE MARGINS, APPALACHIAN PLATEAU, NEW YORK*

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INTRODUCTION

The field trip area (Fig. 1) is located in the Susquehanna River Drainage Basin and includes parts of the Unadilla River, Wharton, Oaks, and Butternut Creek valleys. Local relief of the bedrock-drift interface reaches 1200 ft, while surface elevations range between 1050 and 2350 ft. The bedrock is predominantly Devonian sandstone, siltstone, shale (Hamilton Group) and limestone (Onondaga and Helderberg Groups). The purpose of this report, and associated field trip, is to establish and illustrate criteria for the recognition and correlation of ice margin positions in the upper Susquehanna River Drainage Basin.

This part of New York State was no doubt subjected to repeated glaciations during the Pleistocene Epoch. Multiple glaciations are suggested in the subsurface by interbedded diamictons (tills) and outwash gravels (Randall, 1972). However, the abundant glacial deposits within the field trip area formed during the advance and retreat of the Late Woodfordian ice sheet.

Six ice-marginal positions were held during Late Woodfordian time. They are, from south to north, the Wells Bridge, Oneonta, New Berlin, Cassville-Cooperstown, Middleburg, and Valley Heads ice margins. The Wells Bridge, Oneonta, and New Berlin ice margins were established during what is inferred to have been a semi-continuous retreat of the glacier. The glacier readvanced to form the Cassville-Cooperstown margin. The Middleburg ice margin developed during subsequent retreat from the Cassville-Cooperstown position. The final event within the field trip area was a glacial readvance that deposited the Valley Heads Moraine.

TOPOGRAPHIC CONTROL OF ICE-MARGINAL POSITIONS

The dissected Appalachian Plateau has a bedrock relief (exclusive of overburden) on the order of 600 to 700 ft, and in some areas as much as 900-1,200 ft. This is greater than most areas in the U. S. that were

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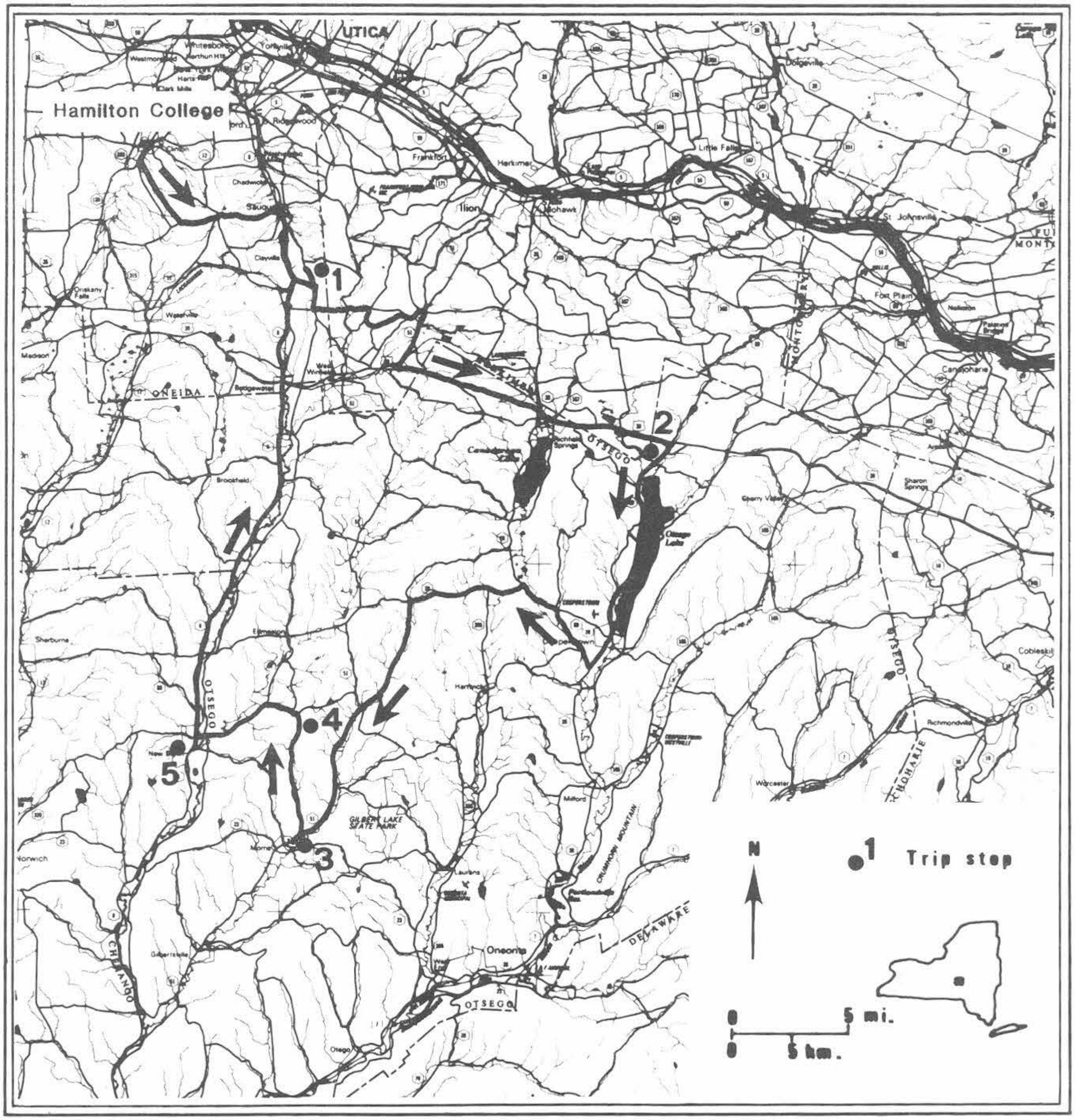

Figure 1. General field trip area.

subjected to continental glaciation and can be recognized to have influenced ice-marginal positions on a local scale. Cadwell (1972, 1973b, and 1978) describes the formation of ice lobes as glacier salients extending downvalley from the common ice margin. Fleisher (1983) further developed this concept by relating the influence of various topographic and ice-marginal configurations to depositional landform distribution.

The upper Susquehanna Drainage consists of major SSW flowing tributary streams that join the SW flowing Susquehanna to form an asymmetric drainage pattern. The regional ice flow direction was sub-parallel to the major tributary streams, thereby preferentially enlarging their valleys and increasing their relief. During deglaciation the regional ice margin trend was perpendicular to these tributary valleys and diagonal or sub-parallel to the main Susquehanna Valley. As a result, flow within the thinned ice margin adjusted to local topographic conditions. Figure 2 illustrates several possible configurations of ice-marginal positions relative to local valley trends. The location and distribution of depositional landforms commonly formed along the ice margin also are shown. The concept of topography (significant relief and valley trend) influencing local ice-marginal deposition is important for the recognition and correlation of these positions.

The major tributary valleys were not equally enlarged by the erosional effects of concordant ice flow. The larger ones probably were open to the north (hanging valleys) prior to glaciation as the result of earlier capture of the Susquehanna headwaters through headward growth of the Mohawk system. These lacked headward upland divides, thereby permitting easy access to glaciers, with subsequent valley enlargement and through-valley enhancement. Similar valley enlargement would not have occurred in valleys with headward upland divides (non-captured valleys). As a result, the longitudinal profiles of SSW flowing tributaries maintain significantly lower headward elevations in through-valleys, whereas in all non-through valleys the profiles rise to meet an upland divide.

This contrast in headward elevations had a major effect on determining which valleys could sustain active ice flow during deglaciation. As illustrated in Figure 3, the receding ice margin within a non-through valley creates thinning on the divide. This eventually reduces nourishment to the terminus allowing a negative ice budget to develop, with massive stagnation and downwasting in the valley. The resulting dead-ice environment would favor the formation of eskers, ablation moraines and local glaciolacustrine deposition resulting in deltaic outwash, kame-deltas and hanging deltas. Typical valley train and massive outwash accumulation is precluded here by effective detachment of the stagnant lobe from the hydrologic system of the main ice mass (Fleisher, 1984a). This situation is well demonstrated by the landforms and stratigraphy of the Butternut Valley.

CRITERIA FOR THE RECOGNITION OF ICE-MARGINAL POSITIONS

Deglaciation of the eastern Appalachian Plateau took place during a time-transgressive retreat between circa 16,500 and 14,500 yrs BP

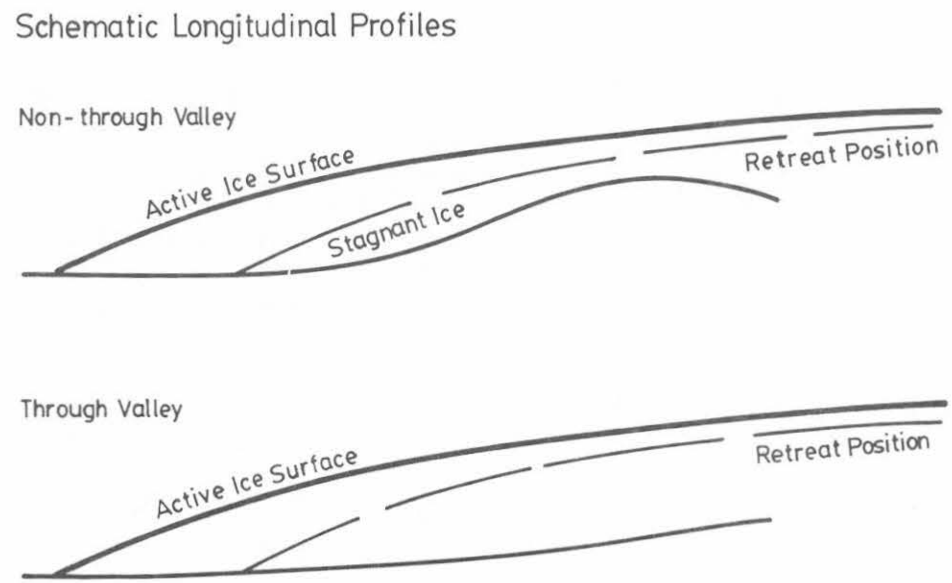

Figure 3. Schematic diagram of non-through valley and through valley longitudinal profiles and retreating glacier surface. (from Fleisher 1984a, 1984b)

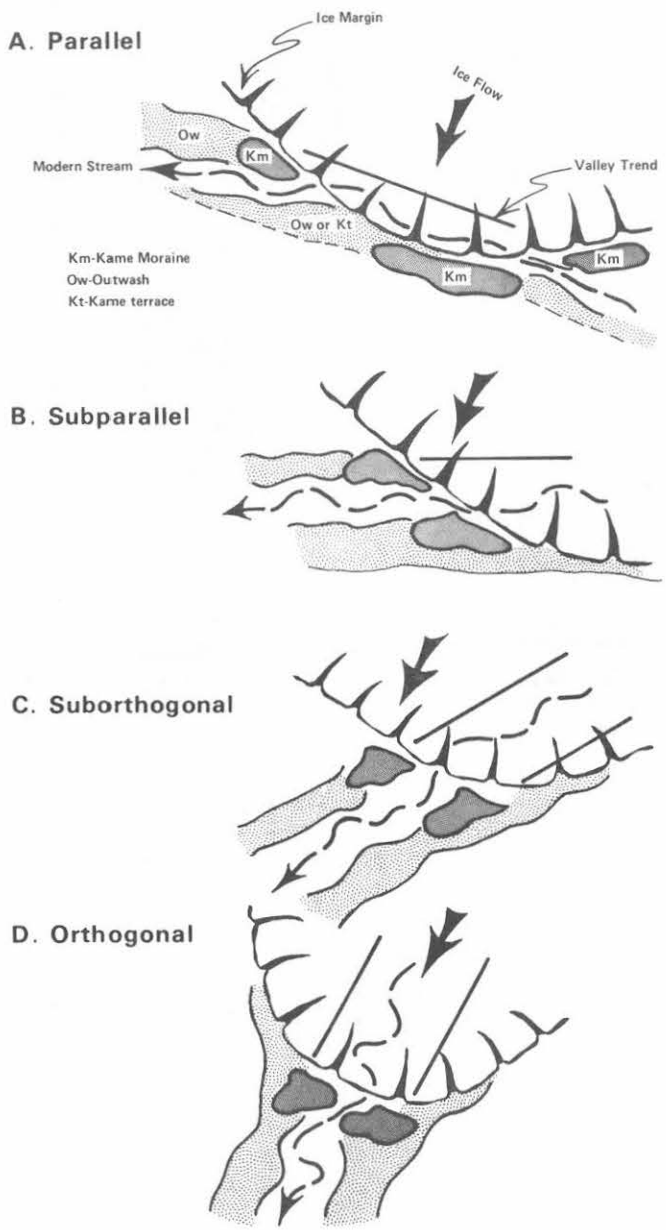

Figure 2. Factors controlling the distribution of ice-marginal landforms. The occurrence of landforms is influenced by the orientation of the ice margin relative to the valley trend. (from Fleisher, 1983, 1984a, 1984b)

as documented by Cadwell (1973a), Coates (1974), Fullerton (1980), and Fleisher (1983). At any given time the glacier terminus was draped across the landscape along a single, continuous trend.

The term "ice margin" refers to the location of the glacier margin during episodes of retreat (as in recessional positions) or readvance (as in end positions). Landforms representing the ice margin are both depositional and erosional, and are presumed to form synchronously along any given margin. These landforms appear in two distinct topographic facies (Fleisher 1984a, 1984b). The recognition of ice-marginal landforms and their short-distance correlation establishes positions held during glacier retreat or readvance. These ice-marginal positions are used in regional correlation.

Valley Floor Facies

1. Kame moraines and associated outwash - Kame moraines consist of hummocky, kame and kettle topography that spans the full valley width and is dissected by modern drainage. They generally stand 80 to 100 ft in relief above the common valley floor and may have served to dam the valley for a period of time following glacier retreat. Kame moraines consist primarily of gravel (generally coarse, displaying all degrees of sorting and stratification), but diamict may also be present. They form along the margin of actively flowing ice by glacial-glaciofluvial accumulation in an ice-contact environment. Massive quantities of outwash are associated with kame moraines and form valley trains or delta terraces. The Wells Bridge Moraine across the Susquehanna Valley between Oneonta and Sidney is a good example and is illustrated in Figure 4 (Fleisher 1977, 1984b).

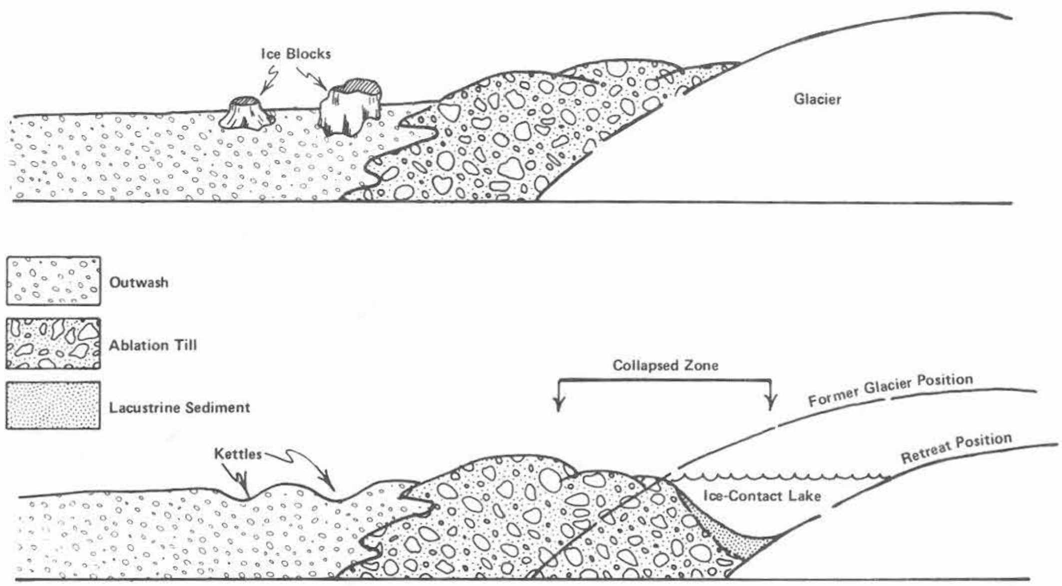

Figure 4. Longitudinal cross section of Wells Bridge kame moraine and associated outwash (from Fleisher 1977).

2. Pitted outwash and dissected valley train - While these landforms commonly are found in association with kame moraines, they also occur independently. They are considered to be ice-marginal landforms for two primary reasons.
   a) Their surfaces grade upvalley to an elevation above the modern flood plain that could neither have been established during post-glacial deposition, nor could they be erosional remnants of a once more extensive valley train. Erosion to that degree would be inconsistent with landforms in other parts of the same valley. This indicates ice must have been present at that position, from which meltwater was discharged and outwash deposited (Fleisher 1983, 1984b).
   b) Kettles and other collapse features indicate deposition in contact with ice.

   Good examples are in the Bridgewater Flats valley (Stop 1), and in the Unadilla Creek valley at the confluence with Wharton Creek in the village of New Berlin (Stop 4).

3. Dead-ice sink - This is a landform and stratigraphic feature similar in origin to a kettle, but on a scale that occupies most of the valley floor width. Dead-ice sinks are recognized by two landform characteristics that are diagnostic when they occur together. They are,
   a) an anomolously wide flood plain with many tight meanders and/or very poor drainage.
   b) associated massive outwash (dissected valley train or delta terraces) in both the upvalley and downvalley directions (Fleisher 1983, 1984a, 1984b).

   When large masses of stagnant ice (dead-ice) become detached by glacier retreat and are buried in part or totally by outwash, subsequent melting will create a progressively developing void (sediment sink) that is kept full of lacustrine and/or fluvial sediment as it grows. Large, detached ice blocks were associated with some ice-margins, thereby making the dead-ice sink an ice-marginal landform. An example can be seen at the mouth of Wharton Creek, between New Berlin and Pittsfield, as shown in Figure 5.

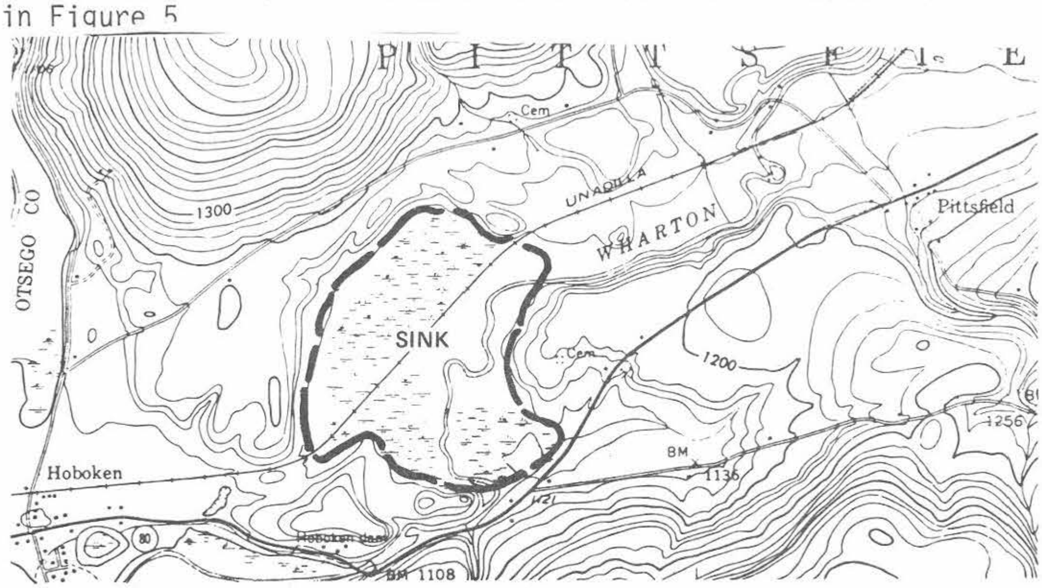

Figure 5. Topographic map expression of dead-ice sink (from Fleisher 1984a).

Valley Slope and Divide Facies

1. Isolated kames and ablation moraines - Slope wash, mass wasting and erosion by meltwater associated with ice on the divides tends to hinder the preservation of depositional landforms. Lodgement till is the most common overburden here, except for areas across which ice margins can be traced. The term "ablation moraine" is used to signify areas of limited hummocky topography, with only moderate to low relief. They appear as "patches" of morainic terrain and lack an association with typical outwash landforms. They are interpreted to indicate small scale areas of limited downwasting (Fleisher 1984b).

2. Underfit streams - These are low order tributaries (usually 1st, 2nd, or 3rd) or drainageways that occupy valleys which appear inordinately large for the size of the modern stream. They are interpreted to have developed through the benefit of meltwater discharge related to a nearby ice margin. They are often associated with discontinuous patches of ablation moraine. Examples are not common, but Brook Creek, a tributary of the Unadilla River north of New Berlin, is a particularly good example (Fleisher, 1984b).

3. Upland meltwater channels - These are not easily distinguished from glacially developed cols, but can be associated with an ice margin when found in association with meltwater gravels. They also will reflect a shape more commonly eroded by water rather than ice. An upland meltwater channel in the field trip area is the Cedarville col at Cedarville.

IDENTIFICATION OF RECESSIONAL AND READVANCE ICE MARGINS

The topographic expression of a recessional moraine (formed during retreat) is very similar to an end moraine (formed by readvance). They can be distinguished, however, on the basis of their stratigraphy. Evidence for a readvance includes lodgement (meltout) till over outwash, distortion of stratified drift by overriding ice, and compaction of fine-grained stratified drift by the weight of the overriding ice. Examples of distorted and compacted stratified drift will be examined at Stop 2 on the field trip. Surface exposure of these not only are uncommon but also ephemeral, therefore, stratigraphic evidence as revealed in water well logs and test borings becomes increasingly important.

The stratigraphic distinction between recessional and end moraines is illustrated in Figure 6. Basically, both consist of coarse sand and gravel, which grade laterally downvalley into a normal association with outwash (valley train or delta terraces) that, in this diagram, prograde into an ice-contact lake. Within a recessional moraine the outwash is interstratified with lacustrine silt and sand. However, readvance to an end moraine position would place till and outwash (both consisting of sand and gravel in the logs) stratigraphically above lacustrine sediment. Interstratification versus superposition of gravel and lake sediment is the diagnostic evidence for distinguishing recessional from end-moraine positions.

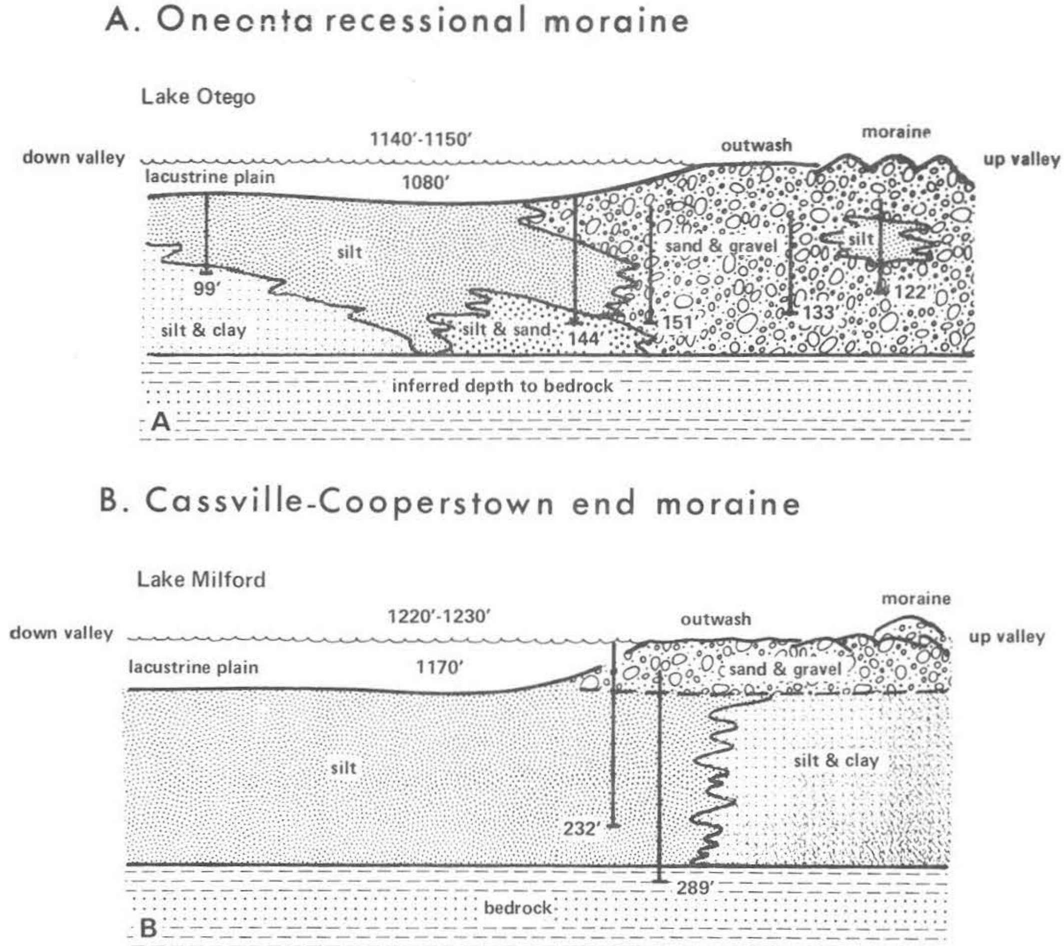

Figure 6. Stratigraphic distinction between recessional and end-moraine (from Fleisher 1983, 1984b).

A - outwash gravel interstratified with lake sediment.

B - outwash gravel overlies lake sediment.

The Oneonta and New Berlin ice margins (Fig. 7) are both recessional in origin. The thickness and stratigraphic relationship of the sediments at a recessional margin is controlled by the specific depositional environment. This is demonstrated by the interstratification of outwash with lacustrine sand, silt, and clay at the Oneonta margin illustrated in Figure 6A.

The Cassville-Cooperstown Moraine and the Valley Heads Moraine are end moraines, each forming during a readvance of the Woodfordian glacier. The depositional environment associated with the formation of the Cassville-Cooperstown ice margin is illustrated in Figure 6B. Thick outwash gravels (50-60 ft) were deposited above 150 ft of lacustrine silts and clays that are interpreted to continue upvalley beneath the moraine, thereby suggesting the glacier readvanced into a proglacial lake. Commonly well records are not available to complete the stratigraphic interpretation for an ice margin. Therefore, additional evidence must be used to reconstruct the environment of deposition associated with the ice margin.

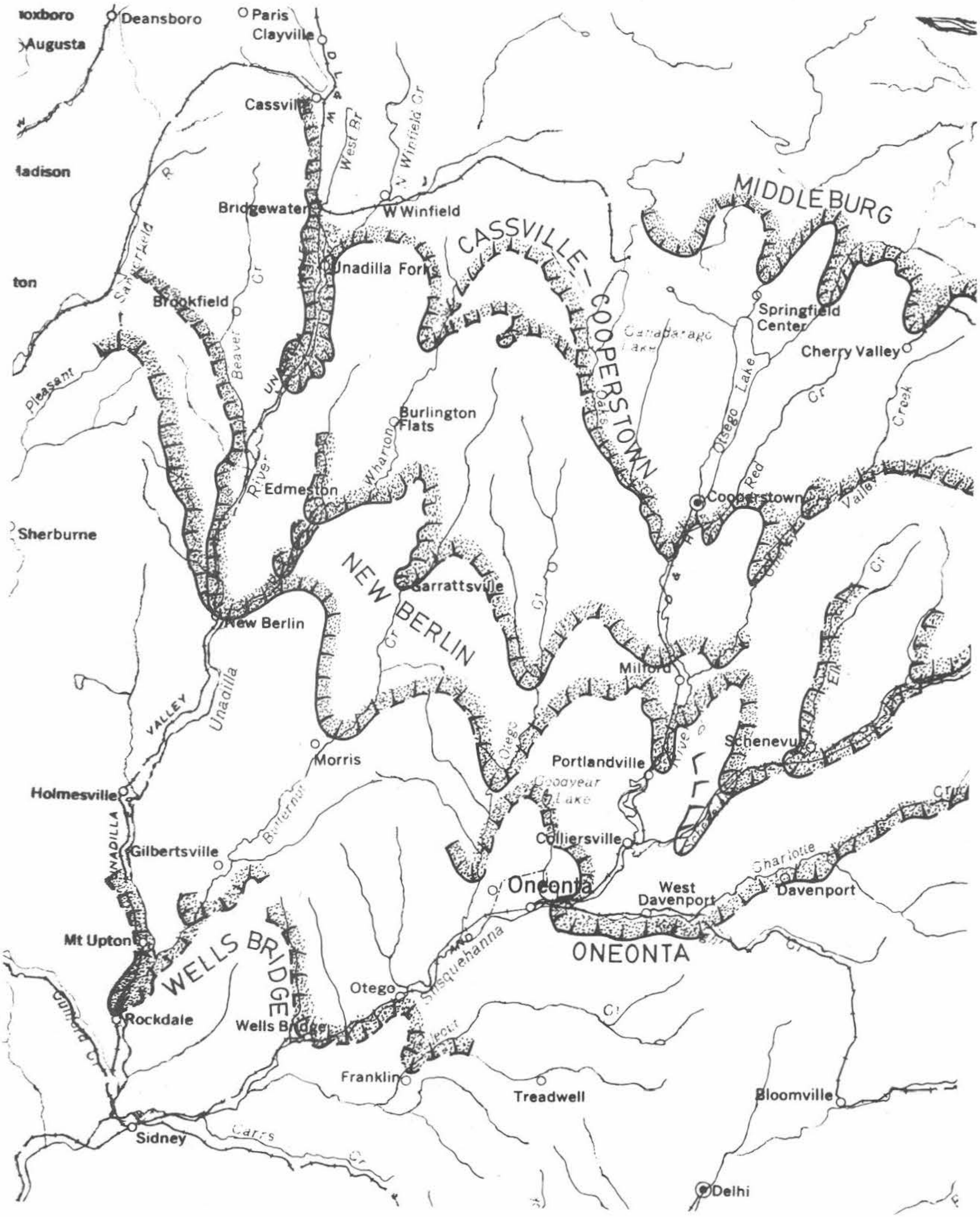

Figure 7. Ice-marginal positions in the upper Susquehanne Drainage (from Fleisher 1984a, 1984b).

While the field evidence does not clearly demonstrate a readvance, it does suggest that the mode of origin for these deposits is not retreating ice. For example, the existing well records in the Bridgewater Flats area, south of Clayville suggest thick outwash gravels (20-60 ft) with only thin layers of interbedded silt and clay (10 ft). Such a stratigraphic record does not illustrate evidence for a readvance as previously described. Therefore, additional criteria were developed to test the Valley Heads as a readvance.

Stratigraphic evidence in the form of stratified drift within kames adjacent to the Bridgewater Flats outwash plain permits relative age to be determined. Here the kames are generally 100-160 ft above the valley floor and were deposited during retreat of the Cassville-Cooperstown ice, while a marginal ice tongue (salient) occupied the valley. Meltwater streams flowed between the glacier and the adjacent valley walls forming kame terraces; kame deltas were formed in ponded areas. As deglaciation continued, the ice margin retreated several miles, leaving blocks of stagnant ice in the Bridgewater Flats Valley. These blocks melted prior to, or during, the glacier readvance to the Valley Heads marginal position. The thin layers of silt and clay, recorded in the well logs, were deposited in the kettle depressions during deposition of the sand and gravel outwash plain.

Previous correlations of the Valley Heads Moraine system were suggested by Chamberlin (1883), mapped in detail by Tarr (1905), and formally named by Fairchild (1932). The Valley Heads margin was traced to within several miles of Clayville by Fairchild (1912, 1932), Denny (1956), Denny and Lyford (1963), Fullerton (1971) and Cadwell (1973a). This correlation is consistent with our interpretation of the field trip area. The Valley Heads ice margin has been recognized in the headwaters of the Chenango River at Pratts Hollow to include a large kame moraine. Similar types of landforms are used to trace this margin eastward to Clayville.

CORRELATION OF ICE-MARGINAL POSITIONS

Six distinct ice-marginal positions have been recognized, correlated, and named. In chronologic order, from youngest to oldest, they are:

Valley Heads Moraine - this is the least well represented of all mapped margins, preserved only in the Bridgewater Flats valley north of Clayville. This was originally named by Fairchild (1932).

Middleburg margin - named for the ice marginal position originally mapped by LaFleur (1969); this margin is represented by a traceable moraine from Cobleskill to Richfield Springs.

Cassville-Cooperstown Moraine - named for the moraine originally mapped by Krall (1972) and Fleisher (1983, 1984b); this margin is represented by the most continuously traceable moraine and is the only one produced by a readvance.

New Berlin margin - a closely spaced, dual margin consisting of parallel trending marginal landforms, well expressed in both valley and slope facies of the Unadilla drainage (Fleisher 1983, 1984b).

Oneonta margin - named for the assemblage of landforms in the vicinity of Oneonta along the Susquehanna and Charlotte Creek valleys (Fleisher 1983, 1984b).

Wells Bridge margin - named for the well developed Wells Bridge Moraine in the Susquehanna Valley (Fleisher 1983, 1984b).

Figure 7 illustrates the ice margin positions and their correlation within the Susquehanna Drainage Basin. The correlation chart of Table 1 indicates the regional correlation of the ice margins.

TABLE 1 CORRELATION CHART
(modified from Fleisher 1983)

Susquehanna Drainage	Schoharie Drainage	Catskill Mountains
(Fleisher 1983, 1984b and present study)	(LaFleur, 1969)	(Cadwell, 1983)
Valley Heads Moraine		
Middleburg margin	Middleburg readvance	Middleburg margin
Cassville-Cooperstown Moraine	Middleburg readvance	Middleburg margin
New Berlin margin	Prattsville readvance	Glacial Lake Grand Gorge phase
Oneonta margin	Tannersville readvance	Wagon Wheel Gap margin
Wells Bridge margin		

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ROAD LOG

Miles	
0.0	Start at intersection of Rt. 412 & Rt. 12B (south), proceed south on Rt. 12B
1.0	Hard left turn on Grant Rd. (not Post St.)
1.6	Grant Rd. becomes South St. where Martin Rd. joins from the left
4.0	T-intersection, turn left
5.8	Intersection with Rt. 12, turn right (south) on Rt. 12
6.3	Enter Village of Paris
6.4	Bear left toward Sauquoit on Paris Green Rd. and then immediately turn left on Paris Hill Rd. (mileage 6.5)
9.3	Cross intersection with Oneida St. at STOP sign, Sauquoit
9.6	Turn right onto access ramp to Rt. 8 (south)
10.5	Highway begins to climb valley wall behind Valley Heads Moraine
12.4	Hummocky crest of moraine on both sides of road
13.2	Turn left on Stone Rd.
14.5	Turn left (north) at T-intersection onto Holman City Rd.
15.85	Entrance to Ludlow Sand & Gravel Company Quarry via dirt road on the right - STOP 1.

STOP 1 LUDLOW SAND AND GRAVEL COMPANY

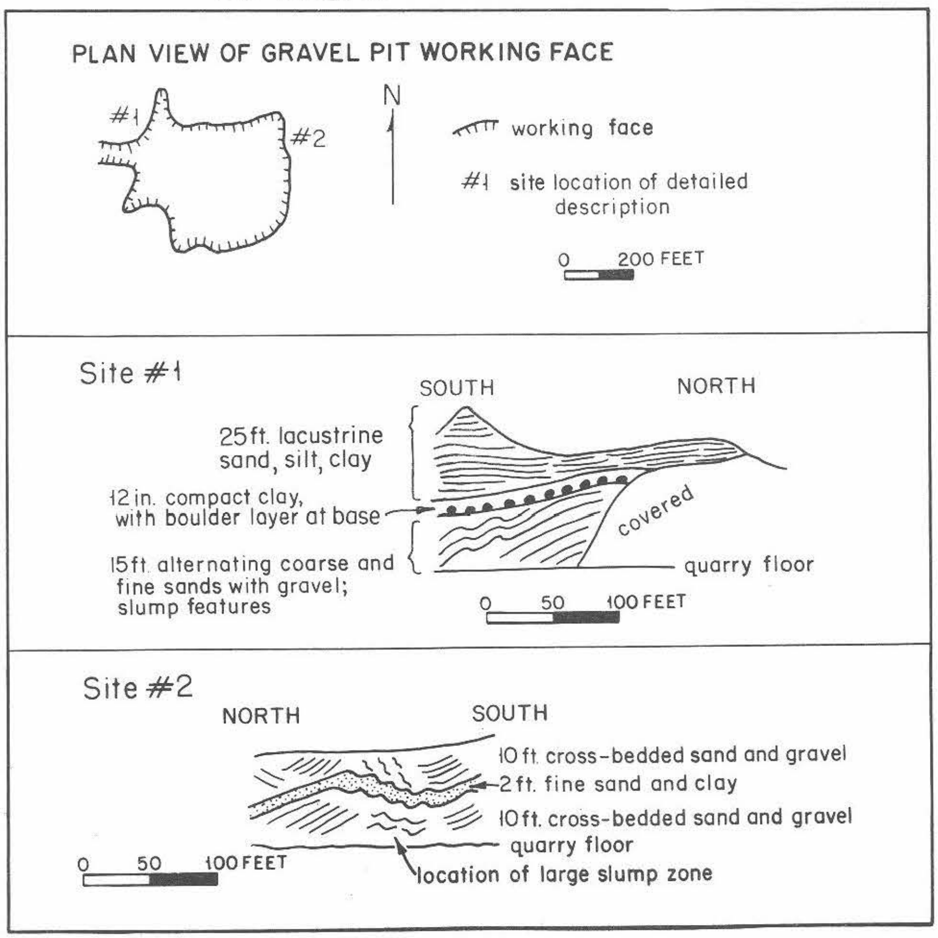
This gravel pit is located at the Valley Heads Moraine. Past exposures have illustrated the complex environments of deposition associated with this ice-marginal position.

Materials: well sorted, stratified sand, silt and clay; coarse cross bedded gravels; delta foreset gravels; laminated lake clay; poorly stratified fine sand; compact clay diamict (till).

Sedimentary structures: cross-bedding; channel lag gravels; cut and fill; large foreset beds; ripple drift laminations; slumped sands, gravels and silts.

Environment of deposition: Large(?) lake with meltwater streams of variable discharge, with deposition of gravels, sands and silts; near glacier terminus (possibly ice-contact) with deposition of sediments over blocks of glacier ice.

Noteworthy characteristics: ice-contact collapse features; thick, poorly stratified sands; well stratified, interbedded sands and gravels; channel cross bedding; delta foreset beds; compact clay layer with boulders concentrated at the base. This is diamict, deposited during an oscillation of the ice margin.



Return to entrance of gravel pit; turn left (south) on Holman City Road

16.05 Segment of Valley Heads Moraine (on left and right)

16.55 On left are ice contact, crossbedded outwash gravels

16.75 Pitted outwash on right

17.20 Stone Road, on right

18.10 STOP sign at Babcock Hill intersection
Turn left onto Babcock Hill Road, toward Cedarville

18.40 Intersection, continue on Babcock Hill Road

18.75 Enter Herkimer County, North Winfield

19.75 STOP sign, in town of North Winfield
Continue straight on Babcock Hill Road

20.85 Intersection, turn right onto Brace Road

21.55 Turn left onto Cross Road

22.15 STOP sign at intersection with Meeting House Road, turn left

22.25 PICTURE STOP: "Smith Esker" on right. This esker can be traced for almost a mile. Continue on Meeting House Road.

23.85 STOP sign. Turn right onto Babcock Hill Road, continue toward Cedarville

24.85 STOP sign. Turn right onto NY Rt. 51 (south)

24.90 Cross Cedarville meltwater channel

24.95 Turn right, stay on NY Rt. 51 (south)

27.75 Cross railroad tracks, small gravel pit on right in outwash gravels

28.20 Junction Route 20. Turn left (east)

29.20 Enter Otsego County

35.40 Intersection with Rt. 28; proceed east on Rt. 20

35.60 Enter Richfield Springs

36.30 Rt. 167 (north) enters from left; proceed east on Rt. 20

42.10 Traffic light intersection, turn right on Rt. 80 (south

Sign for Village of Springfield Center

42.35 Turn right on dirt road entrance into Hussey Quarry (unmarked, across from swampy pond) - STOP 2

STOP 2 HUSSEY QUARRY

This gravel pit contains a diamict (till) that documents the Cassville-Cooperstown readvance. The main things to see here are the stratigraphic units and the nature of their deformation.

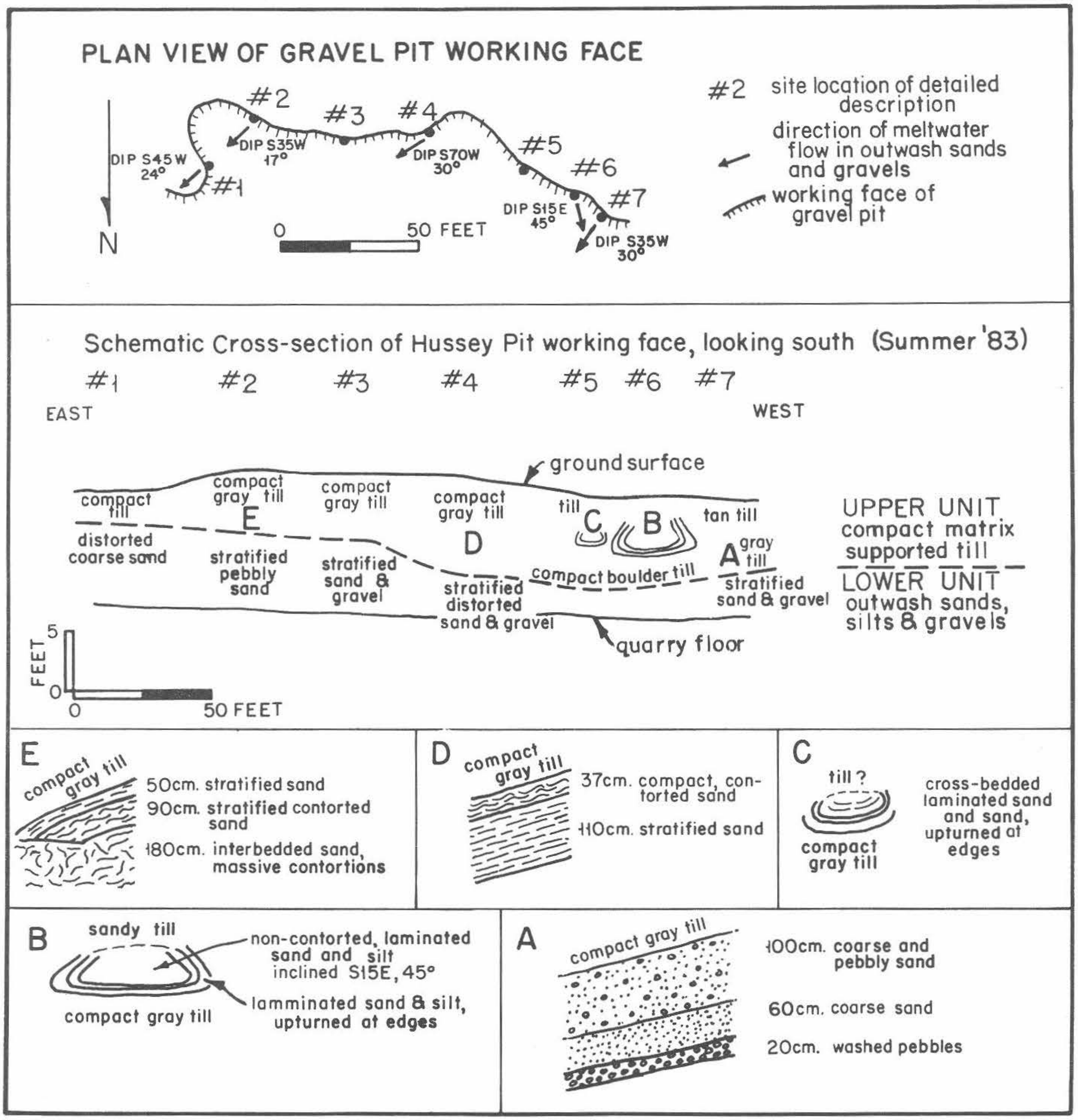
There are three fundamental stratigraphic units exposed in the south wall of the quarry (see STOP 2 diagram). They are 1) a compact, fine-grained, matrix-supported gray diamict, which overlies 2) a tightly compact stratified drift containing fine gravels, interbedded coarse sands, and well sorted, highly distorted fine sands, and 3) a lower gravel unit containing well washed medium to coarse grained pebbles, cobbles and boulders. The compact stratified drift occurs as distorted lenses of cross-bedded sand and silt within the diamict. The lenses are upturned at their edges and contain distorted sand and silt and show thickening of each unit along fold axes. This thickening suggests that the sand and silt were NOT frozen during deformation. The underlying gravel is not well enough exposed to determine if it too is distorted.

The following questions must be addressed.

1. Origin of the compact stratified drift -
    a. Were the sand and silt lenses sheared up from the lower outwash and included in the diamict by overriding ice movement?
    b. Were the lenses deposited at the same time as the diamict?
    c. Were the lenses deposited after the diamict and subsequently distorted by the diamict squeezing up and around them?
2. Causes of compaction and distortion -
    a. Were the lens edges folded during emplacement through shearing?
    b. Were the lenses deposited within the diamict with subsequent glacier overriding and deformation?
    c. Were the lenses distorted during "dewatering" of the diamict?

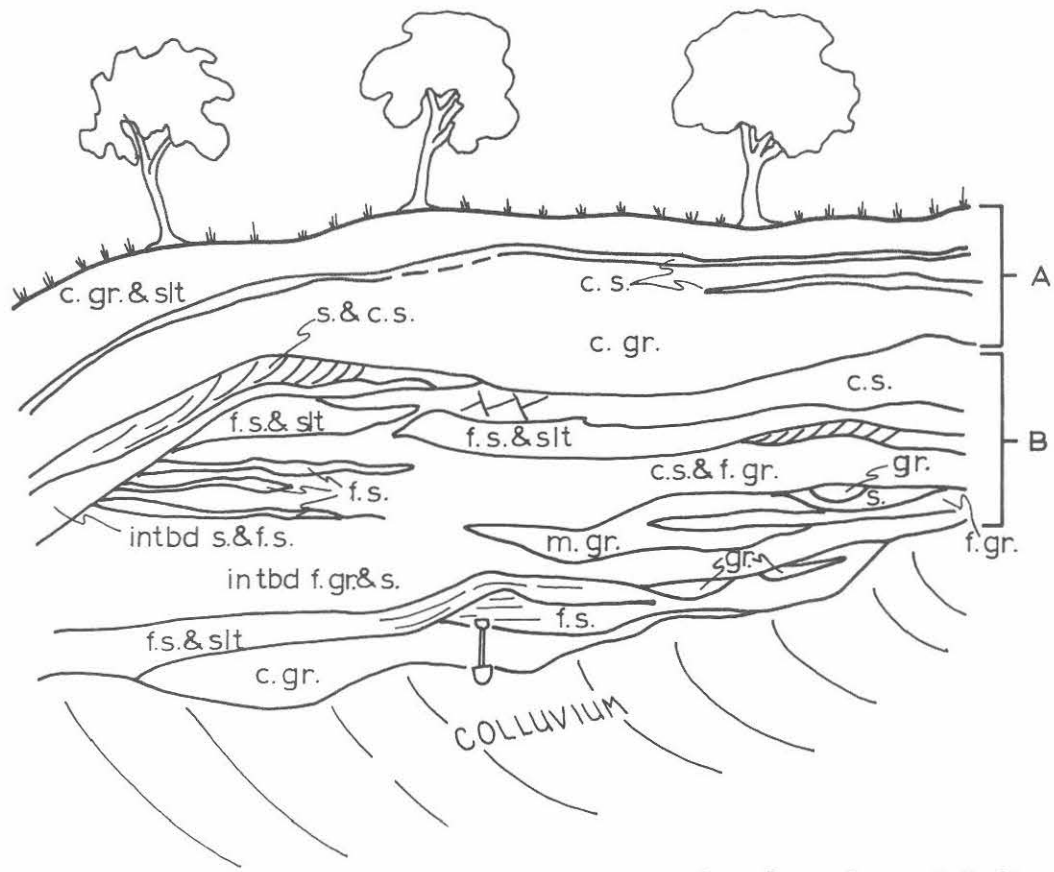
STOP 2 diagram - Stratigraphic units and nature of deformation in Hussey Quarry on the following page.

STOP 2 diagram. Stratigraphic units and nature of deformation in Hussey Quarry.



42.80	Continue south on Rt. 80 through Village of Springfield Center
44.90	Rt. 80 traverses hanging delta to Lake Cooperstown
51.90	Village of Cooperstown; follow Rt. 80 & Rt. 28 through Cooperstown
52.80	Proceed south on Rt. 28 past intersection with Rt. 80 west and Rt. 28 north
54.70	Turn right onto Otsego County Rt. 26, which climbs up the kame and kettle topography of the Cassville-Cooperstown Moraine (excellent view of moraine to the left)
54.70	PICTURE STOP - Proceed west on Rt. 26.
58.35	Intersection with Rt. 80 (west) and Rt. 28 (north)
60.55	Turn left on Rt. 80 (west) & Rt. 205 (south)
62.50	Rt. 205 turns south; continue west on Rt. 80
66.70	Turn left in hamlet of Burlington at blinking light on Rt. 51 & Co. Rt. 16
68.75	Esker on valley floor to the left, associated with ablation till
72.25 to 72.45	Esker complex on left
72.90	Turn left (east) in hamlet of Garretsville on Co. Rt. 16 and cross valley
73.20	Turn left on dirt road
73.25	Entrance to New Lisbon Landfill - along New Berlin ice margin - OPTIONAL STO
73.30	Back on Co. Rt. 16, heading south
73.90	Bear right on dirt road and right again back down onto valley floor
74.40	Intersection with Rt. 51, turn left (south)
74.55	Hill on left is the upvalley end of an esker
75.35	Additional eskers are seen downvalley
78.45	Entrance on left to quarry in deltaic outwash establishing a body of water in Butternut Creek valley at approximately 1150'
80.9	Road enters from right, Co. Rt. 49
81.10	Road on the left through split rail fence and across corn field; bear left at bottom of hill and through woods to quarry entrance, which cannot be seen from Rt. 51 - STOP 3

STOP 3 MORRIS KAME QUARRY diagram and description.



STOP 3 Diagram. Ice-contact stratified drift in a kame .75 mile east of Morris, on the west side of Butternut Creek

In this quarry are exposed deposits typical of non-through valley deposition (stagnant ice blocks) and the associated conditions of glacier retreat. This kame and other landforms across the valley to the south depict an ice-contact environment dominated by local ponding and glaciofluvial deposition. The diagram above illustrates the northwest-facing working exposure in 1983.

stratigraphic units	sedimentary structures
A - Coarse gravel fining upward to silty matrix Interbedded coarse sand lenses and layers	A - Crude cross bedding, graded bedding and imbricate clasts. Average thickness is 8 feet.
B - Well sorted sand, interbedded fine gravel and sand, sorted sand and interbedded fine sand and silt	B - Cut and fill, channel lag gravel, collapse displacement, cross bedding, draped bedding, slump tilting. Average thickness above quarry floor (general elevation of 1140 feet) is 12 feet.

Miles

81.10 Return to Rt. 51 and turn right (north)

81.95 Turn left on Otsego Co. Rt. 49, which climbs up the Aldrich Creek valley. Aldrich Creek is an underfit stream occupying a valley that was enlarged by meltwater discharge along the New Berlin ice margin. Patches of discontinuous ablation till are found scattered along the valley.

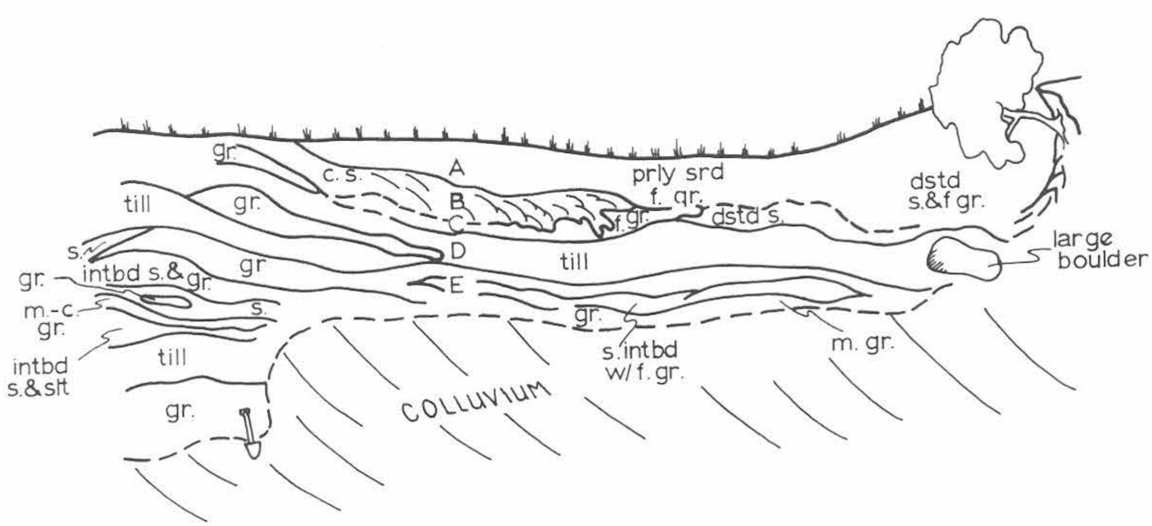
83.45 House and outbuilding on the right are situated on ablation till

87.55 Intersection with Ramey Road on left and Burski Road on right (the names of both are unmarked at intersection), proceed straight (north)

87.65 Entrance to gravel quarry on right - STOP 4

STOP 4 DIVIDE FACIES OF ICE-MARGINAL DEPOSITS

This semi-active small quarry lies along the trend of the New Berlin ice margin. Typically, ice-marginal positions are correlated across divides by recognizing erosional features such as cols, meltwater channels or underfit streams. Here, however, is a rare view of the materials constituting a depositional landform, which resembles an ice-contact kame. The diagram below illustrates the association of stratigraphic units at STOP 4.



shovel scale = 3.5 ft.

Stop 4 Diagram. Stratigraphy and ice-contact structure of divide facies deposits.

Stop 4 Description on following page.

STOP 4 Description.

Unit	Thickness	Description
A	36"-48"	poorly sorted fine gravel, distorted in places
B	24"-30"	well stratified coarse sand, distorted by slump, collapse or injection from below
C	6"-12"	fine gravel with sand and silt matrix
D	30"-40"	compact diamict with clay matrix and striated cobbles
E	36"-?	washed gravels interbedded with a few layers of well sorted sand (few inches thick) which seems compact

Miles

Proceed north on Otsego Co. Rt. 49

88.35 Turn left at intersection with Otsego Co. Rt. 17 and proceed west. Rt. 17 follows along the New Berlin ice margin as it descends from the divide through the small hamlet of Cardtown and toward Pittsfield.

89.75 Turn left on Rt. 80 (west) and proceed toward New Berlin

90.1 Kame moraine complex on the right is separated from valley wall by an outwash channel

90.9 Hamlet of Pittsfield. Highway climbs up the back side of a kame moraine-outwash complex that swings across the valley marking a brief hesitation along the retreating New Berlin ice margin. Several similar complexes are found northward along Wharton Creek toward Edmeston.

91.7 Rt. 80 descends the pitted outwash surface and follows the southern margin of a prominent dead-ice sink.

92.05 View of dead-ice sink on the right.

92.50 Bear left on Musk Road up a small hill (unmarked dirt road at bridge over Wharton Creek). Don't follow Rt. 80 across bridge!

92.95 Another dead-ice sink can be seen on the valley floor at 2 o'clock

93.40 Intersection with Otsego Co. Rt. 18 (unmarked) at YIELD sign. Turn left and follow Rt. 18 for .2 mile.

93.60 Intersection with Otsego Co. Rt. 13, turn right (west)

93.95 New Berlin valley train on left - OPTIONAL STOP

Proceed west on Rt. 13

94.20 Cross Unadilla River, enter Chenango Co. and Village of New Berlin

94.40 Intersection with Rt. 8 at YIELD sign. Turn left and proceed south on Rt. 8

94.85 Entrance to New Berlin Gravel Quarry on the right - STOP 5

STOP 5 NEW BERLIN GRAVEL QUARRY

The gravel quarry has been developed at two levels within a deltaic valley train. The upper level is primarily within the topset beds and the lower level (adjacent to Rt. 8) exposes massive foreset beds. Limestone and associated chert are major lithologic components constituting approximately 26% of all clasts (14% limestone, 12% chert). Postglacial leaching and reprecipitation of carbonates accounts for the various stages of induration found within some of the gravel units.

The topsets consist of 20 to 25 feet of moderately to poorly sorted, horizontal cobble gravels that contain some coarse sand lenses. Coarse lag gravels are common and depict a cut and fill origin. Crude channel cross bedding also is evident. Some of the sand lenses contain small-scale collapse features which are too small to have disturbed the associated gravel.

The underlying foreset beds are inclined at 28° to the southeast (S 30°-50°E) and generally consist of a finer pebbly gravel interbedded with sand. The gravel units consist of both well sorted, clast supported, matrix-free layers and sandy, pebbly fine gravel. The sand ranges from fine to coarse, with occasional silt layers up to 1 foot in thickness. No major collapse features or contorted beds were exposed in 1983.

This deposit is interpreted to be part of a massive deltaic valley train that was prograded downvalley from the New Berlin ice margin (just .5 mile to the north) into an ice-contact lake. The dam was located 15 miles downvalley in the vicinity of Mount Upton and Rockdale. The elevation of the dam corresponds to the topset-foreset contact elevation here. A major dead-ice sink marks the ice-marginal position at the head (upvalley extent) of the valley train. These depositional landforms and their association are helpful in recognizing the valley facies of ice-marginal positions.

Turn around and proceed north on Rt. 8

95.60 Traffic light intersection of Routes 8 and 80. Continue straight on Rt. 8 (north) and Rt. 80 (west)

96.85 Proceed north (straight ahead) on Rt. 8 at intersection where Rt. 80 (west) turns to the left

98.10 Highway follows base of kame terrace scarp for the next 2.5 miles. Kame terrace stands at 1300 ft. The kame terrace represents outwash shed along an ice margin that paralleled the Unadilla River valley, from New Berlin to Columbus Quarters. Associated kame moraines also occur along the valley, as at South Edmeston on the east side of the valley and Columbus Quarters on the west side. Late glacial discharge from the north (possibly associated with the Valley Heads readvance) dissected all of these ice-marginal landforms.

101.30 Highway climbs onto outwash associated with kame moraine

101.75 Columbus Quarters intersection with Chenango Co. Rt. 41. Kame-moraine complex to the right. Continue north on Rt. 8

102.00 Highway descends north side of kame moraine, which is part of the New Berlin ice margin

104.40 Enter Madison County; proceed north on Rt. 8 to Bridgewater

106.70 Breached and eroded remnant of Cassville-Cooperstown Moraine can be seen on the valley floor

113.00 Outwash plain forming the valley floor on the right developed from Valley Heads discharge originating from the north

113.90 Enter Oneida County

114.50 Junction with Rt. 20 at Bridgewater; proceed north on Rt. 8

116.50 Outwash surface on the right grades northward to Valley Heads ice-marginal position near Cassville, 3 miles to the north

119.00 Leave Rt. 8 (which bears to the right) and proceed straight ahead toward Cassville

119.30 Turn left in Cassville on Summit Road

119.90 Road crosses characteristic hummocky topography of Cassville-Cooperstown Moraine for about one mile

121.30 Proceed straight toward Paris on Doolittle Road

124.40 Sign for Paris

124.55 STOP sign intersection with Rt. 12, bear right (north) on Rt. 12

125.30 Turn left toward Clinton on Fountain Street and enter Town of Marshall. Road crosses trend of Valley Heads Moraine, which is not well expressed in the topography here.

129.15 Sign for Village of Clinton

129.50 STOP sign intersection with Rt. 12B, turn left at Clinton Village Square to YIELD sign and proceed straight

129.55 Traffic light intersection

129.70 Traffic light intersection of Rt. 12B (south) and College Street (Rt. 412) where road log began. Continue straight for entrance to Hamilton College.

N O T E S