

Friends of the Pleistocene

38th Reunion

Stroudsburg Pa.

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THE LATE WISCONSINAN GLACIAL BORDER
IN NORTHEASTERN PENNSYLVANIA

A friendly trip led by
G. H. Crowl, G.G. Connally and W.D. Sevon

Starting with the work of Lewis and Wright in 1884, the Late Wisconsinan "Terminal Moraine" has been the dominating feature of glacial geology in northeastern Pennsylvania. Most persons working with the Pleistocene deposits in that area have used the Terminal Moraine as either a starting point or a major reference. Work and thought related to drift outside the Terminal Moraine has been influenced by the early work of Leverett (1934) who recognized only Illinoian drift and some potentially older drift. Since the start in 1961 of detailed mapping (scale of 1:24,000) in several counties in northeastern Pennsylvania, new information and new ideas have enlarged the scope of our understanding of glaciation and deglaciation east of the Salamanca re-entrant.

The first mapping of the surficial deposits in the area was that of Epstein (1969) who recognized deglaciation ice positions later refined by Connally (Connally and Epstein, 1973). Epstein and others (1974) have produced the most comprehensive treatment of the Illinoian drift in the area and Epstein presents some evidence within the report for possible pre-Illinoian drift. Connally, in about 1972 (unpublished), was the first to recognize in the Saylorsburg area the existence of glacial deposits intermediate in age between Illinoian and Late Wisconsinan. Similarly positioned deposits, now tentatively called Early Wisconsinan in age, were later verified elsewhere by Sevon (1973 & 1974), and Crowl (unpublished). The remainder of the work in the area has been almost exclusively mapping of the drift.

In the southeastern sector of the Terminal Moraine the Woodfordian glacier advanced to the vicinity of Blue Mountain, the frontal Appalachian

ridge. North of Blue Mountain an ice margin can be reconstructed from a massive till plug in the Aquashicola Creek valley, a kame moraine in the Buckwa Creek valley, and an invash kame-delta near Brodheadsville; between these features the margin has been inferred at the geographic contact between Woodfordian and pre-Woodfordian tills. From Brodheadsville to the Pocono Plateau the ice margin is reconstructed from disconnected morainal segments and ice-marginal drainage features. South of Blue Mountain a margin can be reconstructed from the massive Bangor moraine near the mountain and traced eastward toward the Delaware River along a line that separates Wisconsinan till on the proximal side from Illinoian till on the distal side. Evidence for an ice margin is absent in the immediate vicinity of the Delaware River and on Blue Mountain itself.

The northern and southern ice margins traditionally are included as parts of the Terminal Moraine (although neither represents a continuous drift accumulation). However, correlation of till units north and south of Blue Mountain presents a problem and the Woodfordian ice margin north of the mountain may be significantly younger than that to the south. Four critical till units have been observed north of Blue Mountain and three to the south.

Illinoian till is recognized both north and south of Blue Mountain on the distal side of the Terminal Moraine. The Illinoian till, oxidized at the surface, is brown (5YR 4/8) clay-loam with a strong brown (7.5YR 5/6) solum > 48 in. deep developed on it. Wisconsinan till south of Blue Mountain is moderate yellow brown (10YR 5/4) coarse sandy-loam with a 24 to 26 in. solum. North of the mountain both pre-Woodfordian and Woodfordian till are present. Woodfordian till is reddish brown (5YR 4/2 to 5/4) loam with a 22 to 24 in. solum. The pre-Woodfordian till, which geographically separates the Illinoian and Woodfordian tills, is very gritty, moderate yellow brown

(10YR 5/4) clay-loam. Does the 10YR 5/4 sandy-loam till south of Blue Mountain correlate with the 10YR 5/4 clay-loam till (pre-Woodfordian) or the 5YR 5/4 loam till (Woodfordian) north of the mountain?

To complicate matters further, there is a medium gray (N4) silty-clay till exposed, apparently at the surface, north of Delaware Water Gap; this till underlies the 10YR 5/4 till south of the Gap!

North of Blue Mountain seven deglacial sequences have been identified (Connally and Epstein, 1973) starting with the Terminal Moraine. As the glacier receded northeastward from the moraine, Lake Sciota formed at 680 ft. in the McMichael Creek Valley, between the ice and the moraine at Brodheadsville. Lake Sciota expanded adjacent to the retreating glacier until the ice margin reached the Delaware River (≈ 300 ft.); it emptied with only a slight hesitation at 500 ft. Drainage then commenced southward via Delaware Water Gap.

In sequence 5 an ice channel filling west of Pocono Creek isolated an ice block, against the upland. When the ice block melted a kettle with more than 60 ft. of closure resulted. A bog which developed in this kettle was cored to a depth of 7.25 m in 1973. The stratigraphy reported below correlates with Saddle Bog (Sirkin and Minard, 1972) on the Augusta Moraine in northwestern New Jersey, Flower Hill Bog (Sirkin, 1967) on Long Island, and sample BR 12 in the Delaware Valley north of Trenton (Sirkin and others, 1970).

C zone	0 - 3.75 m
B zone	3.75 - 4.75 m
A ₄ zone	4.75 - 5.00 m
A ₃ zone	5.00 - 5.25 m
A ₁₋₂ zone	5.25 - 5.75 m
Herb zone	5.75 - 7.25 m

A date of $11,430 \pm 300$ yrs. B.P. (W-2893) was obtained from peat at 5.15 to 5.25 m, at the A_4 - A_3 boundary. Does the radiocarbon age of 11,430 yrs. B.P., or the pollen stratigraphy to the base of the bog, serve as an upper limit on the age of deglaciation?

The radiocarbon dates from the region provide some problems. The dates follow:

OWU 430 13,235 \pm 1620 YBP	Echo Lake (4.5 mi NE of Marshalls Creek, above Delaware Water Gap). Silty clay gyttja at base of organic section, overlying clay.
OWU 415 12,520 \pm 825 YBP	Leaps Bog (1 mi NE Marshalls Creek) Decomposed woody peat at contact with underlying clay.
W-2893 11,430 \pm 300 YBP	Near base of kettle hole bog in Saylorsburg quad. In A_3 zone 2 m above Herb zone.
SI 1559 12,750 \pm 100 YBP	Sausser Bog. Clay gyttja at bottom of bog in Lycoming Valley, N of Williamsport.
SI 1341 12,760 \pm 135 YBP	Brodheadsville. Fragmental material in lake clay overlain by silts and gravel of Late Wisconsinan outwash.

The first four of these dates are bog bottom dates and mark the younger limit on the age of deglaciation. The last date is from material buried by outwash. Why are the dates so close together?

The thrust of this trip is to examine deposits of each of the recognized glaciations and their relationship to the Terminal Moraine. Emphasis will be placed on the role of bedrock control of till character; reasons for age differentiation of the various deposits; the extensive development of boulder fields of presumed periglacial origin (Smith, 1953; Sevon, 1969a); and the significance of the 11,430-13,500 YBP radiocarbon dates obtained from deposits in the area.

BEDROCK SUMMARY

MISSISSIPPIAN

Mauch Chunk Formation. 2,200'. Red siltstones and sandstones with some shales.

Pocono Formation. 1387'. Light gray, quartzitic sandstones and conglomerates.

DEVONIAN

Catskill Formation. 7948'. Nine members. Equal amounts red and non-red units. Variety of conglomerates, sandstones, siltstones and shales. Coarser in upper third.

SILURIAN AND DEVONIAN

Marine. 5600'. Sixteen units ascending from Pocono Island Formation through Trimmers Rock Formation. Upper 3800' dark gray shales and siltstones. Remainder variety of limestone and dolomite units with some sandstones.

SILURIAN

Bloomsburg Red Beds. 1500'. Red sandstone, siltstone and shale.

Shawangunk Conglomerate. 1389'. Three members. Gray, quartzitic sandstones and conglomerates.

ORDOVICIAN

Martinsburg Formation. 9000'. Three members. Dark gray claystone slate with interbedded siltstones and sandstones.

FIELD TRIP LOG

Cumulative Mileage	Increment Mileage	First Day
0.0	0.0	Penn Stroud Hilton Inn. Turn right (west) on Business US 209 S.
0.2	0.2	Stop light. Go straight ahead.
0.5	0.3	Bear right at Fork on US Route 209.
1.0	0.5	Marker on right, Shell Station.
1.1	0.1	Turn right on I-80 W.
3.2	2.1	Marcellus (Devonian) shale on right.
3.9	0.7	Late Wisconsinan till on left.
5.1	1.2	Trimmers Rock Formation (Devonian) on both sides
5.7	0.6	Base of Catskill Formation (Devonian) on both sides marked by gray sandstones and red beds. We will be in this formation the rest of the morning.
6.4	0.7	Catskill red shale and siltstone and gray sandstone on both sides.
8.0	1.6	To the left is view of Camelback Mountain, a projection of the Pocono Plateau. Late Wisconsinan end moraine wraps around its flanks.
9.0	1.0	Climb the Pocono Plateau escarpment.
11.6	2.6	Now traveling in Late Wisconsinan Terminal Moraine.
12.8	1.2	Late Wisconsinan till on right.
13.7	0.9	Bear right on I-380.
14.3	0.6	Late Wisconsinan till on right.
15.3	1.0	Borrow pit in sand and gravel on right has a variety of igneous and metamorphic erratics including a garnetiferous gneiss from the Adirondack Mtns. Crystalline erratics are generally rare in this region and this pit has an anomalous concentration.
16.2	0.9	Bear right on Exit 1 to Pennsylvania Route 940.
16.4	0.2	Turn left on Pennsylvania Route 940.
16.6	0.2	Turn left on road (LR 45040) to Emerald Lakes and Long Pond. Travel across Late Wisconsinan ground moraine.

17.5	0.9	Cross road; continue ahead. Ascend proximal slope of Late Wisconsinan Terminal Moraine. Small road cuts show till.
18.4	0.9	Turn left at Emerald Lakes Entrance. These are private grounds and we enter by special permission.
		STOP 1. Late Wisconsinan Terminal Moraine.
		Late Wisconsinan till exposed here is typical of that found in the Terminal Moraine in this area. It is brown, sandy, very stony, dominated by gray sandstone pebbles and cobbles and has very thin soil development. Note the extremely bleached white color of the gray sandstones at the surface and the fresh color of similar sandstones within the till.
		The Terminal Moraine complex in this area varies from sandy till to ice-contact stratified drift and no clayey tills have been observed. Well developed end moraine topography is obvious in this area. Glacial striae north of this area indicates ice movement about S10°W.
0.0	0.0	Leave Emerald Lakes. Turn left (south) on Long Pond Road.
0.8	0.8	Emerald Lakes in kettle holes.
1.1	0.3	Travel down the south, distal, margin of the Terminal Moraine onto early Wisconsinan ground moraine. Cross an extensive flat on this till developed by Late Wisconsinan solifluction.
2.3	1.2	Cross over I-80.
3.9	1.6	Turn right at Y intersection.
6.5	2.6	Pit on left shows Catskill sandstone overlain by early Wisconsinan till.
6.7	0.2	Pocono International Racway on left. The race-track embankments are made of early Wisconsinan till.
8.0	1.3	Turn right at junction with Pennsylvania Route 115.
9.5	1.5	Borrow pit on left in kame at south margin of Late Wisconsinan Terminal Moraine. Till overlies sand. We will pause here briefly, later.
11.3	1.8	Cross over I-80
11.9	0.6	Cross Tobyhanna Creek flowing parallel to the north margin of Terminal Moraine.

12.8	0.9	Blakeslee stoplight. Continue straight ahead.
13.5	0.7	Bear left on side road.
13.6	0.1	Turn left on dirt track onto property of Dream Mile Road and Gun Club, permission granted by Blue Ridge Real Estate Co.
13.8	0.2	Stop in Catskill red shale borrow pit.
STOP 2. Late Wisconsinan Ground Moraine.		
Late Wisconsinan till exposed here is typical of the reddish brown till found in much of northeastern Pennsylvania. The reddish brown color is inherited from red shales of the Catskill Formation such as those exposed in this borrow pit. The till is more clayey and contains fewer gray sandstone pebbles and cobbles than the till exposed at Stop 1, but has comparable soil development.		
Two features are well exposed here: (1) Gradual transition upwards from bedrock into broken bedrock into till which strongly reflects the immediately underlying bedrock, (2) local bedrock facies of red shale grading laterally into green shale is reflected in change of till color from reddish brown to light reddish brown.		
0.0	0.0	Return to highway, turn right (south) on Pennsylvania Route 115.
0.7	0.7	Blakeslee stop light. Continue straight ahead.
2.2	1.5	Cross over I-80.
4.0	1.8	Hilltop. Watch for right turn!
4.1	0.1	Turn right on side road. Small snack bar on left, borrow pit on right. Bridge over Tunkhannock Creek ahead. PAUSE. Gravel pit in road corner on right. Kame overlain by red till derived from Catskill Formation. This is front edge of Late Wisconsinan Terminal Moraine. Travel southwest along moraine front.
4.7	0.6	Approach sharp curve!
5.0	0.3	Stop sign. Turn right on Pennsylvania Route 903.
6.0	1.0	Lake Harmony entrance on right. Continue straight ahead.
6.4	0.4	Blocks of Catskill conglomerate (Duncannon Member) on left.

8.2	1.8	Junction Pennsylvania Routes 903 and 534. Continue straight ahead on Route 903.
8.9	0.7	Entrance to Towamensing Trails on left. Continue straight ahead.
9.1	0.2	Turn left at intersection onto gravel road.
9.4	0.3	Sand Pit in Late Wisconsinan kame overlain by till on left. This is part of a small area of Late Wisconsinan drift lying south of the Terminal Moraine.
10.4	1.0	Pull into borrow pit on left.
		STOP 3. Illinoian till.
		Very clayey, yellowish brown material exposed in vertical face is interpreted as clay-enriched B horizon of a soil profile developed on Illinoian till during the Sangamonian Stage. Darker material exposed locally at the top of the exposure may represent superimposed modern soil profile. Weathered till apparently lacking clay enrichment can be excavated from lower levels of the pit.
		This site occurs in a very broad flat part of the Pocono Plateau and has not been subjected to much, if any, cryoplanation or colluviation. There is no evidence that the site has been overridden by either Early or Late Wisconsinan ice.
0.0	0.0	Return on route to Pennsylvania Route 903.
1.3	1.3	Turn right on Pennsylvania Route 903.
2.2	0.9	Junction Pennsylvania Routes 903 and 534. Turn left on Pennsylvania Route 534.
3.8	1.6	Village of Albrightsville on Late Wisconsinan till plain.
4.6	0.8	Hickory Run State Park boundary.
4.9	0.3	Late Wisconsinan till exposed on left. This is part of a small area of Late Wisconsinan drift lying south of the Terminal Moraine.
6.7	1.8	Travelling over colluvium which is locally exposed in roadside drainage ditches.
7.1	0.4	Side road on right to Stony Point Forest Fire Tower. Frost-riven sandstone of the Duncannon member of Catskill Formation exposed here. Similar outcrops have been the source of the Hickory Run Boulder Field.

8.9	1.8	Turn right at entrance to Hickory Run State Park day use area. The road here is on the end moraine. A frontal drainage channel is immediately to the right.
9.3	0.4	Road fork. Go left to Boulder Field. Traveling over end moraine.
10.5	1.2	Kettle hole at outer edge of end moraine on the left. Travel over well vegetated boulder field traceable up slope to sandstone outcrop of Pocono Formation (Mississippian). We are now south of area glaciated by Late Wisconsinan ice. Area possibly glaciated by both early Wisconsinan and Illinoian, but evidence lacking.
10.6	0.1	Hickory Run Lake on right.
10.7	0.1	Borrow pit on left. Originally it exposed outwash and lake deposits.
11.5	0.8	Pass under Northeast Extension Pennsylvania Turnpike.
12.1	0.6	Side road on right; go straight ahead.
13.0	0.9	Parking Area.

STOP 4. Hickory Run Boulder Field.

Hickory Run Boulder Field is probably the finest example in Pennsylvania of a deposit resulting from periglacial activity. This boulder field is only one of many in Pennsylvania and is not the largest even in the local area. However, it does possess the lowest known gradient (1%) of such fields in Pennsylvania and preserves many features such as: stone rings, lithology streams, fitted and polished surfaces, imbrication and downfield boulder rounding and size reduction. The boulder field lies within a mile of the Late Wisconsinan Terminal Moraine and presumably is a by-product of that glaciation. The mechanism of origin is not fully understood, nor is there absolute agreement about whether vegetation is encroaching upon or retreating from the boulder field.

This field was first described by a long time Friend, H.T.U. Smith, (19) and was made a Registered Natural Landmark in 1967.

0.0	0.0	Leave parking area.
0.9	0.9	Turn left on Exit Road.
1.2	0.3	Cross Hickory Run and lower end of boulder field which here is almost completely vegetated.
2.5	1.3	Pass under Northeast Extension Pennsylvania Turnpike. Soil here is developed on colluvium of Pocono Formation (Mississippian).
3.3	0.8	Hillside shoulder on right on gray sandstone of Spechty Kopf Formation (Devonian-Mississippian).
4.0	0.7	Road junction; bear right through the picnic area.
4.8	0.8	Road fork; bear left.
5.2	0.4	Leave Hickory Run State Park day use area. Turn right on Pennsylvania Route 534.
5.8	0.6	Hickory Run State Park Headquarters on left.
6.0	0.2	Cross Hickory Run. Pocono-Mauch Chunk Formations (Mississippian) transition zone exposed on right.
6.6	0.6	Late Wisconsinan Terminal Moraine; re-enter glaciated area.
7.6	1.0	Late Wisconsinan till exposed in road cuts on left.
7.9	0.3	Mauch Chunk Formation (Mississippian).
8.3	0.4	Cross Black Creek. Ahead on right is a Late Wisconsinan kame.
9.1	0.8	Village of Lehigh Tannery. Tanning mill formerly located here was the main reason for cutting the local hemlock forests during the 19th century.
9.3	0.2	GO SLOW! Sharp right around curve on Pennsylvania Route 534 at road fork.
10.1	0.8	La Chateau golf course on left is on Late Wisconsinan ground moraine. Note large locally derived erratic.
10.7	0.6	Peat bog on right.
11.1	0.4	Cross I-80.
11.2	0.1	Turn left (west) onto I-80 W.
12.3	1.1	Outcrops of Mauch Chunk Formation on both sides. This formation provides the distinctive red brown color of the Late Wisconsinan till in this area.

12.4	0.1	Cross the Lehigh River.
12.6	0.2	Bear right onto Exit 40 at White Haven.
12.8	0.2	Turn left on Pennsylvania Route 940.
13.1	0.3	Outcrops of Mauch Chunk Formation on both sides.
13.4	0.3	Road fork; bear right on Pennsylvania Route 940.
15.3	1.9	Outcrop of Mauch Chunk Formation on right.
15.5	0.2	Turn left at entrance to Hickory Hills Estates, go to end of road.
16.0	0.5	Turn right at T intersection.
16.5	0.5	First ridge of end moraine on north slope of mountain.
16.6	0.1	STOP 5. Late Wisconsinan End Moraine at Hickory Hills
		End moraine was developed here where ice flow was impeded by the mountain slope to the south. Moraine ridges trend obliquely up the slope at about S 28° W. The till is derived from the underlying Mauch Chunk red sandstones and shales, and is typical Woodfordian till in this area.
		Leverett mapped this area as Illinoian drift, apparently basing his interpretation on the red color of the drift, which, in fact, is unlike the ordinary "red" Illinoian till. He probably did not see this local end moraine.
0.0	0.0	Turn right, downhill, Note end moraine ridges.
0.1	0.1	Turn right and return to entrance road. Note that end moraine ridges die out at base of mountain.
0.8	0.7	Turn left onto entrance road.
1.3	0.5	Exit from Hickory Hills Estates. Turn right on Pennsylvania Route 940, retrace route, travelling over ground moraine.
3.1	1.8	Road fork, turn right on paved road. Pennsylvania Power and Light (PPL) Center on left ahead.
3.3	0.2	Kames on both sides of road. These are part of a belt of scattered kame areas in the ground moraine north of Buck Mountain which lies ahead of us on the right.
4.3	1.0	Crossroad; go straight ahead.

5.3	1.0	North edge of Late Wisconsinan end moraine. It has weak topographic expression in the area to the west and here lies on bedrock hills north of Sandy Run.
5.6	0.3	On left is Mauch Chunk Formation hill in end moraine.
5.9	0.3	Cross Sandy Run in the midst of the end moraine.
6.7	0.8	South edge of the end moraine.
7.0	0.3	Carbon County line.
7.2	0.2	Late Wisconsinan pro-moraine till beyond end moraine was shown in basement excavations on both sides.
Note that there is no "terminal moraine" at the Woodfordian border here; till gives way to colluvium on bedrock. This type of border is common west of here where there was no topographic barrier to ice movement.		
7.5	0.3	Bedrock and colluvium formerly exposed in house excavation on right.
8.2	0.7	Crossroad; continue straight ahead.
8.7	0.5	PAUSE; look at residual soil and colluvium from the buses. Note the angular fragments of sandstone in the soil.
8.8	0.1	Bear right on main road at intersection.
9.3	0.5	Rock and colluvium in roadcuts. Travel farther over rock and colluvium.
11.4	2.1	Lake on left. WATCH FOR TURN.
11.6	0.2	Turn left on hidden dirt road, an old railroad grade.
12.2	0.6	Park buses, walk downhill into sand pit.

STOP 6. Early Wisconsinan Kame at Drumbor Sand Pit.

Kames in this area lie about 3 miles south of the Woodfordian border, and were mapped as Illinoian by Leverett. However, they are unlike Illinoian gravel deposits in this area, for they are much less weathered. They are more weathered than Woodfordian kames, and on the basis of their intermediate weathering profiles are assigned to the Early Wisconsinan.

Return to Stroudsburg.

0.0	0.0	Return to highway.
0.6	0.6	Turn right on highway and return to I-80.
8.7	8.1	Turn right onto I-80 E.
10.3	1.6	Pass under Pennsylvania Route 534.
10.4	0.1	Mauch Chunk Formation on both sides.
12.2	1.8	Cross over Northeast Extension Pennsylvania Turnpike and enter Late Wisconsinan Terminal Moraine from ground moraine. We stay on end moraine most of the way to the edge of the plateau.
18.0	5.8	Cut in kame on right.
19.2	1.2	Cross under Pennsylvania Route 115 on end moraine.
20.0	0.8	Pipeline right-of-way to right shows good end moraine topography. Look sharply!
23.5	3.5	Cross south margin of end moraine. I-80 is to the north and parallel to the moraine for some distance.
24.4	0.9	Small boulder field in trees on right. Look sharply!
26.4	2.0	Re-enter end moraine.
27.3	0.9	Borrow pit in end moraine on right.
27.6	0.3	I-80 route sign across highway.
29.2	1.6	Start long descent of Pocono Plateau escarpment. We are still in end moraine. Good view of Camelback Mountain ahead to right. End moraine wraps around mountain on the lower slopes.
31.3	2.1	Till exposed in valley on right.
31.5	0.2	Catskill Formation exposed on right.
35.2	3.7	Base of plateau escarpment. Numerous road-cuts ahead show Catskill Formation.
37.5	2.3	Trimmers Rock Formation (Devonian) on right.
38.8	1.3	Till in ground moraine on right.
42.7	3.9	Bear right onto Exit 50 to Park Ave.
43.0	0.3	Turn left on Park Ave. and proceed to Penn Stroud Hotel.
43.3	0.3	PENN STROUD HILTON INN.

FIELD TRIP LOG

Cumulative Mileage	Increment Mileage	Second Day
0.0	0.0	Penn Stroud Hilton Inn. Proceed south on Route 209.
0.2	0.2	Continue south on Route 209, Route 611 leaves to the right.
1.0	0.8	TURN RIGHT onto Route 80 west.
1.3	0.3	Stop sign. Stay in right lane and continue south on Route 209-33.
2.3	1.0	Cross Sequence 6 kame moraine.
3.6	1.3	Cross Sequence 5 kame moraine.
4.0	0.4	Cross Sequence 4 kame moraine, pit on left shows kame-delta deposition into Glacial Lake Sciota.
7.0	3.0	Sequence 3 ice channel filling on right feeds the Sciota Delta.
7.8	0.8	Sequence 3 Sciota Delta on right.
8.0	0.2	EXIT RIGHT to Route 209 South.
8.9	0.9	EXIT RIGHT for Sciota and Route 209 (Business).
9.1	0.2	TURN LEFT on Route 209 South at Stop sign.
10.4	1.3	TURN LEFT (east) on the Blue Mountain Golf Course Road.
10.5	0.1	STOP 1. Park on the right shoulder and walk into the gravel pit operated by the Edinger Construction Company. Although this pit is in a Sequence 2 deposit, it is typical of the Terminal Moraine north of Cherry Ridge.
0.0	0.0	Return to Route 209 via the Blue Mountain Golf Course Road.
0.1	0.1	TURN LEFT on Route 209 and continue south.
1.1	1.0	Saylors Lake on left.
1.4	0.3	TURN LEFT at Stop Sign, following Route 209 south.
1.5	0.1	Borough of Saylorsburg
2.0	0.5	Crest of Cherry Ridge
2.6	0.6	TURN LEFT on the Kemmerton Road

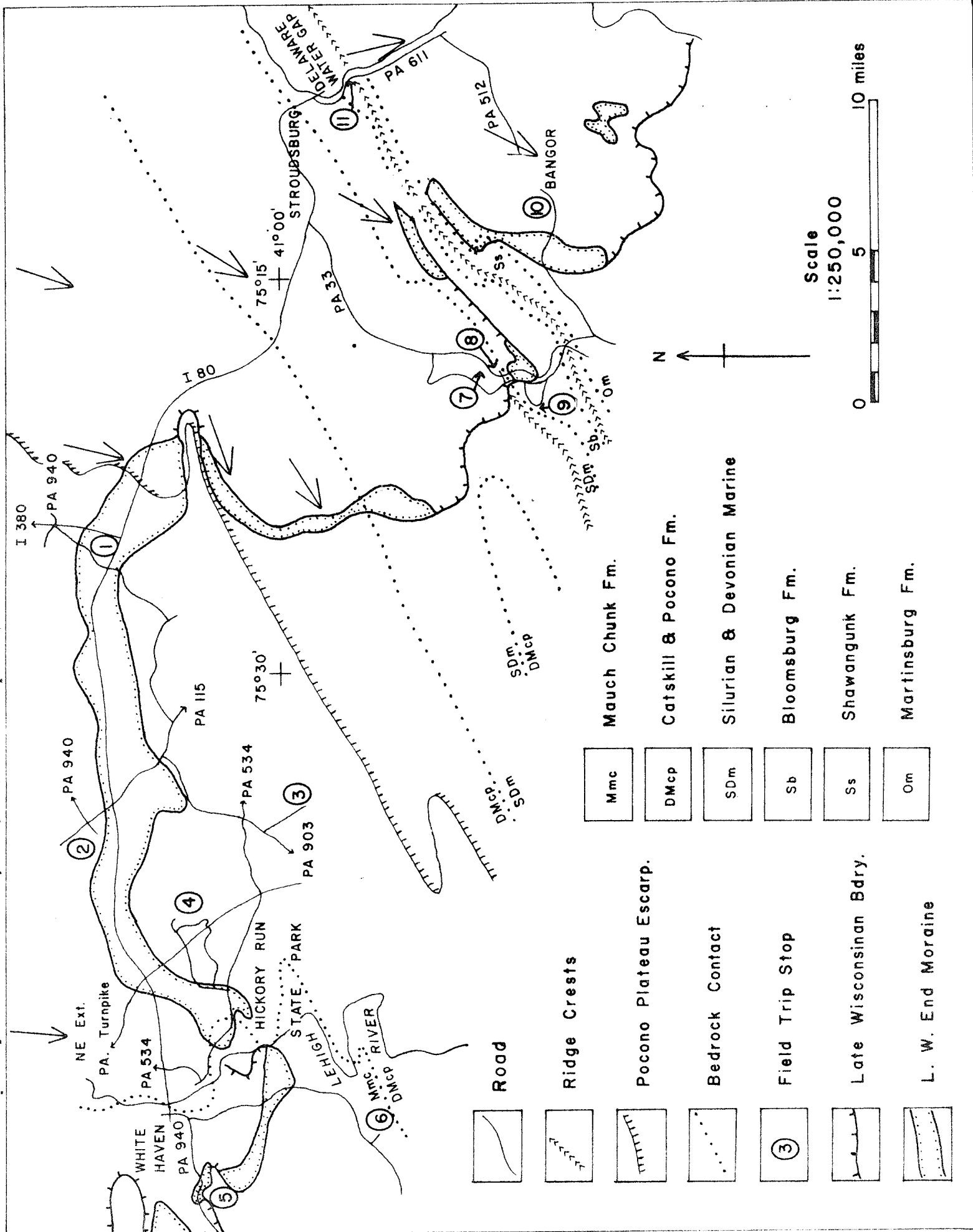
2.8	0.2	<p>STOP 2.</p> <p>Park on the right shoulder and walk up the gravel road immediately west of the Route 33 underpass. The exposure is on the right side of this road.</p> <p>This stop will illustrate the typical Woodfordian till north of Blue Mountain-Kittatinny Mountain. The Terminal Moraine between Cherry Ridge and Kittatinny Mountain is composed entirely of lodgement till.</p>
0.0	0.0	Return to Route 209 via the Kemmerton Road.
0.2	0.2	TURN LEFT on Route 209 and continue south.
1.2	1.0	TURN RIGHT on the Palmerton Road.
2.1	0.9	TURN RIGHT on the Saylorsburg Road immediately after crossing Aquashicola Creek.
2.3	0.2	<p>STOP 3</p> <p>Park on the right shoulder. The exposure is on the left side of the road.</p> <p>This stop will illustrate the typical pre-Woodfordian(?) till beyond the Terminal Moraine.</p>
0.0	0.0	Continue east toward Saylorsburg.
0.3	0.3	A mixed till and colluvium exposure on the left.
1.3	1.0	Ascend the distal slope of the Terminal Moraine.
1.5	0.2	TURN RIGHT on Route 209 south.
1.6	0.1	TURN LEFT on Route 33 south.
4.2	2.6	EXIT RIGHT to Route 512.
4.3	0.1	TURN LEFT on Route 512 at Stop Sign.
4.4	0.1	Route 33 underpass, Crest of Blue Mountain, Shawargunk outcrops.
5.3	0.9	TURN LEFT at traffic light, continue to follow Route 512 north.
7.7	2.4	Traffic light, Borough of Pen Argyl, continue straight on Route 512.
7.9	0.2	Bear left on Route 512 toward Bangor.

8.1	0.2	Bear right on Route 512 toward Bangor.
9.3	1.2	TURN LEFT on Kennedy Drive.
9.4	0.1	STOP 4.
Park in the parking lot of John Goffredo and Sons, and walk to the exposure north of the warehouse.		
This stop will illustrate the till of the Terminal Moraine south of Blue Mountain and the topographic expression of the moraine. Compare this till with Woodfordian and pre-Woodfordian(?) tills north of Blue Mountain.		
0.0	0.0	Return to Route 512 on Kennedy Road
0.1	0.1	TURN LEFT on Route 512 and continue north.
0.8	0.7	Traffic light, Borough of Bangor, continue straight on Route 512. (Market Street)
1.3	0.5	TURN RIGHT on Route 191 south (First Street)
1.8	0.5	TURN LEFT on Messinger Street and cross railroad overpass.
1.9	0.1	Traffic light. Continue straight
2.2	0.3	TURN RIGHT on Center Street toward Richmond.
2.3	0.1	Bear left on the Richmond Road.
3.3	1.0	Bear left on the Richmond Road.
3.7	0.4	Bear right on the Richmond Road.
3.9	0.2	Continue straight onto the Martins Creek Road.
4.8	0.9	Martinsburg shales exposed on right.
5.2	0.4	Bear right on the Martins Creek Road.
5.5	0.3	Hill crest, note topographic expression of the proximal slope of the Terminal Moraine straight ahead.
5.7	0.2	Weidman Kettles in woods at right.
6.5	0.8	Bear left on the Martins Creek Road. Frost wedges in thin Wisconsinan till which overlies Illinoian till near the house on the right, as noted in the summer of 1974. This is the distal slope of the Terminal Moraine.

6.8	0.3	TURN LEFT onto Route 611 at the Stop Sign and proceed north.
6.9	0.1	Crest of the Terminal Moraine. Note the subdued morainal topography to the west and the absence of topographic expression toward the Delaware River Valley to the east. The Terminal Moraine must be traced eastward using soil stratigraphy.
12.5	5.6	Route 512 leaves to the left.
14.1	1.6	Railroad underpass.
14.3	0.2	TURN RIGHT on Route 611 north.
14.6	0.3	TURN LEFT at the Stop Sign and continue north on Route 611. The Delaware River is on the right.
14.8	0.2	Traffic light. Borough of Portland.
16.5	1.7	Gravel terraces visible on left and across the river on the right. Delaware Water Gap is straight ahead.
17.8	1.3	Arrow Island Overlook.
18.4	0.6	STOP 5.
Here we will discuss the significance of moraines, terraces, correlations, and the age of the Delaware Water Gap.		
0.0	0.0	Continue north on Route 611.
2.0	2.0	Borough of Delaware Water Gap.
2.2	0.2	Traffic light, continue straight on Route 611.
2.5	0.3	TURN LEFT at Stop Sign on Route 611 north.
4.2	1.7	Fox Gap, crest of Godfrey Ridge.
4.9	0.7	Junction with Route 191, continue straight.
5.0	0.1	Bear right on Route 611 at blinker.
5.2	0.2	Route 80 entrance and overpass. Continue straight
5.6	0.4	Junction Route 209, Penn Stroud Hilton Inn

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