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William H. Callahan

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THE GEOLOGICAL SOCIETY OF AMERICA

GUIDEBOOK FOR FIELD TRIPS PITTSBURGH MEETING, 1959

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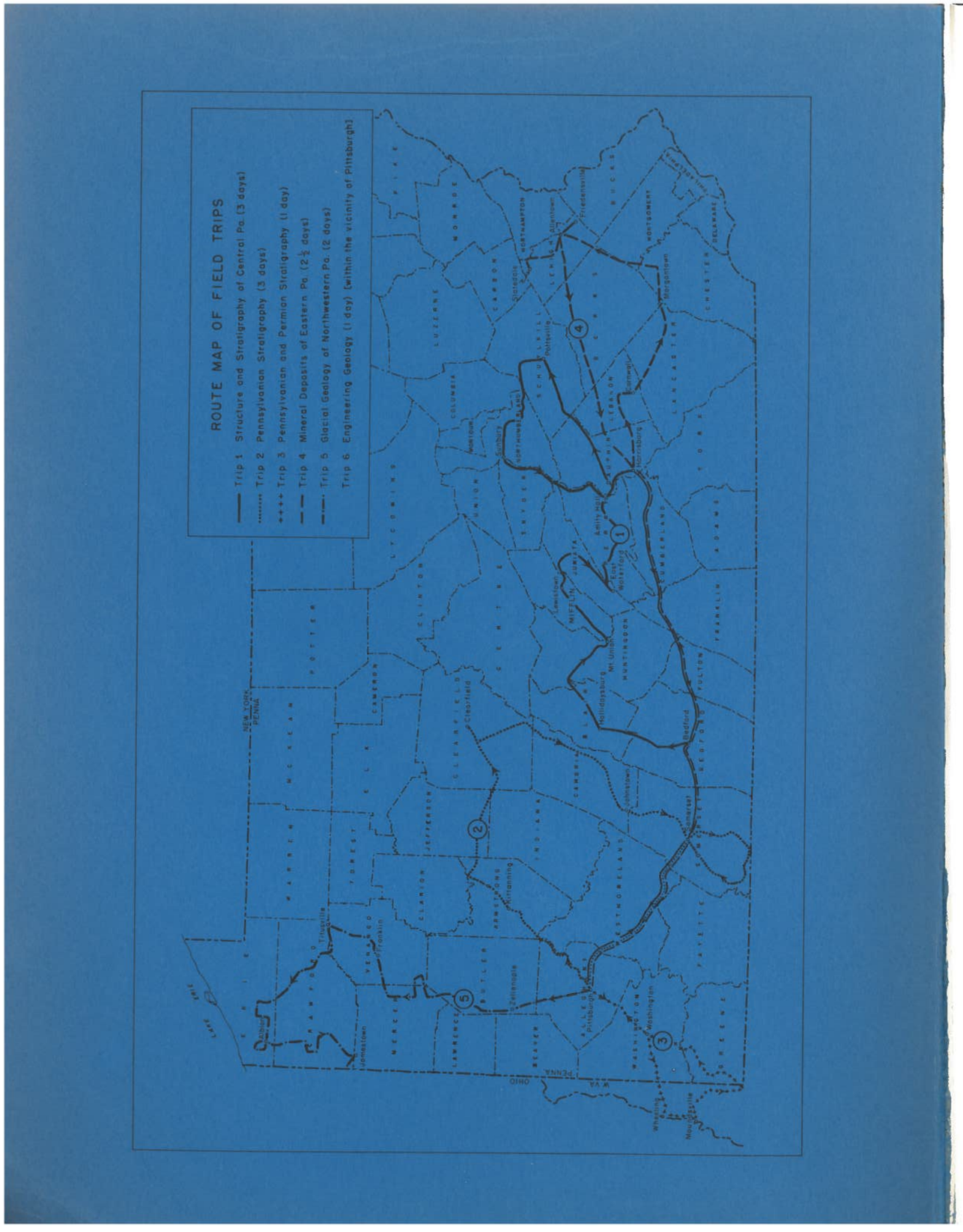

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PITTSBURGH MEETING, 1959

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CONTENTS

FIELD TRIP 5

GLACIAL GEOLOGY OF NORTHWESTERN PENNSYLVANIA

by

Vincent C. Shepps
Pennsylvania Geological Survey

November 5 and 6, 1959

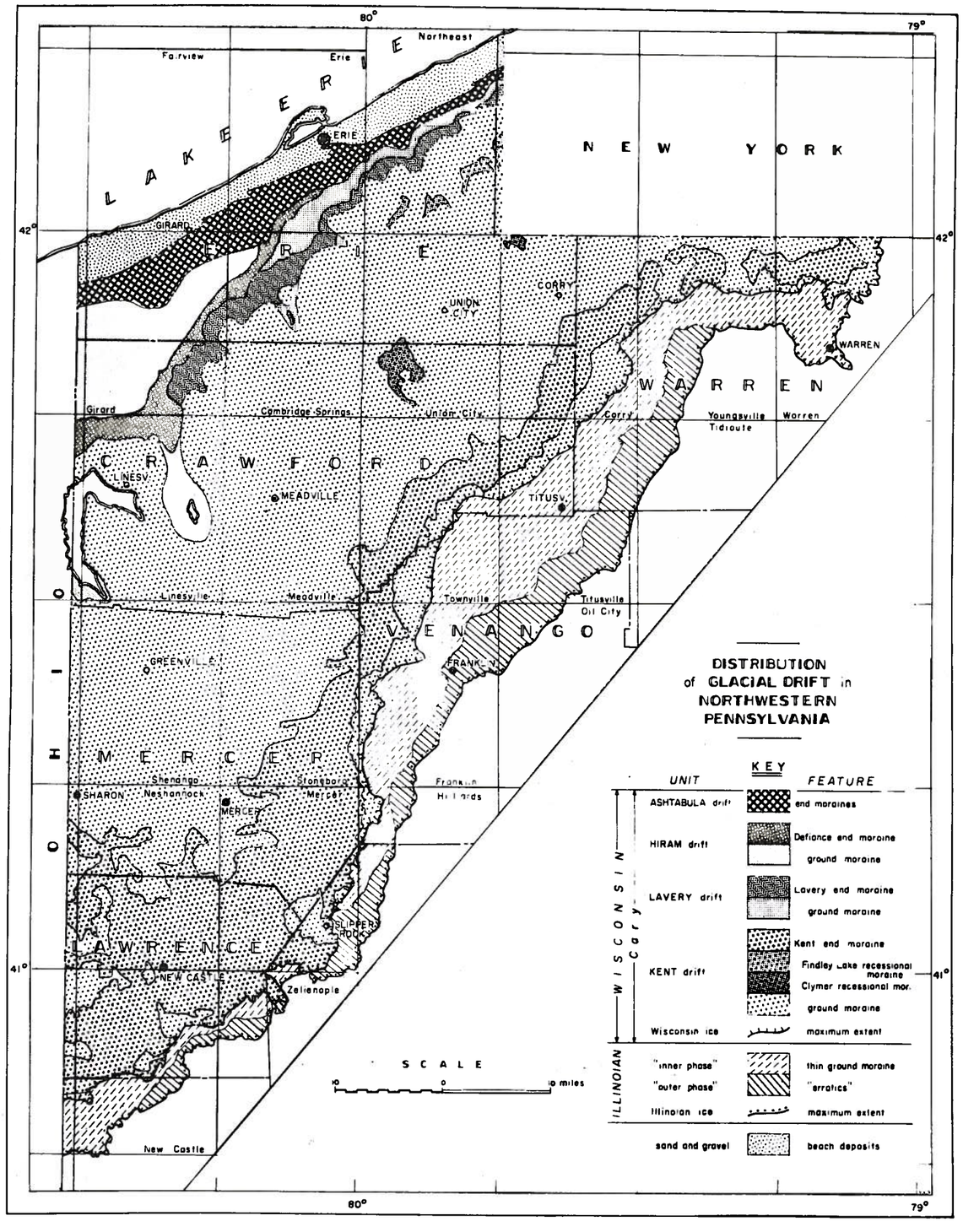
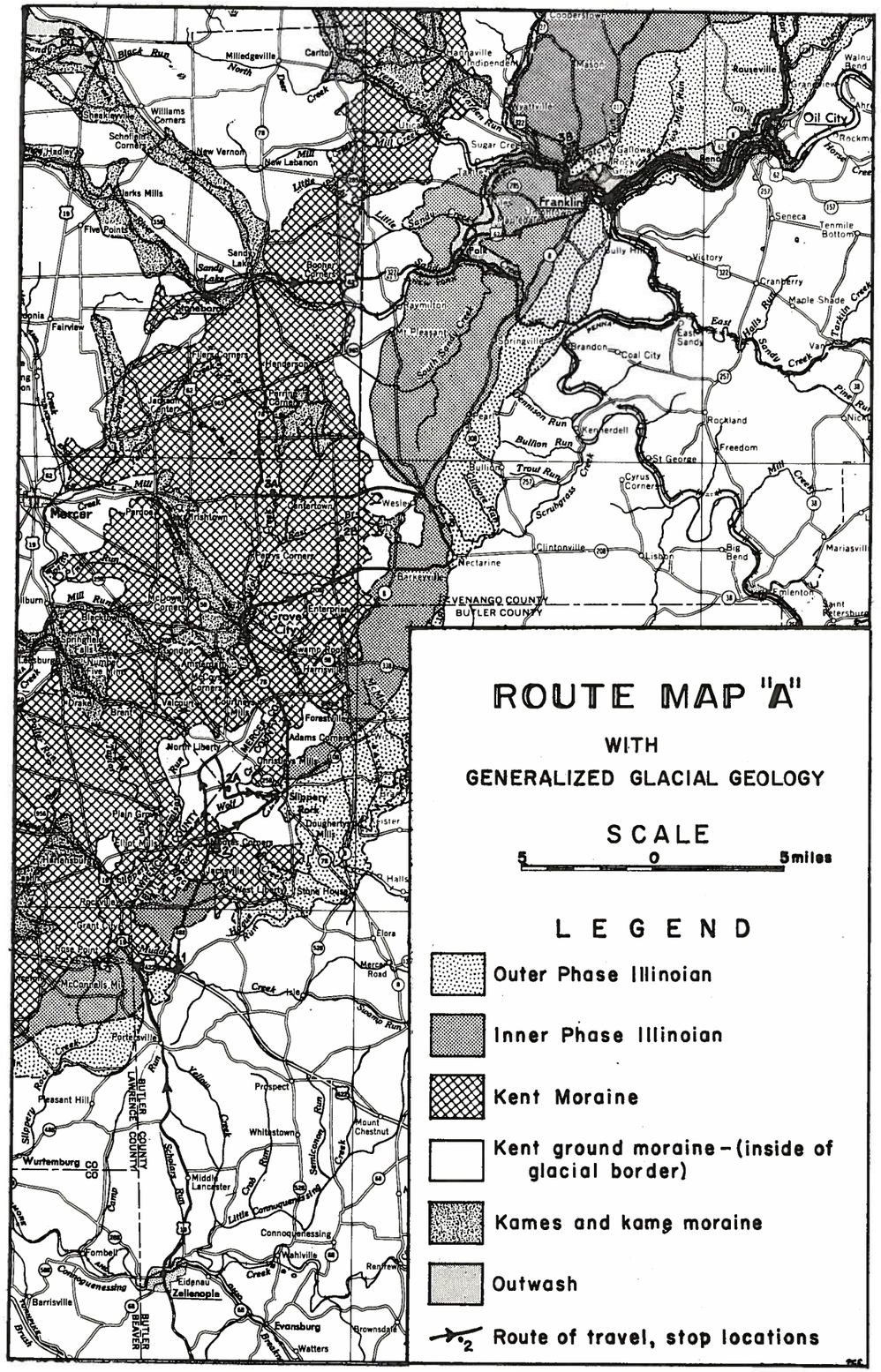


Figure 1. Map showing the distribution of the glacial deposits of northwestern Pennsylvania.

AGE	DEPOSITS	FEATURES	FORMER NAMES
PLEISTOCENE SERIES			
WISCONSIN STAGE			
Cary Substage to Recent time	Sands and gravels, silts and clays	Beach deposits of lakes in the Erie basin	
Cary Substage	Ashtabula Till	Ashtabula Morainic System	"latest Cary" Lake Escarpment Morainic System (Leverett, 1902)
Ashtabula advance	Sand and gravel	kames and outwash	
Hiram advance	Hiram Till	Defiance moraine ground moraine	"late Cary" Inner Cleveland moraine (in part) of Leverett, (1902)
	Sand and gravel, silt and clay	kames, outwash, and lake deposits	
Lavery advance	Lavery Till	Lavery moraine ground moraine	"middle Cary" Inner Cleveland moraine (in part) of Leverett (1902)
	Sand and gravel, silt and clay	kames, outwash, and lake deposits	
Kent advance	Kent Till	Kent moraine ground moraine	"early Cary" Main terminal moraine of Lewis (1882)
	Sand and gravel	Clymer and Findley Lake recessional moraines kames and outwash	Inner and outer Cleveland moraines (in part) of Leverett (1902)
Tazewell Substage	Tazewell till	ground moraine in subsurface	
ILLINOIAN STAGE			
"Inner phase" advance	Thin till, sand and gravel	ground moraine, kames, and outwash	
"Outer phase" advance	Erratics	ground moraine (?)	

Figure 2. Classification and nomenclature of the glacial deposits of northwestern Pennsylvania.



INTRODUCTION

The glacial geology of all of northwestern Pennsylvania has been studied in detail since 1952 by students of Professor George W. White of the University of Illinois and is at the time of this writing being prepared for publication by the Pennsylvania Geological Survey. In the area covered by this report studies were made by Robert F. Sitler (Kent State University), John B. Droste (Indiana University) and V. C. Shepps (Pennsylvania Geological Survey). Areas studied by the various authors and covered by this field trip include Butler and southern Mercer counties (Sitler), eastern Mercer, Crawford and Venango counties (Droste) and western Crawford and Erie counties (Shepps).

This two-day field trip is designed to acquaint workers with the glacial deposits and the glacial history of northwestern Pennsylvania. The route will pass over deposits of all but one of the advances and stops are designed to permit the examination and comparison of the tills of each advance. Because of the large area involved much time will be spent travelling through the various deposits and ample opportunity will be available to study their surface expression.

Northwestern Pennsylvania was glaciated on no less than seven occasions by continental ice of the Erie Lobe which moved along the basin of Lake Erie from the northeast. Movement of ice into Pennsylvania occurred as a lateral spreading of the southern margin of the Erie Lobe or the eastern margin of a tongue of ice called the Grand River Sublobe which moved into eastern Ohio. Advances occurred twice during the Illinoian Stage and five times during the Wisconsin Stage – once during the Tazewell Substage and four times during the Cary Substage. Distribution of these deposits is shown in Figure 1. Tazewell deposits are found only in subsurface and consequently do not appear in Figure 1.

Deposits made during the advances of the Cary Substage have been given local names in Ohio and in Pennsylvania which are shown in Figure 2. Figure 2 shows, in addition, the classification and nomenclature applied to the various advances, and the deposits and features formed by those advances. All units have been correlated with those to the west in Ohio (White, Droste, Sitler, and Shepps, 1957). The units named "Hiram" and "Ashtabula" were so proposed by G. W. White in Ohio (personal communication) and have not been published as of the date of this writing. Their usage here does not constitute a formal proposal for their adoption and is for convenience only. The units named "Kent" were so named by White in an earlier publication (White, 1957).

The trip passes over bedrock ranging in age from late Pennsylvanian to late Devonian beginning at Pittsburgh in the youngest rocks and passing over successively older rocks to the north. The first day's route passes over rocks of Pennsylvanian and Mississippian age and ends at Titusville in the Pocono beds of Mississippian age. The route on the second day travels across sandstones and shales of the Pocono Formation and Upper Devonian shales and siltstones which are rarely exposed.

F I R S T D A Y

Mileage

Start Pittsburgh. Travel north on Route 19 to Zelienople (See Route Map A.). Route is entirely through non-glaciated country underlain by Pennsylvanian rocks of the Conemaugh Formation and the Allegheny Group. Going north the rocks become progressively older. Travel approximately 41 miles to Zelienople where the trip mileage begins.

0.0 In Zelienople at the stoplight on Route 19 just south of the bridge over Little Connoquenessing Creek. Route is straight ahead (north).

9.8 Portersville; continue straight ahead on Route 19.
Route is still outside of the glacial border. Approximately 2.4 miles out of Portersville the route crosses the glacial border and enters the area once covered by Illinoian ice. The change is not apparent, however, since topography is essentially the same inside and outside of the Illinoian border. The only evidence of glaciation is the presence of erratics of foreign material in the soil. Scattered patches of thin, highly weathered Illinoian till can also be found.

12.9 Intersection with Route 422; turn right onto Route 422.
Route continues in the Illinoian area.

14.9 Intersection with Route 488; turn left (north) onto Route 488. (NOTE: Route 422 has been recently relocated so that this intersection does not appear on the Zelienople quadrangle map).

Prior to construction of new Route 422 a huge anorthosite erratic stood just west of this intersection.

STOP 1 LAKE DEPOSITS Road banks show clays and silts of lakes which were impounded by the advancing edge of the Kent ice. These deposits reach thicknesses as great as 60 feet. The history and extent of the lakes bordering the Kent ice have been studied for a number of years by Frank W. Preston of Butler, Pa. (Preston, 1950). The lake at this position, filling the valley of Muddy Creek, was named Lake Watts by Preston (Fig. 3). To the north a much larger lake, named Lake Edmund, filled the valley of Slippery Rock Creek. These two lakes shown in figure 3 were at one time joined to form a single large lake called Lake Arthur by Preston.

After stop continue on across bridge. Notice to the right the level surface of the lake deposits.

Bear to the left after crossing bridge (Portersville Station).

To the left across a small stream is a knob containing sand and gravel. This knob, as well as the hill to the right, is part of the Kent moraine. At this place the Kent ice apparently advanced farther than the Illinoian ice.

15.4 View ahead of the lake deposits.

The surface on the lake deposits here is not level as would be expected were it developed on lake deposits as seen at Stop 1. The rolling surface is underlain by gravels rather than lake silts and clays and marks an area of transition between outwash which poured in from the west (left) and a lake which existed here and to the right (east) of here. The front of the Kent moraine can be seen to the left. The flat surface of the lake deposits can be seen to the right.

17.1 The route again enters the Illinoian area. As noted earlier, the topography does not mark the change from non-glaciated to glaciated land, and the existence of ice in this area is known only by the presence of erratics and thin, discontinuous till.

18.1 Intersection with road to West Liberty; continue on Route 488.

19.4 Entering Jacksville.

As Jacksville is approached, a long ridge resembling an abandoned railroad embankment is seen to the right. This ridge is crossed just at the edge of Jacksville. The ridge is part of a three-mile-long esker which, at Jacksville, is just inside of the Wisconsin border. The route for a number of miles is in either the Kent moraine or in Kent ground moraine. Areas mapped as ground moraine occur within and in front of the Kent moraine in addition to the very extensive area of ground moraine behind the end moraine. Ground moraine is distinguished from end moraine on the basis of topography.

The Kent moraine displays distinctly constructional, knob-and-kettle topography with numerous undrained depressions and occasional ponds. In most places the Kent moraine does not mark the outer border of the Wisconsin advance, the border being marked instead by the maximum extent of Kent till which is usually present as a thin ground moraine (Fig. 1).

20.1 Turn right onto gravel road.

The route continues in the Kent moraine. Topography along this road is characteristic of the Kent moraine. The strongest knobs are composed of sand and gravel rather than till. Masses of sand and gravel are common in the southern "broad" part of the Kent moraine and are mapped as "kame moraine" since they are integral parts of the end moraine.

21.2 Turn left onto gravel road at crossroads. Note gravel in the roadcuts.

21.7 STOP 2 GRAVEL PIT IN KAME MORAINE

Material in this kame moraine ranges from silt to gravel, but the amount of fine-grained material is low, and till masses are lacking. Sorting is better than in most kames

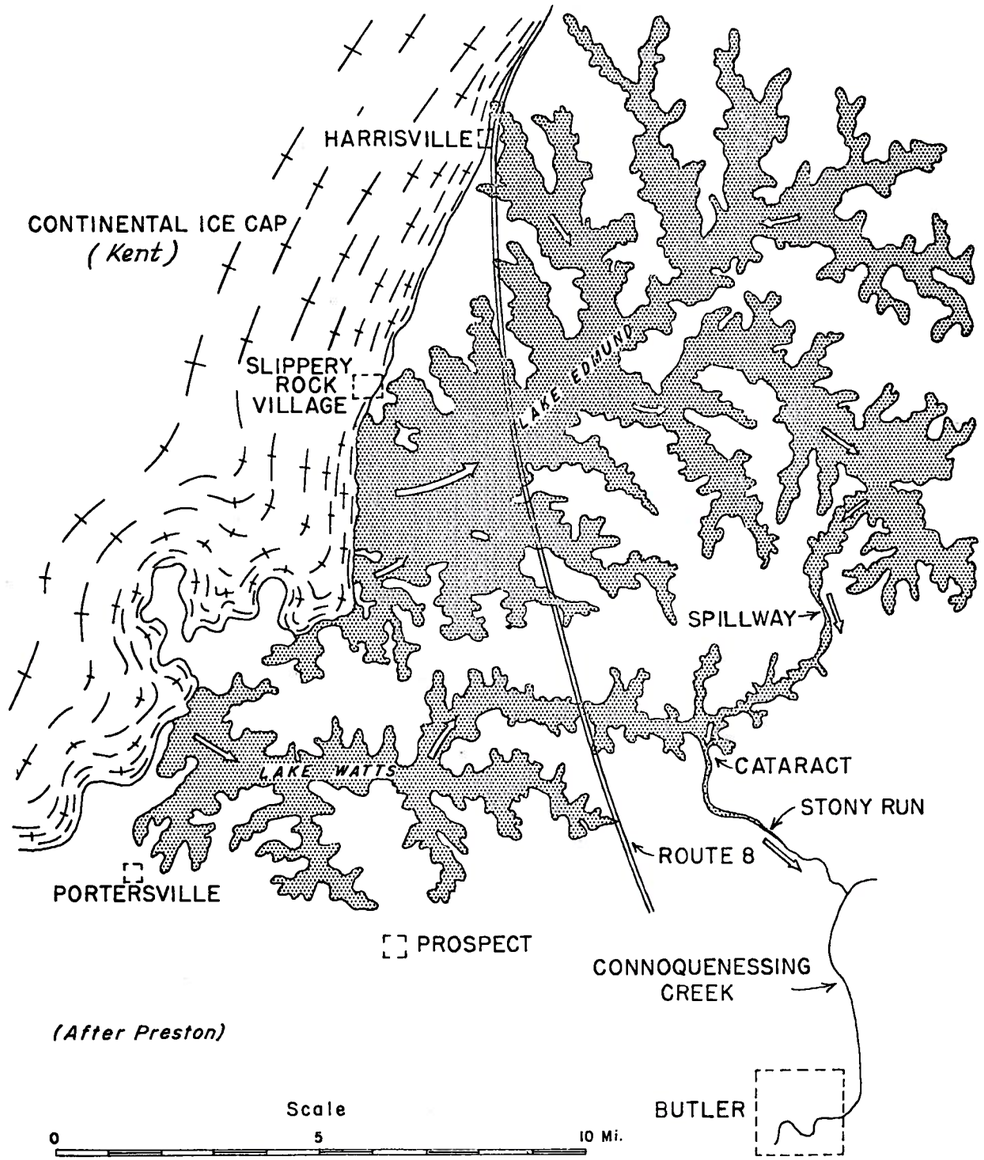


Figure 3. Configuration of glacial Lake Watts and Lake Edmund in front of the Kent ice sheet. (Preston, 1950)

and cross-bedding seems to be persistently in the same direction. These sedimentary features suggest considerable current action of the melting waters.

After stop continue north along gravel road.

22.8 Intersection with Route 108; turn right toward Slippery Rock. Alternate route turns left here. Whether or not alternate or main route is followed, the road from here to Slippery Rock is over ground rather than end moraine. Although knobs are rarely present, the land surface is not obviously constructional, but is instead smooth and gently rolling. Entering the town of Slippery Rock by either route, the road rises onto a low hill. Wisconsin drift (Kent) is lacking on this hill and the area has been mapped by Sitler (1957) as an Illinoian "window" within the Kent ground moraine.

ALTERNATE ROUTE

Because of active strip mining of coal at the time of this writing, stops cannot be planned in advance in this general area. Exposures have been reported in this area which show Kent till above Illinoian till. This alternate route is included to cover the possibility that it may be feasible to stop at these exposures.

0.8 Intersection with Route 488; turn right onto Route 488.

3.3 Intersection with road to North Liberty; bear right.

4.5 Turn right just after cemetery.

6.2 STOP 2A STRIP MINES These mines show Kent till resting upon bedrock. Coals of the Allegheny Group are being mined. For a description of the Kent till see Stop 3A. Other parts of the strip mine may show Illinoian till below Kent till. After stop continue south on the same road.

6.4 Road turns left toward Slippery Rock Village.

8.7 Intersection with Route 258 in Slippery Rock; turn right.

8.8 Intersection with Routes 108 and 78 at stop light in Slippery Rock; turn left and continue with itinerary of main trip.

END OF ALTERNATE ROUTE

25.7 Left turn on Route 78 toward Grove City.

The route follows the border of the Kent drift for the first mile; Illinoian drift is to the right (east) and Wisconsin (Kent) drift is to the left (west). Knobby hills along the route are bedrock, with thin Illinoian drift, if any, at the surface. Outcrops of rocks of the Allegheny Group may be seen in some of the road cuts.

After the first mile the route is over the Kent moraine. Approximately two miles out of Slippery Rock the route crosses an esker, much of which has been removed by operations of the Grove City Sand and Gravel Company. The esker is marked by the sign of this company.

35.0 Intersection with Route 58 in Grove City at stop light; turn left.

35.2 Traffic light; turn right on Route 78.

36.0 Turn right in Grove City onto Route 208.

39.3 Intersection with gravel road at Sterling gas station; turn left for alternate route. Main route continues straight ahead.

ALTERNATE ROUTE

1.3 STOP 2B STRIP MINE These mines, from time to time, expose excellent sections of Kent till, so that the character of any exposure cannot be predicted for a future visit.

2.6 After stop return to intersection at Sterling gas station and continue after left turn on main itinerary.

END OF ALTERNATE ROUTE

41.8 Intersection with Route 8 in Barkeyville; continue straight ahead on Route 208. Just before entering Barkeyville the route crosses the Wisconsin border and enters the area of "inner phase" Illinoian. The topography in the inner phase Illinoian area is smooth, rolling and non-constructional. At the surface is highly weathered, decomposed till. The till in the inner phase area is nearly always present though not continuously and in most places it is only a few feet thick. Outside of the area of inner phase Illinoian is an area where till as such is rare; in that area, designated "outer phase" Illinoian, drift is represented nearly everywhere by erratics. Topography in the two areas is similar so that a line drawn between the two is necessarily based upon a detailed study of the materials underlying the surface.

These two types of deposits are believed to represent deposition from two separate Illinoian ice advances. The existence of two separate advances is evidenced not only by these two surface representations, but also by the presence, in a number of sections behind the Wisconsin border, of till or tills beneath the Kent till. These tills show weathering profiles indicating that they are Illinoian rather than Tazewell and are similar in textural composition to the Illinoian till seen at the surface. The upper till (inner phase Illinoian) is a light olive-gray to light gray, moderately to sparingly pebbly, weakly calcareous, silt to clayey silt till. The outer phase till, based on only a very few observations, is a dark olive-gray, weakly calcareous, moderately pebbly, sandy clayey till.

44.3 Intersection in the small settlement of Nectarine; turn left.

Nectarine is in the outer phase Illinoian area, just outside of the inner phase area. After the turn at Nectarine the road passes immediately back into the inner phase area.

45.3 STOP 3 INNER PHASE ILLINOIAN TILL Road cuts (just south of intersection with road from the west) along the right side of the road expose thin, highly-weathered, inner phase till under colluvium. Weathering on the till has produced a reddish soil.

47.1 Intersection with Route 8; turn left. Road at intersection has entered Kent ground moraine with weak constructional topography.

47.2 Turn right off Route 8 onto Centertown road.

Route contines for about two miles in ground moraine and then crosses into hummocky Kent moraine. Cuts show Kent till which is somewhat coarser than normal.

52.0 Centertown; continue straight ahead.

53.5 ALTERNATE STOP 3A KENT TILL This stop will be used in the event that neither stop 2A or 2B is available.

As elsewhere along this road, the Kent till is somewhat coarser in texture than is normal. The normal Kent till, i.e. the Kent till of the ground moraine in northwestern Pennsylvania and northeastern Ohio and in the end moraine north of here, is a bluish-gray, moderately pebbly to pebbly, loam or sandy loam till. In this area the till is a sandy till. Sitler (1957) has found that the Kent till becomes progressively coarser toward the southern and southeastern parts of the Kent moraine in Pennsylvania. The overall texture of the Kent till, except in this southern area, is quite uniform as shown by a study of more than 350 samples of till collected by the various workers in northeastern Ohio and northwestern Pennsylvania (White and Shepps, 1952; Shepps, 1953; Shepps et al, 1959). The depth of leaching

in the Kent tills ranges from 5½ feet to 10 feet. Depth of leaching is related as much to texture and drainage conditions as it is to age. In general the greatest leaching is in the southern part of the area where tills are of the coarsest texture.

53.7 Intersection with Route 78: turn right.

Kame topography occurs at the intersection and for some distance to the north after the turn. The route from here to Sandy Lake is entirely within the Kent moraine. Note the persistence of strong constructional topography throughout the moraine. North of here the Kent moraine is narrower. Patches of ground moraine and kame moraine, common in the "broad" part of the Kent moraine to the south are seldom seen in the narrow band. Kames and kame moraine are restricted to the walls of through valleys which cross the path of the moraine. A band of ground moraine becomes a constant feature in front of the end moraine north of here.

58.0 Perrine Corners; intersection with Route 965; continue straight on Route 78.

61.8 In the village of Sandy Lake at the intersection with Routes 62 and Alternate 322 turn right onto Routes 62-Alt. 322.

Route from here continues through Kent moraine and after four miles enters Kent ground moraine in front of the end moraine. In and around Sandy Lake the valley bottom contains Kent valley train terraces, and kames and kame terraces line the valley walls.

69.8 Intersection with Route 965; continue straight ahead on 62-Alt. 322.

From here the road descends from the uplands into the valley of Sandy Creek. The valley here marks the border of the Kent advance and contains Kent valley train terraces.

70.5 Enter Polk.

To the left is the state hospital for the feeble-minded. The hospital is built upon a high, well-developed terrace. The town of Polk is built upon another and lower terrace. As the route follows along the valley bottom these and other terraces can be seen. None of these terraces has been dated.

As the route rises onto the upland it enters the area of inner phase Illinoian. Bedrock is close to the surface with only a very thin till cover on the slopes. Till is thicker on the uplands.

74.6 Junction with Route 285; continue on 62-Alt. 322.

The route continues across inner phase Illinoian and descends into the valley of French Creek at Franklin. Note the increasing ruggedness of the terrain and the very thin soil-cover over bedrock in many places. The land surface, thickness of soil, large amount of outcrop, etc. suggest that the route has crossed the glacial border, but detailed investigation especially on the upland surfaces shows that erratics of foreign material cover much of the surface and that a large percentage of the soils is developed on very thin till.

75.7 Junction with Route 8; bear left into Franklin.

Franklin is built upon at least two major terrace levels. It seems certain that one and possibly both levels relate to Kent melting, but neither has been accurately dated.

77.2 Main intersection in the center of Franklin; Route 322 joins here with routes 8, 62, and alt. 322. Main itinerary continues straight ahead on Route 8. Alternate route turns left onto Route 322.

ALTERNATE ROUTE

0.5 Junction with Route 417, turn left and continue on Route 322.

The road has been following a low terrace. From here to the next turn the road will follow this and then a higher terrace. For part of the distance the higher terrace will be just to the right (north) of the road.

2.6 Turn right off Route 322 just before Dairy Isle Drive-In.

3.5 STOP 3B ILLINOIAN KAME Sand and gravel pit is in the kame. After stop retrace route

back to main intersection with Route 8 in Franklin.

7.0 At intersection with Route 8, turn left onto Route 8 (Liberty Street) and continue on main itinerary.

END OF ALTERNATE ROUTE

77.7 Turn left on Route8-62.

Road out of Franklin follows lowermost of two prominent terraces along the Allegheny River. Note gravel-dredging operations in the river. From a tower on the river bank, a dragline is pulled on a cable across the river and is then pulled back across the river bottom to recover gravel.

High terraces are especially well developed at Reno, four miles after the last turn.

84.9 Enter Oil City; follow Route 8 along the river and north out of the city.

The route proceeds through the outer phase Illinoian area, but is entirely within a valley bottom. When the road rises onto the upland out of the valley bottom the route is again in the inner phase Illinoian area. (See Route Map B).

93.9 Route 417 enters from the left; continue on Route 8.

99.8 STOP 4 INNER PHASE ILLINOIAN TILL

High road-bank exposes Illinoian till (inner phase). This is the only section in northwestern Pennsylvania found thus far where unoxidized, unleached Illinoian till is exposed (except where found beneath Kent till). The section in this cut as measured by Droste and Tharin (1958) who studied the clay minerals in the till and the weathering zones in detail, is as follows:

	feet	inches
Loam, silty, gray-brown becoming dusky yellow downward (A horizons)	1	4
Loam, silty, clayey, mottled orange and gray, weathered (B horizon)	2	7
Till, silty, clayey, thoroughly weathered, manganese staining	1	11
Till, as below, but leached	2	3
Till, silty, moderately pebbly, yellow-brown, weakly calcareous	7	4
Till, as above but light olive-gray with oxidation along joints (Matrix is composed of sand 31%, silt 36%, and clay 33%)	8	6
Sand and gravel, brown, calcareous	7	6
Bottom of cut at 31 feet, 11 inches		
Depth of leaching 8 feet, 7 inches		

Just beyond this cut a gravel pit has been opened in a large Illinoian kame.

After this stop continue north on Route 8 into Titusville.

100.8 Enter Titusville

END OF FIRST DAY TRIP

ROUTE MAP "B"

WITH

GENERALIZED GLACIAL GEOLOGY

SCALE

5 0 5 miles

LEGEND

- Kent ground moraine
- Clymer recessional moraine
- Kent moraine
- Inner Phase Illinoian
- Outwash
- Outer Phase Illinoian
- Kames and kame moraine

SECOND DAY

Mileage

Start Titusville (at the Colonel Drake Hotel); drive west on Route 27.

0.4 Intersection of routes 8 and 27; bear left on Route 27.

Titusville is built upon two different terrace levels. Leaving Titusville the route follows these terraces until it begins to climb onto the uplands approximately one-half mile out of Titusville.

The route across the upland surface is in the area of inner phase Illinoian. East of the inner phase area (4 miles east of Titusville) the outer phase Illinoian deposits form a three to four mile wide band. Still farther to the east is an area mapped by Leverett (1934, pp. 94-98) as pre-Illinoian (Kansan). This mapping cannot be confirmed in the field. Leverett postulated Kansan glaciation and defined the Kansan border almost entirely on the basis of supposed Kansan outwash. Most of these outwash deposits can now be shown to be Illinoian. In the area mapped as pre-Illinoian by Leverett nothing of glacial origin, except outwash in valleys, can be found. The outermost occurrence of erratics is mapped by Leverett as Illinoian. Leverett's Illinoian border very closely coincides with the border of the outer phase Illinoian of this report.

7.0 Intersection with Route 428; turn right onto Route 428.

The route follows the inner phase Illinoian for 2.6 miles and then enters the area of Kent ground moraine. The placing of the boundary is based on aerial photograph studies, till character, and soil character (Bacon et al, 1954). The route approaching Troy Center descends into a flat-bottom valley filled with Kent valley train.

10.2 In Troy Center turn right on Route 428.

The route is still in the Kent ground moraine in front of the end moraine. As noted previously this ground moraine in front of the end moraine is a common feature.

11.3 Entering Kent moraine.

Hummocky topography of the Kent moraine is in noticeable contrast to the topography on the ground moraine, or of the Illinoian area. The Kent till in the end moraine and in the ground moraine in front and behind the end moraine is similar to the Kent till seen earlier, but is somewhat finer grained on the average. The till is generally a loam till or a sandy-loam till, but is rarely a sandy till in the northern areas.

11.6 Intersection with Route 408; Route 428 ends. Turn left on Route 408.

For the next six miles the route is across the Kent moraine. Note that the hummocky topography persists throughout the moraine.

17.1 Leaving the Kent moraine and entering the area of Kent ground moraine.

The route for the next 14 miles is over the Kent ground moraine. The topography on the upland surface and the broad valley slopes is essentially smooth and non-constructional. Constructional topography when seen in the ground moraine area is invariably upon kames and kame terraces, features which abound in the Kent ground moraine area. Till in the ground moraine is generally thin on the uplands and the valley slopes and thickest in the valley bottoms. In the areas where Tazewell till is present in subsurface, the total thickness of till over bedrock is greater.

The advance of the Tazewell ice appears to have stopped at some distance behind the Kent moraine, for no Tazewell till is found below the Kent till in the area of the Kent moraine or for a number of miles behind the end moraine. The Tazewell till is found in western Mercer County and southwestern Crawford County, where it is a sand till similar to the Tazewell till found at the surface in Ohio near Akron (White, 1953, p. 39, pl. 26; Shepps, 1953, fig. 1, p. 43). Tazewell till has been found buried beneath later tills in the area between Akron and western Pennsylvania by White (1957).

Continue straight ahead through Townville.

21.0 Junction with Route 78; turn right on Route 408.

23.4 Intersection with Route 77; turn right on Route 408.

23.6 Turn right on Route 408.

25.0 Descend into valley near Miles Corners.

Low knobby topography on kames is present on both sides of the road. From here to Cambridge Springs the route is along the south side of the valley of Muddy Creek and then French Creek after it is joined by Muddy Creek. The road after Miles Corners proceeds on the top of a rather continuous terrace. The terrace contains gravelly sand and is thought to be a kame terrace.

29.0 State Game Farm.

The road here leaves the high terrace and drops down onto a lower terrace. The wide, flat valley bottom to the right (northeast) becomes wider as Cambridge Springs is approached (See Route Map C). The valley bottom just beyond Cambridge Springs reaches a maximum width of nearly 2.5 miles and has less than 30 feet of relief. This extensive valley filling consists of Lavery outwash (valley train); the depositing waters were probably ponded in the vicinity of Cambridge Springs and eastward. The valley at depth is probably filled with Kent and earlier drift, and represents a pre-glacial valley. Leverett felt that it may have been one of the major north-flowing valleys in pre-glacial times. Depth to bedrock is known to exceed 200 feet in a well just southeast of Edinboro and a number of other measurements indicate fill thicker than 100 feet. The outlines of the buried valley are not known, but no deep buried valley has been found north of Edinboro and especially across the lake plain to suggest that this valley becomes larger or deeper northward. It seems likely that this valley was not used by a major north-flowing stream, but by a major tributary flowing southward into the old Middle Allegheny System of Chamberlin and Leverett (1894) via a channel in the position of Muddy Creek and parts of upper Oil Creek. This channel was choked by the Kent moraine and by Kent kames so that in the valley of French Creek there could have been ponding of the melting waters from the Kent ice. Ponding would have filled the valley to the level of a low col between Cambridge Springs and Meadville. Subsequent erosion of the col would have lowered the level of the lake gradually and would have, at the same time, created a new channel for French Creek between Cambridge Springs and Meadville. Ponding as described above may account for some of the terraces above the main valley bottom deposits, but detailed work has not been done to demonstrate this relationship.

32.4 Enter Cambridge Springs.

33.0 Intersection with routes 19, 86, and 99; turn right.

33.1 Turn left on routes 86 and 99 after crossing bridge.

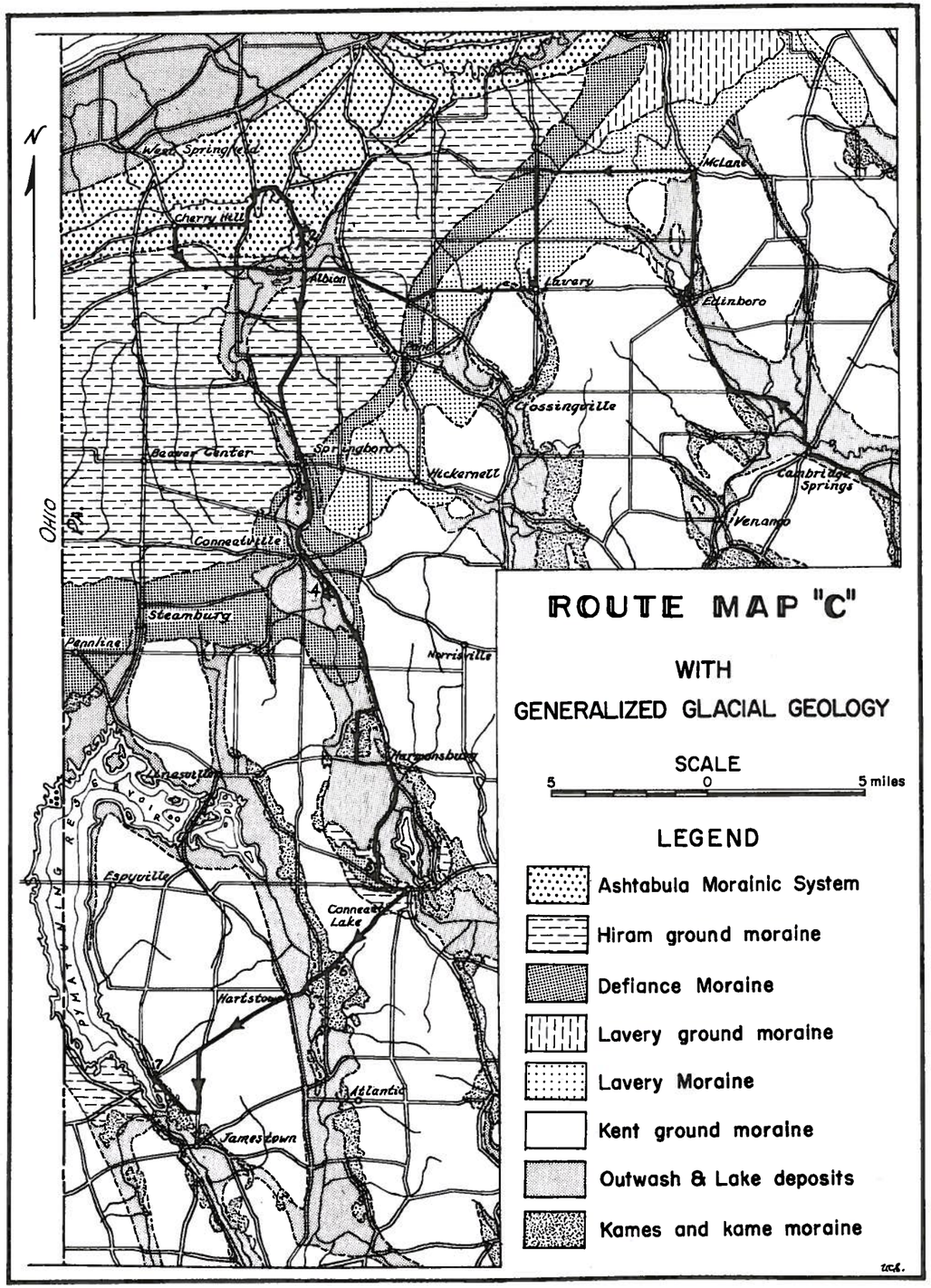
33.3 Turn right on Route 99 and follow it to Edinboro.

The road from Cambridge Springs to Edinboro follows the surface of the Lavery outwash filling the valley bottom. Note the width of this valley fill. As Edinboro is approached the gradient of the valley train surface increases faster than the gradient of the present stream so that the stream becomes increasingly entrenched into the valley train surface. This entrenching is especially noticeable just before entering Edinboro where the stream flows parallel to the road.

35.0 Intersection with Route 6N at stoplight in Edinboro; continue straight ahead on Route 99.

North of Edinboro the road passes to the right of Edinboro Lake and passes through somewhat dissected Lavery outwash and Lavery kames. The valley wall on the right (east) is covered in part by Kent ground moraine and in part by Lavery kames.

In this area north of Edinboro the Lavery valley train fills the valley bottom but the gradient on the surface is steeper than on the valley train south of Edinboro. Edinboro Lake is in the center of the valley train. The main Lavery end moraine passes approximately three miles north and northwest of Edinboro. However, the town of Edinboro is on a kame moraine-outwash complex of Lavery age. This anomaly is one which is found in a number of places across northwestern Pennsylvania. Such a situation is believed to have resulted during the first advance of the ice when the leading edge of the ice mass was sufficiently



plastic to allow tongues of ice to move into valleys in advance of the main ice mass. At Edinboro two tongues moved ahead of the main ice front, joined just north of the town and advanced as far as the town. At this position the combined tongues deposited a moraine composed not of till, but of sand and gravel (kame moraine). Materials were carried away from the ice front and were deposited as outwash in the valley to the south.

Because of their overextension these tongues stagnated while the main ice mass to the north continued to advance and build up a major end moraine. Meltwaters flowed from the front of the main moraine and filled the valley abandoned by the melting ice tongues with outwash. At the site of Edinboro Lake a mass of unmelted ice from one of the tongues remained until after meltwaters from the north ceased to flow. Later melting of this ice mass left a water-filled depression now called Edinboro Lake.

38.9 Approaching McLane; turn left on paved road.

Knobby topography to the right after the turn is on kame moraine of the main Lavery moraine. The road is on the kame moraine for approximately .8 mile after the turn and then passes over the Lavery (till) moraine for 3.6 miles. Topography of the till moraine is rather subdued, with only an occasional tract of constructional topography. Throughout much of its extent the moraine is gently rolling with rare, poorly drained areas. The till of the Lavery advance is a silt till, noticeably finer grained than the Kent till.

Shortly after the route passes the crossroads called Mishlin Corners, the till at the surface becomes more clayey and the road is now on the Defiance moraine of Hiram age. Because of precedence the name "Hiram", which has been given to the age, the till and the advance, cannot be used for the end moraine. The Hiram till is a clay or silty clay till. In this area the Defiance moraine is compounded with the Lavery moraine and it is not possible to delineate the outer edge of the Defiance moraine except by studying the surface materials. Topographic expression of the Defiance moraine is very subdued but becomes stronger going westward, especially west of Conneaut Creek and in Ohio. Much of the tracing of the Defiance and the Lavery moraines has been done with the aid of aerial photographs.

44.0 At the intersection called Franklin Corners, turn left onto Route 98.

The route is still in the Defiance moraine at Franklin Corners.

45.3 Approximate outer margin of the Defiance moraine (Hiram till).

47.8 STOP 1 LAVERY CROSSROADS

Crossroads; intersection with Route 6N. This is the type area for the Lavery moraine and for the Lavery till. The morainic expression along the road north of here is considered to be typical Lavery moraine, and till in the road banks is typical Lavery silt till. Walk north from the intersection to see Lavery till in the road cuts. Calcareous (unleached) till may be seen at the base of some of the higher cuts.

After stop turn right (west) onto Route 6N toward Albion.

48.1 Crossing marginal channel along the front of the Lavery moraine; entering Kent ground moraine.

49.2 Crossing marginal channel and going back into the Lavery moraine. This channel is well shown on aerial photographs.

The route for the next 3.3 miles is across the Lavery moraine and then into the Defiance moraine. The change from one to the other is, as previously noted, not obvious. After 3.3 miles the route leaves the Defiance moraine and enters the area of Hiram ground moraine. The surface in the ground moraine area is devoid of constructional topography and undrained depressions are extremely rare.

54.0 Lundys Lane; continue straight ahead on Route 6N crossing valley in which bedrock is exposed.

The route has been down a gradual north-dipping slope after leaving the Defiance moraine. This slope eastward becomes progressively steeper until it is a distinct escarpment formed on resistant rocks in the Upper Devonian Conneaut Formation. Till along this slope and on the face of the escarpment is very thin so that many of the small streams flowing northward down the slope expose bedrock somewhere along their course. The escarpment appears to have controlled the advance of the Hiram as well as the later Ashtabula ice.

54.9 Enter Albion.

Just as the route crosses the railroad tracks in Albion the materials at the surface change from Hiram till to sand and gravel representing outwash from the next advance after the Hiram, the Ashtabula advance.

55.5 Turn right at North Main Street traffic light.

55.7 Good Ashtabula outwash terraces to the right and directly ahead as the route approaches and crosses the creek.

The route, after crossing the bridge, is in the Ashtabula morainic system (Leverett's Lake Escarpment morainic system). The southernmost moraine was named the Ashtabula moraine by Leverett (1902). Stop 2 is in this moraine. The topography on all of the Ashtabula moraines is strongly constructional, knob and kettle topography.

56.9 STOP 2 ASHTABULA TILL

Cut in Ashtabula till reveals a complete section from the surface down to unleached, unoxidized till. Note the shallow depth of leaching and oxidation and the texture of the till. The Ashtabula till is a silt till with a composition similar to that of the Lavery till.

The route after stop 2 continues north passing through an area of subdued topography. This area served as a drainageway during deposition of the Painesville moraine (Leverett, 1902). The road turns west through an area of moderately hummocky topography on the Painesville moraine.

59.5 Intersection with north-south road; turn left (south).

The road descends into a valley which divides the northern moraine from the southern moraine and marks the position of the marginal channel in front of the northern moraine. Drainage from the Ashtabula moraines was blocked from flowing southward by the north-dipping slopes and the escarpment and was forced to flow westward along the front edges of the moraines. These marginal channels today carry parts of the courses of numerous north-flowing streams so that streams flowing into Lake Erie commonly flow first north, then west, and then north again. The creek crossed here by the route of this trip is Conneaut Creek, which, at this place, is within three miles of Lake Erie. The creek, however, instead of flowing directly north into Lake Erie is diverted westward by this marginal channel so that it finally enters Lake Erie after 25 miles rather than three miles.

The Ashtabula moraines were deposited en echelon along the southern shore of Lake Erie as far west as Cleveland. Because of the en echelon arrangement there are always at least two, and commonly three, moraines running parallel to each other. The tills of the Ashtabula morainic system become progressively coarser westward and are now the subject of detailed study along the margin of the moraine from Cleveland, Ohio to the Pennsylvania-New York state line. The topography on all of the Ashtabula moraines is boldly constructional, knob and kettle topography.

60.8 Turn right toward Cherry Hill.

The road leads from here to Cherry Hill along the center of the Ashtabula moraine so that the strong, knobby topography can be seen on both sides.

63.2 Turn left (south) on Route 6N.

63.8 Leave the Ashtabula moraine crossing a small marginal channel and enter the area of Hiram ground moraine. The till in the Hiram ground moraine is a sparingly pebbly, clay or silty-clay till. Depth of leaching is usually between three and four feet. At some places in the ground moraine the Hiram till is so thin that it makes up only the upper foot or two of the soil profile.

66.8 Cross steel bridge across Conneaut Creek. From here to Albion is Ashtabula outwash in the form of low terraces, and "islands" of Hiram ground moraine.

68.7 Intersection at stoplight in Albion with Route 18; turn right (south) onto Route 18.

Route after Albion is across the upland over Hiram ground moraine.

73.9 Entering the Defiance moraine.
The moraine is poorly developed but becomes gradually better defined to the south.

75.2 Enter Springboro; continue on Route 18.

76.5 Gravel pit in Hiram kame on the left.

77.3 STOP 3 HIRAM TILL
Road cuts along the road in front of the Conneaut Valley High School and south from there show Hiram clay till. (This is a busy highway – watch for automobiles!!!)

After stop continue on Route 18 through Conneautville. Note various terrace levels to the right of the road (west) before entering Conneautville, and to the left (east) after entering the town. The route is still within the Defiance moraine but follows lake and river deposits in Conneaut Creek valley. The lake deposits are Hiram in age and have a rather complex pattern of distribution here and to the south.

Lake deposits in this area are found at a number of elevations with the highest being just below 1060 feet. (The bottom of the valley is at approximately 940 feet elevation). South out of Conneautville the topography along the route becomes strongly hummocky, exhibiting typical kame and kettle topography with numerous ponds. None of the ponds is visible from the road.

80.5 Turn right onto gravel road.

80.8 Intersection; turn right.

81.0 STOP 4 LAKE DEPOSITS
Cuts on the right side of the road contain bedded (varved) silts and fine sands (Figure 4). These are very similar to materials found throughout this part of the valley of Conneaut Creek and are considered to be lake sediments. The kame and kettle topography over which the route has been passing is developed on these sediments. This can be explained most satisfactorily if it is considered that the sediments were deposited in a lake which existed in the presence of a stagnant, decaying ice mass. Distortion of the varves can be attributed to slumping after disappearance of the ice.

After the stop continue straight ahead, take first right and return to Route 18.

81.5 At Route 18, turn right.
Once again the route is across kame and kettle topography developed upon lake sediments. These deposits continue for several miles. Note silts in the road cuts evidenced by wet streaks, slumping, and lack of pebbles on the surface.

82.5 Gravel pit and knobby topography on the left. The road runs parallel to a Defiance kame moraine which, to the south, forms a loop across the valley. (The route will pass through the loop, but it is still in the lake deposits and will continue in them for another 1.5 miles.) This kame moraine is part of the main Defiance moraine.

82.9 Gravel pit on the left.
This pit is in the end of an esker which trends NW-SE. High hills south of the esker are composed of lake silts. After crossing the highest point on these hills, descending, and crossing several small streams the road enters the Defiance kame moraine.

84.0 Gravel pit in the kame moraine.
Leaching in the Hiram gravels averages approximately six feet. From here the road rises onto the upland still in the kame moraine.

84.8 On the upland in the Kent ground moraine.
Bedrock is near the surface all along the road until the next turn and is exposed in

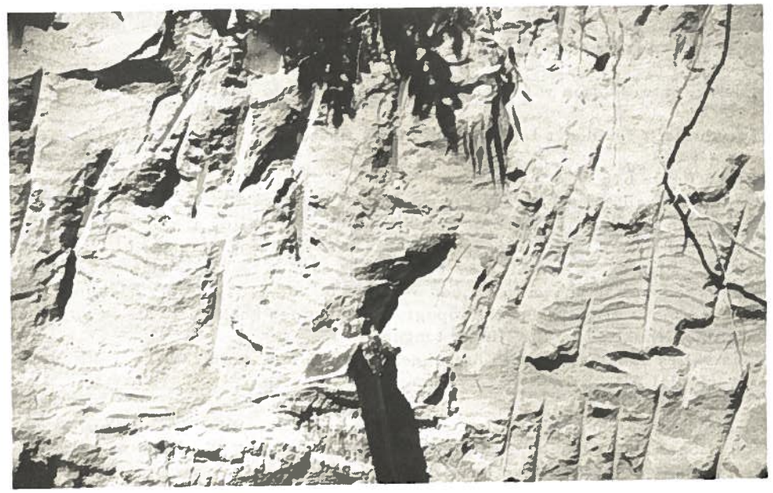


Figure 4. Varved yellow-brown silts and fine sand deposited in a pro-Hiram lake. Deposition is thought to have occurred in water ponded in the presence of a decaying ice mass in Conneaut Creek valley. Distortion of bedding is attributed to slumping which attended melting of the ice mass. Topography on the surface of these sediments is strongly hummocky, kame and kettle topography.

some of the cuts along the left side of the road. The route is now south of the Defiance moraine, and Conneaut Creek valley (on the left) is no longer choked with kame and kettle topography. Note the open appearance of the valley. The valley bottom south of the Defiance moraine contains terraces composed of yellow silts and fine sands much like those seen at Stop 4. These are still lake deposits indicating that an open body of water filled this part of the valley. The terraces in the bottom of the valley range from 20 to 60 feet above the present stream and in general slope toward the center of the valley. This suggests that the lake was never completely filled with sediments or that the level of the water was gradually being lowered.

86.7 Turn right onto gravel road leading down into the valley bottom.

87.5 Turn left at intersection.
Note yellow silts in the road banks at this intersection. Beyond the turn the hills ahead contain sand and gravel and represent part of a kame moraine. This kame moraine is a Hiram recessional moraine. Once again, as at Edinboro, a tongue of ice moved ahead of the main ice mass and formed a moraine in front of the main moraine. The kame moraine here is not the outermost moraine deposited by the ice tongue and is consequently called a recessional moraine.

88.7 Coming over the crest of the highest hill.
Straight ahead is a wide, flat outwash plain. On both sides of the road strongly rolling topography with undrained depressions can be seen. Though not apparent from the road, the

rolling topography is in the form of long, linear ridges such as would be deposited against a retreating ice front. The linear and parallel nature of these ridges is well expressed on aerial photographs. It is this kame moraine which blocked the south-flowing drainage and ponded the waters to the north.

89.1 Intersection with paved road; turn left.

The road from here to Harmonsburg follows the north edge of the outwash apron. Note the linear ridges of the kame moraine to the north (left) and the outwash surface to the south (right). In the gravel pits on both sides of the road the gravels of the outwash plain are leached approximately six feet. On the left (after the gravel pits) is a lake formed when peat was removed from a large bog. Clearwater Lake

90.1 In Harmonsburg, intersection with Route 18, turn right onto Route 18.

90.6 Gravel pit on the left; Conneaut Lake ahead. Note flatness of the plain ahead.

91.0 Turn right onto Route 618.

The route leads south across the surface of the outwash. Ponding may have occurred and may explain the flatness in some places. Along the valley slopes to the east (left) is a kame terrace of Hiram age. This terrace was formed along the edge of the ice tongue by meltwaters flowing to the south. The route leads around the west side of Conneaut Lake. The depth to bedrock is known to exceed 300 feet in this area. After passing Conneaut Lake Park the road rises slightly and the topography becomes knobby. This is interpreted as kame moraine deposited by the Hiram tongue.

This valley is considered to have been the principal outlet to the north for the waters of the pre-glacial Allegheny River system.

94.1 Material at the surface changes from sand and gravel to clay till. Topography along the route is constructional, but subdued. Elsewhere in the area mapped as end moraine the topography is rolling to knobby. This is interpreted as end moraine formed by the Hiram ice in this valley.

94.3 STOP 5 HIRAM TILL of the end moraine.

Hiram clay till is exposed in the road banks. Note the shallow depth of leaching and the fine texture.

In the excavation for the school just ahead at the intersection an excellent section was exposed which showed four feet of clay till leached three feet ten inches, above 12 feet two inches of leached sand and gravelly sand, above four feet plus of sandy loam till leached two inches and oxidized three feet four inches. This section is interpreted as showing Hiram till over Kent glaciofluvial deposits, in turn overlying Tazewell till.

94.5 Intersection with Route 6, turn left toward Conneaut Lake Village. Just beyond the turn there is a brief view of a large Kent kame (in the distance) on the east side of Conneaut Lake.

95.1 Enter Conneaut Lake Village.

95.5 Intersection at stoplight with routes 322 and 285, turn right. Route out of Conneaut Lake Village is over Hiram ground moraine in front of the end moraine.

96.5 Cross possible marginal channel of the Hiram ice and enter Kent ground moraine. As seen earlier the upland surfaces on the Kent ground moraine are typically smooth and non-constructional with the exception of rare, poorly drained areas. The Kent till here is generally thin over bedrock, or over thin pro-glacial outwash or coarse Tazewell till.

98.6 STOP 6 KENT KAME

This is a typical kame with materials varying from clay to boulders and with sorted as well as unsorted materials. This kame contains a large block of till along with the other materials. The till in the block has the normal Kent texture and in all other aspects is characteristic of Kent till.

After the stop proceed westward on Route 322 and descend through kames to the valley bottom. The valley bottom contains extensive swamps suggesting that the valley was once ponded. This ponding may have occurred when the valley west of here was blocked by a Hiram ice tongue.

101.0 Hartstown; continue straight ahead on Route 322.

104.4 Dirt road continues straight ahead; bear left on paved road.

106.7 Approaching Jamestown; turn right onto paved road.

106.9 Intersection; turn right.

Route is across Kent ground moraine for 0.6 mile beyond the turn, and then is over sand and gravel in Hiram kames for 0.7 mile.

108.7 STOP 7 HIRAM TILL

At intersection with road to the right. Hiram till is in the road cuts. (Pymatuning Reservoir is to the west.)

The presence of Hiram till here, and in a number of other cuts in this area and on the opposite side of the reservoir, indicates that a tongue of Hiram ice invaded this valley as it did the valleys at Edinboro and at Conneaut Lake. Kames to the south of the till show leaching of approximately six feet and likewise indicate Hiram, or at least post-Kent, activity. Just S of + visible from this intersec is a wave cut lake bluff on the north side of a peninsula extending into the lake. 20' of oxidized Hiram w/o lacustrine till are exposed. Nearby is a stream cut of possible Kent over Titusville Till. Lower Titusville Moraine (1 2nd).

END OF TRIP

Return to Pittsburgh via Jamestown, Greenville, Mercer and Route 19. Distance to Pittsburgh is approximately 82 miles from Stop 7.

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