WHITE, S. E.

FRIENDS OF PLEISTOCENE GEOLOGY

17th Reunion

May 22 - 23, 1954

WELLSBORO - ELMIRA - TOWANDA REGION

PENNSYLVANIA - NEW YORK

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Soil Conservation Servic

SUBDIVISIONS OF WISCONSIN STAGE

Local name	Possible correlation with Central Lowlands
"Valley Heads" drift	Cary substage
	"Brady interval"
"Binghamton" drift	Tazewell substage
"Olean" drift	Iowan and/or Tazewell substages
("Eastern Olean")	
("Western Olean")	

Notes for Friends Reunion

Lyford and Denny began a reconnaissance soil and geologic field study of the Wellsboro-Elmira-Towanda region in 1953 and expect to continue the work in 1954.

Geologic data

In this region, three drift sheets of Wisconsin age had been identified previously: "Valley Heads," "Binghamton," and "Olean" of local usage. For areal extent see figure 1.

"Olean" drift (MacClintock and Apfel, 1944):- The drift is composed almost exclusively of material derived from the local bedrock, and is "very slightly" calcareous (table 2). Depth of leaching ranges from 6 feet to 20 feet or more. No exposures were seen where the assumed stratigraphic position of "Olean" drift beneath "Binghamton" drift could be demonstrated with certainty. There is little ground moraine (areas of complex slopes, not single slopes). Alluvial fans are found along the valley sides in many places.

Fragmentary evidence that is part topographic, part lithologic, and part pedologic suggests that the "Olean" drift is divisible into a "western Olean" drift and an "eastern Olean" drift, as follows:

Criteria	"Western Olean" drift	"Eastern Olean" drift
(1) Topographic	Absence of lakes	Abundant small lakes
	Long smooth slopes, valleys are flat-floored, or the lower valley walls have gentle slopes and meet along the axial stream.	Long smooth slopes that are dissected along the axial stream
	Many valleys appear to have been partly filled.	
	Alluvial fans along valley sides in many places	Alluvial fans along valley sides in many places
(2) Lithologic	Most drift derived from local bedrock	Most drift derived from local bedrock, in places contains a few percent of erratics
(3) Pedologic	Depth of leaching ranges from 6 to 20 feet	Depth of leaching ranges from 5 to 10 feet
	Abundant secondary clay ("clay flows") to depths of as much as 20 feet.	Moderate amount of secondary clay ("clay flows") to depths of as much as 10 feet

The contact between "eastern Olean" drift and "western Olean" drift appears to more or less coincide with State Highway Pa. 14 (see fig. 1). Perhaps the "western Olean" belongs to the Iowan substage and the "eastern Olean" to the Tazewell substage.

"Binghamton" drift (MacClintock and Apfel, 1944):- The drift contains numerous erratic pebbles, ranging from about 5 percent to 30 percent or more by number and is "highly calcareous" (table 2). Depth of leaching ranges from about 4 to 14 feet, the average is about 7 feet. The critical stratigraphic relations of the drift to "Olean" and "Valley Heads" drifts have not been observed. Topographically "Binghamton" drift resembles "Olean" drift, except that areas of morainal topography are perhaps more numerous, and the valley floors have been dissected below the adjacent gentle slopes. Numerous alluvial fans are found along sides of larger valleys. Perhaps the "Binghamton" glacier had a border consisting of narrow ice tongues that extended southward for many miles.

"Valley Heads" drift (Fairchild, 1932):- The drift has not been studied in detail. It is lithologically similar to "Binghamton" drift, but is distinct topographically from older drifts. There are extensive areas of ground moraine both on uplands and in valleys; and numerous ice-marginal channels cut into bedrock. Alluvial fans are small and scattered. Depth of leaching ranges from 2 to 14? feet, the average is between 3 and 4 feet.

Modification of drifts by periglacial processes:- Topographic, lithologic, and stratigraphic evidence indicates that "Olean" and "Binghamton" drifts were subjected to congeliturbation (solifluction and other mass movements) shortly after deposition, but probably in large part prior to "Valley Heads" time. Such modification appears to be slight on the "Valley Heads" drift.

Pedologic data

1. There are two main kinds of "zonal" soils in the area.

    a. Acid Brown Forest-Gray Brown Podzolic extragrades.

    b. Podzol-Acid Brown Forest-Gray Brown Podzolic extragrades.

2. The former seem to be localized in the valleys and adjacent uplands; the latter in the uplands above an altitude of about 1,200 feet.

3. The boundaries between the "zonal" soils coincide rather closely with the boundaries between northern hardwoods and oak-chestnut as shown by generalized vegetation maps. See attached Vegetation Map.

4. In the area of "Binghamton" and "Olean" drifts, to the south of the "Valley Heads" moraine, the better drained soils of the uplands show no major differences in development other than those which can be related to vegetation.

5. The fact that both the "Olean" and the "Binghamton" drift were modified by mass movements (congeliturbation) in pre-"Valley Heads"? time perhaps explains the uniformity of soil development on the uplands and perhaps indicates that the movement or disturbance of soil materials was a regional matter and took place everywhere at about the same time irrespective of the kind of drift (ie., after deposition of "Binghamton" drift).

6. Uniformity of soil development even on relatively steep slopes indicates that the soil parent materials on such slopes have been in place long enough to permit the soils to reach equilibrium.

7. In a few places on the uplands there are "islands" of soils with neutral sola (Erie-Langford soils) and no pedologic pan as distinct from ordinary hard till (i.e., much shallower depth to free carbonates than found in most bodies of "Binghamton" or "Olean" drift). Origin of these "islands" is unknown.

8. On the kames, kame terraces, and valley trains the same two main kinds of "zonal" soils occur, but the depth of solum development varies more than in the soils of the uplands. See attached soil profile diagram and sample soil profile descriptions.

9. Some evidence points to a deeper solum on the older glaciofluvial deposits("Olean"), but perhaps as good a case can be made to explain the deeper solum on the basis of corresponding smaller amount of carbonate in the older glaciofluvial deposits.

References

Fairchild, H. L., 1932, New York moraines: Bull. Geol. Soc. America, vol. 43, pp. 627-662.

Leverett, Frank, 1934, Glacial deposits outside the Wisconsin terminal moraine in Pennsylvania: Pa. Geol. Survey 4th ser., Bull. G-7.

MacClintock, Paul, and Apfel, E. T., 1944, Correlation of the drifts of Salamanca Re-entrant, New York: Bull. Geol. Soc. America, vol. 55, no. 10, pp. 1143-1164.

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Table 1. Pebble counts from Karl D. Shiner gravel pit 1 mile southwest of Wysox, Towanda quadrangle, Pa. (Pebbles passing a 1-inch and retained on a 1/2-inch screen)

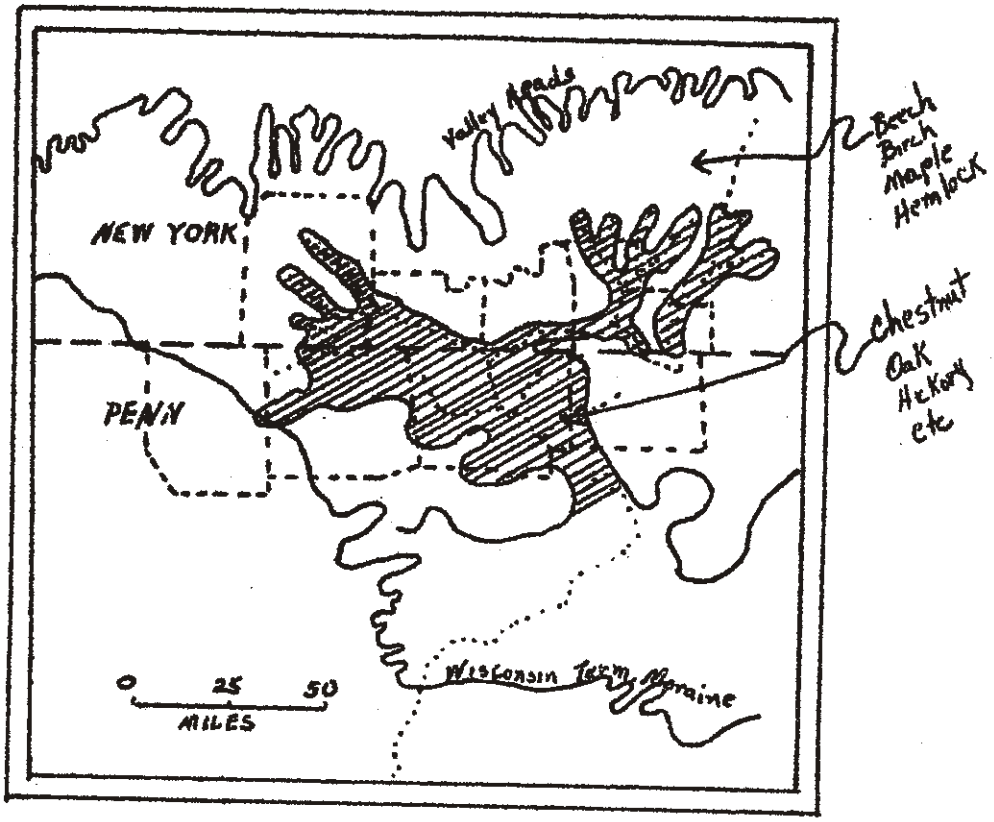
(Values in percent by number)

Location of samples and soil horizons	Depth		"Sandstone" and "siltstone" olive gray	Sandstone, red	Sandstone, white, quartzitic	Limestone, black	Limestone, pale gray	Limestone, leached	Chert	"Pre-Cambrian" erratics	Total pebbles
Sketch #2											
Ap	0-9 in.1/		59.7	5.3	5.4	0.0	0.0	0.0	22.7	7.0	300
B	15-17 in.1/		53.5	3.3	12.2	0.0	0.0	4.8	17.7	8.6	271
B_2t	(top) 21-22 in.1/		54.6	8.0	11.0	0.0	0.0	8.8	10.5	7.0	399
B_2t	44-48 in.1/		61.6	4.2	6.9	0.0	0.0	5.0	15.1	7.2	404
C	56-62 in.	calcar.	32.9	3.0	2.7						
		noncalcar.	27.4	1.9	3.8	14.2	1.6	1.1	6.6	4.6	366
C	9½ ft.		55.6	4.5	9.6	7.7	5.1	0.0	14.1	3.2	311
C	15 ft.	calcar.	28.0	4.3	5.3						
		noncalcar.	18.4	2.0	6.9	12.8	4.3	0.0	14.1	4.0	304
Sketch #1-C	14 ft.		46.0	8.3	6.7	19.0	5.7	0.3	9.7	4.3	300
Half way between Sketch #1 and #3-C	15 ft.		52.8	4.6	7.2	13.9	4.8	0.0	11.0	5.7	373
Average of C horizon			52.2	5.7	8.4	13.5	4.3	0.3	11.1	4.4	1654
Range of C horizon		High	60.3	8.3	9.6	19.0	5.7	1.1	14.1	5.7	
		Low	46.0	4.6	6.5	7.7	1.6	0.0	6.6	3.2	

1/ No calcareous pebbles

Table 2. Pebble counts
(Pebble passing a 1-inch and retained on a 1/2-inch screen)
(Values in percent by number)

Location	Sandstone & siltstone	Limestone	Chert	"Pre-Cambrian" erratics	Total pebbles	Depth of leaching (feet)
Kame ("western Olean"). Gravel pit near Middlebury Center, Elkland quadrangle, Pa.	100.0	0.0	0.0	0.0	102	20
Terrace ("western Olean"). Gravel pit on Mill Creek, Tioga quadrangle, Pa. Stop 3.	100.0	0.0	0.0	0.0	521	12-16
Kame ("eastern Olean"). Gravel pit near Canton, Canton quadrangle, Pa. Stop 10. Soil is Chenango gravelly loam.	100.0	0.0	0.0	0.0	350	7-9
Kame ("eastern Olean"). Gravel pit near Monroeton, Monroeton quadrangle, Pa.	98.3	1.0	0.0	0.7	417	6-10?
Kame ("Binghamton"). Gravel pit near Chemung, Waverly quadrangle, N. Y.	95.8	4.2	0.0	0.0	334	8-11
Kame ("Binghamton"). Gravel pit at Seely Creek, Elmira quadrangle, N.Y. Stop 5.	74.9	17.8	3.6	3.6	307	6-7?
Terrace ("Binghamton"). Cellar hole near East Corning, Elmira quadrangle, N. Y.	74.5	18.4	5.3	1.8	282	5-6
Terrace ("Binghamton"). Gravel pit near East Corning, Elmira quadrangle, N. Y. Stop 7.	71.0	16.2	11.2	1.6	371	5-11
Kame ("Valley Heads"). Gravel pit near Pine Valley, Elmira quadrangle, N. Y.	64.3	28.7	4.1	2.9	341	3-8
Terrace ("Valley Heads"?), Gravel pit at Sayre, Sayre quadrangle, Pa. Soil is Howard gravelly loam.	64.8	18.8	13.0	3.4	353	3½-6



MAJOR VEGETATION REGIONS OF

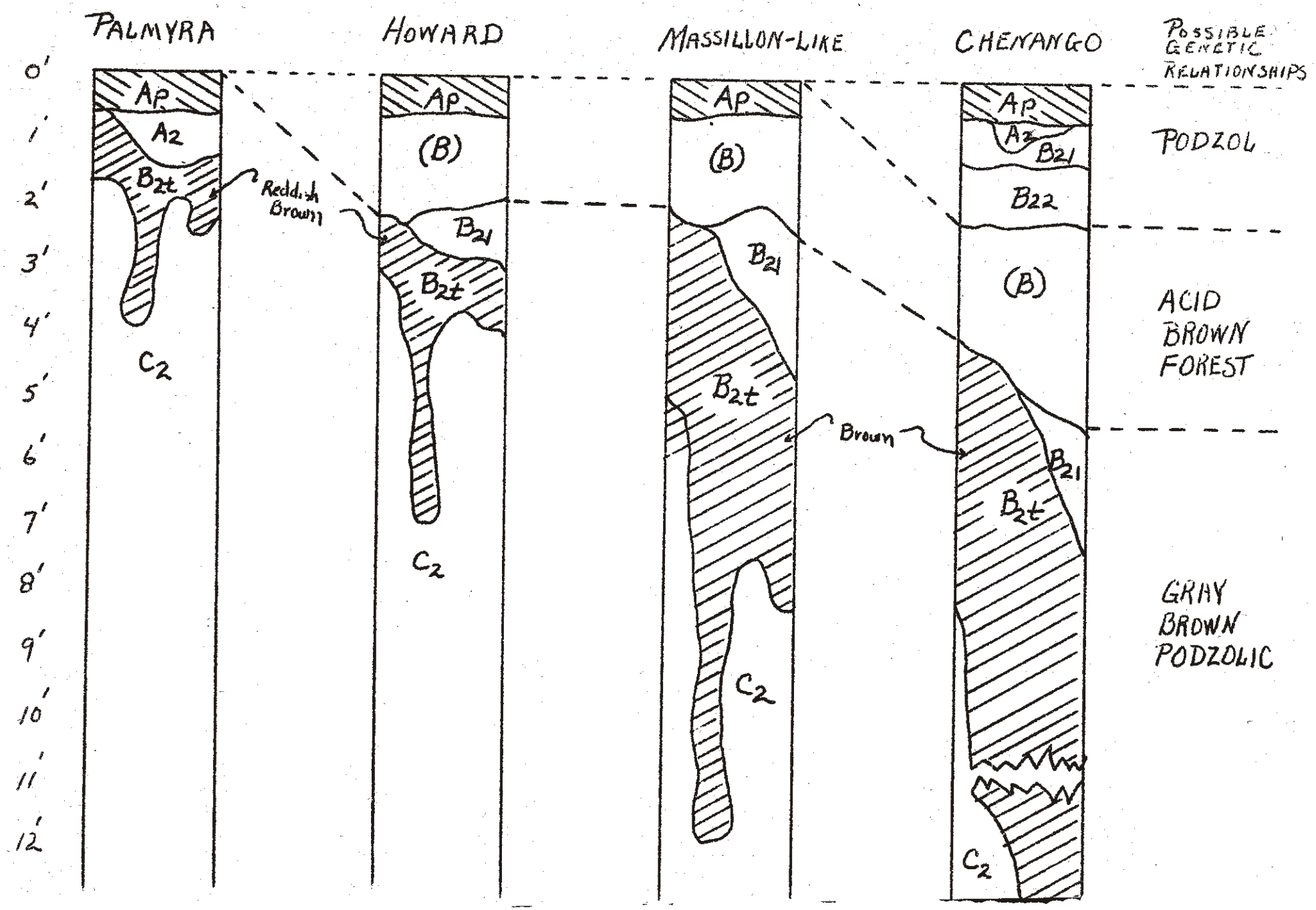
THE UPPER SUSQUEHANNA RIVER WATERSHED

Based on Hough and Forbes
Ecol. Monog. 13 299-320, (1948)

Preliminary work by Denny and Lyford in 1953 indicates a reasonably close relationship between kind of soil development and vegetation as shown on this map. Acid Brown Forest with the Chestnut-oak-hickory - Podzol with the Beech-birch-maple.

GENERALIZED PROFILES OF SOILS ON CALCAREOUS PEBBLY GRAVEL IN THE ELMIRA N.Y AREA

3/1/54 WHL



Established Series

PALMYRA SERIES

The Palmyra series consists of well drained Gray-Brown Podzolic soils on calcareous glacial outwash gravel and sand from limestone, sandstone and shale. It is the well drained member of the catena that includes moderately well drained Phelps, poorly drained Homer, and very poorly drained Westland series. The series has a well-developed textural profile comparable to that of the Fox series. It has a more strongly expressed and thicker solum than the Kars series proposed in northern New York. It has a less strongly acid A_2 horizon, a thinner and less yellowish A_{21}, and a thinner solum over calcareous material than the Howard series, which is an intergrade to Brown-Podzolic soils. It is developed on gray materials in contrast to the Wampsville soils on reddish material. The Rippleton series is the equivalent of Palmyra moderately deep over shale or clay.

Soil Profile: Palmyra gravelly loam--virgin

A_{oo}	1-0"	Forest litter consisting mainly of leaves from tree species that are heavy feeders on bases. Almost completely incorporated with mineral soil by midsummer. A_o horizon absent. 0 to 2 inches thick
A_1	0-4"	Very dark grayish brown (10YR 3/2) gravelly loam with moderate medium or fine crumb structure. Very friable. Neutral to slightly acid. High in organic matter. Filled with fine roots. 3 to 6 inches thick
A_{21}	4-6"	Brown (10YR 5/3) gravelly loam with weak fine crumb structure. Friable. Slightly acid. A horizon of incipient release of iron. Commonly masked by organic matter from the horizon above. 2 to 5 inches thick
A_{22}	6-11"	Grayish brown to light brownish gray (10YR 5/2-6/2) gravelly loam with very weak, very thin platy to fine crumb structure. Friable. Medium to slightly acid. Many roots present. 4 to 6 inches thick
B_{21}	11-18"	Dark brown (10YR 4/3) gravelly heavy silt loam with weak medium subangular blocky structure. Friable, slightly sticky and plastic. Slightly acid to neutral. Fair water holding capacity. Medium and large roots present. 6 to 9 inches thick
B_{22}	18-22"	Dark brown (10YR 4/3) gravelly clay loam with strong medium subangular blocky structure. Firm, slightly sticky and plastic Neutral or mildly alkaline. May be weakly calcareous. Roots extend through horizon. 3 to 5 inches thick
C_1	22-26"	Grayish brown gravelly sandy loam with very weak structure. Loose. Calcareous. 3 to 6 inches thick
C_2	26"+	Highly calcareous light brownish gray stratified gravel and sand. Very rapidly permeable. Roots penetrate deep into this material.

Range in Characteristics: Depth to carbonates ranges from 18 to 30 inches. A_{21} horizon may be absent. Texture of B_2 horizon ranges from heavy silt loam to light clay loam in the loam type.

Topography: Nearly level to hilly or steep (glacial outwash terraces and kames).

Drainage: Good; runoff medium to high; internal, rapid.

Vegetation: Sugar maple, basswood, ash, tulip poplar, black chorry, hop hornbeam, oak.

Uss: Hay, corn, samll grains, and vegetables, and fruit on terraces; hay, pasture, and some corn on kamas.

Distribution: Ontario plain and Mohawk and Hudson Valleys in New York, western Massachusetts.

Type location: Town of Caledonia, Livingston County, New York.

Series established: Wayne County, New York, 1919.

Source of Name: Palmyra, Wayne County, New York.

Remarks: Kames and terrace faces now included as phases of Palmyra soils were mapped as Groton soils until 1946. Profile variations on similar-textured material are small between kames and terraces, however, and the Groton series is now confined to soils with very weak textural profiles on materials comparable to those of Palmyra.

JT
1-15-47
Rev WJL
11-11-46
Rev. MHC
4-25-50

Division of Soil Survey - BPISAE
ARA - U. S. Department of Agriculture

Howard Gravelly Loam
ABF-GBP

Sayre-8
Bradford Co., Pa.
9/18/53
WHL

Road from Athens, Pa. to Willawana about 100 yds. east of the bridge. Gravel pit in a large terrace. We stopped here briefly last year when Smith, Denny, Higbee, and Goodlett were along. At that time we decided the profile was Brown Podzolic over Gray Brown Podzolic. This does not seem to be the case today because I could find no evidence of Brown Podzolic profile. Denny made a scale diagram of the tongued B_2t-C contact and has a pebble count here. The average depth to carbonate is about 5 feet.

Ap 0-8" 10YR 4/2-3/2 gravelly loam, weak fine granular structure, friable; pH 6.2-5.8.

A_2 8-15" 10YR 4/4 (wet) gravelly loam, weak fine subangular blocky structure crushes easily to weak fine granular. Very friable, pebbles clean. No evidence of Brown Podzolic sequum, pH 5.8.

(B_1) 15-24" 9YR 4/4 (wet) gravelly sandy loam, weak fine subangular blocky structure, crushes easily to weak fine granular, very friable, pebbles clean, pH 5 to 6.

B_2t 24-60" 6YR 4/4 (wet), looks more reddish than it appears on the chart. Gravelly sandy loam to clay loam, localized silty clay areas. Clay flows are visible. Weak, medium subangular blocky structure where not too gravelly. Underlying boundary very sharp. Strong brown, yellowish brown, light grey, and black ghosts numerous in this horizon. A few cavities from the decay of the black limestones can be found. This horizon is characteristically wavy in its lower part and in one or two places the pipes extended to a depth of 6 feet. These pipes were examined for sandy interiors like those found at Wysox. These were found in the lower part of the pipes, but they are weak and would have been missed if I hadn't known what to look for. The pebbles amount to 60% of the whole weight and by count 50% sandstone, 20% limestone, 10% chert, 5% granite, quartzite and other stones.

C 60" plus 10YR 3/2-3/3 coarse sandy pebbly gravel, calcareous; pebbles clean, unweathered, and cemented in some places with secondary lime.

In many places the upper solum has been modified somewhat as a result of windthrows and the growth of stumps. Invariably where deep V's in the upper solum occurred, the upper B horizon was finer textured and perhaps there was some evidence of clay flow in this finer textured material indicating that it had been torn from the underlying B_2t by windthrow and brought to the top. The B_2t here at this pit is less clayey than the one at Wysox and is more of a gravelly sandy loam with the clay loam localized in spots. In one portion of the pit there is a 20 ft. area where very fine sand deposits occur over the gravel. This is a Gray Brown Podzolic profile with fragipan. This tendency of very fine sand deposits over the gravels to develop fragipans and Gray Brown Podzolic profiles has been noted in other places. There is no tendency at all in the gravelly deposits for fragipan development if the gravel comes to the top as it does in Howard gravelly loam.

Massillon-Like Gravelly Loam - Generalized Description
ABF-GBP

This description is based on profiles near Chemung between Athens, Pa and Elmira, N. Y. in the Binghamton terraces and at Savonna in Steuben County, N. Y. 8/54 WHL.

Ao 0-8" 10YR 4/2 gravelly loam with 20-30% by volume sandstone and siltstone pebbles; weak fine granular structure, many roots. pH 4 to 4.5.

(B) 8-26" 1Y-2.5Y or 10YR 4/4 to 5/4 when moist, non-sticky and non-plastic gravelly loam; in some places slightly lighter textured than the horizon above, generally with weak fine granular structure, but in some places with weak subangular blocky structure that crushes easily to weak fine granular. Pebbles amount to 20-40% or more of the soil mass and this interferes with the development of structure. pH 4.5 to 5.2.

B_{21} 26-30" 10YR 4/3-4/4-5/4 gravelly silt loam or clay loam with weak medium subangular blocky structure that easily crushes to weak fine granular. In some places this horizon is not present. Depth variable and the underlying B_2t may come in at 26" or as deep as 36".

B_2t 30"-8' 10YR 4/3 or 4/4 gravelly clay loam; weak subangular blocky or weak fine granular structure intermingled with the very numerous pebbles that range in size from $\frac{1}{2}$ to 2 inches in diameter. Many soft, porous, leached limestones with strong brown, pale grey or nearly black colors; in some places the limestone fragments have completely leached away and only the cavity remains. Some of these cavities are filled with black silty or clayey materials. The texture is somewhat localized; in between voids of some of the pebbles the clay may be concentrated. Here the texture is silty clay. In other places clayey sand areas occur. In general the main mass of the texture is clay loam. Clay flow surfaces are very evident. The horizon tongues characteristically into the underlying material. Depth to the underlying calcareous material is variable, therefore, and ranges from as little as 5 to as much as 11 or 12 feet. General average 8 to 10 feet. pH 6.3-6.5. Never calcareous except in the spots where an unusually large limestone pebble, say 2 inches across, has not completely leached of its free lime. The inner core then may be calcareous.

C 8' plus 2.5Y 3/2-4/4 calcareous, loose, very coarse sandy gravel, weakly cemented in some places. The majority of the pebbles are in the $\frac{1}{2}$ to 2 inch range, about 10% larger than 2 inches. Limestone pebbles between $\frac{1}{2}$ and 1 inch about 10-15%; sandstone about 60 or 70% and the remainder is made up of chert, pre-Cambrians, and quartzites. Pebble counts at several pits have been made by Denny.

In contrast to the Valley Heads terrace deposits, these deposits seem to be characterized by a great amount of silt. This makes them rather dirty and perhaps not so desireble for road material. The silt deposits cap the pebbles and appear, therefore, to be moving downward. Many of the pebbles have patterns on their surfaces that look a good deal like worm tracks. These apparently result from the contact of the pebbles with overlying pebbles or silty cap materials.

Centon-1
Tioga Co., Pa.
9/22/53
WHL

Chenango Gravelly Loam
Podzol

Kame of Olean lithology, 1 mile south of Centon on Route 14, west of the road. Denny previously had made a pebble count from this spot. The kames in this vicinity are of typical Olean lithology, but in contrast to the ones studied earlier south of Roseville they are leached only to 5-8 feet rather than 15-25 feet. Denny feels that this may tie in with his hypothesis that there are two Olean drifts.

There is no question here about a Podzol and the bleicherde can be found fairly often even though the surface of the kame was once plowed. Even where it does not occur, however, the typical Podzol B_{21} shows up even from some distance. The B_2t is dull colored and not so marked either in color, texture or waviness as in the Howard.

A_1 0-2" Nearly black gravelly loam, weak fine granular structure, very friable, pebbles make up 10-30% of the entire soil mass throughout this horizon and the underlying horizons.

A_{12} 2-5" 10YR 4/3 (moist), gravelly loam, very fine granular structure, very friable, pH 5.4. The Ap where present is 10YR 4/3 gravelly loam, weak fine granular, very friable.

A_2 5-7" Looks like a bleicherde when dry, but is dark when wet. 7.5YR 8/2 (dry), 7.5YR 4/4 (moist), gravelly loam with weak very fine subangular structure which crushes easily to weak fine granular. Very friable, pH 5.0. Horizon occurs only in the spots originally in a depression. Cultivation covered it rather than disturbing it.

B_{21} 7-16" 5Y 4/4 moist, gravelly loam, weak fine subangular blocky structure which crushes to weak very fine granular, very friable, pH 5.0.

B_{22} 16-48" or (B) 10YR 4/4 gravelly sandy loam, weakly brittle, weak subangular blocky structure, friable, not sticky or plastic, 50-60% coarse skeleton with cobbles and pebbles ranging from ½ to 4 inches in diameter for the most part. 20% red sandstone and the rest grey Chemung. There is an occasional limestone ghost toward the lower part.

B_2t 48"-8' 10YR 4/4-7.5YR 3/4 (moist), gravelly sandy loam with numerous sticky reddish clay flows as bridges but not enough to make a clay loam. Little localization of clays, loose to friable, pH 6.5 to 7.

C_2 8' plus 10YR 3/2 coarse sandy gravel, sharp boundary to the horizon above, loose, weakly calcareous with secondary lime under the pebbles. The grey Chemung fossiliferous limestone pebbles and cobbles are the main source of lime, and these are numerous. The inclined beds are alternate cobbly and pebbly. This material is not especially silty in the C horizon as in some kames.

The localization of clay in the kames which are leached more deeply may be worthy of more study. This was first noticed in a kame of Olean lithology that Denny showed me first this year north of Middlebury. This localization and the siltiness are both criteria that should be watched. This soil here seems to fit very well into the concept of the Chenango soils as weak Podzols. The clay flow surfaces are at 48" and, therefore, considerably deeper than would be examined in normal soil mapping procedures. All the Chenango soils seen this summer have had these deep B_2t horizons.

ITINERARY

SATURDAY, MAY 22

Total Mileage	Next Mileage	
		Antrim quadrangle
		Leave Penn-Wells Hotel at 7:50 A.M. in order to reach assembly point (3.0 miles) by 8:00 A.M.
0.0	3.0	Turn left on Main St. from hotel parking lot one block to U.S. 6. Follow U.S. 6 and Pa. 84 (east and then north) to point where U.S. 6 and Pa. 84 separate (Stokesdale Junction).
		Elkland quadrangle
3.0	1.0	Stop 1 - ASSEMBLY POINT
		Park on right side of Pa. 84 going north at point where U.S. 6 turns west.
		Continue northward on Pa. 84.
4.0	6.8	Swamp on valley floor at right is divide between headwaters of northward-flowing tributary of Tioga River and southwestward-flowing tributary of Pine Creek. Pre-Wisconsin meltwater flowed southwestward through this broad valley and cut a gorge across the Tioga River-West Branch Susquehanna River divide southwest of Wellsboro. This gorge is "Pennsylvania's Grand Canyon."
		Northward from this point for several miles the highway passes over and around remnants of "Olean" kame terraces.
		Tioga quadrangle
		Gravel pit on left. Stop along highway.
10.8	4.2	STOP 2 - CONGELITURBATE OVER "OLEAN" KAME GRAVEL

Section (generalized)

Congeliturbate, a red flaggy colluvium with silt loam matrix, unstratified, noncalcareous. Contains sandstone slabs as much as 4 feet long that are orientated with their flat surfaces more or less parallel to ground slope. Sandstone blocks on ground surface are as much at 15 feet long. Soil is Lackawanna channery silt loam.

Thickness = 8 to 17 feet.

----- Contact in places sharp, wavy; elsewhere transitional through 1 foot -----

Silt, sand, and some gravel, interbedded, gray, yellowish brown and red, nonclacareous. This material is transitional between the congeliturbate above and the kame gravel below. Thickness = 2 to 8 feet.

----- Contact gradational through 1 foot -----

"Olean" gravel, pebbly and cobbly, and coarse pebbly sand. Abrupt changes in texture vertically and horizontally. Slightly calcareous except in upper 6 inches. Thickness exposed = about 25 feet.

Pit at base of steep slope that ranges from 10° to 20°.

Questions

(1) Does presence of transitional material indicate that congeliturbation took place immediately following outwash deposition?
(2) Did mantle on the bedrock slope become unstable at close of outwash deposition, or was congeliturbate deposited piece by piece so that annual increments of congeliturbate were lost in superabundance of outwash?
(3) Was mantle on bedrock slope frozen during outwash deposition ("Olean"), and became unstable when slope mantle thawed?

Across valley to south at mouth of Hills Creek is small "Olean" kame surrounded by gentle toe slopes that are probably underlain by post-kame congeliturbate. Deposits are dissected by Hills Creek which built small alluvial fan at mouth.

Sequence of events in this area:

(1) Erosion of Crooked Creek - Pine Creek Valley. Cutting of "Grand Canyon" (pre-Wisconsin).
(2) "Olean" glaciation
Development of kame terraces
(3) Mass movements (solifluction) down slopes to form congeliturbates (late "Olean" or "Binghamton").
(4) Development of alluvial fans (late "Olean" and "Binghamton")
(5) Stabilization of slopes by "Valley H eads" time (i.e. perhaps during "Brady inverval"). Stabilization caused (?) by return of forest and/or disappearance of frozen ground.

Leaving Stop 2 continue northeastward on Pa. 84.

15.0 1.9 Large "Olean" kames on right.

16.9 2.7 At Tioga (Junction of Pa. 84 and U.S. 15) turn right (south) on U.S. 15.

19.6 3.4 Turn left (east) on gravel road along north side of Mill Creek.

23.0 3.2 Large "Olean" kames near Painter Run.

26.2 0.2 Turn right (south) on paved road to Pa. 549. Cross Mill Creek and stop at gravel pit on right (west) side of highway.

26.4 3.1 STOP 3 - "OLEAN TERRACE"

Section

Gravel, unstratified, in part silty, congeliturbate (?), Thickness = 1½ to 4 feet. Soil is Chenango gravelly loam.

----- Contact sharp, wavy, local relief of 2 feet -----

Gravel, pebbly to bouldery, lenses of coarse pebbly sand. Composed of local sandstone and siltstone, erratics probably less than 0.01 percent by number. Noncalcareous matrix to depths of 12 to 16 feet. Below matrix is calcareous in places. Perhaps this lime is in part secondary, derived by leaching of overlying material. Thickness exposed = 17 feet.

Pebble counts given in Table 2.

Topography along valley of Elk Run to south is characteristic of "Olean" drift in Tioga and Potter Counties, Pa. (Long smooth slopes, with gentle toe slopes and rounded divides.)

Turn around and proceed northward on Pa. 549.

Troy quadrangle

29.5 6.1 Pass through Roseville and continue northward on Pa. 549.

Topography from Roseville to Jobs Corners is typical of "Olean" drift in Potter and Tioga Counties.

35.6 1.6 Near Jobs Corners, our route passes into area of "Binghamton" drift (largely kame terraces with some lacustrine deposits). Stop along Pa. 549 on north side of Daggett. This stop may be omitted.

37.2 4.2 STOP 4 - CONGELITURBATE OVERLYING LAKE BEDS. (MAY BE OMITTED)

Leave cars and cross field on west side of highway to bank on west side of Seely Creek.

Continue northward on Pa. 549.

Numerous exposures of "Binghamton" kame gravel along Seely Creek.

Elmira quadrangle

41.4 1.2 Cross N. Y. - Pa. State line.

Pa. 549 becomes N. Y. 328

Continue northward to Seely Creek. Turn right into gravel pit.

42.6 0.3 STOP 5 - "BINGHAMTON" KAME - LUNCH

Pebble counts given in Table 2.

Return to N.Y. 328 and continue northeastward down Seely Creek Valley.

42.9 1.5 "Binghamton" kames on east side of valley.

44.4 2.9 N.Y. 328 crosses small alluvial fan at Pine City.

47.3 2.3 Follow N.Y. 328 through Southport (left fork at stop light).

Highway is on "Valley Heads" valley train terrace.

Cross Chemung River into Elmira.

49.6 2.5 Turn left (west) on U.S. 17E and continue northwestward to Big Flats.

Highway is on "Valley Heads" valley train terrace.

52.1 0.5 Fitch Bridge on left (alternate route from Stop 6a joins us at this point.

52.6 2.0 Note flaggy and bouldery colluvium (congeliturbate?) at base of steep slope on north side of highway.

54.6 3.0 Note furrowed bedrock cliffs on south side of Chemung River that is flowing in glacially diverted bedrock gorge. River once flowed around north side of Hawes (Harris) Hill, from Big Flats to Horseheads, and thence southward to Elmira.

57.6 0.2 Leave U.S. 17E (that curves westward) and continue straight ahead into Big Flats.

57.8 0.5 Left on U. S. 17 for about 100 feet.

Right (northward) on west side of restaurant.

Pass under two R.R. bridges.

58.3 0.4 Turn sharp right (east).

58.7 0.7 Turn left (north) up west side of Cuthrie Run.

59.4 1.0 Distal end of alluvial fan built by Cuthrie Run, perhaps largely of "Binghamton" age. Material is leached to depth of at least 7 feet.

Ascend fan and enter valley of Cuthrie Run. Park at road corner and walk northward to bridge. Go east to bank on east side of creek.

60.4 2.6 STOP 6 - CONGELITURBATE OVERLYING "BINGHAMTON" TILL

Section (at base of 6° to 10° slope)

Congeliturbate, flaggy, silty matrix ("Binghamton"?), contains a few erratics and rounded pebbles. Flagstones in upper part oriented more or less parallel to ground surface. Thickness, about 20 feet. Soil is Volusia channery silt loam.

Transition zone is a mixture of till and congeliturbate. Thickness, about 15 feet.

Till, "Binghamton," slightly calcareous, olive gray, contains erratics and striated stones. Thickness, about 10 feet.

Bedrock.

Turn around and retrace route to Big Flats.

63.0 1.7 At Big Flats go right (west) on U.S. 17.

Highway follows low terrace ("Valley Heads"?).

64.7 0.7 Enter Steuben County.

65.4 0.6 Cross R.R. on bridge.

66.0 0.2 U.S. 17 becomes a 4-lane divided highway.

66.2 0.2 Turn right on gravel road to gate into abandoned gravel pit and park.

Stop 7. Walk into pit and go to south-facing north wall of pit. Note that this pit is the easternmost of several large pits. Those to west are actively worked.

STOP 7 - CONGELITURBATE ? BURIED IN "BINGHAMTON"? VALLEY TRAIN TERRACE

Section (generalized)

Gravel, pebbly; and coarse sand ("Binghamton"?) horizontal stratification, largely noncalcareous. Thickness, 4 to 12 feet.

Sand, medium to coarse grained, horizontal stratification, largely noncalcareous. Thickness, 5 to 15 feet.

----- Contact sharp, horizontal -----

Gravel, pebbly and cobbly, in part calcareous, in part noncalcareous. Thickness, 1/2 to 1 foot.

----- Contact sharp, horizontal -----

Congeliturbate? (Brodel). Gravel, pebbly and cobbly, unstratified, calcareous, partly cemented by calcium carbonate. Pebbles and cobbles have preferred orientation, with longer axes more or less vertical. Gravel includes stringers and irregular masses of pebbly and silty fine sand, unstratified; suggestion of deformed bedding in some places. Contains masses of coarse gray sand. Thickness, 9 to 12 feet.

----- Contact sharp, wavy, has relief of about 3 feet -----

Sand, coarse grained, gray; and gravel, pebbly and cobbly ("Binghamton"?), calcareous; horizontal stratification. Bedding slightly contorted in upper few inches. Thickness exposed, 5 feet.

Pebble counts given in table 2.

Conclusions:

(1) Congeliturbate? is buried in "Binghamton" outwash
(2) Congeliturbate? is deformed and pebbles have preferred orientation.
(3) Congeliturbate? was developed from gravels and sands similar to those above and below.
(4) Thin gravel layer that rests on the congeliturbate? is conformable with the overlying sands, but is discordant with the congeliturbate? below.

Questions:

(1) Was thin gravel layer present when congeliturbate? was deformed, or was top of congeliturbate? eroded off prior to deposition of overlying gravel and sand?
(2) Is congeliturbate? result of: (a) overriding by ice; or (b) frost action?
(3) Does preferred orientation of pebbles in congeliturbate? favor origin by frost action rather than by overriding ice?
(4) If congeliturbate? is result of frost action:
    (a) Was congeliturbate? formed at surface of ground and later buried?
    (b) Was congeliturbate? formed at present depth because of hydrostatic deformation while a thawed layer between two frozen layers?

This is the last stop.

Continue westward on U.S. 17.

66.4 2.2 Enter Corning quadrangle

East of Corning U.S. 17 is on "Binghamton" valley train terrace.

"Binghamton" drift in high banks on right.

68.6 3.7 Cross Chemung River and follow U.S. 17 through Corning.

72.3 4.4 Turn left (south) on U.S. 17 and 15 at Painted Post.

Cross Cohocton River.

Continue southwestward on U.S. 17 to junction with U.S. 15 just south of Erwins.

Highway follows outer edge of "Binghamton" valley train terrace built (?) by meltwater that flowed down the Canisteo River Valley.

76.7 0.4 Leave U.S. 17 and turn southward on U.S. 15 to Pa. State Line.

77.1 7.7 Cross Canisteo River.

Large "Binghamton" kames on east side of Tioga Valley.

Apparently a tongue of "Binghamton" ice extended southward up this valley at least as far as a point about 1 mile south of the State line.

84.8 0.2 Cowanesque River enters Tioga Valley just north of State Line. Lake beds found in Cowanesque Valley apparently deposited in lake dammed by ice in Tioga Valley ("Olean" or "Binghamton"?).

85.0 0.9 State line

Tioga quadrangle

Continue southward on U.S. 15 to Tioga.

85.9 1.3 Cross to east bank of Tioga River. South end of "Binghamton" kames on east side of valley.

87.2 0.4 Large "Olean" kames on east side of valley.

87.6 2.0 Cross distal ends of alluvial fans at mouths of Harts and Lane Creeks. Fans probably were built largely during "Binghamton" time.

89.6	2.7	Typical "Olean" topography (long smooth slopes, with gentle toe slopes) on east side of valley.
92.3	16.9	Turn right (west) on Pa. 84 at Tioga.
		Follow Pa. 84 to Wellsboro.

Elkland quadrangle

Antrim quadrangle

109.2	0.0	Penn-Wells Hotel.

Annual dinner at 7:00 P.M.

SATURDAY

ALTERNATE ROUTE AFTER LUNCH - (STOP 5)

42.6	0.1	Leave gravel pit and turn left (south) on N.Y. 328.
42.7	3.6	Turn right (west). Cross bridge over Seely Creek. "Binghamton" kame on right. Continue westward up valley of Mudlick Creek.
46.3	0.2	Turn right (north) up side valley.
46.5	0.9	Turn left up main valley.
47.4	0.6	Keep to right fork at corner and ascend to upland.
48.0	0.4	Keep straight ahead at fork.
48.4	0.2	Keep straight ahead at fork. (Road is on County line.)
48.6	0.1	Turn left (west) at corner.
48.7	0.3	Turn right (north) at corner.
49.0	0.1	Keep straight ahead at corner.
49.1	0.8	Park along road or in farm yard on right. Cross fence into field on west side of road.
		STOP 6a - PATTERNED GROUND
		Age, "Binghamton" or later (?).
		Continue northward into Hendy Creek Valley.
49.9	4.0	Turn right (east) and continue down valley of Hendy Creek to Chemung River.

53.9 1.3 Upper end of alluvial fan at mouth of Hendy Creek.

55.2 0.3 Cross Chemung River.

55.5 0.0 Turn left (northwest) on U.S. 17E at Fitch Bridge.

WE ARE NOW BACK ON MAIN ROUTE WHERE TOTAL MILEAGE = 52.1

ITINERARY

SUNDAY, MAY 23

Antrim quadrangle

Leave Penn-Wells Hotel at 7:45 A.M. in order to reach assembly point (6.2) miles at 8:00 A.M.

0.0 6.2 Turn left on Main St. from hotel parking lot one block to U. S. 6. Turn right (east) on U. S. 6.

Follow U.S. 6 for 6.2 miles to Junction with Pa. 660.

Blossburg quadrangle

Tioga quadrangle

Turn right on Pa. 660 and park along road. This is assembly point.

6.2 4.5 STOP 8 - ASSEMBLY POINT

Continue eastward on Pa. 660. Landscape typical of "Olean" drift in Potter and Tioga Counties.

10.7 1.6 STOP 9 - STREAM BANK ALONG NORTH ELK RUN

Stop on right side of highway and cross fence to top of bank.

Section (generalized)

Congeliturbate, olive brown (2.5Y 5/3), silty material (silt loam to clay loam texture) containing numerous angular fragments of sandstone and a few rounded or striated fragments; structureless, noncalcareous to depth of 40 inches, slightly calcareous below 40 inches. Thickness, 5 to 6 feet. Soil is Erie gravelly silt loam

----- Contact, sharp, horizontal; not well exposed -----

Lake deposits (varves) alternating thin layers of gray silt and fine sand, and thinner seams of red sticky clay. In lower part varves range from 1½ to 2 inches in thickness. Slightly calcareous throughout. Scattered pebbles and thin lenses of till (?) in lower part. Thickness, about 20 feet.

----- Contact sharp, essentially horizontal -----

"Olean" till, gray (5Y 5/1), sandy and silty matrix (loam to fine sandy loam texture), very firm, brittle, contains numerous boulders. Faint, irregular stratification in places. Slightly calcareous. Rock fragments dominantly of olive gray sandstone; other types include fossiliferous sandstone (Chemung formation?) and red sandstone (Catskill formation?). Numerous striated stones. "Pre-Cambrian" erratics very scarce. Thickness exposed, 20 feet.

Sequence of events:

(1) Deposition of "Olean" till.
(2) Deposition of varves in ice-marginal lake ("Olean"?)
(3) Deposition of congeliturbate by mass movements ("Olean" - "Binghamton"?).

Problems:

(1) Why is congeliturbate slightly calcareous at depth of only 40 inches? Is it "Valley Heads," or was it partly removed in post-"Binghamton" time?

Continue southward and eastward along Pa. 660.

12.3 5.6 Turn right (south) on U.S. 15.

Blossburg quadrangle

Continue southward through Covington to Blossburg.

17.9 8.3 On north side of Blossburg turn left into town.

Continue south through Blossburg and southward to Ogdensburg via headwaters of Tioga River.

Canton quadrangle

26.2 6.3 Turn left (east) at Ogdensburg on Pa. 414.

Continue eastward on Pa. 414 through Gleason to Pa. 14 in valley at headwaters of Towanda Creek.

32.5 0.4 Turn left (north) on Pa. 14 and 414.

32.9 1.2 Turn left into gravel pit and park.

STOP 10 - "OLEAN " KAME

Pebbly and cobbly gravel and coarse pebbly sand, in places silty, in part deformed apparently contemporaneous with deposition. In places there is a suggestion of foreset beds dipping southward. Pebbles are dominantly of olive gray sandstone, plus numerous pebbles of reddish sandstone and fossiliferous gray sandstone. Deposit contains only a very few "pre-Cambrian" erratics. Matrix is noncalcareous to depths ranging from 7 to 9 feet, slightly calcareous below. Soil is Chenango gravelly loam. See attached description.

Pebble counts given in Table 2.

Interpretation:

From about this longitude eastward to New Jersey the "Olean" drift includes numerous small upland lakes; such lakes are essentially absent in "Olean" drift to the west. Possibly this "eastern Olean" is younger than that to the west. Note that here the depth to free carbonates and amount of secondary clay in lower part of soil profile are not as great as in "Olean" gravels seen yesterday (as at Stop #3 on Mill Creek, Tioga quadrangle.)

Return to Pa. 14 and 414 and go northward to Canton.

34.1 25.2 Turn right (east) on Pa. 414 and continue eastward down valley of Towanda Creek to Towanda.

Numerous "Olean" kames on valley sides between Canton and East Canton.

Powell quadrangle

"Olean" kames near West Franklin

Monroeton quadrangle

Towanda quadrangle

59.3 1.9 In Towanda, turn right (east) on U.S. 6, cross Susquehanna River, and continue eastward on U.S. 6.

61.2 0.6 Turn right (south) on gravel road that is on west side of "Drive-In" theater.

61.8 0.0 Turn left (east) into Shiner gravel pit and park. This is Stop 11, the last stop. (Hungry?)

STOP 11 - "BINGHAMTON" ? VALLEY TRAIN TERRACE

Section

Pebble gravel in coarse sandy matrix, contains a very few cobbles and boulders, most pebbles rounded. Gravel appears rather homogeneous, bedding is indistinct except for a few lenses of coarse pebbly sand. Pebbles imbricated in some places.

Depth to carbonates highly variable, ranges from 2 to 14 feet ("pipes" and "pillars").

Pebble counts given in table 1. Soil is Howard gravelly loam. See attached diagram and description.

Figure 1. Map showing drift borders in the Wellsboro - Elmira - Towanda region, Pa. - N. Y. "Valley Heads" drift border in large part from Williams and others (1909); "Binghamton" drift border in part from MacClintock and Apfel (1944); "Olean" drift border from Leverett (1934).

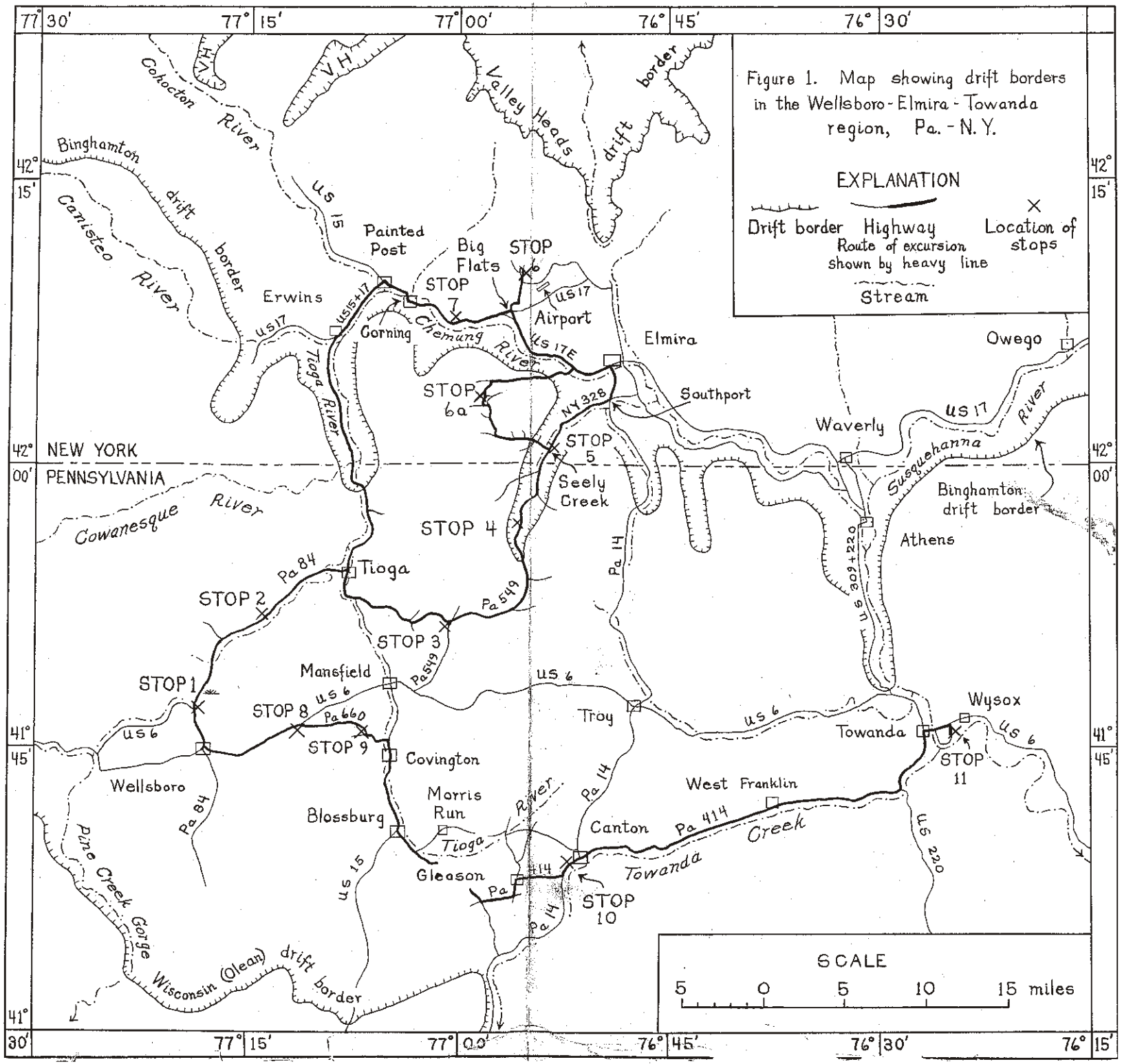


Figure 1. Map showing drift borders in the Wellsboro-Elmira-Towanda region, Pa.-N.Y.
EXPLANATION
Drift border
Highway
Route of excursion shown by heavy line
Location of stops
Stream
SCALE
5 0 5 10 15 miles
77° 30'
77° 15'
77° 00'
76° 45'
76° 30'
76° 15'
42° 15'
42° 00'
41° 45'
41° 30'
NEW YORK
PENNSYLVANIA
Binghamton drift border
Cohocton River
Valley Heads drift border
VH
Canisteo River
Painted Post
Big Flats
STOP 6
STOP 7
Erwins
Corning
Chemung River
Airport
Elmira
Owego
Tioga River
STOP 6a
Southport
NY 328
STOP 5
Seely Creek
Waverly
Susquehanna River
Binghamton drift border
Athens
STOP 4
Cowanesque River
Tioga
STOP 2
STOP 3
STOP 1
Mansfield
STOP 8
STOP 9
Covington
Troy
Towanda
Wysox
STOP 11
Wellsboro
Blossburg
Morris Run
Tioga River
West Franklin
Canton
Towanda Creek
Gleason
STOP 10
Pine Creek Gorge
Wisconsin (Olean) drift border
US 15
US 6
US 17
US 15+17
US 17E
US 220
Pa 84
Pa 549
Pa 660
Pa 414
Pa 14