SOIL SURVEY OF THE WESTFIELD AREA, NEW YORK.

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LOCATION AND BOUNDARIES OF THE AREA.

During the season of 1901 three and a half months were spent in making a soil survey of a portion of Chautauqua County, N. Y. The object of the survey was to investigate and map the soils of the Chautauqua grape belt and adjacent uplands. Observations were made and notes taken upon the agricultural conditions existing in these different localities and upon the relative crop values of the several soil types.

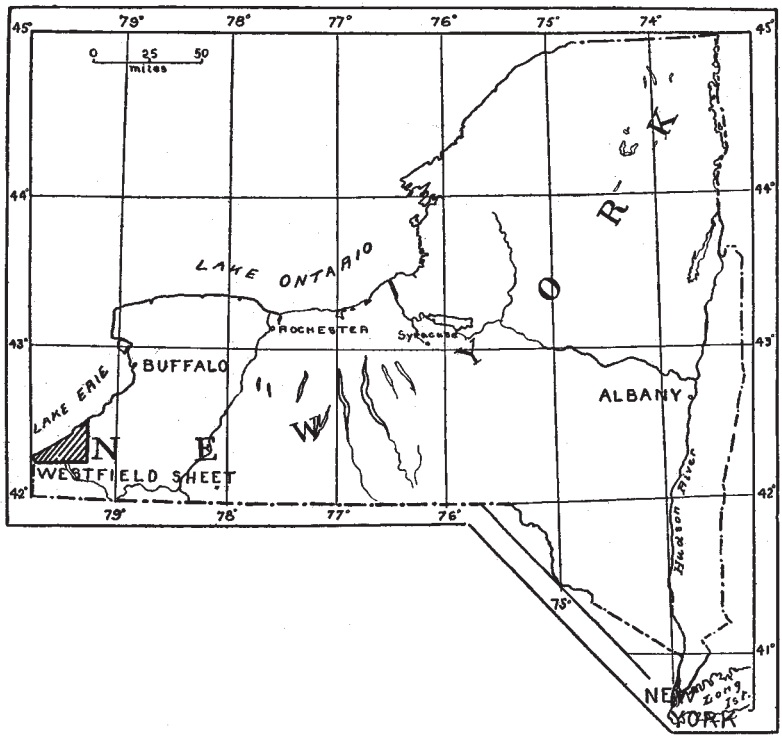


FIG. 1.—Sketch map showing area surveyed in New York.

The area comprises the most important section of the grape belt and lies between 42° 15′ and 42° 31′ north latitude and 79° 15′ and 79° 46′ west longitude, extending 35 miles along the Lake Erie shore. The towns of Ripley and Dunkirk lie within the northern limit of the area, and Lombard, Mayville, and Sinclairville within the southern. The area surveyed contains 166,160 acres, or between 259 and 260 square miles. (See fig. 1.)

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The earliest Indian tribe to occupy this area, as far as we have any record, were the Eries, a tribe of the Huron Iroquois family. They were in possession of the land when La Salle, the French explorer, penetrated the forest and discovered Chautauqua Lake.

The county was a part of the disputed area in the French-English colonial war, and in 1749 De Celeron, a French captain, landed at Barcelona Harbor, crossed the ridge to Chautauqua Lake, and passed by the Allegheny into the Ohio River, taking possession in the name of France. The first settlement was made in 1802, at a point about three-quarters of a mile west of the present site of Westfield, where a stone monument has been erected to mark the spot. A clearing of about 10 acres was made and planted to corn—the beginning of agriculture in this fertile country.

The year following settlers began coming in more rapidly. The tide of immigration from eastern New York and the New England States brought many pioneers, who found in the fertility of the soil and in the favorable climate a promise of certain reward for their labors. They purchased their claims, for which they paid about $2.50 per acre, from the Holland Land Company. These frontiersmen built their rude huts of logs, chinking them with mud to keep out the cold. Of necessity they gained a subsistence chiefly by hunting and fishing. Many engaged in trade with the Indians, while lumbering was an important industry in the southern part of the county. But soon the gun and rod gave place to the plow, sawmills and gristmills were built, and in place of log shanties comfortable frame houses were erected.

As fast as the land could be cleared of its timber the soil was put under cultivation. In 1820 the largest clearings and best cultivated farms were within 3 or 4 miles east and west of Fredonia. These did not contain more than 30 to 60 acres each and were worth from $10 to $20 per acre. The principal crop was corn. There is record of a New England farmer who brought with him into the wilderness a quantity of apple seeds, from which he started a nursery and set out an orchard. And so at this early time fruit growing was begun in the county that has since become one of the important centers in the country for the raising of fruit.

In 1811 county officers were appointed by the governor of the State and Chautauqua became a fully established county. Towns were divided into school districts and a free school system was established. An agricultural society was organized at Mayville, and every effort was made to advance the interests of the farmer. The county made rapid progress and development, until in 1830 the population exceeded

34,000. At that time the northern part of the county was the most thickly settled, and a large percentage of its inhabitants were engaged in agricultural pursuits.

CLIMATE.

The climatology of this section is one of the most important factors in the present agriculture. The two great physiographic divisions of forelands and uplands present considerable difference in climatic conditions.

It is to be regretted that the statistics of observations made are limited to the past three years. These were made at voluntary stations in a north and south line from the present shore to the uplands—at Barcelona upon the lake shore, at Westfield, at a station between Westfield and the crest of the escarpment known as Station Three, and at Volusia, upon the uplands.

However much the characteristics of soil may affect the quality and yield of the grapes grown in the Chautauqua district, it is believed to be the peculiar climate of the region which has made possible the remarkable growth of the industry there. This peculiarity is distinctly traceable to local topography, the two main features being the lake and the escarpment, the latter lying nearly parallel with the lake front, confining and accentuating the lake influence within the narrow intervening plain or foreland.

Prof. R. S. Tarr, in a paper on the "Geological history of the Chautauqua grape belt,"[a] says:

> The lake is a great modifier of climate. In the spring, by reason of the low temperature of its waters, it holds back the vegetation, and this tends to keep it behind the ordinary frosts. Its very presence checks frosts by moderating the temperature of the neighboring air. In the summer the water tends to cool the air of the day and keeps the nocturnal temperature fairly high. During the fall the water has been warmed by the summer sun, and the influence of this warm body of water lengthens the growing season and tends to keep off the early frosts.

The annual rainfall appears to be greater and the mean temperature lower on the uplands than on the forelands. The figures given below seem to indicate that the highest temperature and the least amount of precipitation occur on the escarpment. This inference is opposed to that drawn by Tarr, who states in the paper previously quoted that "the rainfall is greater on the escarpment than on the lake plain." The evidence now at hand is somewhat more weighty than that available in 1896, but neither statement rises to the dignity of a conclusion.

[a] Bul. 109, Cornell Univ. Exp. Sta., Jan., 1896.

Mean monthly temperature.

1899.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Barcelona	.....	.....	.....	48.6	58.0	70.0	75.0	75.4	62.3	55.2	42.4	30.0
Westfield	26.5	20.4	32.6	48.6	58.2	68.6	70.8	69.1	60.2	55.0	43.1	31.3
Escarpment	.....	.....	31.8	48.6	58.8	69.4	71.7	70.8	62.3	56.7	43.8	32.9
Volusia	.....	.....	.....	.....	56.0	66.2	67.6	67.9	58.0	54.5	39.6	28.6

1890.

Barcelona	27.6	21.9	25.6	46.8	58.8	66.8	67.5	73.3	66.2	59.4	41.0	30.0
Westfield	29.8	23.7	26.6	45.3	58.1	67.2	71.8	74.0	66.4	60.1	43.0	32.4
Escarpment	30.2	24.6	27.0	44.0	56.2	66.4	71.8	74.4	67.5	60.9	44.9	33.9
Volusia	26.8	22.0	24.2	44.8	56.8	65.4	69.2	72.0	64.4	57.8	38.6	28.0

1891.

Barcelona	26.4	17.0	32.6	44.2	55.3	.....	74.4	.....	.....	.....	.....	.....
Westfield	28.6	18.6	34.4	43.8	55.4	67.4	75.4	.....	.....	.....	.....	.....
Escarpment	29.3	19.4	34.1	42.0	53.2	66.2	75.4	.....	.....	.....	.....	.....
Volusia	25.2	15.6	31.5	43.4	54.2	65.1	72.8	.....	.....	.....	.....	.....

AVERAGE.

Forelands	28.65	20.8	30.1	45.5	57.0	68.5	72.7	71.9	64.1	57.8	43.2	31.7
Uplands	26.0	18.8	27.8	44.2	55.3	65.6	69.9	69.5	61.2	56.1	39.1	28.3

Monthly precipitation.

1899.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
Barcelona	.....	.....	.....	.....	.....	2.05	3.50	1.00	.....	.....	1.81	4.85
Westfield	1.23	1.35	2.98	1.01	4.30	2.42	2.80	1.18	1.02	2.61	1.59	3.26
Escarpment	.....	.....	.....	.....	3.68	2.11	1.53	.88	7.20	2.39	1.43	4.89
Volusia	.....	.....	.....	.....	5.07	2.57	4.93	2.18	8.27	2.45	1.95	.....

1900.

Barcelona	3.73	3.22	3.75	1.13	2.31	1.41	5.40	1.17	3.02	3.03	6.22	1.70
Westfield	3.60	3.16	1.43	.64	2.44	2.03	5.75	1.39	2.61	3.29	.....	.....
Escarpment	.....	2.92	2.65	1.86	1.90	1.44	4.70	1.18	4.18	3.48	6.53	1.14
Volusia	3.08	3.93	3.27	1.65	2.44	1.46	5.21	1.51	4.46	3.40	7.02	3.25

1901.

Barcelona	2.58	.....	3.02	6.65	4.76	4.79	1.82	1.64	.....	.....	.....	.....
Westfield	2.10	0.92	1.86	4.83	4.15	6.30	2.51	3.44	.....	.....	.....	.....
Escarpment	1.88	1.44	2.57	3.84	3.47	2.91	1.82	3.18	.....	.....	.....	.....
Volusia	3.41	1.74	3.43	6.20	4.29	4.06	2.01	3.32	.....	.....	.....	.....

AVERAGE.

Forelands	2.52	2.17	2.72	2.85	3.38	2.83	3.31	1.67	4.91	2.96	3.52	3.17
Uplands	3.11	2.83	3.35	3.92	3.93	2.69	3.06	2.35	6.36	2.97	4.48	3.25

The prevailing winds for the time covered by these observations have been from west and south. At certain seasons of the year there is a day lake breeze and a night land breeze, which in all probability tend to diminish the frequency of damaging frosts by keeping the air in motion. No records of the dates of killing frosts were obtainable for this territory.

In view of the marked difference in quality and yield of grapes grown upon the several soils of the area, it is much to be regretted that at the present time conclusions as to how far soil and drainage conditions and how far climatic conditions are responsible for these differences can not be drawn.

TOPOGRAPHY AND GEOLOGY.

The section surveyed has two great physiographic divisions. These are separated by what is known as the "Hill" or escarpment, which extends east and west, parallel to the lake. One of the divisions noted above is known as the Erie forelands, while that portion to which the Erie escarpment acts as a frontal bluff is known as the uplands. The surface features of the forelands are very regular. They present a slightly undulating ascent from the present wave-cut bluff of Lake Erie toward the escarpment, in which the gradient will vary from 100 to 250 feet to the mile.

From the crest of the escarpment the uplands are of a rolling character. The hills are elongated in form, their major axis lying north and south, while they rise in successive tiers east and west, varying in altitude from 100 to 500 feet above the upland valleys.

The surface geology of this region is typical of a glaciated area. In the uplands the physiographic features plainly show the action of the great continental ice sheet that at some former time must have covered the region. Erratic bowlders from a few inches to 3 or 4 feet in diameter are thickly scattered over the northern slopes of the hills. The crests of the hills are elongated in form, sloping in convex curves to the valley.

Along the crest of the escarpment there is a belt of glacial débris of sand, gravel, and bowlders known as a moraine, which varies in width from 2 to 3 or 4 miles and extends in a line approximately parallel to the shore of Lake Erie. This belt probably marks a point where the ice sheet tarried in its recession. Numerous kames, terraces, and kettle holes occur throughout the valleys, and the valley in the southern portion of the area has a depth of 80 to 100 feet.

The Erie forelands also present a very interesting feature of glacial geology in the ancient beach lines. These rise in successive terraces from the present lake level to the base of the escarpment. The number varies from one to four or five, but usually there are two which are quite distinct and well defined. The material is usually a typical

beach gravel, which in some places has been entirely carried away by the forces of erosion, leaving only the shore topography to mark the former location of the beach. These beaches are supposed to have been formed at the time of the recession of the great glacier, which made, in conjunction with the escarpment, a series of dams with outlets at different levels. The relation of the soils to the topography and geology is illustrated in fig. 2.

Between these beach lines and the present shore of the lake are found finer sediments, which were laid down as offshore deposits at the time the beaches were formed. In a number of instances the streams have cut down through these sediments, exposing the underlying bowlder clay that marks the former presence of the ice sheet.

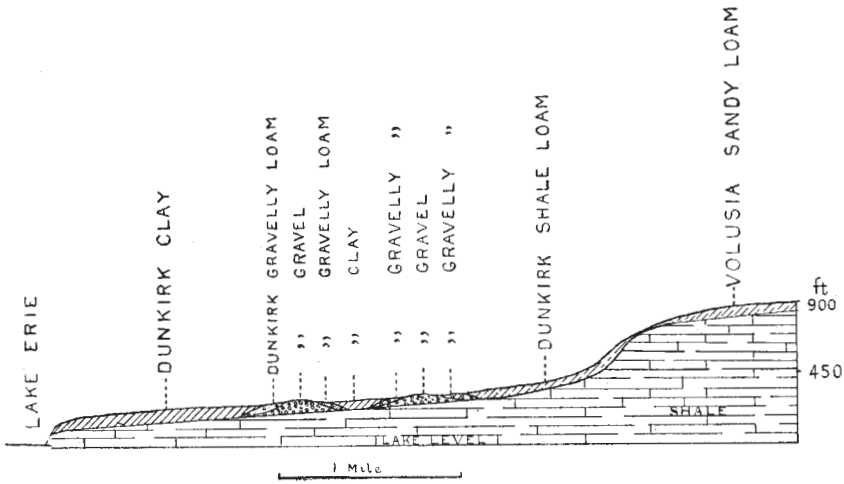


FIG. 2.—Section northeast and southwest through Erie foreland and escarpment between Westfield and Portland, Chautauqua County, N. Y.

The bed rock in this area belongs to the Upper Devonian system. In the western portion of the uplands all outcrops show a bluish mud shale, while in the eastern portion the shale is quite sandy and is interbedded with thin layers of sandstone.

The soils of the uplands are roughly spoken of as glacial in origin, but the close conformity of the soil texture to the underlying rock of the two sections would seem to indicate that, though mixed with bowlders and a quantity of foreign material, the soils are still largely of local origin.

The Erie escarpment forms a divide between the St. Lawrence and Mississippi drainage systems. The drainage south of it is by small streams to the Allegheny, and so by the Mississippi to the Gulf of Mexico, while north of it the drainage is by way of Lake Erie and the St. Lawrence into the Atlantic Ocean.

The upland surface drainage shows the effect of glaciation in numer-

VINEYARD ON THE FORELANDS, SHOWING TERRACE AND ESCARPMENT. WESTFIELD AREA, NEW YORK.

There are 30,000 acres of vineyard on the forelands. The industry was first started on the gravelly terraces, then extended to the clay lands, illustrated in the foreground, and recently to the slope of the escarpment.

ous kettle holes and marshy spots most unfavorable to agriculture. The forelands, on the other hand, are very well drained.

SOILS.

The areas of the different soil types are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Volusia sandy loam	69,940	42.1	Meadow	4,990	3.0
Dunkirk clay	23,490	14.1	Dunkirk gravel	4,840	2.9
Dunkirk sandy loam	22,090	13.3	Cassadaga sand	1,660	1.0
Dunkirk shale loam	21,860	13.2	Total	166,160	
Volusia loam	10,030	6.0			
Dunkirk gravelly loam	7,260	4.8			

DUNKIRK CLAY.

The Dunkirk clay is found upon the forelands between the areas of Dunkirk gravel, and upon the Lake Erie shore east and west of Barcelona, and in the neighborhood of Van Buren Point and Dunkirk. It also occurs in the large valleys of the uplands, in the old Chautauqua Lake basin, and in the Cassadaga and Bear Creek valleys.

The soil is a clay loam from 4 to 12 inches deep, resting upon a stiff, tenacious clay of a mottled color. It is underlain by bowlder clay at a depth varying from 4 to 10 feet. As it occurs between the areas of Dunkirk gravel it is the finest offshore sediment of the ancient beach lines, and is underlain by sand and water-washed gravel. In some localities the soil is in a poorly drained condition and is locally known as muck. This condition could be readily relieved by surface ditching to the underlying sand and gravel.

Where the Dunkirk clay occurs upon the lake shore it is supposed to be due to the finer materials brought by streams from the escarpment at a time when the water stood at the lowest of the ancient beach lines. Here it is in a well-drained condition, and it is being used at present almost exclusively for grape culture, although the discovery that it was adapted for this use is of quite recent date. The present yields, it is reported, will vary from 4 to 5 tons of grapes per acre, depending largely upon the season.

Generally speaking, the grapes grown upon the Dunkirk clay are held next in value to those grown on the Dunkirk shale loam, and superior to the product of either the Dunkirk gravel or the Dunkirk sandy loam.

The Dunkirk clay is a typical wheat and grass soil. The yield of wheat will range from 35 to 45 bushels to the acre and of hay from 2 to 3 tons to the acre.

The following table shows the texture of samples of this formation:

Mechanical analyses of Dunkirk clay.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5938	2 miles W. of Barcelona.	Clay loam, 0 to 6 inches.	0.02	5.70	0.66	1.56	1.74	6.20	5.12	42.30	36.22
5940	1½ miles N. of Chautauqua Lake.	Heavy clay, 0 to 8 inches.	.03	8.76	0.60	3.44	3.34	7.82	5.38	24.74	46.31
5939	Subsoil of 5938....	Clay, 6 to 30 inches	.02	4.70	1.26	1.80	1.72	7.32	5.04	45.96	31.20
5941	Subsoil of 5940....	Clay, 8 to 24 inches	.01	5.00	trace	1.46	1.04	5.32	5.54	42.60	38.59

NOTE.—The "soluble salts, as determined in mechanical analysis," as used in this and the remaining tables of this report, represent the amount of mineral matter, determined by the electrolytic method, calculated as sodium chlorid, dissolved when the soil is mixed with 10 parts by weight of water and shaken for one hour at room temperature.

The organic matter and combined water were determined by igniting in a muffle furnace the different separations obtained from 5 grams of soil, previously dried at 110° C. Water is then added and the sample is subjected to a pressure of about 75 pounds per square inch in an atmosphere of carbon dioxid for half an hour, to replace carbon dioxid driven off from carbonates. In this process a portion of the combined water driven off by the ignition is replaced. After this the sample is dried at 110° C., and the difference between this and the original weight is taken as organic matter and combined water.

DUNKIRK GRAVEL.

This type is a very gravelly soil, occurring on the gravel ridges of the forelands. The soil is composed of waterworn fragments of shale mixed with sand and fine gravel to the depth of 6 feet or more. This is the coarsest material of the ancient beaches described in the preceding pages. This gravel extends along the base of the Erie escarpment from Ripley to Silver Creek in two or three parallel lines from one-sixteenth to one-half mile in breadth. These ridges in many places are broken or merged into each other by cultivation and erosive stream action. This is the type of soil upon which the first grapes were grown and upon which grape growing as an industry was begun.

Owing to its droughty and porous character the Dunkirk gravel is not adapted to general crops, but is better suited to grape culture, and for this purpose it is used extensively at present. The Concord is the variety chiefly grown upon the gravel, as it is upon the other soils of the Erie forelands. This variety grown upon the gravel, it is said, will give an average yield of about 2 to 2½ tons of grapes per acre.

THE DUNKIRK CLAY, OCCURRING ON THE FORELANDS OF THE WESTFIELD AREA, NEW YORK.

This is a stiff clay soil, excellent for wheat and grass, but now considered one of the best grape soils.

DUNKIRK GRAVEL ON ONE OF THE OLD BEACH LINES IN THE FORELANDS OF THE WESTFIELD AREA, NEW YORK.

This is the soil on which the grape industry was begun. It is filled with fragments of waterworn shale, and is too open and porous for other crops except occasionally peaches and some truck crops.

The Moore's Early and the Niagara are said to make a good growth on this soil. The yield of the former in good years is said to be as high as 4 tons per acre and of the latter from 2½ to 3 tons per acre.

This soil type, owing to its light, porous nature, is best adapted to the production of early grapes, such as Moore's Early. This variety has a large berry, and is better for shipment than the Concord grown upon this type of soil, having a tougher skin.

The Dunkirk gravel is also admirably adapted to the peach and plum. Where properly cared for, peach trees set in this soil produce excellent yields of large, splendidly colored fruit. The Japanese plum Abundance is a favorite for cultivation on this type. It is of prolific yield and finds a ready market.

The following table shows the texture of the fine earth of the Dunkirk gravel:

Mechanical analyses of Dunkirk gravel.

[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5945	4 miles W. of Westfield.	Coarse gravel, 0 to 26 inches.	0.02	3.20	24.40	10.86	2.40	4.20	4.92	33.76	16.46
5944	1½ miles SW. of Fredonia.	Coarse gravel, 0 to 36 inches.	.03	4.34	35.76	8.48	2.74	2.70	3.26	22.30	20.03

DUNKIRK GRAVELLY LOAM.

The Dunkirk gravelly loam occurs as an intermediate soil upon the forelands between the Dunkirk clay and the Dunkirk gravel, and also in valley positions upon the uplands. It is a sandy loam, containing from 40 to 60 per cent of very fine gravel that consists of water-worn fragments of shale, very much smaller than the Dunkirk gravel. It is underlain at 3 feet or more by shale fragments or sand.

This type extends in thin, narrow bands at the top or base of the gravel ridges from Ripley to Dunkirk. It is also found upon the uplands on the Hartfield flats, in the Bear Creek Valley east and south of Stockton, and in Cassadaga Valley, in the basin just east of Moons Station. The surface of the soil, as found upon the forelands, has some larger gravel scattered over it through the agencies of erosion and long-continued cultivation. Where it occurs upon the uplands it has a more typical appearance.

Upon the forelands it is the first offshore deposit from the ancient beaches, and there it gradually grades into the coarser Dunkirk gravel.

It is used in conjunction with the Dunkirk gravel almost entirely for grape culture. There is comparatively little difference in the grapes produced on the Dunkirk gravelly loam and those produced upon the Dunkirk gravel, except that on the former the berry is slightly larger and the vines have a greater tendency to wood.

As found upon the uplands the soil has the characteristics of a beach or bar, and occurs in somewhat larger areas than it generally does upon the forelands. It is not well adapted to grass or grain crops, although better for such purpose than the Dunkirk gravel. which is more droughty.

Occurring as it does in the valleys, the Dunkirk gravelly loam is accompanied by about the same climatic conditions as the forelands. The interstitial spaces of the soil are large, so that surplus water is readily carried away; yet it has a good water content.

The Dunkirk gravelly loam is suitable for the production of market-garden truck, and is both early and fertile. The truck raised upon it is of fine quality.

The texture of typical samples of this formation is shown in the following table:

Mechanical analyses of Dunkirk gravelly loam.

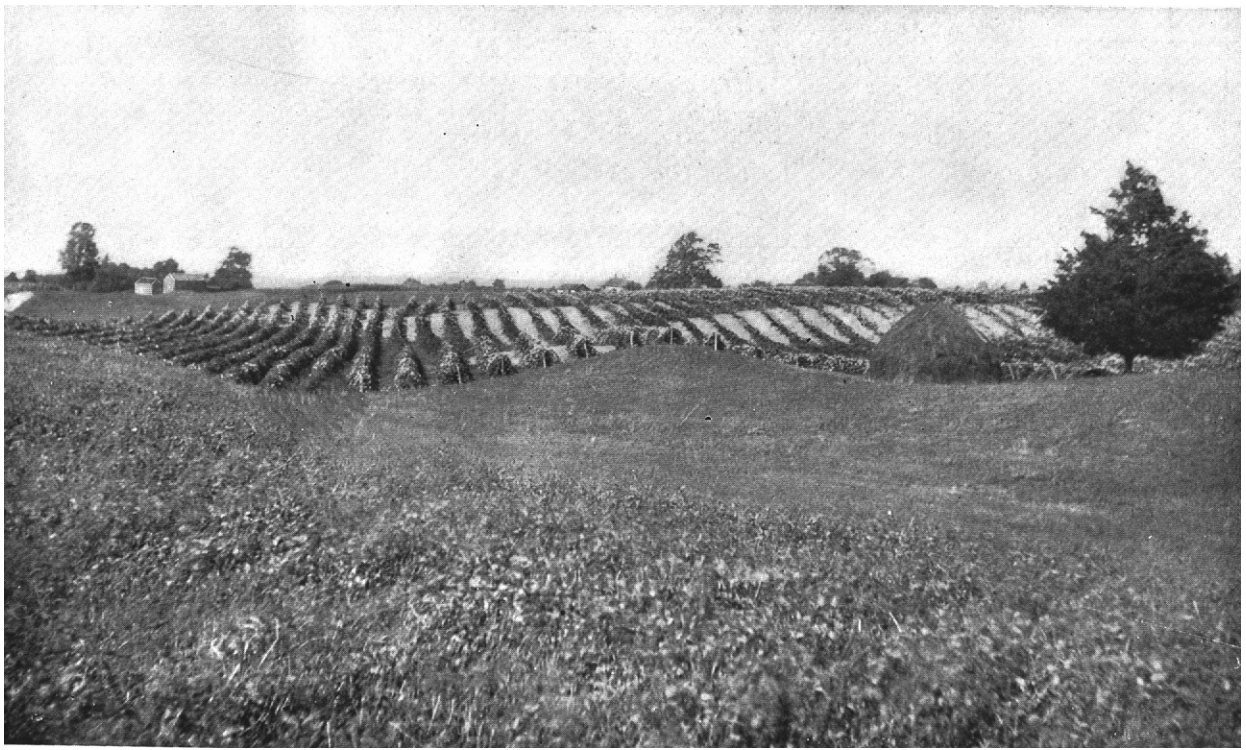
[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5950	2 miles S. of Cassadaga.	Fine gravel and sand, 0 to 7 inches.	0.02	8.80	10.26	14.50	15.82	17.72	4.42	18.66	9.58
5948	Westfield	Gravelly loam, 0 to 8 inches.	.03	4.30	21.22	18.44	5.24	11.06	7.06	22.04	10.69
5946	Hartfield	Fine gravelly loam, 0 to 6 inches.	.02	3.22	8.12	19.40	18.98	6.74	4.86	26.64	12.34
5951	Subsoil of 5950....	Fine gravel and sand, 7 to 36 inches.	.01	3.72	14.78	18.02	15.02	20.28	10.32	9.76	8.19
5947	Subsoil of 5946....	Fine gravel, 6 to 30 inches.	.03	3.14	8.68	22.18	23.12	9.16	4.40	20.52	9.07
5949	Subsoil of 5948....	Gravelly loam, 8 to 36 inches.	.02	3.22	19.92	20.80	5.50	4.36	5.90	27.06	13.12

DUNKIRK SANDY LOAM.

The Dunkirk sandy loam occurs upon the forelands and is usually marked by hummocky or undulating topography. It is found south of Ripley, east of Barcelona, and rather extensively east of Vineyard

Report of Bureau of Soils, U. S. Dept. Agr., 1901.



VINEYARD ON THE DUNKIRK SANDY LOAM, SHOWING THE EROSION OF THE SOIL FROM THE HILLTOPS AND THE ACCUMULATION IN THE DEPRESSIONS, BOTH UNSUITED FOR THE BEST DEVELOPMENT OF THE GRAPE.

and north of Fredonia. It is a brown or yellow sandy loam 6 to 10 inches deep, underlain by medium or fine sand 3 feet or more in depth.

The soil in the vicinity of Vineyard differs somewhat from the usual type The hummocky topography generally characteristic of the type is found here, and in most instances the crests of the hills are denuded of soil, which has been washed to the valleys below, leaving the subsoil exposed. In the same area there are a number of kettle holes. The majority of the hummocks are underlain by silt and bowlder clay, and it appears that the forces of erosion that sculptured the hills have cut down to the bowlder clay. In recent time, however, there has been continual migration of the soil coating, due to wash by rain and cultivation. This has cut off the drainage, and kettle holes have resulted. Such spots are unsuited to grape culture, being too wet. With a little better drainage these patches of waste land could be made productive.

A deviation from the Dunkirk sandy loam as described above occurs east of Fredonia and Dunkirk. The soil is there a heavy sandy loam underlain by sticky sand with silt pockets. In many places there is an underlying hardpan due to imperfect drainage, the sand and silt pockets being partially cemented by iron in soil solutions. The soil, although a sandy loam, appears heavy in texture and is very fair grass land.

At present the Dunkirk sandy loam is generally used for grape culture, the Concord being the variety chiefly grown. This soil is generally recognized by growers as one of the best for the location of vineyard on account of its very large yields. A yield of 5½ tons of grapes per acre has been reported. The fruit, however, does not compare in quality with the product of the Dunkirk clay. The grape is not nearly so sweet, nor will it stand shipment as well. The vines, as a rule, have a very heavy foliage, while the fruit does not ripen in a uniform manner.

The following table contains mechanical analyses of typical samples of the Dunkirk sandy loam:

Mechanical analyses of Dunkirk sandy loam.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5952	2½ miles E. of Portland.	Sandy loam, 0 to 12 inches.	0.04	6.90	2.08	4.86	3.02	14.86	21.58	30.68	15.29
5953	Subsoil of 5952....	12 to 36 inches	.02	1.56	1.00	2.92	1.70	11.14	32.50	35.94	13.27

DUNKIRK SHALE LOAM.

The Dunkirk shale loam occurs upon the Erie escarpment above the Dunkirk gravel from Ripley to the vicinity of Fredonia. It is a brown or gray loam to the depth of about 7 inches, underlain by a stratum of mottled clay from 1 to 3 feet thick.

The surface in most places is covered with shale fragments from 1 to 4 inches in diameter, which stony character is due to the proximity of the underlying shale formation.

The depth of this type is variable, depending upon the declivity of the slope. Where the slopes are most steep the soil is thinnest, having suffered most from the forces of erosion, which have carried the material to the depressions near the base of the escarpment.

The soil is residual, being derived from the decomposition and disintegration of the underlying mud shale. It is Post-Glacial, being the weathered product of the strata left exposed by the progression and recession of the great ice sheet. The underlying shale is interbedded with layers of sandstone. The weathering of these give rise to sandy streaks in the soil. In many places, however, these layers are so thin as only to be noticed as sand pockets in the subsoil.

Most of the steep portions of the escarpment occupied by this soil type are covered with timber and underbrush, and are considered of little or no agricultural value. Where, however, the slopes are less precipitous, they are set out to vineyards. It is upon this soil, moreover, that the grape attains its best quality, the product here being noticeably superior to that grown on any of the other soils of the area, although the yield under the prevailing conditions is much less.

The yields are variable, depending largely upon the depth of soil and character of drainage. The average yield is about 2½ to 3 tons of grapes per acre, although a yield of 4 tons has been reported. On account of the high percentage of saccharine material contained in the grapes grown on this soil, they are highly esteemed for the manufacture of wine. While not so large in berry as the grapes grown on the Dunkirk gravel, their early maturity and tough skin make them better shipping grapes and their sweetness a prime favorite with the consumer.

Great care should be taken to prevent the washing and migration of these soils to the lower levels. As before noted, the yield is usually larger on the deeper soils.

The steeper portion of the escarpment now considered of no value could be grown successfully to the grape by terracing, but probably not profitably in the present state of the industry.

The texture of samples of this formation is shown in the following table:

Mechanical analyses of Dunkirk shale loam.

[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5954	3 miles NE. of Volusia.	Clay loam, 0 to 7 inches.	0.01	4.90	0.90	1.58	1.24	3.94	14.56	40.86	32.21
5955	Subsoil of 5954....	Clay loam, 7 to 30 inches.	.01	6.60	2.04	2.46	1.82	3.02	4.16	30.10	50.11

VOLUSIA LOAM.

Next to the Volusia sandy loam the Volusia loam (locally known as the "hemlock lands") covers the largest area in the uplands. It occurs upon the heavy rolling country west of Chautauqua Lake, in the neighborhood of Mayville, Lombard, and Volusia. It is typically developed in the plain between Lombard and Volusia.

The soil is a brown or black loam, 4 to 10 inches deep, resting upon a yellow silty loam reaching to the depth of 3 feet or more and underlain by bed rock. The surface of the soil is rather thickly strewn with shale fragments, with an occasional erratic bowlder, while the soil itself contains fine particles of shale.

The material from which the soil is derived is of glacial origin and usually consists of morainic material of a heterogeneous composition. On many of the steeper slopes and in the stream courses the bowlder clay is often exposed. It is of a bluish-gray color which weathers into a yellow. The glacial bowlders on the hillsides are characteristic of this area.

The Volusia loam is adapted to crops which make it a typical dairy soil, and it is used almost entirely for that purpose. The frequent frosts make grape growing unprofitable on account of the uncertainty of yield, but usually corn, oats, and grass do well. The yield of corn varies from 40 to 50 bushels to the acre. Oats are said to average from 35 to 50 bushels, while grass yields from 1½ to 3 tons to the acre.

The soil is better adapted to dairy purposes than the Volusia sandy loam, for the grasses last longer and withstand drought better. The natural drainage upon this type has not properly readjusted itself since glacial times, and in many places there are heavy spots and kettle

holes. In these spots the soil is usually acid, due to the excess of water. Proper drainage and the application of lime is the remedy for this condition.

Under the common practice the soil is plowed to a depth of about 6 inches only. Its condition would be greatly improved were the depth to be increased about an inch each year for several years. The soil represents a varied mineral composition and is rich in plant food. The subsoil, or, as it is locally called, the hardpan, should be gradually exposed so as to weather and set free its nutritive properties.

In the table below are given the mechanical analyses of samples of Volusia loam:

Mechanical analyses of Volusia loam.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5958	Volusia.....	Silt loam, 0 to 4 inches.	0.02	4.00	1.00	2.06	1.26	2.68	17.08	47.52	24.08
5956	1 mile E. of Lombard.	Silt loam, 0 to 10 inches.	.02	8.42	.36	.98	.72	2.62	18.08	43.80	24.98
5957	Subsoil of 5956....	Fine silt, 10 to 30 inches.	.01	7.84	3.58	3.82	2.22	5.02	18.90	38.82	20.11
5959	Subsoil of 5958....	Silt, 4 to 24 inches.	.01	5.82	3.16	5.46	2.00	5.40	9.16	47.80	20.99

VOLUSIA SANDY LOAM.

The Volusia sandy loam occupies the largest portion of the area surveyed upon the upland. The soil is a brown sandy loam with a trace of gravel, resting upon a fine orange sand of a slightly loamy nature, 3 feet or more in depth, underlain by bed rock or by sand and gravel. It occurs upon the heavy rolling country of the uplands east of Chautauqua Lake and upon the escarpment near Fredonia and Brockton. There is a heavier phase of this type in the neighborhood of Centralia, east of Cassadaga and north of Sinclairville, and also upon the divide between the Cassadaga and Bear Creek valleys. There is a gravelly phase of this type, characterized by a hummocky topography, south of Shumla, being a portion of the morainic belt.

This soil is used extensively for dairy farming, though it is not so well adapted to this industry as the Volusia loam. The grass lands require reseeding more frequently and are not as well able to withstand drought as the less sandy type.

It is a very productive soil for corn, oats, and potatoes, particularly

CHARACTERISTIC UPLAND TOPOGRAPHY IN THE VOLUSIA LOAM, NEAR STOCKTON, N. Y.

These lands are adapted to general farming and are used extensively for dairy industry.

the latter, of which yields as high as 270 bushels to the acre have been reported.

The texture of samples of this formation are given in the following table:

Mechanical analyses of Volusia sandy loam.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5934	2½ miles E. of Cassadaga.	Fine sandy loam, 0 to 9 inches.	0.02	7.10	3.64	4.24	4.32	10.16	10.62	45.68	14.08
5936	2 miles S. of Lamberton.	Fine sandy loam, 0 to 8 inches.	.01	6.40	4.46	4.16	2.94	8.58	6.86	48.20	18.45
5935	Subsoil of 5934....	Very fine sand, 9 to 36 inches.	.02	3.84	5.64	6.08	5.54	13.28	11.32	43.00	10.84
5937	Subsoil of 5936....	Fine sand, 8 to 36 inches.	.01	6.00	2.00	5.98	4.10	11.26	8.58	33.02	28.91

CASSADAGA SAND.

This type is a coarse sand of an orange or gray color, having a depth of 3 or more feet. The soil occurs in the Cassadaga and Bear Creek valleys. It is generally very poorly drained and only a very small portion of it is under cultivation. It is usually wooded with a thick growth of underbrush.

It has at present no agricultural value on account of its wet condition, which is due to the existence of a hardpan formed by the cementing of the soil particles by iron in soil solutions. In one locality in Cassadaga Valley underdrainage has been tried with great success.

When properly drained the soil is best adapted to grass, and a yield of 3 tons of hay to the acre has been reported.

A mechanical analysis of this formation is given below:

Mechanical analysis of Cassadaga sand.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5933	2 miles W. of Sinclairville.	Sand, 0 to 36 inches.	0.01	1.74	2.44	7.62	12.52	33.06	10.76	21.74	10.45

MEADOW.

Meadow is the name given to the low-lying, flat, and poorly drained land in the old Chautauqua Lake basin, in the Bear and Cassadaga creek valleys, and along the edges of the streams and embayments. It should not be confused with the local usage of the word signifying grass lands. It is, however, generally adapted to grass and pasturage when properly drained.

AGRICULTURAL CONDITIONS.

The two chief forms of agriculture practiced in this area are grape culture and dairying.

In considering the grape interests we are confined to the forelands, as there are few vineyards on the uplands, where climatic influences, particularly the liability of early frosts, are against successful grape growing. The climate of the forelands is practically controlled by the physical features of lake and escarpment. It is more equable than the climate of the uplands, and wonderfully adjusted to the profitable production of the grape. The character of the soils also influences to a remarkable degree the quality and quantity of the fruit.

On the forelands there are 30,000 acres set out to vineyards. Ninety per cent of this area is occupied by the Concord, the other 10 per cent being occupied by different varieties. The annual cash return to the growers is estimated at approximately $2,000,000.

The earliest grapes are picked upon the Dunkirk gravel and the escarpment, these being about two weeks ahead of the heavier soils. The pickers are men, women, and children from the neighboring towns and villages. Baskets cost the grower from 1 to 3 cents, dependent entirely upon the requirements of his market.

In the early years of the grape industry the growers received as much as 25 and 30 cents for a 10-pound basket. In late years the average price for the grape belt has been 7 cents. The greatest difficulty of the growers in this section is the marketing of their fruit. Owing to the great reduction in prices, due to the large number in the industry, growers have been compelled to cheapen processes wherever possible, and much fruit has been carelessly packed and sent to market in a poor and unfit condition. Recently it has been the custom to pick and pack the grapes in the field, whereas they should be stored under cover from twelve to fifteen hours after gathering. This gives the fruit an opportunity to wilt, when it is ready to pack. Fruit handled in this way will keep, with care, for a reasonable length of time. On the other hand, the hurried packing and shipping of the fruit now practiced brings it to the market in poor condition, and low prices result.

The growers have attempted to control the supply and price of fruit, but generally they have failed. The chief cause of such fail-

ures has been the fact that notwithstanding such organizations the grapes grown on land producing only 2½ to 4 tons to the acre, though of much finer quality, brought no more per pound to the growers than the inferior grapes grown on soils producing from 4½ to 5 tons. Still there are some growers in different sections who have combined with success, putting up their fruit in proper condition and making a special market for a superior product. The growers, as a rule, sell their grapes at different stations, accepting the price for the day as satisfactory.

The outlook for the grape industry up to the present has been gloomy, but now the increase in the manufacture of wine has brought relief. Heretofore wine manufacturers have been handicapped by insufficient cellar accommodations, but these have recently been greatly increased. Wine has been made in this section since 1840, when Dea Elijah Fay made the first few gallons. The industry has steadily increased from that time, the statistics of 1900 showing 1,500,000 gallons of wine in local cellars. The wine men and manufacturers of unfermented grape juice are continually increasing the capacity of their establishments, so that in time they will absorb a great portion of the grapes produced in the region.

It may be well to emphasize the importance of perfect drainage of lands devoted to grape culture. There are many places in the forelands where drainage would make a great difference in the quality and time of maturity of the fruit. The grape on properly drained land is sweeter and matures much quicker than on land with poor drainage.

The "two-arm renewal" system of pruning grapes is extensively used. In the employment of this system the grapes are planted at intervals of 8 feet in rows 8 feet apart.

As before noted, dairying is the chief interest of the upland portion of the area surveyed. The climatic conditions, and especially the frequent occurrence of early frosts, are not favorable to the cultivation of the grape. On the other hand, the large amount of rainfall in the hills gives the ideal condition for the production of forage crops.

Particular attention should be given to the drainage of the uplands. In many places in this portion of the area drainage has not properly readjusted itself since glacial times. Kettle holes are found in many places. They are poorly drained spots of a slightly heavier nature than the surrounding soil. They are supposed to have been formed by ice masses detached from the great continental ice sheet, which were covered and surrounded by material deposited by the waters of the glacier. The masses upon melting left depressions below the general level of the surrounding soils. At present the surface waters drain into these places and keep them in a condition most unfavorable to agriculture. The soil contains considerable organic matter, and it appears to have the necessary conditions for celery culture.

Commercial fertilizers are used rather generously throughout this area. Both the "complete" and "partial" fertilizers are used. The soils of the region are generally much in need of organic matter. In most cases the number of cattle upon the farms is insufficient to keep up the fertility of the land. There are considerable areas of peat and muck soils in the large valleys, particularly in the valleys of Bear Creek and Cassadaga. These deposits are from 1 to 3 feet deep. This peat, it seems, could be utilized to a limited extent to incorporate organic matter in the soils of the immediate vicinity.

Most of the cattle upon the uplands are country stock, showing little or no trace of the admixture of better blood, but some Jerseys and Jersey grade cattle are found here and there throughout the area. On one farm there are over 90 head of grade Jerseys. Occasionally a cross between Jersey and Holland cattle is seen, and in the southern portion of the area there are many short-horned Durham cattle.

Corn is considered the best fodder crop grown. The cultivation of sorghum upon the uplands has not proved successful, as the season is too short for it to mature.

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