THE OGDENSBURG CULVERS GAP MORAINE

SUSSEX COUNTY NEW JERSEY

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THE OGDENSBURG-CULVERS GAP RECESSIONAL MORAINE AND GLACIAL STAGNATION IN NEW JERSEY*

by

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*This paper was started as a Masters Thesis at M.I.T. and completed while employed as a geologist with the New Jersey Geological Survey.

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IN SUSSEX COUNTY, NEW JERSEY

FOREWORD

The original manuscript for this geologic report was prepared by the late Henry Herpers while a graduate student. It was held in the files of the New Jersey Geological Survey in the hopes that this could be published as one of a number of short papers of general geologic interest. However, it was not possible to put out such a bulletin prior to Mr. Herpers' untimely death.

The paper, however, was a natural one for inclusion in the Geologic Report Series and the original manuscript was reviewed and edited by Professor Paul MacClintock of the Geology Department of Princeton University. At one or two points in the body of the text and in the final few sentences of the conclusion, the report was rewritten to bring the work prepared by Mr. Herpers, prior to 1941, up to date with respect to the present knowledge of events which occurred during the Pleistocene. Except for these few editorial changes, the work is as prepared by Mr. Herpers and originally submitted to the New Jersey Geological Survey.

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INTRODUCTION

Moraine-like accumulations of till north of the terminal moraine have been observed in New Jersey[1], but they are by no means common. One such accumulation in northern New Jersey forms a continuous belt and was classified as a recessional moraine by Salisbury[2], who named it the Ogdensburg - Culvers Gap Moraine, but showed on his map, Plate XXVIII, only isolated patches of Prm.

In Sussex County, Salisbury traced this moraine across the Kittatinny Valley, from Ogdensburg to Culvers Gap, between which points it is well developed, and locally is a dominant topographic feature. The course of the moraine through the more mountainous regions east of Ogdensburg and west of Culvers Gap was not traced by Salisbury (1890 - 1900), chiefly because these areas were heavily forested and lacked roads and good exposures. Since that time, however, new roads have been built and older roads have been widened and regraded so that many road cuts and other exposures are available for study. It has, therefore, been possible to extend the mapping of the moraine as far west as the Delaware River and as far east as Stockholm. (Fig. 1) Indeed, some observations east of Stockholm suggest the presence of the moraine there, and also suggest that it may be correlated, farther east, with moraine-like areas on the Triassic Lowland.

1) Salisbury, R.D., Report of the State Geologist of New Jersey, Volume V (Glacial Geology), Trenton, N.J., 1902.
2) Salisbury, R.D., op. cit., pp. 350, ff.

GEOMORPHIC CHARACTER OF THE REGION

In Sussex County, the Ogdensburg - Culvers Gap Moraine crosses two of the major geomorphologic divisions of New Jersey - the Appalachian Province and the New Jersey Highlands Province. The topographic features of the two provinces had a profound effect on the deposition of the moraine, inferred from its character.

The Appalachian Province, which is located in the extreme northwestern portion of the state, is divisible into three parts: 1) The areas west of Kittatinny Mountain, 2) Kittatinny Mountain itself, and 3) the Kittatinny Valley, a broad lowland lying east of Kittatinny Mountain, and separating the mountain from the New Jersey Highlands to the east.

(1) The area lying west of Kittatinny Mountain, between the mountain and the Delaware River is eight miles wide and dissected by Flat Brook and its tributaries into rough terrain.

(2) Kittatinny Mountain, the dominant topographic feature of northwestern New Jersey, separates the area just described from the Kittatinny Valley. The mountain presents a bold, almost level crest, some 200 to 300 feet above the valley lying to the east. It extends the length of the state from the Delaware Water Gap, northeast to the state line, a distance of some 36 miles. The eastern slope of the mountain is steeper than the western, and is locally quite precipitous. In the entire distance from the Delaware Water Gap to the state line, the only gap in the mountain is Culvers Gap, near Culvers Lake.

(3) The Kittatinny Valley is a broad lowland, some 10 to 13 miles in width, extending in a northeast-southwest direction. Two parallel sub-valleys lie within the Kittatinny Valley, and they and the valley's tributary to them have so thoroughly dissected the floor of the larger

valley that the topography is quite undulating; but the hills are all parallel to the main structural trend of the region.

The New Jersey Highlands lie east of the Appalachian Province and are bounded on the east by the Triassic Lowland. They average about 20 miles in width. The rocks of the Highlands are chiefly crystalline gneisses and schists of Precambrian Age, but they include several large infaulted or infolded blocks of Paleozoic Formations. The structural trend of the area is northeast-southwest, as seen best in eroded Paleozoic Formations. Valleys dissecting the Highlands are numerous and include some of the narrowest and deepest in the state.

INFLUENCE OF THE TOPOGRAPHY ON THE CHARACTER AND DISPOSITION OF THE MORAINE

In the area west of Kittatinny Mountain and in the rugged region of the Highlands, the moraine forms a narrow belt. It is best displayed in relatively narrow and deep valleys. It seldom is seen on ridges, generally skirting them. The composition of the moraine is largely till, with little sand and gravel. The absence of extensive deposits of water-worked materials suggests that the amount of meltwater from the glacier was small.

In the broad Kittatinny Valley and, to some extent, in the relatively broad valley of the Wallkill River, the character of the moraine differs greatly from that in the more mountainous regions. In the latter, the moraine is disposed as a broad belt and its course is less tortuous. It crosses low ridges, but ends abruptly at higher ones. The moraine is composed partly of till, and partly of water-worked materials, indicating the presence of much meltwater during its deposition. In the Kittatinny Valley, the ice was not afforded much protection from the rays of the sun

because the hills on the valley floor are not very high, and, consequently, could not have protected the ice. The low hills in this region did not impede the advance of the ice as much as did the hills in the mountainous areas, and the moraine is here found farther south than it is in the more rugged regions.

GENERAL

The Ogdensburg-Culvers Gap Moraine is a ridge, varying in thickness from a few feet to 50 feet. The width of the moraine varies from approximately a quarter of a mile to a little over two miles, averaging for most of its course one half mile. In the mountainous areas of the Highlands and the region west of Kittatinny Mountain the width of the moraine is frequently but a few hundred feet.

The moraine is not continuous, because it is frequently interrupted by rock ridges, which it does not cross as a continuous topographic feature, and against which it may be said to be "anchored." In some instances, the moraine does not end abruptly at the ridges, but is piled against their sides, swinging back over them and forming a reentrant angle in the line marking its front. It crosses minor topographic features without loss of continuity.

The top of the moraine is usually hummocky, but near the village of Lafayette the surface is remarkably smooth. The hummocky topography is best developed at Lake Grinnell, about two miles west of Ogdensburg. The lee slope of the moraine is generally more gentle than the stoss slope. Locally, outwash deposits border the moraine, and southwest of Lafayette lacustrine clay indicates that the moraine was, at least in part, deposited in the waters of a glacial lake.

The composition of the moraine is chiefly boulders, cobbles, gravel and sand, with relatively little true till, except in the Highlands region and in the area west of Kittatinny Mountain where till dominates. Locally the water-worked materials are rudely stratified, but in most of the exposures examined stratification was absent or but poorly developed. The lithology of the moraine is variable, especially in the Appalachian Province where many different formations crop out; but throughout the course of the moraine the boulders, cobbles and gravel are all of rocks derived from nearby formations. This is, however, no reason to conclude that the materials composing the moraine are exclusively local in origin, because the direction of ice movement in the area[3] was essentially parallel to the strike of the geologic formations.

DESCRIPTION OF THE MORAINE FROM STOCKHOLM TO DELAWARE RIVER

(1) Stockholm to Ogdensburg

Between Stockholm and Ogdensburg the moraine is found as a narrow belt, some 200 feet in width,[4] on the south side of a major valley cutting across the Highlands. Near Stockholm the morainic topography is fairly well developed, and it may be seen on the south side of New Jersey Highway No. 23 near the point where the highway crosses the boundary between Sussex and Passaic Counties. Several road cuts in the moraine at this point show it to be composed of till, 15 to 20 feet in thickness. The

3) Salisbury, R.D., op. cit., Plate VIII.

4) For detailed maps of the region traversed by the Ogdensburg-Culvers Gap Moraine, the reader is referred to the Milford, Wallpack and Franklin Furnace topographic sheets of the U.S.G.S., and to Sheets Nos. 21 and 22 of the Topographic Atlas of New Jersey, issued by the State of New Jersey, Department of Conservation.

moraine continues in a northwesterly direction for a distance of approximately 1-1/2 miles, when the characteristic topography becomes so obscure that the course of the moraine can only be conjectured. One half mile east of Beaver Lake Station, a patch of moraine with hummocky topography was found on the north side of a ridge, altitude 1109 feet. Although the area is small and although no sections are available for study, it has been included in the moraine because of its irregular, hummocky topography and because its location is such that it lies within the interpolated course of the moraine.

About 1500 feet west of Beaver Lake Station, on the south side of the valley, the moraine can be seen again. Here a road cut exposes a forty-five foot section of till which contains boulders up to three feet in diameter. The moraine is perhaps 200 to 300 feet wide at this point. From here the moraine continues along the south side of the valley for a distance of 1-1/4 miles, where it enters the valley of the Wallkill and merges with the patch of moraine on the east side of that valley[5]. In the Wallkill Valley, the morainic topography is quite distinct. Some of the hummocks there are composed of till, while others are stratified drift (gravel and sand). The surface of the moraine is liberally strewn with cobbles, and even boulders. The moraine continues along the east side of the Wallkill Valley nearly to the village of Ogdensburg, a mile southwest of the point where it enters that valley.

At Ogdensburg, on the east side of the valley, the moraine appears to involve a great spur or embankment of stratified sand and gravel which extends nearly across the valley. Salisbury maintained that the embankment

5) Salisbury, R.D., op. cit., p.350.

was not to be regarded as a part of the moraine but that, although its mode of origin was quite different from that of the moraine, "it was more or less contemporaneous in origin with the moraine." He ascribed the origin of the Ogdensburg embankment to deposition in a crevasse in stagnant ice occupying the valley[6]. Several features of the embankment, however, strongly suggest that it is later in origin than the moraine and, in part, built over it. The top of the embankment is very nearly level, but near its northeastern corner, an elongated hill rises some 20 to 25 feet above its surface. The hill is oriented in such a manner that its long axis lies across the valley; i.e., parallel to the position of the ice front. The southern or lee slope of the hill is gentler than the northern or stoss slope, and the whole hill has a topography of distinctly morainic habit. The composition of the hill differs greatly from that of the embankment; for whereas the embankment is composed of stratified sands and gravel, the hill is composed of sand, gravel, cobbles and even small boulders, which are not stratified at all. In this respect, the composition and structure of the hill are quite similar to the composition and structure of many parts of the moraine; i.e., a kame.

The northern side of the embankment is more hummocky and less regular than the southern side, and more closely resembles morainic topography than a topography developed on materials deposited adjacent to stagnant ice, (ice-contact slopes). Several new cuts in the embankment, especially those on its northern side, show the presence of many large boulders, particularly near the base of the deposit where the moraine-like topography is best developed. The cuts at the base of the embankment also show that the sand and gravel are either poorly stratified or not stratified at all.

6) Salisbury, R.D., op. cit., p. 272.

These observations suggest that the embankment was formed in a crevasse, that the ice on the northern side of the opening was active for a time after the crevasse was formed and that it built a moraine. Later, the crevasse contained a body of water which was subsequently filled with sand and gravel, almost completely covering the moraine. The hill mentioned above, therefore, represents a part of the moraine extending above the surface of the embankment.

On the western side of the Wallkill Valley, across the river from the great embankment and north of the property of the New Jersey Zinc Company, is a small area exhibiting characteristic morainic topography. Hills and depressions with a relief of from 15 to 20 feet are common, but the boundaries of the area are not well defined. Several road cuts in the moraine, particularly the one made by the New York, Susquehanna and Western Railroad, show that the composition of the moraine is coarse sand, gravel and boulders. Locally, the finer material possesses a sort of rude stratification, but the gravel and slightly rounded boulders are unstratified, and do not show much evidence of having been worked in water. The surface of the moraine is strewn with small boulders, a phenomenon noticed at several other localities.

(2) Ogdensburg to Balesville

No trace of the moraine was found on the ridge separating the Wallkill Valley from the Germany Flats Valley to the west. The moraine reappears in a small tributary valley on the eastern side of the Germany Flats Valley. It exhibits the usual morainic topography, its surface is strewn with small boulders, and its composition as seen in a few road cuts is principally gravel and sand, although till is also present. The width of the moraine at this point is about 1200 feet. About 5/8 mile west of the

point where the moraine is first seen in the Germany Flats Valley, it suddenly becomes very wide. The width of the moraine in the Germany Flats Valley is 2-1/4 miles, the greatest breadth attained by the moraine over its entire course, and the relief of the moraine reaches a maximum of 50 feet with morainic topography strikingly developed. An excellent exposure through the entire moraine may be seen in the cut of the Lehigh and New England Railroad at Lake Grinnell. The moraine ends against a ridge which forms the western side of the Germany Flats Valley.

South of the moraine, the Germany Flats Valley is flanked by kame terraces of sand and gravel which extend down the valley to Brighton, some 10 miles southwest of the moraine. A continuous chain of ice-block depressions occupies the center of the valley from the moraine to Andover, a distance of 9 miles. This chain of ice-block depressions intersects the moraine, but neither they nor the terraces are found north of it. Some of the ice-block depressions contain small ponds, such as Lake Grinnell, White Lake, Howell's Pond, Iliff's Pond (Lake Clearwater) and Long Pond (New Lake Wawayanda). Several of the ponds, especially Long Pond, are very deep, indicating that considerable deposition took place adjacent to stagnant ice in the valley during deglaciation.

Tops of the terraces in the Germany Flats Valley are not horizontal, but slope gently and uniformly to the southwest, away from the moraine. Sand and gravel composing the terraces are stratified, the strata dipping in a southerly direction on the east side of the valley and in a southwesterly direction on the west side of the valley; but the strata always dip away from the depressions in the valley's center. These phenomena show that the terraces originated as material washed out from ice at the moraine and that they were deposited adjacent to blocks of stagnant ice

lying in the middle of the valley. Wide terraces separated by a chain of ice-block depressions averaging only 400 feet in width are explained by the fact that the valley containing them is very wide and is bordered by low ridges. Thus stagnant ice in the valley was afforded little protection from the sun's rays and melted, leaving only a narrow belt of ice at the place now marked by the chain of depressions.

No trace of the moraine was found on the ridge between Sparta Station and Lafayette, but the moraine resumes on the western side of the ridge near the intersection of the Lafayette-Franklin road with the Lafayette-Woodruff's Gap road. At this point, as well as at Lafayette, the surface of the moraine is remarkably level, but its lee and stoss sides are steep. The moraine continues westward for a distance of one half mile, where it is interrupted by a gap some 30 feet deep and about 500 feet wide, through which the Paulinskill flows. The width of the moraine in the vicinity of Lafayette is about one half mile.

West of the Paulinskill, where the moraine passes between two rather high ridges, its width is reduced to approximately 1200 feet, but west of the ridges it again widens to one half mile. The moraine continues for a distance of 1-5/8 miles beyond the ridges and ends abruptly against the side of a 754-foot hill.

Between Lafayette and the 754-foot hill, the moraine is bordered on the south by a large swamp known as the Paulinskill Meadow which appears to have been the site of a short-lived glacial lake, formed when the moraine dammed a valley through which, in pre-glacial times, a stream flowed towards the northeast. Except near the moraine, no true shore terraces were found at the edges of the swamp. At the south side of the moraine, however, where it borders the Paulinskill Meadow, a definite shore terrace,

giving further evidence of the former presence of the lake, was found. The material composing the terrace, chiefly sand and gravel, was undoubtedly derived from the moraine. Judging from the elevation of the top of the terrace, the surface of the lake was 615 feet above the present sea level, and 25 feet below the top of the moraine. The outlet of the lake was located near Stickel Pond, about 1-1/4 miles south of Newton, in a small valley which appears to merge with the valley now occupied by the Pequest River.

Because of the heavy growth of vegetation in the gap through which the Paulinskill crosses the moraine, it was impossible to determine whether or not the river follows a line of ice-block depressions throughout this part of its course. But since the river does not flow southward through the outlet of the former glacial lake, and since the level of the lake was so far below the top of the moraine (25 feet), the only way the Paulinskill could find a course across that deposit must have been along a line of such depressions. The small gradient of the Paulinskill north of the moraine, and the extremely small amount of post-glacial erosion of the Wisconsin deposits throughout the northern part of the state, preclude the breaching of the moraine by simple headward erosion of the river.

The moraine is again seen immediately west of the 754-foot hill mentioned above, and it continues west to Halsey, where its course is again abruptly ended by the ridge separating Halsey from Baleville. This unit of the moraine is about a mile in length, and about one half mile in width. The morainic topography is exceedingly well developed, especially 3/8 mile north of the intersection of U.S. Route 206 and the road running from U.S. 206 to Halsey. The composition of the moraine is till, but large boulders are not commonly found in it.

(3) Baleville to Culvers Gap

Between Baleville and Culvers Gap, the course of the moraine is not continuous. Patches of moraine were seen in this region, but it was not always possible to define their limits exactly. All the patches of moraine line up favorably with one another and with the general course of the moraine itself; but it was not possible to organize them into a unit, nor was it possible to organize them into a definite series of patches separated by intervening ridges, as was done with parts of the moraine lying farther east.

At Baleville, the morainic topography is very well developed, particularly near the church and cemetery. The moraine is clearly seen from the Halsey-Baleville road, on the ridge just east of Baleville. The moraine is found on both sides of the Paulinskill, but is better developed on the west side of the river. From Baleville, the moraine swings northwestward, the direction of its course trending toward Culvers Gap. It was traced about a mile in this direction and appeared to end against the 920-foot shale hill northwest of Baleville.

Another area of distinct morainic appearance was found near the Sussex County Almshouse, 1-5/8 miles north of Baleville. Still other patches having characteristic morainic habit and composition were found near the northeastern end of Bear Swamp and at the northern end of Lake Owassa.

(4) Culvers Gap to the Delaware River

At Culvers Gap, the moraine was found both in the gap and east of it, near the western extremity of Culvers Lake. Here the morainic topography is well developed, but the composition of the moraine, as well as its structure, approach those of a kame, the materials being chiefly sand and gravel in part stratified. The moraine is wider in and near the gap than it is west of that point. The kame-like habit of the moraine and its greater

width suggest that this part of it originated as an interlobate deposit, laid down between two lobes of ice, one on either side of Kittatinny Mountain, an hypothesis which is strengthened by the presence of a thick but narrow deposit of till on the eastern side of the mountain, just north of Culvers Lake. Indeed, since the moraine does not cross ridges in the Kittatinny Valley which are much lower than Kittatinny Mountain, there is no reason to assume that it should cross the mountain.

West of Culvers Gap, the moraine follows several transverse valleys, crossing low ridges and skirting higher ones. It is frequently very narrow, averaging 200 feet in width. In the valleys, it occasionally reaches heights of 35 to 40 feet, but on the ridges its height averages only 20 feet. The composition of the moraine is chiefly till, and large boulders are a common component of the till.

A short distance west of Culvers Gap, the moraine dams a small valley. The morainic dam has been heightened by man to make Lake Kittatinny. From Culvers Gap to Big Flat Brook, the moraine is roughly parallel to U.S. Route 206. The morainic topography, while not pronounced, is distinct and many excellent road cuts expose the composition and structure of the deposit. At the point where the highway crosses Big Flat Brook, the moraine swings to the northeast skirting around an 800-foot hill.

Entering the valley of the Little Flat Brook, the moraine turns sharply to the west, continues in that direction for 1/4 mile, and turns abruptly north again, crossing the valley obliquely. The moraine is particularly well developed on the east side of the valley of the Little Flat Brook, 5/8 mile south of the bridge where Highway 31 crosses the brook.

Between the valley of the Little Flat Brook and Hainesville, the moraine is not well developed, but good morainic topography may be seen at

Hainesville in the vicinity of the church. At Hainesville, the moraine turns sharply to the west, crosses a 700-foot ridge, and descends via a small tributary valley into the valley of the Delaware River. The morainic topography is poorly developed on the ridge, but in the valley of the Delaware it is quite distinct and rises abruptly above the terrace gravel of the river opposite Namonock Island.

In the Delaware Valley, the moraine marks a point of discontinuity of the river terraces. South of the moraine, the surface of the terrace has an elevation of approximately 475 feet A.T. The surface of the terrace north of the moraine has an elevation of approximately 480 feet A.T., and the surface of the moraine has an elevation of 480 to 485 feet A.T. Therefore, the moraine quite probably antedates the upstream river terraces.

OTHER MORAINIC AREAS

Several other morainic areas as also described by Salisbury[7], are located in Sussex County. One such area may be seen 1/4 mile northeast of Augusta. It is clearly seen from the grade crossing of U.S. 206 and the Lehigh and New England Railroad. The road running from Augusta to Pellettown crosses the moraine, and the structure and composition of the deposit may be seen in the road cut. Salisbury reported other morainic patches near Brick House, in Montague Township, and near Coleville, in Wantage Township[7]. All of these deposits lie north of the Ogdensburg-Culvers Gap moraine, and thus belong to a later stage in the deglaciation. Salisbury also reported a morainic patch one mile north of Dingman's Ferry, on the New Jersey side of the Delaware River, and another patch about a mile north of Layton. I was unable to verify the presence of either of

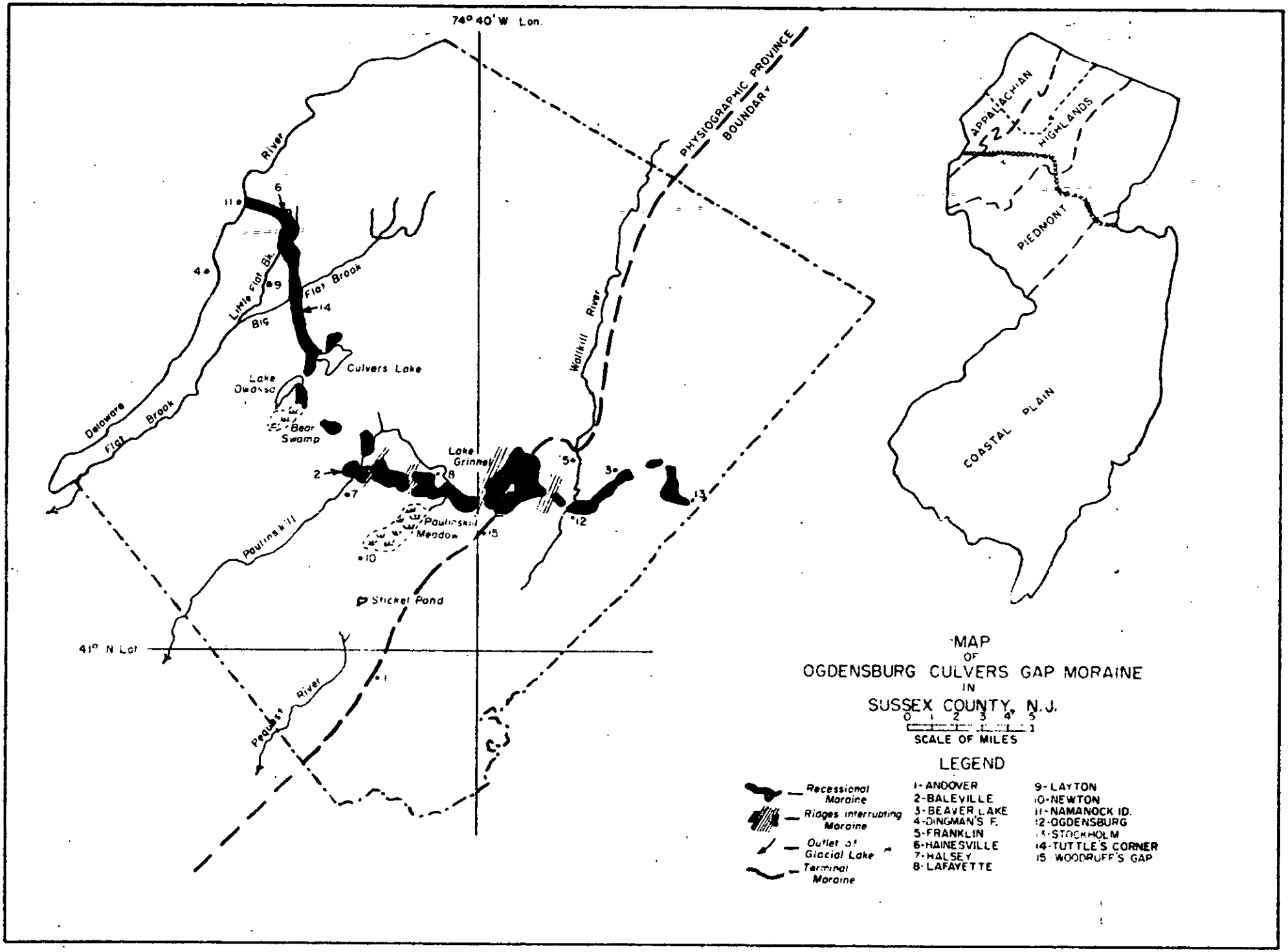
7) Salisbury, R.D., op. cit., pp. 275, 300, 354.

these deposits, but since both localities are heavily forested, the morainic patches may be hidden by recent vegetation. Both of the patches lie south of the Ogdensburg-Culvers Gap moraine, and, if they do exist, represent deposits made by an earlier stand of the ice.

East of Sussex County, in Passaic and Morris Counties, many morainic areas were seen, especially in and near the valley of the Pequannock River. Although no attempt was made to study them in detail, their location and disposition suggest that they represent the eastward equivalents of the Ogdensburg-Culvers Gap moraine, and that they are quite probably correlatable with recessional moraines in Bergen County, farther east. The morainic patches in Passaic County are best developed near Oak Ridge, and those in Morris County, near Newfoundland, Charlotteburg and Butler.

CONCLUSION: RECESSION VS. STAGNATION

The existence of one or more recessional moraines in New Jersey does not necessarily cast doubt upon the theory that stagnation of the glacial ice over large areas played an important part in the process of deglaciation, but it does introduce the thought that the ice may not have stagnated over as wide areas as has been proposed by some geologists. Much evidence of the former presence of stagnant ice can be found in the valleys or parts of valleys lying between the terminal moraine and the recessional moraine described above. Fully as much evidence can be found in the valleys north of the recessional moraine. But the presence of the recessional moraine is proof of an active ice margin during deglaciation and is evidence against the complete stagnation of the Wisconsin ice sheet in New Jersey. The mechanism of deglaciation, therefore, must include both recession and stagnation.


74° 40' W Lon.
PHYSIOGRAPHIC PROVINCE BOUNDARY
Delaware River
Little Flat Bk.
Big Flat Brook
Culvers Lake
Lake Owassa
Bear Swamp
Delaware Flat Brook
Lake Grinnell
Wallkill River
Paulinskill
Paulinskill Meadow
Stickel Pond
41° N Lat
Pequest River
APPALACHIAN
HIGHLANDS
PIEDMONT
COASTAL PLAIN
MAP
OF
OGDENSBURG CULVERS GAP MORAINE
IN
SUSSEX COUNTY, N.J.
0 1 2 3 4 5
SCALE OF MILES
LEGEND
Recessional Moraine
Ridges interrupting Moraine
Outlet of Glacial Lake
Terminal Moraine
1-ANDOVER
2-BALEVILLE
3-BEAVER LAKE
4-DINGMAN'S F.
5-FRANKLIN
6-HAINESVILLE
7-HALSEY
8-LAFAYETTE
9-LAYTON
10-NEWTON
11-NAMANOCK ID.
12-OGDENSBURG
13-STOCKHOLM
14-TUTTLE'S CORNER
15-WOODRUFF'S GAP