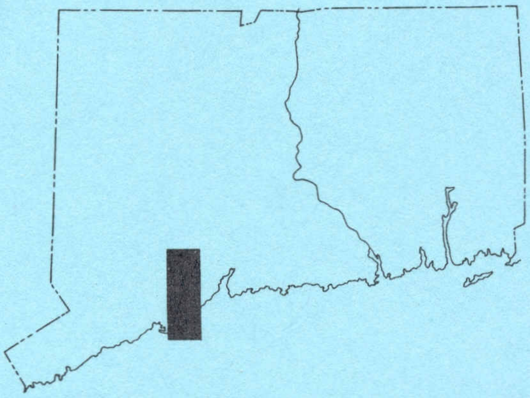
The Surficial Geology of the Ansonia and Milford Quadrangles

WITH MAP

Open Plate 1 Open Plate 2

Open Figure 3 Open Figure 6

BY RICHARD FOSTER FLINT



STATE GEOLOGICAL AND NATURAL HISTORY SURVEY
OF CONNECTICUT

A DIVISION OF THE DEPARTMENT OF AGRICULTURE
AND NATURAL RESOURCES

1968

QUADRANGLE REPORT NO. 23

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BY RICHARD FOSTER FLINT
Yale University

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A Division of the Department of Agriculture
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The Surficial Geology of the Ansonia and Milford Quadrangles

by

Richard Foster Flint

ABSTRACT

The Ansonia and Milford quadrangles lie in the southeastern part of the Western Highland of Connecticut, and include a part of Long Island Sound. Features made by glacial erosion include striations, grooves, stoss-and-lee knobs, and streamline hills. Till covers much of the area, although over some hills and ridges it is thin or absent. The glacial features are believed to have resulted from two successive movements of glacier ice, one toward the south and the other, probably the later of the two, toward the southwest. During the latest deglaciation stratified drift was deposited in many of the lower parts of the area. Much of this drift comprises seven bodies, most of them of valley-train character and in places coalescent. Small areas of lacustrine sediment are associated with two of the valley trains. The character and distribution of the stratified drift indicate that early in the latest deglaciation the ice sheet maintained an irregular front across the southern part of the map area, but that thereafter the ice melted downward to form irregular residual masses along major valleys.

While valley trains were being built up, wind removed material from them and deposited it as a thin covering of sand and silt over adjacent areas. The valley trains were dissected in postglacial time by streams, which deposited thin bands of alluvium on valley floors. Swamp and marsh deposits have accumulated in many shallow basins in bedrock and glacial drift. Most of the marshes along the shore are tidal marshes, a result of the postglacial rise of sea level against the land.

Substances of actual or potential economic value include ground water, sand and gravel, till, and humus. In places the terrain has been conspicuously altered by artificial filling.

INTRODUCTION

The Ansonia quadrangle and the Milford quadrangle maps (fig. 1) together represent a tract in the central part of southern Connecticut, falling wholly within the region known as the Western Highland (fig. 2). More than half of the Milford quadrangle is covered by water; although

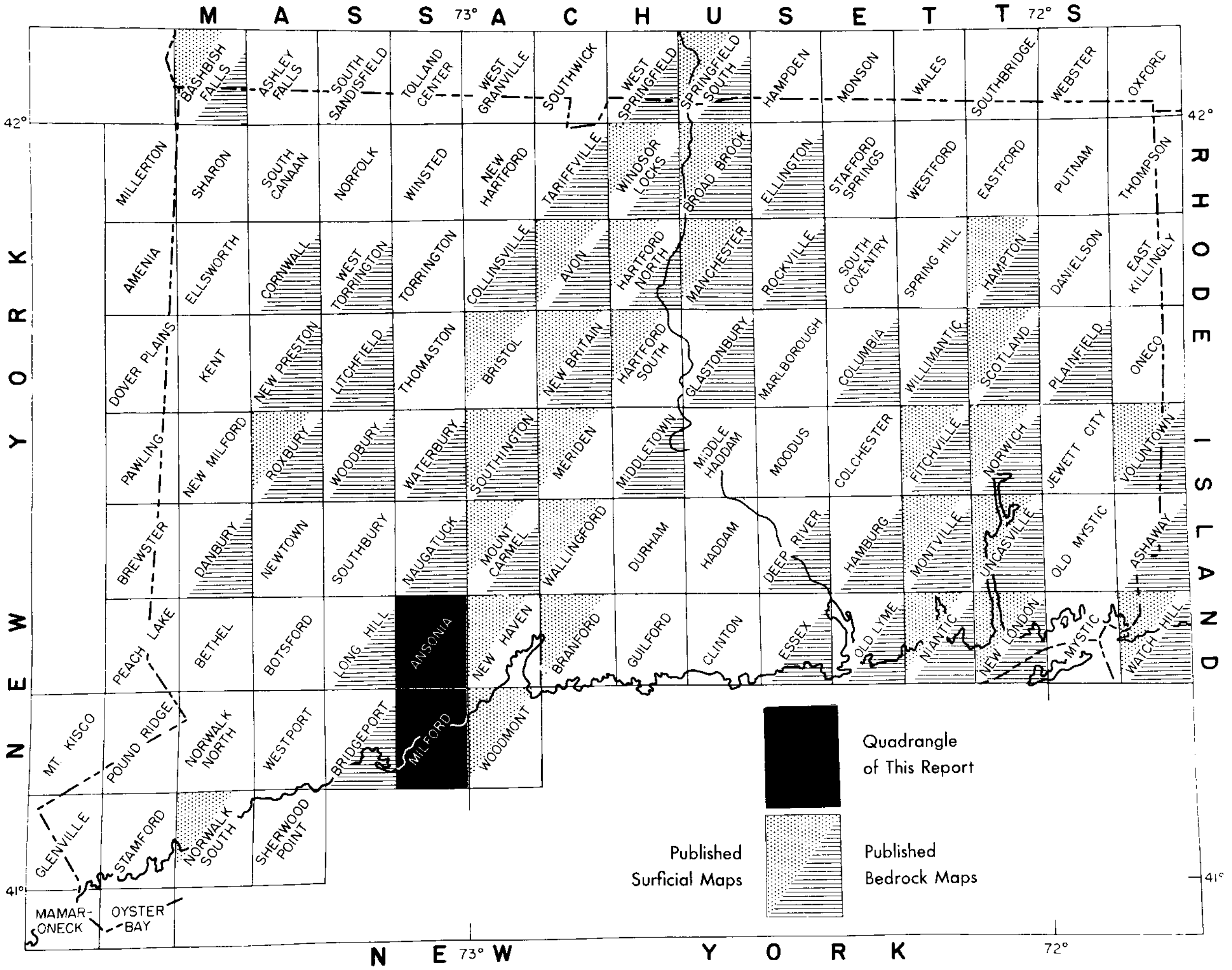

Fig. 1. Index map of Connecticut showing location of the Ansonia and Milford quadrangles and of other published quadrangle maps.

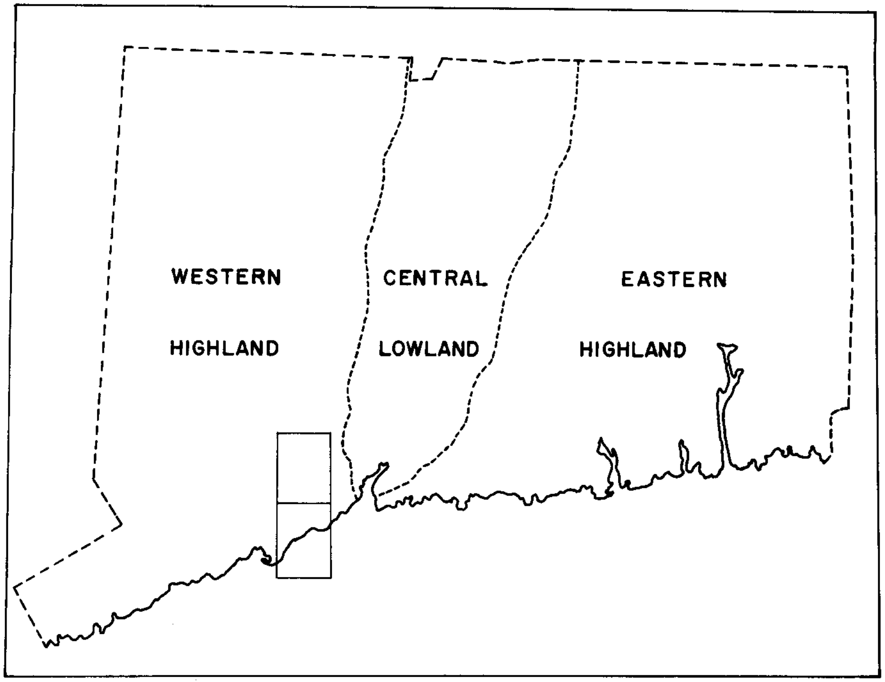

Fig. 2. Map of Connecticut showing boundaries of its three natural regions and the location of the Ansonia and Milford quadrangles.

the aggregate area of the two quadrangles is about 110 sq. mi., their land area is only about 80 sq. mi. The quadrangles include parts of both New Haven and Fairfield Counties, the boundary between them following the Housatonic River. They include the towns of Ansonia and Derby as well as parts of Seymour, Woodbridge, Shelton, Stratford, Milford, and Orange. Their chief centers of population are Ansonia, Derby, Milford, and Shelton.

Mapping of the surficial geology, on the scale of 1:24,000, was done at various times in 1964, 1965, and 1967. Data for the map were obtained chiefly from observations of natural and artificial exposures, test holes made with hand-tools, and analysis of land forms. Subsurface information was obtained mainly from the State Highway Department and the U.S. Geological Survey.

In Connecticut the surficial sediments (the unconsolidated sediments which overlie the bedrock) are chiefly of glacial origin—here glacial geology and surficial geology are nearly synonymous.

That southern Connecticut had been overrun by glacier ice was firmly established by J. D. Dana (1870, 1871). General discussion of the glacial features of Connecticut, although without special reference to the Ansonia-Milford area, can be found in Rice and Gregory (1906, p. 227-259) and in Flint (1930, 1934). J. S. Brown (1925) published a map including the Milford quadrangle and part of the Ansonia quadrangle, on which the distribution of till and stratified drift was shown on the scale of 1:62,500.

Acknowledgment is due to C. E. Fritts for manuscript maps which showed the location of some of the bedrock exposures, some of the striations, and some of the erratic boulders shown on plate 1, and for helpful discussion of the bedrock lithology and provenance of elements in the glacial drift. Discussion with J. H. Hartshorn, who reviewed the surficial geology in the field and critically read this report in manuscript, is acknowledged also.

BEDROCK GEOLOGY

The bedrock geology of the two quadrangles has been mapped and described by Fritts (1965a, 1965b). It consists primarily of subparallel belts of metamorphic and igneous rocks of Early and Middle Paleozoic age, mostly foliated, with their belts of outcrop and their foliation trending NE-SW in a large syncline, the axis of which traverses the entire map area. These rocks are mainly schists, gneisses, and granites. In places they are cut by dikes of Triassic diabase that generally parallel the trend of the metamorphic rocks. Individual bedrock units that are represented by exceptionally large erratic boulders are mentioned specifically in a later section.

Sandstones and conglomerates of Triassic age crop out in the adjacent New Haven and Woodmont quadrangles; diabase is prominent in the New Haven quadrangle. These rocks have contributed to the glacial drift in the eastern parts of the Ansonia and Milford quadrangles.

The identities and patterns of outcrop of these bedrock types control to some extent the surficial geology of the Ansonia-Milford area. The occurrence, in the glacial drift, of rock fragments having identifiable areas of origin makes it possible to determine directions of movement of former glacier ice.

Exposures of bedrock, most of them small, are shown individually on the map in areas covered nearly continuously with glacial drift. In a few hill areas, however, the blanket of drift is so thin and discontinuous that exposures of bedrock are numerous and closely spaced. Such areas are mapped as bedrock, and the thin overlying regolith is not shown separately. Only exposures observed during the course of field work were mapped. These are many more, particularly in upland areas west of the Housatonic River.

TOPOGRAPHY

The surface of the area is irregular, rising northward from the shoreline to a maximum altitude of 640 ft at Great Hill in Seymour, near the northwestern corner of the Ansonia quadrangle. Other high areas center at Derby Hill in Derby and Peck Hill in Woodbridge. These areas are underlain by a variety of metamorphic rocks. Some of the steepest slopes are the sideslopes of the Housatonic and Naugatuck River valleys, upstream from their junction.

Most of the topographic features of the map area tend to be elongate in N-S to NE-SW directions, reflecting the structural trends of the local rocks. The individual bedrock units differ somewhat in erodibility if one judges erodibility from the average altitude of each unit within the map area. A mechanical measurement of average altitude of each of seven units in the Naugatuck quadrangle, followed by statistical comparison, showed that The Straits Schist and the Ansonia Gneiss underlie the highest areas and can therefore be supposed to be the two least erodible rock types in that quadrangle. Probably their comparatively great resistance to erosion results from their large content of quartz and from the fact that their joints are widely spaced.

Followed upstream, the valley of the Housatonic narrows conspicuously and, beginning at the mouth of the Naugatuck, develops steeper sideslopes. The change coincides with a change in the bedrock through which the river flows. South of Shelton it consists of Wepawaug Schist and other rather nonresistant rocks. North of that place the river mainly occupies belts of Prospect Gneiss and The Straits Schist, both strongly resistant to erosion.

In the Ansonia Gneiss and, to a smaller degree, in the Prospect Gneiss, glaciation has quarried out quantities of joint-controlled boulders that range up to more than ten feet in diameter. The bedrock, correspondingly, is sculptured into a maze of small knobs, very apparent in the country southwest of Shelton. In other parts of the map area, particularly in the areas of outcrop of the Wepawaug and Derby Hill Schists, the hills are smooth and little dissected.

The Ansonia-Milford district is part of a coastal belt of dissected hilly country that extends across Connecticut (Flint, 1963). Within this belt hilltop altitudes decline southward at an average rate of about 50 ft per mi., and the whole surface passes beneath Long Island Sound. Where intersected by the sea this surface forms an irregular shoreline, with points and headlands separated by coves. The most conspicuous indentation of the shoreline is the submerged mouth of the Housatonic River. Another noteworthy indentation is The Gulf, the submerged mouth of the Wepawaug River and of its tributary, Indian River.

These, and other smaller streams, enter the sea through areas fringed with tidal marshes. The irregular shoreline and the many islands of the Connecticut coast (including Charles Island on the Milford quadrangle) suggest that this part of the coast has been submerged beneath the sea since the valleys and ridges were developed by erosion. It is apparent also that the submergence, or at least the most recent submergence, postdates glaciation, for terrestrial sediments, including freshwater swamp deposits, lie beneath tidal-marsh peat at positions well below low-tide level in the valley of the Quinnipiac River opposite New Haven, a few miles east of the Ansonia quadrangle.

Except in the larger valleys, the cover of glacial drift that overlies the bedrock is generally so thin that it does not mask the forms of the bedrock hills. In many places it masks only the small details of relief, and some hills have almost no drift cover. Locally, however, individual hills seem to have been heightened by thick accumulations of drift. The group of five smooth, ovate hills east of Milford, each standing 100 ft or more above its surroundings, is an apparent example. As the map shows, no bedrock is exposed in any part of these hills, and therefore it seems likely that they consist substantially, if not entirely, of drift. Other somewhat similar features are Long Hill and Coram Hill south of Shelton. Although each undoubtedly stands on a massive foundation of bedrock, and although bedrock is exposed at both ends of Long Hill, in each mass the topmost part, 40 to 50 ft thick, probably consists largely or entirely of glacial material.

The long axes of a number of hills, such as Grassy Hill in Orange, are nearly parallel with the structure of the underlying bedrock, but other hills, such as Long Hill and Coram Hill in Shelton, trend NNE across the rock structure. It may be that the former group were etched out by preglacial erosion and were merely smoothed by glaciation, whereas the latter group actually were shaped by glacial action. Without detailed information on the form of the bedrock surface beneath the glacial deposits it would be impossible to verify that this actually is the case.

In valleys such as those of the Housatonic and Naugatuck Rivers, bedrock relief has been reduced by filling with glacial drift, in places more than 100 ft thick. With these exceptions, the relief of the area is attributable mainly to the irregular surface of the bedrock, which in its broader features acquired its form before glaciation.

DRAINAGE

Most of the area of the Ansonia and Milford quadrangles is drained by the Housatonic, Naugatuck, and Wepawaug Rivers. Other drainage basins are small. These include the basins of Indian River and Calf Pen Meadow Creek. Probably all these streams formed part of the Housatonic River system before the principal submergence of the southern Connecticut region. At that time Calf Pen Meadow Creek would have joined the Wepawaug-Indian system a mile or more south of Milford Harbor, the combined drainage then continuing southwestward to join the Housatonic.

The drainage pattern as a whole is related closely to composition and structure of the bedrock. The predominating trend of streams is SW, parallel with the structural trends of the rocks. This general relation between stream positions and bedrock characteristics is much like what would be expected had the region not been glaciated. The similarity suggests that glaciation had little effect on the positions and forms of valleys and hills, which evidently were already present before the glacial invasion occurred. On the other hand, the weathered regolith that must have been developed on the bedrock surface in preglacial time is not present; it must have been removed by glacial erosion. Regolith on similar rocks in the nonglaciated region of eastern United States is at least 5 to 10 ft thick. Hence it can be inferred that glacial erosion stripped off a surface layer at least a few feet thick but did not remove enough rock to alter the positions of streams or to destroy the close relationship between altitude and lithology that had developed during a very long period of preglacial time.

The rather small depth of glacial erosion is reflected also in the scanty evidence of glacial diversion of drainage, a common feature of other regions that have been glaciated. Only two probable examples of diversion have been noted.

One involves the Housatonic River in the vicinity of Stratford. It is likely that before glaciation and before the great postglacial rise of sea level, the river did not curve east past Crimbo and Stratford Points as it does today. Instead it may have continued southwestward from Devon, along the trend of the belts of bedrock, passing through what is now the site of the Bridgeport Municipal Airport. As the map shows, no bedrock is exposed in any part of that area; at the surface lie sediments deposited mainly during melting of the ice sheet. Such sediments could have obliterated a former bedrock valley by filling it, thereby offering the river a broad fanlike plain, extending from Rivercliff and Cedar Beach on the east to the center of Bridgeport on the west, over which to flow in a generally southerly direction. Shifting channels of the river probably occupied many positions on the fanlike plain while depositing sand and gravel. The present route, passing between Crimbo and Milford Points, may have originated in the latest such shift.

Glacial diversion of a preglacial Wepawaug River is suggested likewise. Today the river follows the grain of the bedrock southwestward to a point just south of the junction of the Ansonia and Milford quadrangles. The valley, floored with a chain of swamps including Baldwin, Black, Bilberry, Dismal, and Mohawk Swamps, and now partly drained by Beaver Brook, continues southwestward past Devon, but the river turns south, through an area thickly covered with sand and gravel, to enter Long Island Sound. The swamp-filled valley, here referred to as the Black Swamp valley, is partly blocked by glacial sediments. Records of several borings show that the bedrock floor of that valley lies well below the present surface, at one point (at Connecticut Turnpike Interchange 37) more than 80 ft below it. These data suggest that the Wepawaug River formerly continued southwestward through the buried valley but later was diverted to its present route by glaciation. Probably, during melting of the ice sheet, the old valley was filled with ice after the higher areas to the east and west had become ice free. Meltwater flowing down the Wepawaug from the north was thereby prevented from following its old course. It deposited sand and gravel, building up the valley floor to an altitude (now about 50 ft) high enough to enable the water to spill southward. The stream established a new route, along which a continuous body of sand and gravel was built up. More recently the Wepawaug has cut a narrow trench into this body of sediment, but the small width of the trench contrasts sharply with the wider and older valley of Indian River and with that of the now-abandoned valley of the Wepawaug.

Where the Housatonic and Naugatuck Rivers are flowing on thick deposits of glacial drift, they may be in positions slightly different from their preglacial ones. A similar situation is seen along the brook that drains Buttermilk Hollow, immediately west of State Highway 110. The brook has incised a miniature, steep-sided canyon into bedrock (here the Derby Hill Schist). The canyon evidently has been cut since the last glaciation, as it stands in sharp contrast to nearly all the valleys, large and small, in the map area. Very likely the brook at this place took its course over a covering of glacial drift, and cut through the drift into the bedrock beneath.

In a few places, also, streams such as the Wepawaug are interrupted by swamps or ponds, some of them occupying shallow basins created by the irregular deposition of glacial drift. The presence of such basins results from the recency of glaciation; the time since that event has been too short to permit the re-establishment of stream flow uninterrupted by basins.

None of the lakes within the area is known to occupy a wholly natural basin; all were created or were deepened by the building of artificial dams. The lakes include water-supply reservoirs, present or former mill ponds, recreational ponds, and basins excavated in sand- and gravel pits.

GLACIAL-EROSIONAL FEATURES

Striations and grooves, etched into the surface of bedrock by rock particles imbedded in the base of flowing glacier ice, are exposed at some places within the map area. Their lengths range from a few inches to a few feet. Their areal distribution is very irregular, partly because of the varied degrees to which the several kinds of bedrock yield to glacial abrasion (phyllite accepts striation much more readily than does gneiss), but more commonly from the ease with which weathering destroys the markings, especially the smaller ones, after they have been exposed at the surface. Where recent erosion, natural or artificial, has stripped away the mantle of glacial drift, striations and grooves in the rock are commonly visible. However, hills and smaller bosses of bare bedrock, whose general form indicates that they were shaped by glacial erosion, show striations only rarely. Their surfaces, roughened and granulated by weathering, suggest that any striations they formerly bore have been destroyed during long exposure to the atmosphere.

Striations or grooves were seen and recorded at 75 localities. At those places, shown on plates 1 and 2, the bearings range from S 57° E to S 80° W. As indicated in the rose diagram in figure 3, (in pocket) the trends fall into two groups, averaging S 19° E and S 39° W, respectively. The contrast between the two groups suggests that they record two distinct movements of glacier ice over the area. No means of determining which movement was earlier was found in the striations themselves, which, furtheir, yielded no information on the length of the interval between the movements. However, data from a locality about 1 mi. NNE of the northeastern corner of the Ansonia quadrangle suggest that the SW trend may be the younger and that the interval may have been appreciable (Flint, 1961).

At a few places within the map area, small rock knobs are smoothed at their northerly ends to whaleback form, whereas their southerly ends are steep clifflets controlled by joints in the rock. Good examples are seen in knobs of Derby Hill Schist near the southwestern base of Prospect Hill in Woodbridge. Such stoss-and-lee features indicate the direction of sustained flow of glacier ice, and their usefulness is enhanced by the fact that they are likely to persist long after striations have been destroyed by weathering. Their orientations agree well with those of striations in their vicinity, whether of the SW- or SE-trending group.

It is noteworthy that of the 44 striations with SE orientation, all but one occur in the western half of the map area, whereas of the 31 striations with SW orientation, all but four occur in the eastern half. If, as seems probable, the latter group is the younger, it could be argued that striations made by the earlier glacial movement were erased by the later movement, which failed to affect the western half of the area. This concept is supported by the distribution of stones glacially torn from the bedrock and deposited in these quadrangles, as noted below.

In many parts of the area the surface has been molded by glacial action into streamline hills (fig. 3), ovate in plan and ranging in length from about 600 to about 3,000 ft. Some of them exceed 100 ft in height. Although distributed irregularly, the hills occur on nearly all the metamorphic bedrock units that crop out in the map area. Evidently most of the hills consist mainly of bedrock, because bedrock is exposed in many of them. The long axes of the majority of the hills parallel the trends of foliation measured in the nearby rocks. The trends of hill axes range from NW-SE to NE-SW; their average is slightly west of south. These trends are not too different from the orientations of the principal rivers.

From these facts, the long axes of the hills known or inferred to consist mainly of bedrock are considered not to record a regional direction of glacier flow. The hills are believed to have existed before glaciation, and to have been shaped and smoothed, perhaps repeatedly, by components of flow direction that paralleled the pre-existing hills. Possibly flow directions were locally altered and guided by the presence of the hills themselves.

Unlike the streamline hills known or believed to consist mainly of bedrock, those in the southeastern corner of the map area most likely consist mainly or wholly of till. These hills (Eels, Clark, Bryan, Burwell, and Merwin Hills in Milford) expose no bedrock, and shallow dug holes at points on all of them show only till. Their composition could be verified by well records, but none are on file. However, in Round Hill in West Haven, about 4 mi. northeast of Eels Hill, till is known to be more than 107 ft thick (Dana, 1883-84, p. 357). Round Hill and several neighboring hills in West Haven form a group with those in Milford. Whereas the structure of the bedrock exposed nearby strikes generally SW, the long axes of the hills trend more nearly N-S, suggesting that they are not controlled primarily by the underlying bedrock.

Another streamline hill that very likely consists mainly of till is the one immediately east of Parker Pond and west of the Ansonia Airfield. In May 1967 an excavation along most of the eastern flank of the hill exposed 10 to 30 ft of till, with no bedrock visible.

STREAM-ABRADED BEDROCK

At a number of places on the lower slopes of the Housatonic Valley the bedrock has been abraded and smoothed by stream-borne sediment.

Readily accessible examples occur along Highway 110 in the vicinity of Boothe Memorial Park. Presumably the abrasion occurred during melting of glacier ice from the vicinity, and, less probably, during later dissection of stratified drift.

Evidence of abrasion of bedrock by streams no longer active at the locality is known from only one place within the map area. This is on Ray-Bob Road, southwest of Lily Pond, Milford. A boss of Derby Hill Schist about 35 ft long and 15 ft high was exposed there during construction in June 1965. The bedrock had been strongly glaciated, and its surface bore broad, shallow, parallel grooves trending S 5° W. The glaciated surface had been abraded and partly obliterated by turbulent running water loaded with sand and rounded pebbles, some of which had then been deposited with thickness sufficient to bury the bedrock boss. The stream consisted of glacial meltwater, and at this place, at least, it was short lived. It formed a part of the complex of streams and ponds in which the Milford valley train, described below, was built near the terminus of the decaying ice sheet.

A similar feature occurs west of Woodmont Road, Milford, 1,300 ft south southwest of the Clark Pond dam, where a ridgelike boss of Derby Hill Schist was exposed in November 1964 by stripping of overlying sand and gravel. The boss had been glaciated, with grooves trending approximately N 30° E, and had then been abraded by a stream, probably the meltwater stream that deposited the sand and gravel overlying the bedrock here.

At one place within the map area evidence of abrasion of till by a stream was noted. Race Brook in Orange, at the point where it is crossed by State Highway 34, is cut 3 to 4 ft into a flat bench about 100 ft wide, consisting of stones in a compact matrix of sand and silt, a material that appears to be till. Downstream and 1,200 ft upstream from the highway the valley is floored with outwash sediment. Possibly the till area represents a broad, very low hill of till that was planed off by Race Brook, either during the deposition of sediment both upstream and downstream or later.

GLACIAL SEDIMENTS

Sediments of glacial origin, collectively known as glacial drift, are of two general kinds: those deposited directly by glacier ice and those deposited in streams and lakes consisting of water derived from the melting of glacier ice. Both kinds are present in the Ansonia and Milford quadrangles.

Till

GENERAL CHARACTER

Till, a glacial sediment consisting of nonsorted, nonstratified rock particles of all sizes, forms a general although discontinuous mantle over nearly all the higher land in the area. It covers much of the bedrock surface, hills and smaller valleys alike, and thereby shows that the bedrock had been sculptured essentially to its present surface form before

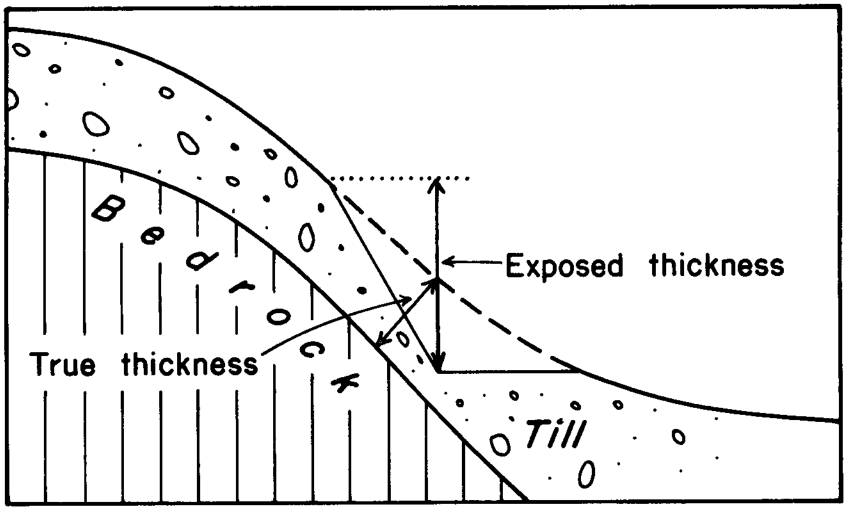

Fig. 4. Idealized section showing that exposed thickness of till on a hillslope can greatly exceed true thickness.

glaciation. Because the major valleys are partly filled with sediments of post-till age, till is rarely exposed in them. On the bedrock floors of the major valleys it passes downward beneath the younger sediments and underlies them, at least in places where it is encountered in borings.

Within the outcrop areas of the least erodible kinds of bedrock, notably the Ansonia and Prospect Gneisses and The Straits Schist, the till mantle is extremely thin or lacking altogether. These rock types, rich in quartz and with very widely spaced joints, were so resistant to glacial erosion that they supplied little material from which till could be made. Also, because they form hills with steeper average slopes than those on other kinds of rock, till can be eroded from them with comparative ease. Probably substantial volumes of till were removed from such slopes immediately following the disappearance of the latest covering of ice from the district. The thin, patchy character of the till mantle overlying such bedrock is reflected in the greater frequency of bedrock exposures in the western than in the eastern part of the map area, as shown on plates 1 and 2.

Thickness of the till mantle varies conspicuously. Except in drumlins, it is generally thinnest on hilltops and thickens downslope. The till smooths topographic detail by filling small valleys and pockets in the bedrock surface, particularly on hillsides. Roadcuts, stream banks, and other surface exposures rarely show more than a few feet of till. The three thickest till sections seen exposed within the map area were, respectively, 32 ft, 30 ft, and 14 ft thick. The significance of these values is difficult to assess. In terms of thickness exposed they are minimum, because at each locality the base of the till was concealed at the time of observation.

However, exposed thickness can be much greater than true thickness, depending on the angle the exposed face makes with the base of the till body, in this case the surface of the underlying bedrock (fig. 4). The scattered subsurface data available show no thickness much greater than 40 ft. Average thickness of till within the area is estimated at between 8 and 15 ft, but because of abrupt variations and the small number of well records on file the estimate can not be considered accurate.

Throughout the map area the till mantle generally has little constructional relief, that is, relief resulting from local variations in till thickness independent of the relief of the underlying bedrock surface. The glacier appears to have smeared the till over the bedrock, in a blanketlike manner.

In this area the till includes a course fraction consisting of pebbles, cobbles, and boulders, and a fine fraction consisting of sand, silt, and clay. As is general throughout much of Connecticut, the coarse fraction is conspicuous in surface exposures, but when measured is found in most samples not to exceed 20 percent of the total. In some samples it amounts to less than 5 percent. Within the fine fraction sand and silt are abundant; hence the till is commonly rather friable. In the eastern part of the map area the till is uncommonly rich in silt derived from underlying phyllitic rocks such as the Derby Hill and Wepawaug Schists. Such till is unusually compact and does not disaggregate readily.

The pebbles, cobbles, and boulders are generally somewhat subangular in shape, reflecting the positions of joints and foliation surfaces in the bedrock from which they were derived. Most of them show some degree of smoothing by abrasion during glacial transport. Corners and edges between facets are rounded, and the surfaces of a few (generally much fewer than 5 percent) are scored with striations. A very few are well rounded; very likely these had been transported in water before being last picked up by the glacier. The sand-size particles are mainly very angular, implying crushing during glacial transport.

In some exposures the shapes of many particles in the coarse fraction (including big boulders) are ragged fracture surfaces with little or no evidence of modification by glacial abrasion. These fragments may have been torn from bedrock by the glacier and transported without coming into frequent contact with other pieces of rock, or may have resulted from crushing while in glacial transport.

In composition the till resembles the bedrock that immediately underlies it or that occurs within a short distance upstream. Composition is reflected in the color of the sediment, which ranges from light olive gray (5Y 5/2) to dusky yellow (5Y 6/4), and in till affected by oxidation, to yellowish brown (10YR range). Colors are described according to the Munsell system (Goddard, 1948). All colors mentioned are those of dry material.

Except for minor dikes in the eastern half of the Ansonia quadrangle, the diabases, basalts, and red sandstones, all of Triassic age, which widely underlie the country immediately to the east, are not present in the Ansonia-Milford area. Nevertheless, boulders, cobbles, and pebbles of such rocks occur in the eastern part of the area, although in small quantity. Readily visible near the eastern boundary of the area, they become rapidly less so toward the west. The broken line on the sketch map, figure 3, marks the western limit of those which have been identified. This limit trends SSW. Along the northern edge of the Ansonia quadrangle it lies 2.6 mi. west of the belt of Triassic rocks; along the northern edge of the Milford quadrangle it lies about 5 mi. west of that belt.

The hypothesis that best explains this distribution is that the particles of Triassic rock were brought into the area by the ice movement recorded by the southwest-trending striations already described. The western limit of such particles does not necessarily also mark the limit of glacier ice at the time when they were deposited. In fact, no other features suggesting the margin of a glacier were found. The limit may indicate nothing more than that at or near this line dilution of Triassic rock types with local rock types becomes so great that the Triassic elements are no longer obvious.

Although till is not generally stratified, in a number of places within the area it possesses distinct fissility consisting of closely spaced, subparallel partings that in most exposures are also approximately parallel with the ground surface. The origin of this structure is not understood; it may have originated in two or more quite different ways. In some places fissility may result from the plastering onto the ground of successive masses of wet, plastic sediment by moving ice. In other places it may be the result of wetting and drying, or other physical changes, in the till after deposition, and even after deglaciation.

STRATIGRAPHY AND CORRELATION

In the Mount Carmel quadrangle, adjacent to the Ansonia quadrangle on the northeast, two distinct till sheets (Lake Chamberlain Till and Hamden Till) have been identified (Flint, 1962, p. 9). These tills, and striations related to them, record glacial flow in a direction nearly due S, followed by SW flow. In the New Haven and Woodmont quadrangles the measured fabrics indicate SW movement and the composition of the till at various points is compatible with glacier flow toward the SW (Flint, 1965). At no place in those quadrangles was a basis found for relating any of the till to more than a single body. That body is believed to be equivalent to the Hamden Till described in the Mount Carmel quadrangle.

In the Ansonia and Milford quadrangles, however, two till bodies were found exposed at a single locality. At a point 400 ft southeast of the southeastern corner of Parker Pond in Ansonia, in an excavation for a new street crossing the top of a steep hill, till like that exposed generally throughout the area overlies till of different character. The upper till, 14 ft thick, is yellowish gray to dusky yellow, appears sandy, disaggregates easily, possesses little structure of any kind, and contains many boulders. The lower till, with an exposed thickness of only about 8 ft, is light olive gray, appears silty, is extremely tough and cohesive, breaks into blocks, contains much stratified material, some of it deformed, and contains very few boulders and only a small proportion of cobble-size fragments.

Correlation of these tills with those in other quadrangles must await their more detailed study; their presence does, however, establish the inference that the Ansonia-Milford area has been glaciated more than once, and suggests that sufficiently deep excavation would reveal additional two-till sections.

Erratic boulders

Erratic boulders, consisting of rock that differs from the bedrock underlying them, are abundant in the area. Some lie free on the surface whereas others are partly imbedded in till. Many of the boulders exceed 6 ft in longest diameter; only those with diameters of 10 ft or more were recorded (pls. 1 and 2; fig. 3). There are 46 of these, of which 30 consist of Prospect Gneiss, 7 are diabase, one is amphibolite of the Maltby Lakes Volcanics, and 8 were not identified. The largest is the amphibolite boulder, 25 ft in longest diameter; the second largest, 20 ft in diameter, consists of diabase. It lies just east of Northrop Road in Woodbridge, about 1,500 ft north of the Pulaski Highway. Although it has split into five pieces as a result of mechanical weathering, it probably formed a single block when deposited.

The chief factor determining the maximum diameter of a boulder is the spacing of joints and foliation surfaces in the parent bedrock. It is noteworthy that of the 38 large boulders identified as to lithology, 30 are Prospect Gneiss and 7 are diabase. These rock types are massive and their joints commonly are spaced widely. The Wepawaug and Derby Hill Schists are generally jointed more closely, and possess surfaces of foliation along which the rock can break.

Because the outcrop area of Prospect Gneiss trends generally NNE, and because boulders and smaller particles of this rock type occur south of the outcrop area, these at least must have been deposited by the ice movement recorded by the SE-trending striations.

Stratified drift

KINDS OF STRATIFIED DRIFT

The sorted sediments, mostly stratified, deposited in streams and lakes derived from melting glaciers are collectively known as stratified drift. Some of this material was derived directly from rock particles in glacier ice, and some consists of reworked and redeposited till. In the Ansonia and Milford quadrangles stratified drift is of three kinds. One consists of lake-bottom sediments, mostly fine grained, deposited on the floors of temporary glacial lakes during deglaciation.

The two other kinds of stratified drift in the area constitute two facies, each an end member of a gradational series. One facies is the drift deposited in contact with melting ice near the glacier margin. The other end member is the drift deposited by streams flowing away from the glacier, miles or tens of miles from the glacier in which it originated.

The sediments of both facies are much the same, although, like all stream-deposited sediments, they become finer grained and otherwise better sorted in the downstream direction. But as long as ice, residual from the glacier, is present beside or beneath the accumulating stratified drift, the drift will have characteristics that betray its peculiar place of deposition, and constitutes a facies labeled *ice-contact stratified drift.* Downstream from the point where the meltwater stream has passed over the last identifiable remnant of buried ice, the sediment will have different characteristics, and constitutes a facies labeled *outwash,* although it is essentially the same body of sediment.

We define ice-contact stratified drift, then, as sediments deposited in streams and other bodies of water against, upon, beneath, or otherwise in immediate contact with melting glacier ice. Such sediments include sand, gravel, silt, and clay, and commonly possess one or more of these characteristics: great internal variability, poor sorting, large and abrupt changes in grain size both vertically and horizontally, inclusion of small bodies of till, erratic boulders, or flowtill (till-like sediment deposited by landsliding off adjacent ice), deformation of sedimentary laminae by subsidence or other displacement activated by melting of underlying or adjacent glacier ice.

Rounding of individual particles, although highly variable, is commonly slight or only partial. In addition, ice-contact stratified drift has, in places at least, constructional topography that includes basins (known as kettles), partial basins, and knoll-like mounds. These features reflect the presence of irregular bodies of melting ice during accumulation of the drift.

In contrast, outwash is defined as stratified drift, deposited by streams beyond the glacier, and free of any influence of buried ice. It is characterized by lenticular beds, each consisting of parallel laminae inclined in the downstream direction. Range of grain size is relatively small (most outwash consists of sand-and pebble sizes), and stratification is more regular and systematic than in ice-contact sediments.

In the Ansonia and Milford quadrangles are bodies of stratified drift that consist of one or more of the kinds described. In the following sections they are discussed, as physical units, beginning at the east and proceeding westward. Figure 5 shows the extent of each unit and Figure 6 the long profiles of units in the largest valley. Some of the drift bodies, being elongate and confined to specific valleys, are referred to as valley trains, notwithstanding the fact that the literature commonly applies this term to bodies of drift said to consist exclusively of outwash.

In this map area virtually all the stratified drift ranges in color from dusky yellow to yellowish gray, reflecting the normal color of comminuted local bedrock. In the outcrop area of Triassic rocks to the east, the drift tends to approximate moderate brown. However, even though some material of Triassic origin is present in the Ansonia-Milford area, it is so thoroughly diluted with material derived from the local rocks that it does not appreciably affect the color of the drift.

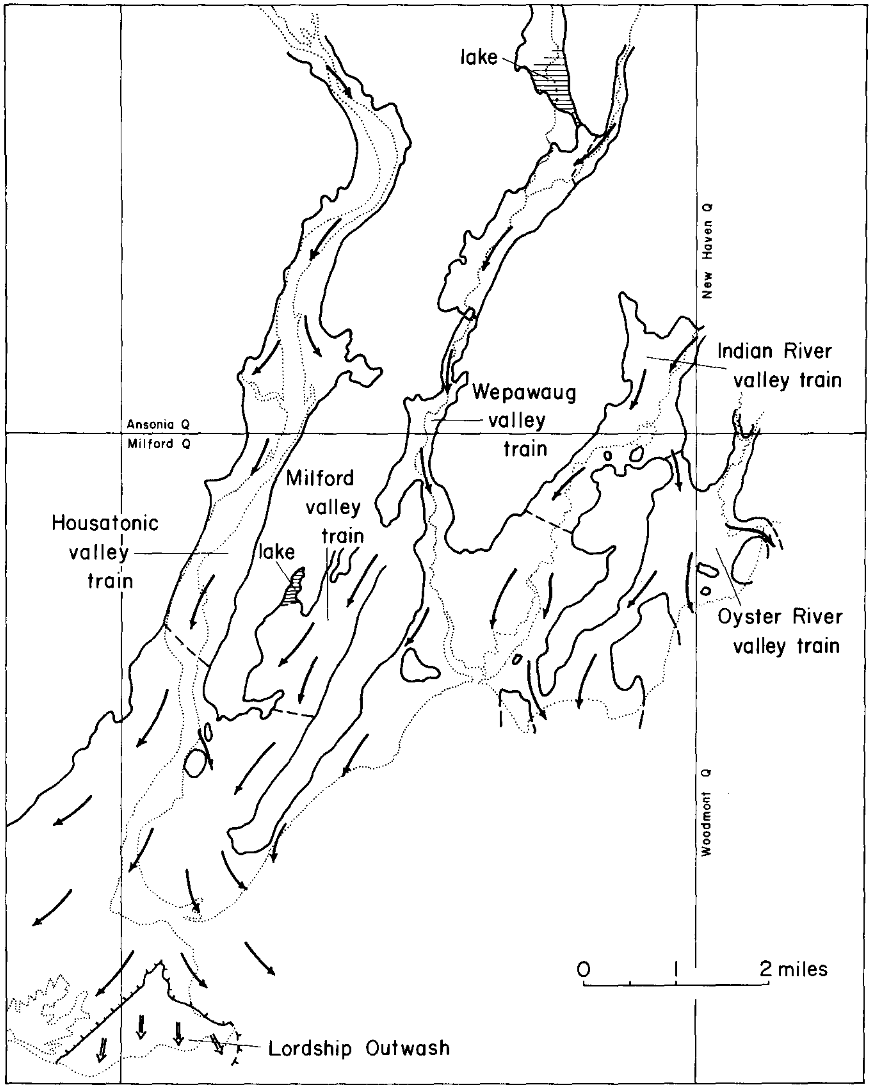

Fig. 5. Sketch map of the Ansonia and Milford quadrangles and parts of adjacent quadrangles showing principal bodies of stratified drift restored to their approximate extent before dissection or burial. Thick arrows indicate generalized directions of flow of former streams of meltwater.

OYSTER RIVER VALLEY TRAIN

This body of stratified drift was named for Oyster River, a small stream that enters the sea at Woodmont, ½ mi. east of the eastern boundary of the map area. Despite its name, the valley train is related to Oyster River only in its eastern part, and consists mainly of outwash sediment derived from the valley of Indian River, by overflow across a low ridge about 1,000 ft southeast of Indian Lake. It partly obscures the preglacial relief, and has three principal exists to what is now the shoreline, one at Point Beach, one northeast of Burwell Hill, and one at Woodmont. The valley train continues seaward beyond the shore, buried beneath recent marine sediment. Streams flowing southward away from the melting glacier deposited so much sediment on their beds that it filled the lower areas and nearly or perhaps wholly surrounded the high Burwell Hill-Merwin Hill area, underlain by till. As the surface of the valley train declines from about 50 ft near Indian Lake to about 30 ft near Point Beach, a distance of 3 mi., the average slope is about 7 ft per mi.

As thus defined, the Oyster River valley train consists entirely of outwash, the related ice-contact stratified drift being wholly within the Indian River drainage basin. It is composed mainly of sand, with a small proportion of rounded pebbles which decrease in number and diameter toward the south. Stratification is indistinct but cross-stratification can be discerned in places. Where exposed it is only a few feet thick, overlying a very irregular surface of bedrock. Probably its thickness is locally greater, but pertinent logs of borings are not available to establish whether this is the case.

Along Oyster River (east of the map area) and Calf Pen Meadow Creek the valley train has been dissected to a maximum depth of 15 to 20 ft. The major part of this dissection probably took place immediately following the withdrawal of the ice from the vicinity.

An unusual sequence, formerly exposed in the sea cliff at the intersection of Norwood Avenue and Morningside Drive, Milford, about 700 ft north of the erratic boulder at Morningside (shown on pl. 2), is probably related to the Oyster River valley train. It consists of 2 ft of parallel-laminated silt and fine sand, mostly dark yellowish orange but including one 3-in. layer of moderate-brown silt, the color of Triassic rocks exposed 2 mi. to the northeast. The silt and sand are underlain by 3 ft of fine pebble gravel. The pebbles, consisting mainly of the local chloritic rocks, have flat faces determined by foliation surfaces. There is no interstitial sand or silt. The gravel is abruptly underlain by till, at an altitude of about 16 ft. A very similar sequence was formerly exposed in the sea cliff about 60 yards east of the eastern limit of the Milford quadrangle (Antevs, 1928, p. 112-114).

The silt and fine sand suggest the bottom sediments of a shallow lake and the gravel is of a type seen in beaches. Thus it can be hypothesized that the stratified layers represent the northwestern wing of the most northeasterly unit of the Oyster River valley train shown in figure 5, accumulated against the hill of till at Morningside. The wing might have been represented by an elongate small lake between the outwash surface and the hillslope, in which an ephemeral beach could have formed. The altitude is compatible with that of the nearest remaining unit of the valley train southwest of Morningside. This explanation seems more probable than others based on the assumption that the gravel, if beach gravel, is of marine origin.

INDIAN RIVER VALLEY TRAIN

The Indian River valley train consists of two distinct facies, ice-contact and outwash, shown separately on plates 1 and 2. The ice-contact facies, about ½ mi. long, extends along Indian River Valley from nearly 1.5 mi. north of Interchange 41 to the shopping center near Forest Heights, where it merges into the outwash facies, flares out to about 1 mi. in width, and merges on the west with the Wepawaug valley train. As already noted, one arm of the Indian River body extends south and forms the greater part of the Oyster River valley train.

The ice-contact part is about 2.5 mi. long, and overlies a bedrock surface that is repeatedly exposed in many small knobs. The sediment exposure is nowhere thicker than 20 ft, and throughout much of its extent its true thickness is probably not much greater. In several former sand- and gravel pits, no longer active, the ice-contact character of the deposit is clearly visible. Average grain size is small and boulders are few, implying that the melting ice was thin, had gentle slopes, and was mostly buried beneath stratified drift when the deposition of sediment ceased.

As a body, the ice-contact facies has a gently undulatory surface, owing partly to the presence of buried or nearly buried knobs of bedrock and partly to basins in the valley train itself. Many of these basins are believed to have been created by the melting of thin buried blocks of glacier ice beneath a covering of stratified drift, causing the drift to subside or slowly collapse in an irregular pattern. Such basins became fewer and shallower in the down-valley direction, and disappear altogether in the vicinity of the shopping center near Interchange 39. Southwest of the shopping center the outwash facies begins. The surface of the valley train is nearly plane, sloping down-valley at a little more than 8 ft per mi., with cut-and-fill strata in which foreset laminae dip down-valley. Likewise the sediment becomes finer grained, with sand constituting 95 percent of an extensive exposure at the Burndy Company plant ½ mi. west of the railroad bridge across Indian River. The remainder consists of rounded pebbles. The fine grain size suggests a source limited in extent and rather short lived, as could be expected of a comparatively small stream with a drainage basin lying wholly within an area of fine-grained, foliated bedrock. The melting ice released few particles of boulder- and cobble size and soon vacated the watershed.

Southeast of Gulf Pond this valley train merged with the Oyster River valley train, and along a line between Forest Heights and Milford Harbor it merged with the Wepawaug valley train, continuing beneath the site of Long Island Sound. Because no scarps are present at critical places as would be the case if a later stream had cut into the outwash built by an earlier one, it can be inferred that the three valley trains were contemporaneous and were built up as a single unit, probably during a rather short interval.

However, both Indian and Wepawaug Rivers have cut into and dissected the combined valley train, as can be seen on plates 1 and 2. This dissection is the work of postglacial streams, and is continuing today.

WEPAWAUG VALLEY TRAIN

The valley train that occupies the valley of the Wepawaug River is a much longer body of sediment than those described above. Originating close to Woodbridge, it follows the Wepawaug River to Milford Harbor, a distance of 10 mi., and is traceable for 3 mi. farther southwest along the shore to Laurel Beach, where it has been cut off by erosion accomplished by the Housatonic River in postglacial time. It has one tributary branch, following Race Brook.

Broadly speaking, the ice-contact facies of this long, narrow valley train can be said to extend from Woodbridge southward about 6 mi. to the vicinity of Clarktown Pond in Orange. There it grades into an outwash facies; the part of this facies not submerged beneath the sea is 4 mi. long. Through the first 3 mi. down-valley from its head, the valley train is a fairly conventional blanket of gravel and sand with an upper surface of knolls, basins, and less definite undulations, and with sections exposing the structural features peculiar to the ice-contact environment. Near the Wepawaug Reservoir, however, the surface becomes smooth and the material changes from sand and gravel to sand and then to gray clayey silt. The mass of silt, about 4,000 ft long, must have been deposited in a lake, into which sediment was fed via a delta whose surface is the smooth sandy area to the north. However, the lake seems to lack a basin—the surface of the silt is about 50 ft higher than any part of the surface which consists mainly of ice-contact stratified drift. Probably, therefore, the lake was held in by a large mass of ice, residual from the glacier. As the ice melted away, the drift overlying it gradually collapsed, and the lake water drained southward across a transverse ridge of bedrock, cutting into it a narrow gorge that begins at the Wepawaug Reservoir dam. This modern dam reproduces, on a much-reduced scale, the dam of ice that created the glacial lake.

Because it contains the record of a lake in the middle of its length, the ice-contact facies of the Wepawaug valley train is unusual. It is unusual also in that its one tributary member, along Race Brook, consists entirely of an outwash facies, extending from the point where the Wilbur Cross Parkway crosses Race Brook down-valley into the Wepawaug Valley. There the Race Brook outwash merges with the ice-contact facies of the main part of the valley train. The merger can be explained by the hypothesis that the downstream segment of Race Brook Valley, being shallow, was cleared of ice before the adjacent segment of the deeper Wepawaug Valley was. The coarser fraction of the sediment which poured into Race Brook from ice at the head of that stream was deposited along Race Brook as outwash; the finer fraction, which reached the Wepawaug, was, however, spread out over the buried ice that still remained there.

The residual buried ice extended nearly 2 mi. down valley to Clarktown Pond, as shown by the transition from ice-contact stratified drift to outwash in that vicinity. From Clarktown Pond to Long Island Sound the Wepawaug valley train becomes fine grained, and its surface slopes smoothly down valley at an average rate of about 16 ft per mi. This slope, nearly twice that of the Indian River valley train, probably reflects a bigger watershed, a larger source of supply of sediment, and also a longer time during which deposition was in progress.

The Wepawaug River occupies a floodplain floored with alluvium spread out in postglacial time. In the segment where it lies within the ice-contact facies of the valley train, the alluvium is narrow (with one exception, 0.5 mi. northwest of Baldwin Swamp, discussed in a later section) and rather uniform in character. In contrast, within the ice-contact segment, between Woodbridge and Clarktown Pond, the floodplain widens and narrows, and in several places is interrupted by swamps or by short stretches in which the valley floor is not much wider than the river channel itself. These features result from the irregular melting of residual ice, which left a highly irregular surface to which the postglacial runoff of water had to accommodate itself, and which has been only partly modified by the river during the geologically short time since deglaciation. Into the smooth surface of the outwash facies, however, the river cut a trench 15 to 20 ft deep, leaving the surface of the valley train as a pair of broad terraces along the valley sides.

MILFORD VALLEY TRAIN

In a foregoing section it was suggested that the Black Swamp Valley in Milford represents a former valley of the Wepawaug River. This valley, continuing southward past Devon, is the site of the main arm of the Milford valley train. Originating at Interchange 38 and with a width of nearly 1 mi., this body begins with a conspicuous ice-contact facies 3 mi. long, merging between Devon and Rivercliff into an outwash facies, which in turn merges into the Stratford outwash. At its main head the surface of the valley train stands at about 80 ft. It declines southward irregularly, owing to extensive collapse over buried ice, to about 30 ft in the area where the outwash facies begins; thus the valley-train surface slopes at an average rate of 10 ft per mi., although the slope may have been somewhat steeper when buried ice was present beneath it. Records of several borings show this valley train to be thicker than those farther east, with a minimum thickness of 80 ft at one point.

The swamps on the valley floor mark the sites of the largest masses of residual ice, and their basins are therefore kettles.

When the Milford valley train began to form, the Black Swamp Valley north of Interchange 38 marked the outer limit of continuous glacier ice. The remnants of this ice—now represented by the kettle that contains Baldwin Swamp and a similar swamp 0.5 mi. north northeast of it—and the ice-cored valley train itself blocked the Wepawaug River, then a short meltwater stream, and prevented it from following its probable former course, Black Swamp Valley. The meltwater abandoned the Black Swamp Valley and spilled through a low area east of West River Street, Milford, following a path that had already been deglaciated. At the point of spillover, the present, new path is at least 30 ft lower than the top of the Milford valley train.

In summary, then, the valley train was constructed by "Wepawaug" meltwater, and became inactive because deglaciation created a lower path for the runoff along a line east of its old route. The Milford valley train is therefore slightly older than the Wepawaug valley train.

A western arm of the Milford valley train, now drained by the head of Beaver Brook, contains a thin body of sandy silt about 3,500 ft long, apparently representing a former temporary lake. It is flanked on the south by ice-contact sand and gravel; the relations between the two bodies are not exposed. If they are gradational, it can be proposed that the lake was created by a large body of residual ice on its southern side. As the ice melted, the lake drained and drift covering the ice subsided through at least 50 ft to its present altitude.

STRATFORD OUTWASH BODY

The Housatonic Valley and its tributary, the Naugatuck, contain a far greater bulk of stratified drift than do the other valleys in the map area. However, because it is not known whether all this drift belongs to a single valley train, it seems best to describe the ice-contact stratified drift separately from the two outwash units that are clearly distinguishable. One of the outwash bodies is here referred to as the Stratford outwash, because it is well developed in the part of the town of Stratford that lies within the Ansonia-Milford quadrangles.

As is shown on plate 2, the Stratford outwash fringes the Housatonic River from its mouth near Sniffens Point and from an extensive area west of Lordship and outside the map area, upstream to the vicinity of Fowler Island, where gradation into an ice-contact facies is complete. The outwash has been so extensively eroded by the river that only a minor part of its original area remains. It is known to have filled the valley from side to side, because strings of borings made during construction of the Connecticut Turnpike- and Washington Bridges reveal outwash sand, its upper surface eroded, extending as deep as -115 ft (Upson and Spencer, 1964, pl. 1, B). As the upper surface of the nearest outwash remnant stands at about +35 ft, the valley train here must have been around 150 ft thick. The slope of its upper surface is about 8 ft per mi., similar to that of the Wepawaug outwash facies.

In its southern part the Stratford outwash consists of sand with less than 25 percent gravel, most of it pebble size. Farther upstream, in the B. J. Carten pit east of Popes Island, gravel increases to about 50 percent and is mostly of cobble size. At the northern end of the Beard pit east of Fowler Island and 1 mi. farther upstream, gravel exceeds 50 percent, with average diameter somewhat greater than that exposed in the Carten pit. In all exposures the pebbles and cobbles are rounded as a result of transport in the meltwater stream.

In both the Carten and the Beard exposures the outwash unconformably overlies ice-contact stratified drift. Probably this relationship results from gradual melting of residual ice during a transition from ice-contact conditions of sediment deposition to ice-free, outwash conditions. If large commercial pits had not been present in this critical zone, the relationship of the two kinds of sediment would have been less well, if at all, exposed. Possibly similar relationships exist beneath the surfaces of the other valley trains as well.

It was stated earlier that the Milford valley train merges with the Stratford outwash. Without a minute study of the mineral composition of the sediments from the two watersheds it is not possible to determine the nature of the contact between the two bodies. Their common upper surface is smooth, and in the built-up area of their junction exposures are lacking. A curved, west-facing scarp about 10 ft high, passing through Devon (shown on pl. 2), represents a cut made by the Housatonic, at some time after the Milford valley train had ceased to be active and while a few small masses of ice lay buried beneath the stratified drift, as indicated by small kettles in the vicinity.

The ice-contact facies related to the Stratford outwash is described in a later section.

LORDSHIP OUTWASH BODY

A triangular remnant of outwash older than the Stratford outwash, about 1 mi. in greatest diameter, occupies the Lordship area, terminating on the east at Stratford Point. Its pre-Stratford age is indicated by two facts: 1) It reaches an altitude of more than 30 ft, whereas the Stratford body, whose nearest undisturbed part 600 ft north of the northern tip of the Lordship remnant, reaches barely 10 ft. It is confidently inferred that beneath the intervening tidal-marsh peat and artificial fill, the Stratford outwash lies against the sides of the eroded Lordship mass. 2) The Lordship outwash is coarser than the Stratford outwash and was built in closer proximity to the margin of the glacier.

In May 1927 the writer examined a gravel pit east of Stratford Road and 800 or 900 ft south of the Marine Basin inlet. The pit, 10 ft deep, exposed tough, compact till overlying broken and closely folded layers of sand and gravel, the folds being overturned toward the south. In that year the surface, for about ½ mi. toward the southeast, was gently undulating and was marked by scattered boulders up to about 4 ft in diameter. These features suggest that at least some of the northern tip of the Lordship mass was overridden by the glacier, which released boulders over the surface of its own outwash. The pit has been obliterated and the boulders moved away during urbanization of the area since 1927. Possibly more till is present in the mass, which is mapped as outwash only because that is the predominant material now exposed. The sand and pebble gravel exposed in the sea cliff at Lordship is of typical outwash character. It has been described briefly by Denny (1936).

The original extent of the Lordship mass is not known. The till seen in 1927 indicates that ice was present along its northern edge and suggests that the mass extended little north of its position today. Its nearly straight northwestern edge has been cut artificially during grading of the adjacent airport. It may have been eroded earlier, to an unknown degree, by the meltwater streams that deposited the Stratford outwash sediments.

The Lordship body of sediment possibly marks a position of the southern margin of the ice sheet, extending nearly parallel with the coastline. If this was the case, any sediments marking a continuation of this position toward the east or west would now be submerged beneath the sea, because the Lordship body occupies a conspicuous peninsula.

Following the Stratford outwash northward, we find it overlying ice-contact sediments in two pits. Strictly speaking, therefore, it postdates those sediments; however, because of the continuity shown in figure 6, the two units are believed to be broadly contemporaneous facies of a single valley train. The figure shows the long profile of the Lordship body, sloping southward from the airport to the sea cliff, and below it the profile of the Stratford outwash, which can be traced with confidence from the outwash into the ice-contact facies, to a point about 3 mi. upstream from Washington Bridge. There a gap occurs. North of the gap, the drift in the vicinity of Pine Rock Park possibly belongs to the same valley train, but as no sure basis for bridging the gap was found, the two bodies are left uncorrelated.

The ice-contact bodies are shown on plates 1 and 2 and in figure 6. They are discontinuous, perhaps partly because their deposition was interrupted in places by large masses of ice, but mainly because they have been deeply eroded by the two large rivers. The bodies are crudely terracelike, and the faces of all of them have a stream-cut form rather than the complex primary form that results from deposition against residual ice.

Nevertheless, most of the sections exposed in these bodies indicate the presence of ice beneath or beside the accumulating sediment. Not only do the layers show structural evidence of collapse, but the abundance of layers of sand and even silt implies that much of the sediment was deposited in pockets ponded behind local, perhaps ephemeral, dams. In such pockets the velocities of currents were smaller than those of the streams in which the Stratford outwash was deposited. The implication is that large but discontinuous masses of residual ice occupied the central parts of the valleys, while sediment was deposited in streams and ponds situated between the ice and the steep, rocky sides of the valleys, and also directly on top of the ice itself. The profiles of the remnants suggest a general down-valley slope, created by the escaping meltwater, which must have flowed southward throughout the deglaciation of the map area.

Where tributary valleys create re-entrants in the sides of a main valley, the ice-contact stratified drift extends into them and becomes finer grained up valley, indicating that the sediment was built into the tributaries from the direction of the main valley. This relationship is best shown at Turkey Hill Brook, where the drift body extends as much as half a mile up that tributary, creating a barrier behind which a swamp has developed.

Both maps and profiles show places where two distinct benches or terraces exist in a single cross-profile of a valley. Although no exposures were found at the line of junction of two benches, the similarity of the material exposed in adjacent benches, and the smooth and uncomplicated character of the break in slope between them, support the belief that at each place the lower bench was cut from the higher mass rather than built up against it.

These relations imply that as the masses of residual ice shrank by melting, the streams that flowed beside or upon them lowered their gradients and cut into deposits already made, with ice continuously present during the process. How much terracing of this kind occurred is not known because the postglacial rivers have eroded so much of the glacial material that a substantial part of the record has been destroyed.

Although the lower benches seem to have been cut from higher masses of ice-contact stratified drift, it is not clearly evident whether exposed structures indicating collapse were made before or after the benching or at both times. The presence of kettles in the lower benches would indicate collapse after benching, but as no such features were seen, the question remains open. We do not even know whether the higher masses on the two sides of a valley, when fully built, were separated from each other by residual ice and were therefore kame terraces, or whether they were joined together by a roof of sand and gravel that covered the intervening ice and gave the valley the appearance of having a continuous sedimentary floor.

The time relation between the high-standing ice-contact stratified drift that lies mainly in the Ansonia quadrangle and the lower-level drift, (including Stratford outwash) in the Milford quadrangle is not known. The two groups could be of about the same age, but data are insufficient to justify a more definite statement.

OTHER BODIES OF ICE-CONTACT STRATIFIED DRIFT

Apart from the ice-contact stratified drift described in foregoing sections, four additional masses of such drift, apparently unrelated to major valleys or valley trains, were identified. Most of them occupy isolated positions and all lie at comparatively high altitudes. They represent restricted areas in which sediment accumulated in contact with wasting ice, rather early in the deglaciation of the district. The five masses are numbered and briefly described.

1. *Shelton Reservoir body:* A mass about 0.3 mi. long, lying in the valley of Curtis Brook in Shelton, at an altitude of 270 to 300 ft. A single exposure in its southeastern corner shows 8 ft of nearly parallel-stratified sand with a few pebbles, suggesting obstructed or ponded drainage. Probably the sediment was deposited when glacier ice still filled the Housatonic Valley up to the altitude mentioned.

2. *Military Reservation body:* A mass 0.5 mi. long, at altitude 440 ft, on the divide between the Naugatuck and Wepawaug drainage basins and on the boundary between the towns of Ansonia and Woodbridge. In its western part a pit exposes 9 ft of collapsed sand and gravel, and in its northern part constructional topography, indicating the presence of ice, is apparent.

3. *Bethel Cemetery body:* About 0.8 mi. long, at altitude 150 ft, 0.5 mi. E of Twomile Island in the Housatonic River. Consisting of sand and gravel, and with a very irregular surface, it represents an early deposit along the eastern flank of glacier ice in the Housatonic Valley.

4. *Ford Street body:* At least 0.2 mi. long, exposed near the intersections of Ford Street, Milford, and the Boston Post Road, at altitude 90 ft. An artificial exposure on the property of the Westport Manufacturing Co. shows coarse gravel with a large proportion of cobbles and boulders. This mass is adjacent to the Milford valley train but is distinct from it by virtue of its much coarser grain size. Its extent is difficult to determine in this urban area, and may be greater than that shown on plate 2.

5. *Nells Island body:* A mass 700 ft long, standing as an island 20 ft high in the tidal marsh SE of Rivercliff. Now not well exposed, it consists mainly of coarse gravel that includes many boulders. It is considered to be ice-contact stratified drift because of its isolation and its dissimilarity in grain size to the nearby outwash sediment which must considerably postdate it. Its age may be close to that of the Lordship outwash; probably it was buried or nearly buried by the Stratford outwash, from which it was exhumed by subsequent dissection.

The small number and small size of these five bodies of ice-contact stratified drift imply that in this area the load of drift carried in the base of the ice sheet was not abundant. Not until the ice had thinned to such a degree that it was restricted to a few large valleys was enough drift deposited to form large, conspicuous bodies.

LAKE-BOTTOM SEDIMENTS

Apart from the ephemeral ponds recorded in exposed sections of ice-contact stratified drift mentioned earlier, only two conspicuous bodies of lake-bottom sediment were seen within the map area. One is the Wepawaug Reservoir mass, described as part of the Wepawaug valley train; the other is the mass at the head of Beaver Brook in Milford, described as part of the Milford valley train. Both were temporary, and neither could have existed without a dam or plug of residual ice on its southern side, to create a basin.

POSTGLACIAL SEDIMENTS

Terrace alluvium

Along a segment of Indian River, extending 0.6 mi. upstream from the telephone-line crossing, is a pair of poorly defined benches that stand 6 to 8 ft above the river and that together reach a maximum width of 700 ft. The benches are covered with a discontinuous layer, only 1 to 2 ft thick and lying upon till, of mixed fine sediment interpreted as terrace alluvium. The sediment consists of silt and fine sand, locally clayey, and containing stones, most of them little modified by stream wear. Its color is moderate yellowish brown (10YR 4/2); no stratification was discerned. This material is believed to be alluvium derived from the erosion of till by the river, and later incised by the river channel to a depth of a few feet, to form the terraces. Erosion of till and deposition of the alluvium may have occurred at a time soon after deglaciation, when the gradient of Indian River was reduced somewhat by the accumulation of stratified drift through a long segment farther downstream.

At first thought it may seem remarkable that terraces with veneers of alluvium do not occur along other streams within the map area, particularly along the Housatonic and Naugatuck valleys, inasmuch as such features are well developed in the Quinnipiac, the next major valley to the east (Flint, 1965, p. 27). However, the Quinnipiac Valley was filled from side to side with sand and pebbles, the outwash facies, 30 mi. long, of a major valley train. This provided a smooth, uniform surface on which, in postglacial time, the river could meander, cutting laterally into the valley train and depositing a veneer of alluvium. Along the Housatonic and Naugatuck valleys within the Ansonia and Milford quadrangles no such long body of outwash exists, at least above present sea level. Instead, these valleys seem to be floored with ice-contact stratified drift. Because of this difference one can reasonably speculate that in early-postglacial time these rivers followed very irregular surfaces created by the melting-out of ice bodies, in a manner analogous to that described for the postglacial Wepawaug. Under these circumstances a well-defined pair of terraces veneered with alluvium would not be expected.

In addition, borings in the lower Housatonic Valley show that postglacial estuarine mud with marine shells unconformably overlies stratified drift at depths as great as 60 ft below sea level. Most of the postglacial features of the valley floor are therefore submerged, having been drowned by the rise of sea level that has occurred since the maximum of the last glaciation.

Alluvium and colluvium

Alluvium, ranging from cobble gravel down to silty sand and in places even to clayey silt, occurs on valley floors and in stream channels. The coarsest alluvium is found along small streams having steep gradients; the finest along streams of gentle slope. Although most of the sediment mapped as alluvium lies at the surfaces of floodplains, which are inundated at times of high water, some may overlie very low terraces, not inundated under existing regimens.

The lithologic character of the alluvium varies with that of the local bedrock. As the sediment is very poorly exposed, its thickness is not known; in most places it is probably less than 3 ft thick. At some points along the bases of steep slopes alluvium is overlain by or is interbedded with colluvium that has crept or washed down the slopes.

As it is very discontinuous and mostly very thin, colluvium is included on the map either with alluvium or with bedrock.

Special mention should be made of the alluvium deposited along the Naugatuck River during the exceptional flood of August 18 and 19, 1955. At the peak of that flood the discharge measured at a point north of the Ansonia quadrangle was more than 11 times greater than that of the mean annual flood, and the crest of the flood at Ansonia rose to more than 25 ft above mean low water (Bogart, 1960). Floods of this intensity occur only at intervals of several decades or even centuries. One of the effects of the 1955 flood was the deposition of patches of rubble along the Naugatuck River. According to eyewitnesses, these were as much as 15 ft thick in places. The rubble included not only ordinary boulders and cobbles but also debris of bridges, buildings, and other objects. In the Ansonia-Milford area most of the material thus deposited has been artificially removed, reworked, or covered up, but patches of cobbles and boulders were visible adjacent to the river channel in the Naugatuck quadrangle immediately to the north, as recently as 1967.

Wind-blown sediments

A thin cover of sand and silt, believed to have been deposited by wind, is present discontinuously over the map area, mainly in the vicinity of the Housatonic, Naugatuck, and Wepawaug Rivers. Its observed thickness ranges from 4 ft to less than 2 ft—too thin to permit representation on the map. The wind-blown sediment occurs as a patchy cover over stratified drift and over till. It consists of various proportions of sand and silt. Thickness and sand content are maximum in the major valleys, decreasing away from the valleys in both directions, but the sediment is still recognizable at distances as great as a mile from the valley floor and at heights of 250 ft above it. The material lacks stratification and in places contains scattered stones, possibly because of the incorporation of underlying drift, either during slow downslope movement or through the action of freezing and thawing of the ground, uprooting of trees by wind, and similar activities. Its color is moderate yellowish brown (10YR 5/4), darker than the materials that generally underlie it, probably because it is thin enough to have been oxidized by weathering from top to base.

It overlies valley trains but has not been seen overlying alluvium; therefore it is believed to antedate the alluvium. Probably it accumulated mainly during the building and beginning of dissection of the valley trains. More material has possibly been added in exceptionally dry periods. However, even if it is assumed that all the material originated in valley trains, its distribution tells nothing significant about wind directions at the time or times when the sediment accumulated.

At a few localities along the shore in the Milford quadrangle, Denny (1936, p. 335) found ventifacts (stones faceted or polished by the abrasive action of wind-blown sand and silt) in the surface layer of wind-blown sediment. Probably the ventifacts were abraded during the general period of deposition of wind-blown sediment. Most if not all of the ventifacts have been moved somewhat since they were abraded.

Estuarine sediment

The downstream segment of the Housatonic River, affected by tides as far north as Derby, is floored with estuarine sediment at least as far above the river mouth as the Merritt Parkway bridge. Information on the estuarine material comes principally from borings made for the construction of bridges. Logs of the borings show that the sediment is gray mud including silt, sand, clay, fine organic matter, bits of plants, and broken shells, attains a maximum thickness of about 60 ft, and overlies stratified

Table I.—Genetic classification of swamps and marshes in the map area.

Genetic origin	Example	Type
Basins in till	Unit east of Benz Road in Ansonia	swamp
Basins created by dams of stratified drift	Unit near head of Turkey Hill Brook in Milford	swamp
Kettles; basins in collapsed surfaces	Unit 1 mi. north of Wepawaug Reservoir	swamp
Valley floors without definite basins [1]	Unit traversed by Wepawaug River south of Ansonia Road in Woodbridge	swamp
Tidal marshes[2]	Unit, including Nells Island, south of Rivercliff in Milford	marsh

[1] Such units reflect conditions in which drainage is impeded by variations in permeability of the floor material, which includes plant matter.

[2] Detailed in accompanying text.

drift. The mud has been deposited while sea level, rising relatively against the land, has been encroaching into the Housatonic. The time of encroachment is inferred, from radiocarbon dates obtained in other areas, to have embraced the last 7,000 years or more.

Swamp and marsh deposits

Swamps (wooded) and marshes (nonwooded), as described in table 2, occur in various parts of the Ansonia and Milford quadrangles, and have an aggregate area of between 2 and 3 sq. mi. The deposits in them, which underlie the living vegetation, consist mainly of muck, an olive-gray to dark-gray or brownish mixture of silt, clay, and fine sand with a high percentage of comminuted decayed plant matter, and also of peat, which is nearly pure organic matter. Such deposits in the small swamps are seldom more than 10 ft thick; beneath the larger ones thicknesses are possibly greater.

The thicker swamp deposits preserve a fossil record of changes in vegetation and climate since the time when the ice sheet melted off the area. Swamps and marshes in the Ansonia-Milford area have not been studied from this point of view, but a marsh in New Haven (Deevey, 1943, p. 726) has yielded a core, 28 ft long, containing a record of fossil pollen that shows the kinds of trees and other plants that lived in the vicinity during approximately the last 15,000 years. The succession of vegetation shows, in general, progressive warming of the climate with intermediate fluctuation.

Among the swamps and marshes in the map area tidal marshes constitute a special category. They do not occupy basins but lie at and upstream from the mouths of streams, and hence are open to the sea. They have resulted from submergence or "drowning" of the lower parts of valleys. The tides move in and out, creating an environment for the growth of specialized plants, mostly grasses. Within the area every valley or low land that extends to the coast is floored wholly or partly with tidal marsh. Stream channels within the marshes normally have an intricate pattern of meanders. In some marshes, such as those near Myrtle Beach and Silver Beach, the natural channels have been replaced by straight artificial drainage ditches and are filling with vegetation.

The vegetation of the marshes grades upstream from grasses adapted to tolerate salt water, into reeds, cattails, and bulrushes characteristic of water with low salinity. As the gradation is irregular, it is not feasible to separate true tidal marsh from freshwater marsh by a line on the map. Consequently all swamps and marshes within the quadrangle are indicated by a single map convention.

The deposits of the tidal marshes consist of muddy peat and peaty mud, and form crudely wedge-shaped bodies that thicken seaward. Their seaward parts are underlain generally by estuarine mud, their landward parts generally by valley-train sediments or till. These relations indicate that the Connecticut coast has been undergoing gradual submergence by rise of sea level, subsidence of the land, or both. Rate of accumulation of tidal-marsh sediment at the western shore of Nells Island, Milford, was measured over a period of 3 years, and was found to average 8 mm per year (Bloom, 1967, p. 18-20).

Beach sand and gravel

Only about 2,300 ft of the coast within the map area consists of till or bedrock; the remainder is fringed with beaches consisting of sand, gravel, or both. The longest single stretch of beach, from Fort Trumbull to Milford Point, is more than 4 mi. in length. Beach development is related closely to erodibility of the local materials. Burwells Beach, lying between two small headlands of bedrock, is a narrow, crescent-shaped band fringing a cove. Where the coast consists of till, as at Gulf Beach, the beaches are longer. Where stratified drift is exposed along the coast, as between Milford Harbor and Milford Point, beach sand is virtually continuous.

The grain size of beach sediments likewise reflects the character of the materials locally exposed to the surf. Thus Gulf Beach, which fronts a bluff of till, consists partly of pebbles and cobbles, whereas Wildermere and Laurel Beaches, which front a low bluff of sandy outwash, consist largely of sand.

Part of Bayview Beach fronts only a tidal marsh. Probably, before the marsh was created, this beach formed first as a bar connecting two small promontories, at a time when the area shoreward of them was a shallow lagoon. A similar development is occurring today at Milford Point, a spit being built SW into the Housatonic estuary in prolongation of Laurel Beach. Here the river current and tidal movement will keep the estuary open.

The beach sediments rarely exceed a very few feet in thickness. They are maintained by a precarious balance between local erosion and deposition by surf and longshore currents, and are easily altered by the building of structures on the beaches themselves or on the points between them. This fact is being taken into account increasingly in the planning of construction programs, so as to protect what has become a valuable recreational asset. Efforts to counteract local erosion of beaches and to widen them for recreational use have included importation of sand for dumping on the beaches.

Although the surf has cut low cliffs in both stratified drift and till, no cliffs have been cut in the bedrock exposed along the shore. Indeed, smooth glaciated surfaces of bedrock at the shoreline testify to the almost total lack of erosion of bedrock by surf.

ARTIFICIAL FILL

Artificial fill consists of deposits made by human activity; these include railroad, road, and building-construction fills and large accumulations of trash. Much of the fill material mapped was obtained from areas close to the fill bodies, but some of it was brought from distance sources. The largest bodies of fill within the map area are those related to the Connecticut Turnpike, the parkways, the airport in Stratford, and large industrial plants along the Housatonic and Naugatuck Rivers.

In densely populated areas much of the surface material underlying streets, driveways, and lawns is fill. However, fill is mapped only where it is known or judged to be at least 5 ft thick and where it is large enough in area to be shown at the scale of the map. Areas of conspicuous artificial cutting that are continuous with areas of fill are mapped as fill.

WEATHERING, SOILS, AND POSSIBLE FROST EFFECTS

Where the contact between bedrock and overlying till is exposed, the surface of the bedrock is fresh and unweathered, just as it was left after glacial abrasion. However, in places where no till was deposited or where overlying till has been stripped away by erosion, the surface of the bedrock is slightly but noticeably weathered. Weathering takes the form of slight roughening, slight bleaching, or oxidation. Along joints these weathering changes extend downward well below the surface. This is the extent of local postglacial weathering in rocks.

In glacial drift and wind-blown sediments the most obvious effect of weathering is oxidation, which in most places is limited to a depth of 2 or 3 ft. Oxidation imparts a yellowish or brownish hue to the fine-grained particles in the drift and also forms rinds of limonite on boulders and small particles of diabase.

One of the seven large erratic boulders of diabase mentioned in a foregoing section is undergoing weathering in a peculiar manner. The boulder, 14 ft in longest diameter, lies on the shore, at low-tide sea level, at Morningside, and is indicated on plate 1. It is being exfoliated actively and conspicuously. As the other diabase boulders were brought from the same source rock, probably at the same time, but are not being weathered in this way, a special cause must be looked for. It can be suggested reasonably that the Morningside boulder, which is exposed to the surf continuously, is being weathered at an unusually fast rate because of its exposure to sea water. Salt water is chemically more reactive than rain water, and waves and tides cause frequent wetting and drying.

Within the thin zone of weathering, soils are developed. The Ansonia-Milford area lies within the region of Brown Podzolic soils of northeastern United States. Brown Podzolic soils are imperfectly developed Podzols characterized, in forested areas, by a thin gray leached zone beneath a thin mat of partly decomposed organic matter. These soils, having weakly developed profiles, are normally less than 30 in. thick. Within the map area there are a number of soil types, some of which have been discussed in a publication by Morgan (1930). As the quadrangle lies within a single zone of climate and vegetation, local differences among its soils must result mainly from differences in parent material, relief, and drainage. Of these factors parent material is believed to be the most important.

In a foregoing section the presence of a surface layer of wind-blown sand and silt, in places containing ventifacts, was mentioned. According to Denny (1936) the ventifacts have been moved from their original positions, probably by heaving caused by freeze and thaw, and some of them occur at depths that are probably greater than that reached by present-day frost penetration. He concluded that the frost heaving occurred while deglaciation was in progress and is a record of the cold climate of glacial time.

GLACIAL AND POSTGLACIAL HISTORY

Before glaciation of the region began, the principal valleys, ridges, and hills had already been shaped by long-continued erosion and except in detail, were similar to those of today. Probably the surface was mantled with a regolith developed by weathering of the underlying rocks.

Evidence from outside the area indicates that Connecticut was overrun by a sheet of glacier ice at least twice and possibly several times, during the last two or three million years. The glacial features of the area, in conjunction with those of the Mount Carmel quadrangle, imply two glacial movements rather closely related in time. Movement was almost directly S in the earlier one. In the later movement ice flowed across the area in a SW direction. Because evidence of glaciation is present on the highest hills as well as in the valleys, it is clear that when the glacier reached its maximum extent the area was completely buried beneath ice. The depth of the buried bedrock floor of the lower Housatonic Valley, more than 100 ft below sea level, indicates that the glacier had a minimum thickness of roughlv 750 ft in the map area. It could have exceeded that thickness by a wide margin. The cumulative effect of this and earlier glaciations was to smooth, round off, and generally streamline the hills and ridges and to smooth and widen some of the valleys.

In the Great Lakes region the combined evidence of till layers and radiocarbon dates indicates that a group of related glaciations occurred within the last 70,000 years or so and that the last major invasion culminated around 18,000 years ago. How the glacial movements in southern Connecticut are related in time to the glaciations recorded in the Great Lakes region is not known with certainty, but it seems likely that hills began to reappear from beneath the melting ice of the last invasion somewhat before 15,000 years ago. At least throughout a wide belt near the southern margin of the glacier, melting occurred to a large extent by general thinning of the ice body.

Within this belt thickness was reduced so much that the ice near the outer margin of the glacier ceased to flow and became inert. Thinning exposed the highest hills and then progressively the lower hills, while tongues and detached masses of ice remained in the valleys. Streams of meltwater flowed between the margins of such ice bodies and the adjacent valley sides and built up high embankments of sand and gravel. In many places coverings of stratified drift completely buried residual ice masses. In this way the valley trains were built up, their downstream parts deposited in a zone that had become entirely ice free. The distribution of ice-contact features in the valley of Mill River, east of the map area, suggests that the zone of separated bodies of residual ice was at least 6 mi. wide.

The Lordship outwash body was the first to form. While it was being built up by meltwater the margin of the glacier probably lay close to the northern edge of that body, trending ENE, south of the present shoreline. The Milford valley train began to form next, accompanied or soon followed by early phases of the Stratford, Wepawaug, Indian River, and Oyster River valley trains. These continued to function long after the Milford valley train had ceased to be active. In the region south of the present coast they merged into a single valley train, joining a massive body of outwash being built by SW-flowing meltwater that had emerged from the Quinnipiac and other valleys in the adjacent New Haven area. At that time the sea stood far below its present level, and most or all of Long Island Sound was land.

As deglaciation progressed northward, the Oyster River, Indian River, and Wepawaug valley trains ceased to function, in that order, leaving only the Housatonic and Naugatuck valleys as avenues of meltwater discharge. When the margin of continuous ice in the Housatonic Valley had migrated as far north as the site of Fowler Island, the head, or upstream end, of outwash deposition progressed no farther north. In the northern part of the map area only ice-contact stratified drift is exposed above the river surface, indicating that ice was present throughout the period of deposition of the exposed drift. Any further outwash, derived from melting ice upstream beyond the Ansonia quadrangle, could have been built in this area only after the streams had cut down into their deposits, lowering their beds to positions below present sea level.

During the period of activity of meltwater streams in all parts of the area, sand and silt were blown from valley floors and were spread as a very thin, discontinuous blanket over adjacent slopes. Probably this activity was brought to an end by the establishment of a continuous cover of vegetation over valley floors, first in the smaller valleys and last of all along the Housatonic and Naugatuck, where deposition of stratified drift continued long after it had ceased elsewhere. By analogy with other parts of Connecticut, the vegetaion was first tundra, soon changing to spruce forest, and was thus still quite different from that of today.

With the disappearance of their extraordinary glacial sources of abundant sediment the rivers of the area became relatively underloaded, assumed the single-channel habit they have today, and began to dissect the valley trains. This resulted in stream terraces, and in valley floors cut into ice-contact stratified drift and outwash sediments, and covered with thin veneers of alluvium deposited from the bed loads of the rivers. The vegetation evolved from predominantly coniferous forest to the mixed deciduous forest characteristic of the region at present. The climate became warmer, but with fluctuations.

From its very low position at the time of maximum extent of the glacier, sea level gradually rose as meltwater returned through streams to the sea. By about 5,900 years ago the sea had risen, relative to the land, to a position about 26 ft below present mean sea level, as shown by a series of radiocarbon dates on wood and peat from beneath estuarine mud at several places along the Connecticut coast (Bloom and Stuiver, 1963).

Throughout postglacial time the existing soils were forming and developing beneath the surface, under a cover of largely forest vegetation. The youngest soils are those on postglacial terraces and on alluvium bordering the streams. The accumulation of peat in swamps and the postglacial return of forests have altered the landscape appreciably, but the deforestation, cultivation, and construction of various kinds brought about by man constitute changes that are even more conspicuous.

When settlement of coastal Connecticut by European people began in the 17th century, all the land within the map area, with the exception of tidal marshes, some other marshes, and some patches of bare rock, was forest. Today about half of the area consists of woodland. The Podzolic character of the local soils reflects the influence of the forest cover.

ECONOMIC GEOLOGY

Sand and gravel

Although much of the area of the towns of Milford and Stratford is underlain by the sand and gravel of various outwash bodies, there is little production of this much-needed resource because most of the area is densely settled. Only a few large pits, all on the Housatonic River, remain. These include the Carten and Beard Pits in Milford, the Grasso pit in Shelton, and the Beard operation in the river bed at Twomile Island. As a rule, ice-contact stratified drift is a less desirable source of sand and gravel than outwash is, because of the common presence of cobbles and boulders, including many of very large size. A few smaller pits are operating in such material, at least intermittently. The overall supply, apart from what can be recovered from the beds of the two major rivers, is dwindling rapidly, and imports and substitutes are likely to find increasing favor.

Landfill

The material most commonly used as artificial fill is till, because it is relatively abundant and because it contains a variety of grain sizes, including silt and clay, which promotes compaction. Ordinarily pits are created as fill is needed, at localities close to the areas to be filled, and are abandoned as filling is completed. The supply of till is still extensive, particularly in the eastern half of the map area where the till cover is both thicker and freer of large boulders than it is in the western half. Ice-contact stratified drift also can be used as fill for many purposes.

Swamp and marsh deposits

The organic deposits in swamps and non-tidal marshes within the map area are potential sources of garden humus. However, as most of the bodies are small in area and probably also in thickness, it is doubtful whether economic development is feasible.

Ground water

Various bodies of stratified drift within the Ansonia-Milford area constitute potential sources of ground water for domestic use or for small industrial plants. However, because they consist of sand and gravel, they are very permeable, and the water table is generally low (in many places 25 ft or more below the surface), and rather closely adjusted to the level of tidewater or to that of the nearest surface stream. In consequence, the development of a reliable water supply from such material depends on thickness of the sediment in the zone below the water table. This is a matter for local investigation in each case.

Till is generally too thin and in some places too impermeable to be a source of water other than for shallow wells of low yield. Most users of water within the map area prefer to derive their supplies either from surface reservoirs or from wells drilled into bedrock.

Discussions of ground-water problems pertinent to the Ansonia-Milford area are contained in reports by Gregory (1909) and by Brown (1925).

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The price of this report (including the two quadrangle maps) is $1.00 (maps alone at 25¢ each). Copies may be ordered from the State Librarian, State Library, Hartford, Connecticut 06115 (postpaid; Connecticut residents must add 3½ percent sales tax). Like all publications of the Connecticut Geological and Natural History Survey, one copy is available, free of charge, to any public official, exchange library, scientist, or teacher who indicates to the State Librarian, under official letterhead, that it is required for professional work. The *List of Publications* of the Survey is also available from the State Librarian on request.